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Project

STATUS REPORT

(NORTHERN REGION)

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English

NARP

STATUS REPORT

Northern Zone

Vol. I

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Northern zone

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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 the regional research stations in the different agroclimatic zones in terms of research manpower and infrastructure facilities was the essential feature of the NARP. The eligilibility of the Kerala Agricultural University to the project was approved by the ICAR in May, 1980. The project has completed its first phase in all the five agroclimatic zones of the state. The second phase of the project was launched in March, 1989.

The essential pre-requisite for starting the NARP is the preparation of the Staus 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 Staus 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 collectiong the details and pruning the information to the present form. I congratulate them for their sincere and devoted efforts.

PREFACE

The first Status Reports of all the Five Agroclimatic 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 1983 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, Agroecological 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. Considera ble 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.

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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 one of the small states in India with a geographical area of 38862 km, 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 streams and rivers 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 catchment 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.

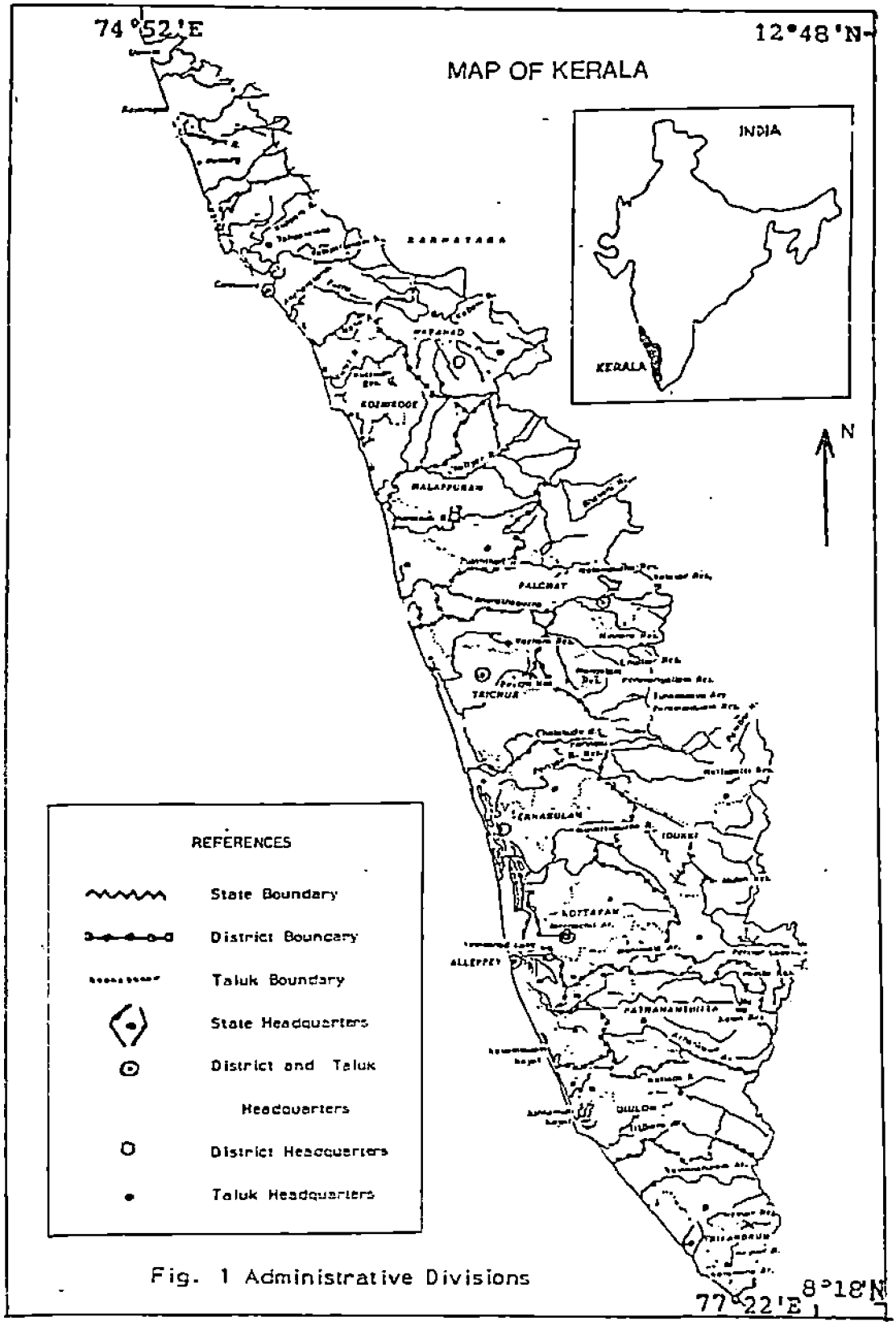


Fig. 1 Administrative Divisions

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 (2960 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 a Aramboli, Kumali, Kambam, Thevaram, Bodinaikannur Karkken, 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 lives 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 valleys 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

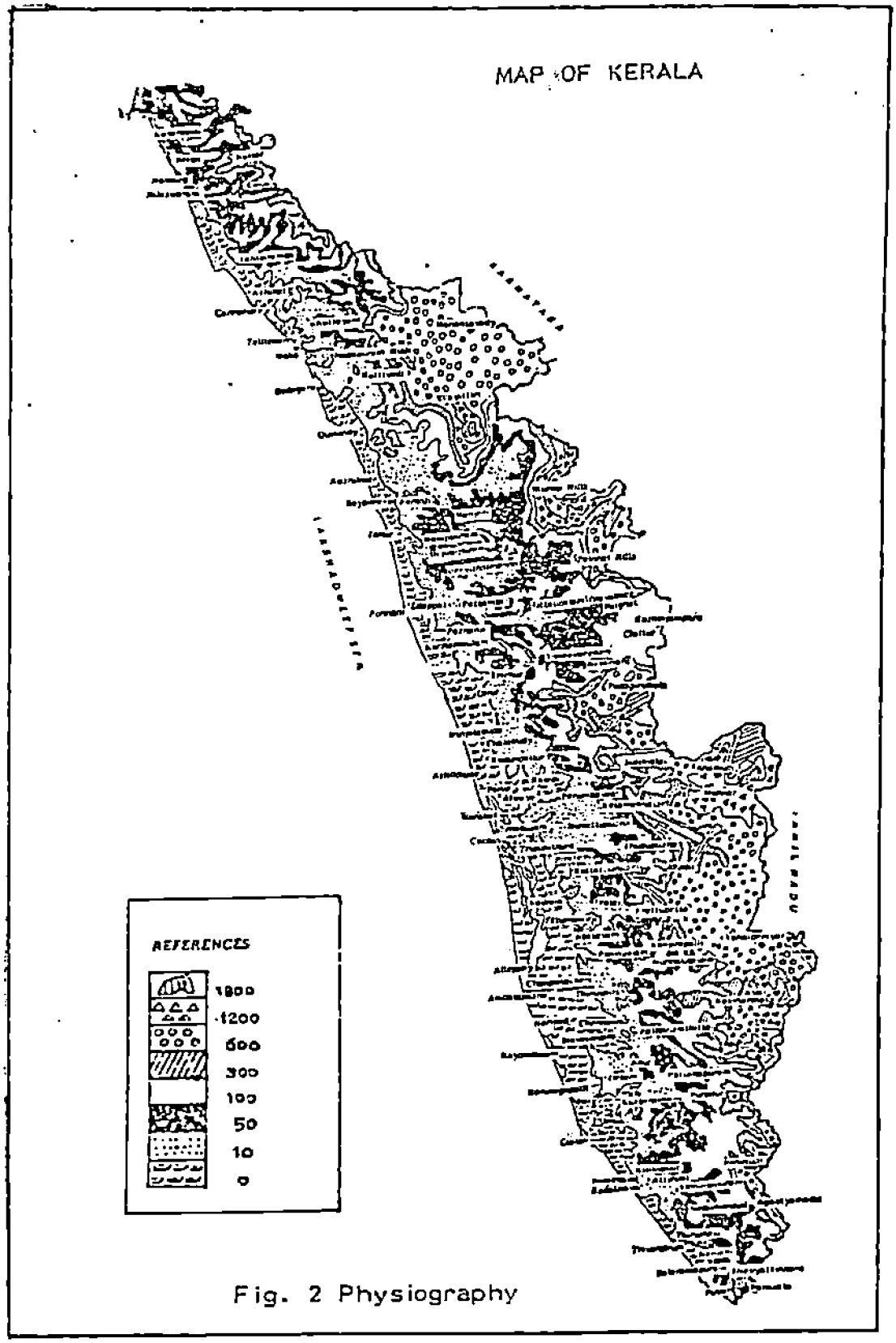


Fig. 2 Physiography

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 pliocene) 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 granitiferous ferruginous quartzites, mica, talc, schists etc. and 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 quartz orthoclase, mica and hornblende. Charnockite and leptynites are the most common gneisses in this area.

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 instrusive relationship with peninsular gneiss. They are highly granitiferous as compared to the charnockites of north Kerala where granite is absent.

v. Closepet granite

Archaean intrusions of post charnockite age are found

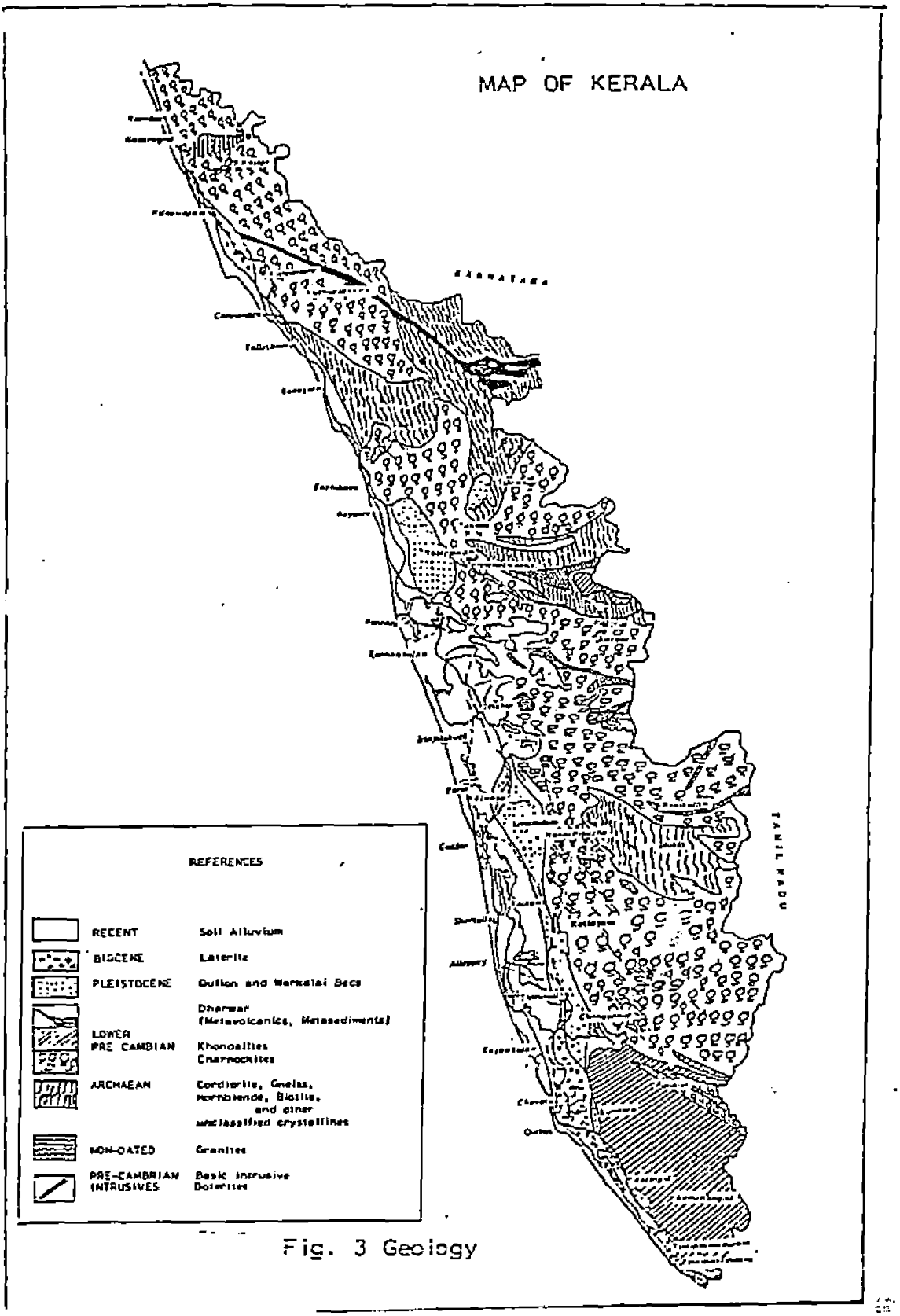


Fig. 3 Geology

in Malabar region. The two intrusions of biotite-granite found in Kalpetta hills and Sultan's Battery, have strong resemblance to the Dornegneiss 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 preserve 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 varigated 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 dominent factors of soil formation. On the basis of the morphological features and

Table-1 Soil types of Kerala and their taxonomic classification

Soil types	Order	Suborder	Great Soil group
Red loam	Alfisol	Udalf	Tropudalf
Laterite	Oxisol	Orthox	Eutrorthox
Coastal alluvium	Entisol	Psamment	Tropopsament
Riverine allunium	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	Tropudalf

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

physicochemical 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 1.

Red Loam

Red loams of Kerala are localised in occurrence and are found mostly in the southern parts of Trivandrum district. These soils occur in catenary sequence along with laterites

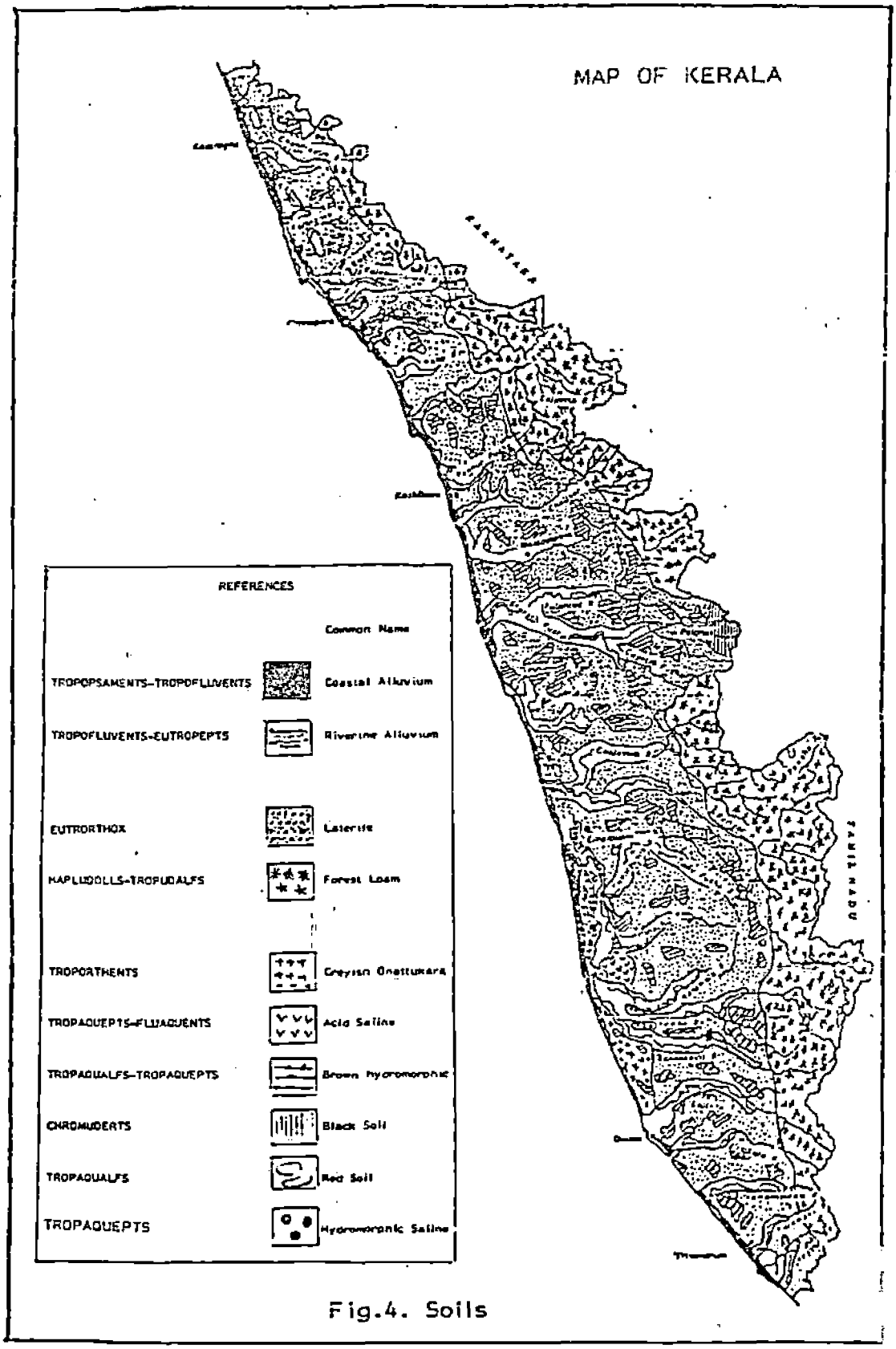

MAP OF KERALA
KARNATAKA
TAMIL NADU
REFERENCES
Common Name
TROPOPSAMENTS–TROPOFLUVENTS
Coastal Alluvium
TROPOFLUVENTS–EUTROPEPTS
Riverine Alluvium
EUTRORTHOX
Laterite
HAPLUDOLLS–TROPUDALFS
Forest Loam
TROPORTHENTS
Greyish Onattukara
TROPAQUEPTS–FLUAQUENTS
Acid Saline
TROPAQUALFS–TROPAQUEPTS
Brown hydromorphic
CHROMUDERTS
Black Soil
TROPAQUALFS
Red Soil
TROPAQUEPTS
Hydromorphic Saline

Fig.4. Soils

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

Laterite

Laterites of Kerala are typical kaolinitic weathering products of gneissic and granitic rocks developed under humid tropical conditions. Heavy rainfall and high temperature prevalent in the state are 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. It 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. and 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.

Reverine 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 gley 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, Tricnur 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 . 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 15m mhos/cm . 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) soils come under this category..

The Kuttanad region covering about 875 km^2 is a 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 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) phosphrous 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

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	16,000
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.

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.

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 concentration 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

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-	-
Myladumpara	Indian Cardamom Research Institute	3,500
Puthupally	Rubber Research Institute of India, Kottayam	2,000
-do- (Mobile)	-do-	3,000
Udyogamandal	FACT	30,000
-do- (Mobile)	-do-	10,000
Vandiperiyar	UPASI Tea Research SubStation	2,000

Source: Fertilizer Association of India.

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 1.4 lakh tonnes and assuming the same rate of growth experienced during the last 25 years, the consumption by 2000 AD is predicted to be 2.56 lakh tonnes (Table 4). The cropwise fertilizer 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

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.

coconut) the requirement of K_2O is more and hence the ratio suggests the lack of application of fertilizers at the recommended rate.

1.4 Climate

The state of Kerala falls under perhumid 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

Table-5 Projected (potential) fertilizer requirement of crops in Kerala (1983-'84) assuming 100 per cent adoption of reccommended does of fertilizers (in '000 tonnes)

Crop	N	P_2O_5	K_2O	Total
Rice	44.4	22.2	22.2	88.8
Coconut	60.7	38.9	146.0	245.6
Rubber	24.4	24.4	24.4	73.2
Tapioca	11.7	11.7	11.7	35.1
Cashew	5.4	2.7	2.7	10.8
Pepper	11.7	4.7	16.3	32.7
Coffee	6.8	4.6	6.2	17.6
Arecanut	8.2	3.3	11.4	22.9
Cardamom	4.1	4.1	8.2	16.4
Banana and Plantains	7.4	7.4	14.8	29.6
Pulses	0.6	0.9	0.3	1.8
Cocoa	0.6	0.3	0.9	1.8
Vegetables	3.1	1.6	1.6	6.3
Sesamum	0.4	0.2	0.4	1.0
Ginger	1.1	0.7	0.7	2.5
Groudnut	0.1	0.7	0.7	1.5
Sugercane	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

Sourse: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 Agri.Chemistry,College of Horticulture,Kerala Agricultural Universly,Vellanikkara.

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

Sl.No.	Criteria	MAR	Symbol
1.	6 or more months with MAI in the 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 of 0.99 - 1.33	Humid	D
5.	5 or more consucetive 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

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 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 minimun (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

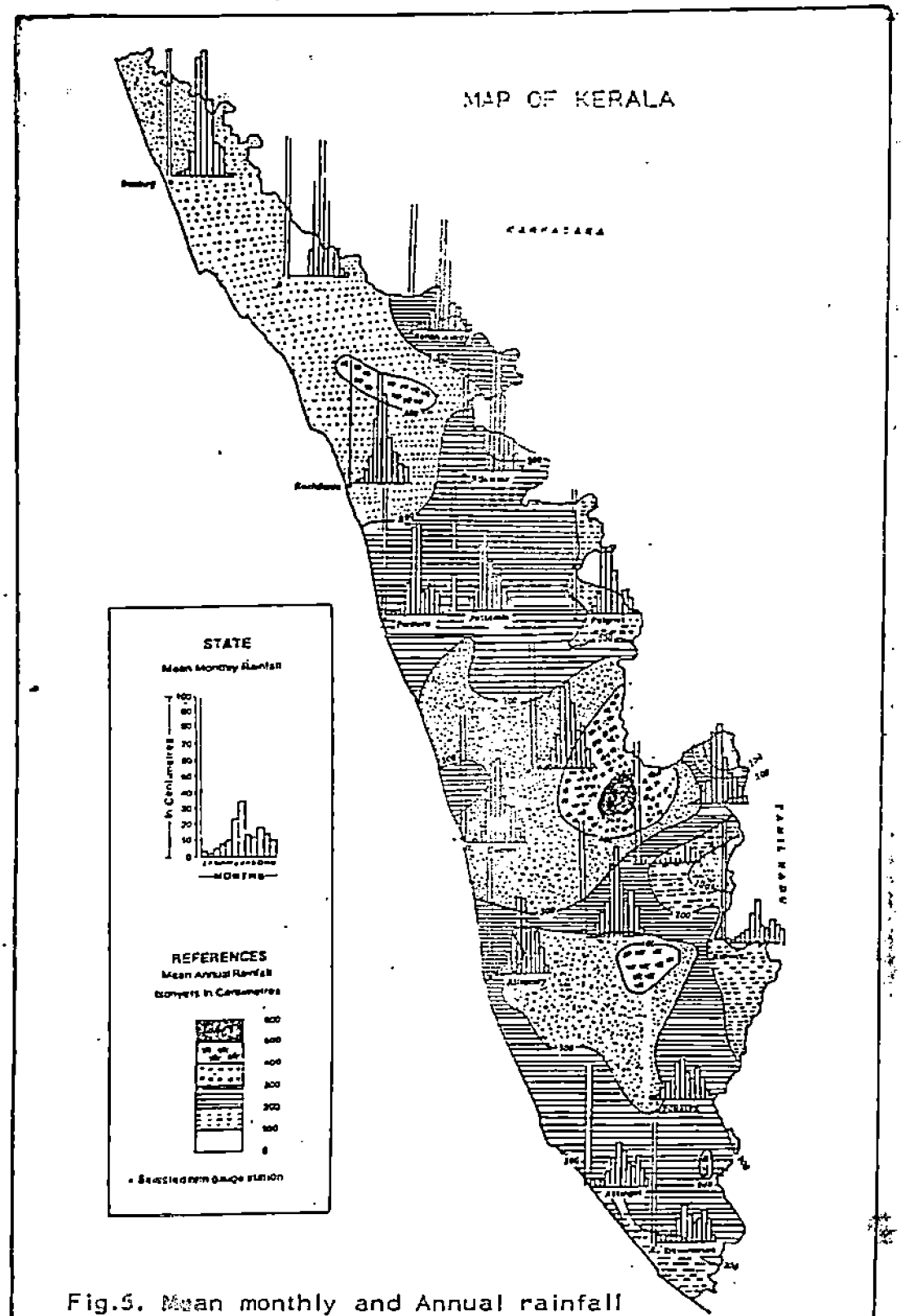


Fig.5. Mean monthly and Annual rainfall

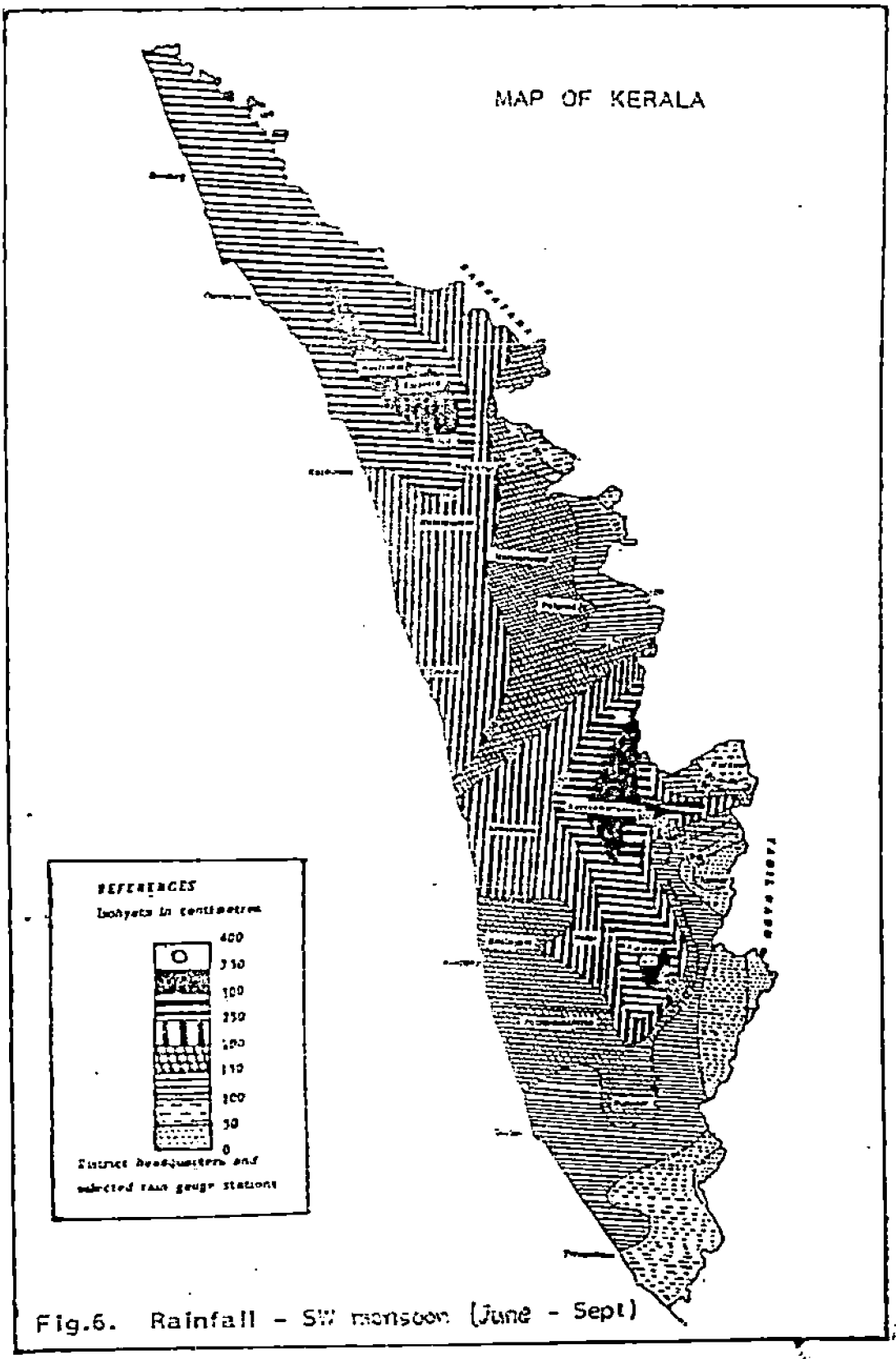


Fig.6. Rainfall - SW monsoon (June - Sept)

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 Cannnore 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 tempature

The mean annual temperature varies from 25.4°C to 31.0°C in the Central part of Kerala (Fig.10). 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 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 the yearclear or party 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, Palgnat experience easterly and westerly winds due to covering effect of the Gap. Westerly and north westerly winds are noticed in Cochin and Alleppey (Fig.11). In general, easterly and north easterly winds

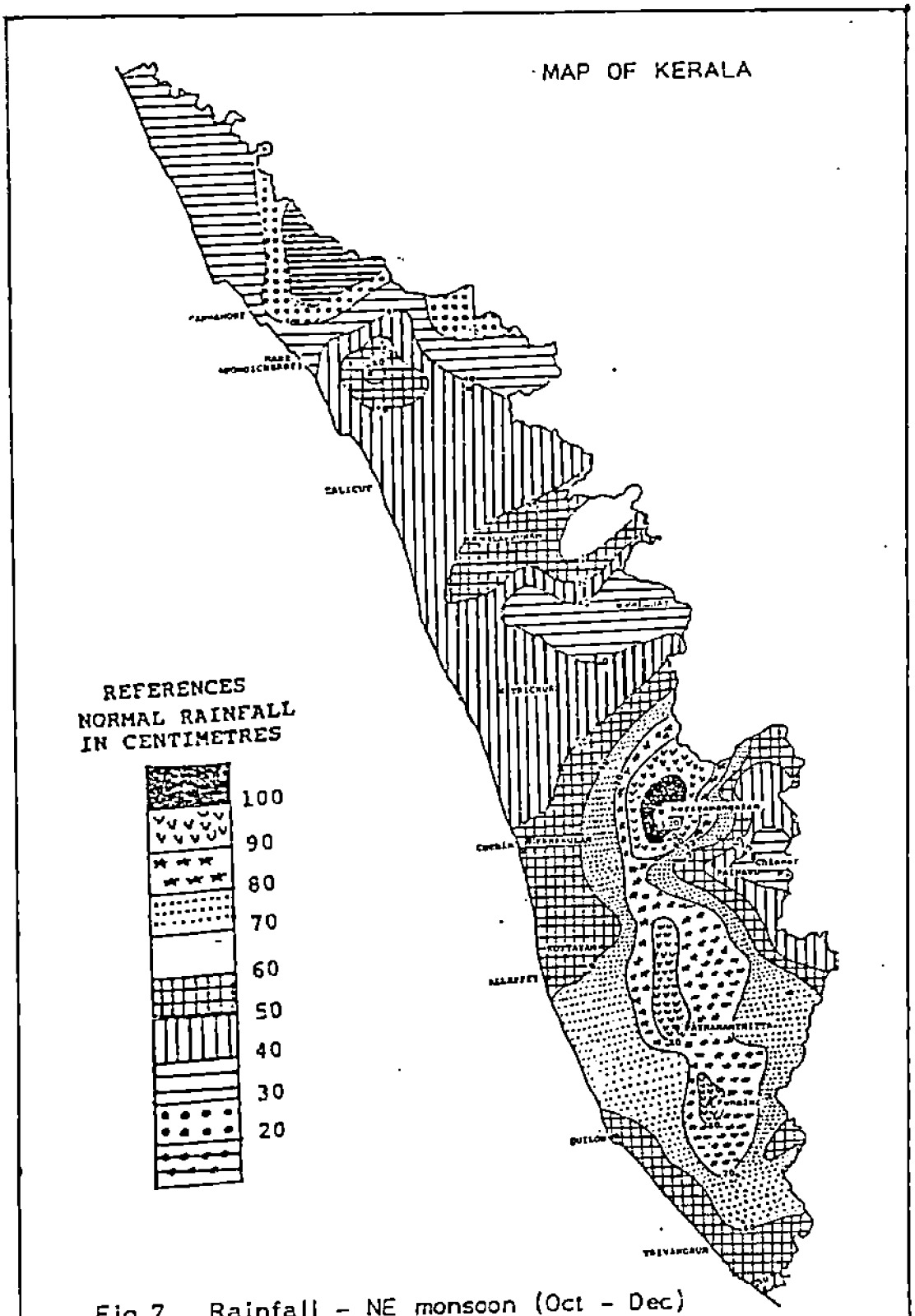


Fig.7. Rainfall - NE monsoon (Oct - Dec)

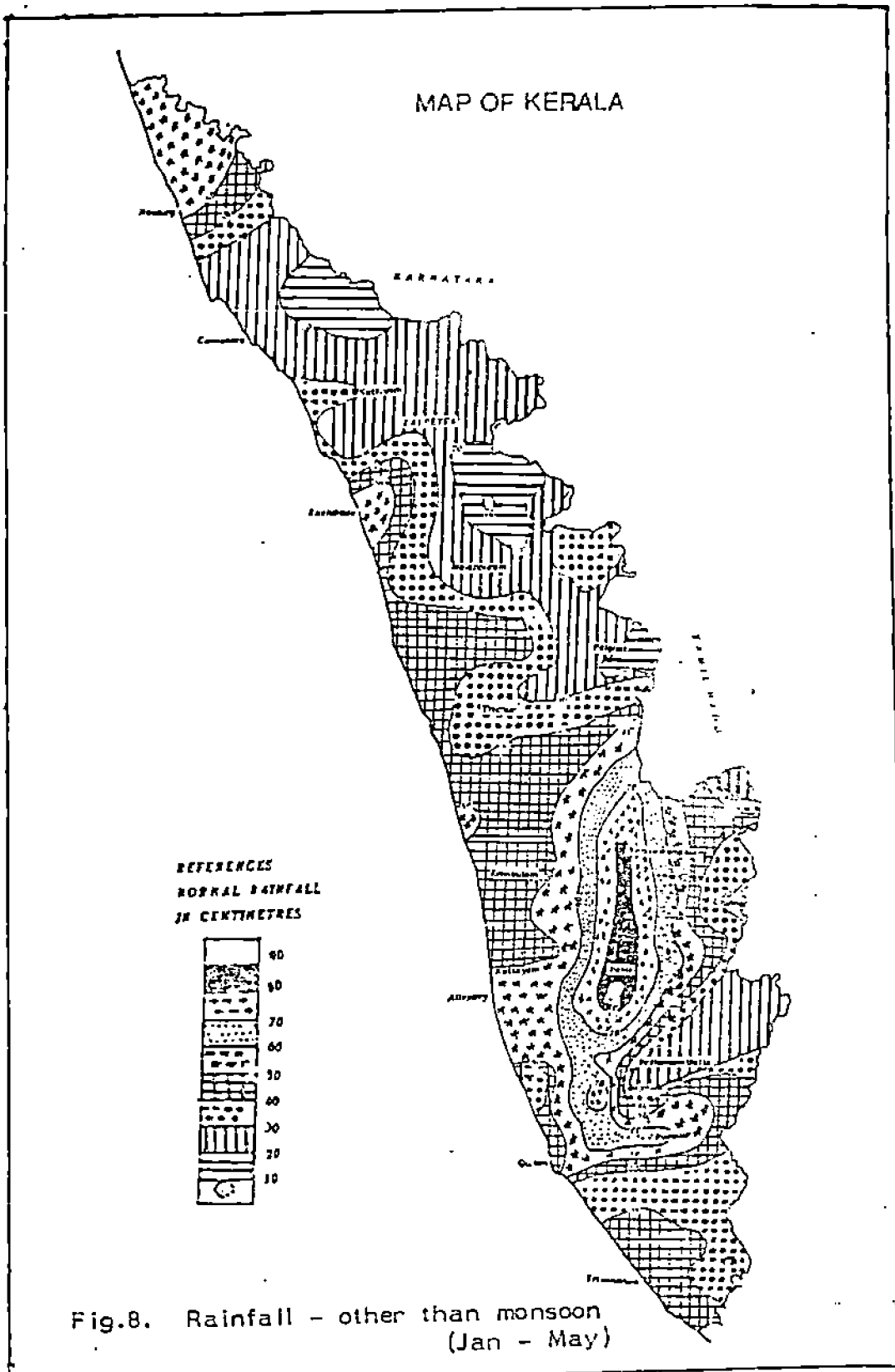


Fig.8. Rainfall - other than monsoon (Jan - May)

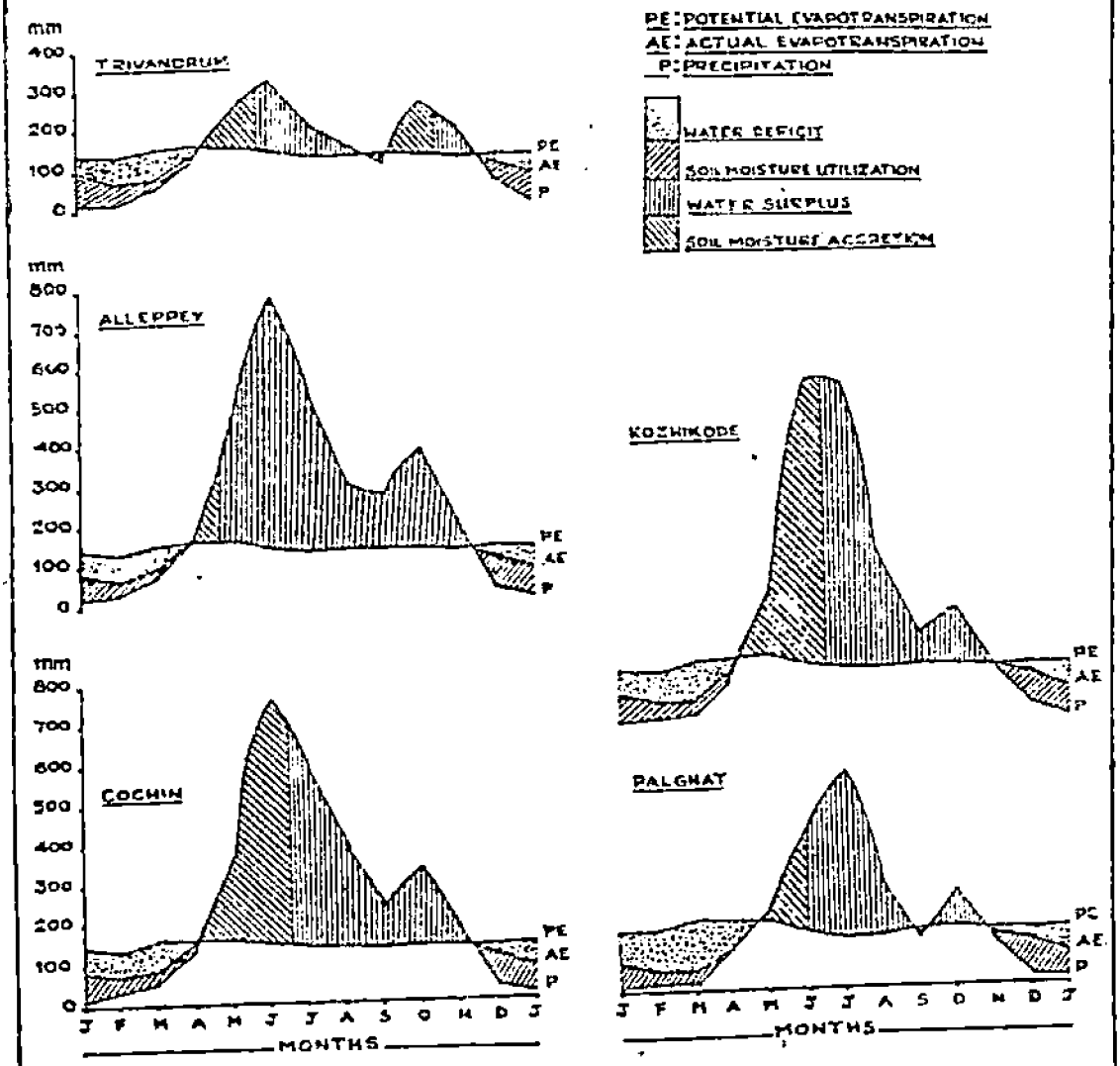


Fig.9. Climatic water balances of Kerala

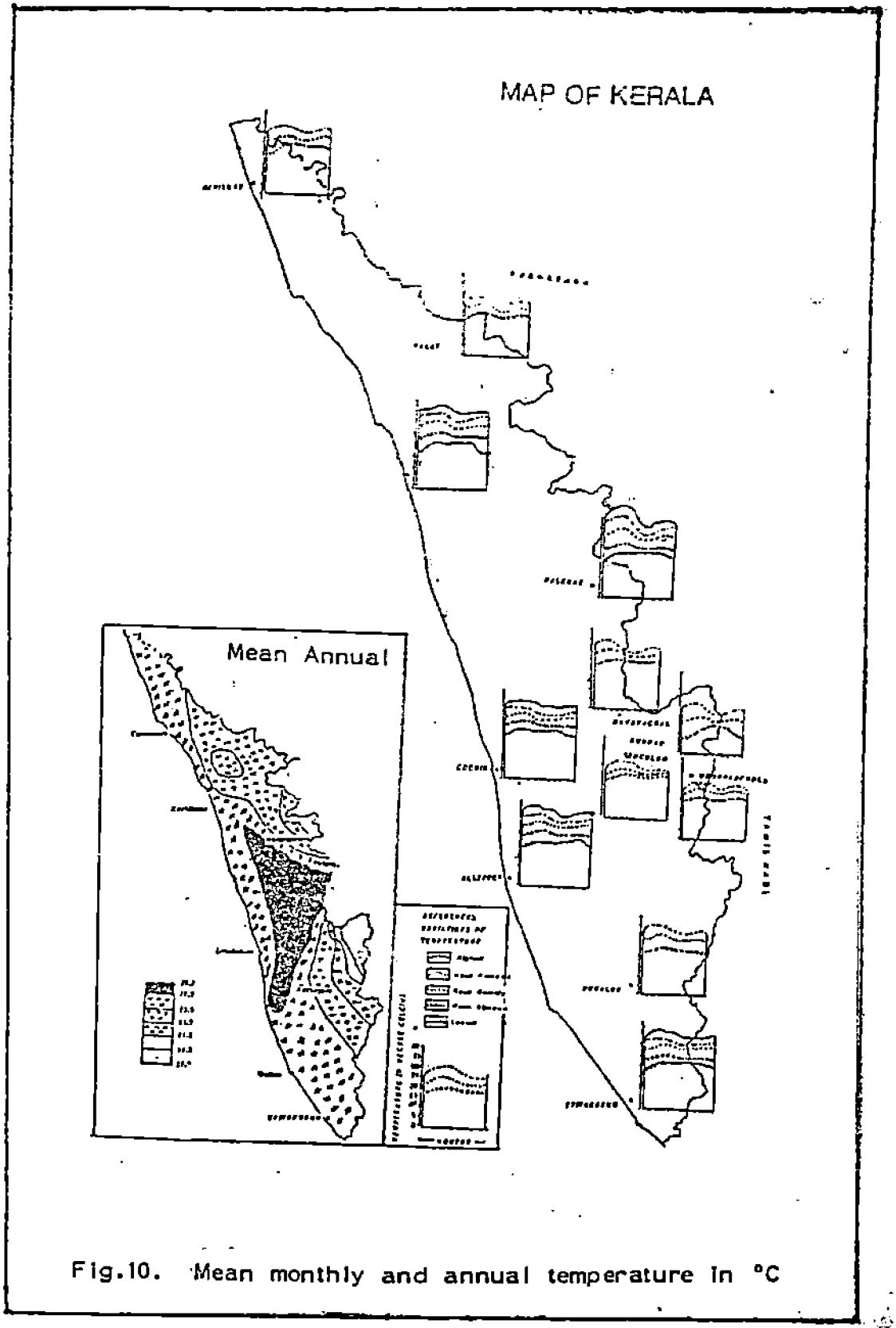


Fig.10. Mean monthly and annual temperature in °C

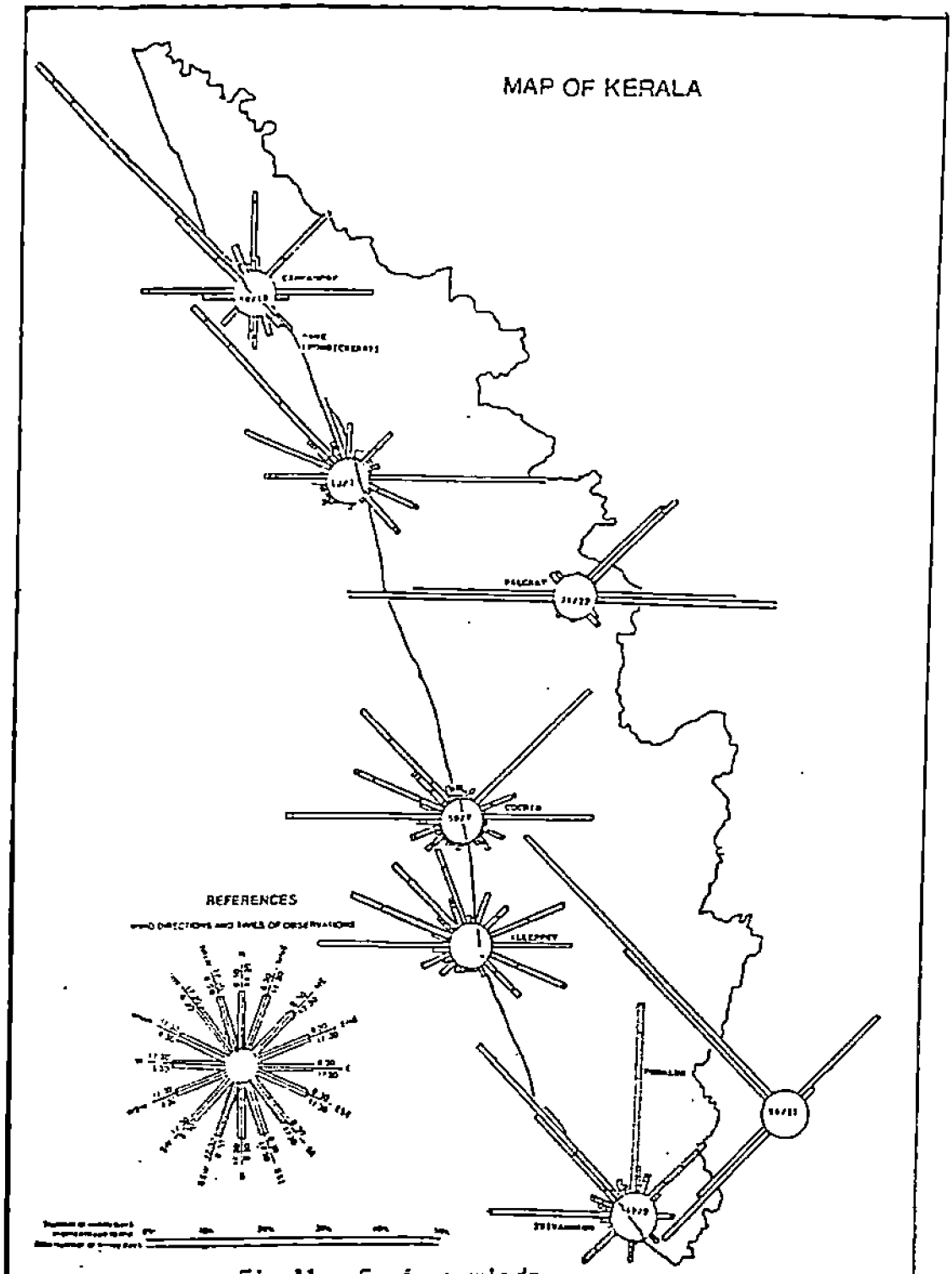


Fig.11. Surface winds

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, 4.5 mm at Trivandrum and 5.8 mm at Ollukkara and Pattambi. The pan evaporation is less than 3 mm/ day during the South West monsoon and starts increasing from October onwards 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 4h./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 croped 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 lands, land under miscellaneous tree crops, cultivable waste, fallow other than current fallow, and current

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	83-4	84-85
Total Geographical are 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 Statistics1975.

2 Economic Review 1985, State Planning Board, Trivandrum.

3 Progress of Kerala in three decades 1956 - 1985, Department of Economics and Statistics, Trivandrum.

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 past 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.

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.

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. 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. The distribution pattern of rain fall in

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 lands	1.17	0.73	0.13	0.10
Land under miscellaneous tree crops	5.29	3.24	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	50.0
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.

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 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.

1.6.2. Irrigation potential

According to the study of the Planning Commission, the irrigation potential of Kerala was estimated as 2.5 million 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 per cent 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 which are potential ground water resources. 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 designs were given for 686 open irrigation wells, 869 tube/bore wells and 233 shallow bore wells to a depth of 60 m. in various parts of the state. 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)

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 and a coastline interspersed with backwaters.

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	—	159357

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 tota! inland water route in India. This can be categorised under the following three main heads: viz., 1) 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 carrying about 60 per cent of the total tonnage of cargo transported by inland water ways. 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 langth 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 aggregage length of navigable backwaters is approcimately 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 regions, 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 suggeted 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 km^2 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 83.76in 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.

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

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

Scheme	Fifth plan Outlay 1974-1979 (in million rupees)	Out lay proposed 1978-1983 (in million) rupees)
Direction & Administration		
i) Establishment of Dredger Organisation (PWD).	-	25.00
Assistance to Transport Services		
i) Completion of existing & 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) c) Equipment and Workshops d) Training of Staff	1.60	9.90
iii) Ferry Service of the KSRTC		
a) Acquisition of fleet	—	7.50
b) Workshop 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 routs operated by the SWT Department		
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.

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: Economics Review, 1985. Directorate of Economics and Statistics.

consisting 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

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 conducted in 1980, about 18 per cent of the labour force numbering 14 lakhs were chronically unemployed. Annexure 23 shows the educational status. There were 2.98 lakh of students studying in high schools and 2.98 lakh in Arts and Science Colleges in 1984-'85. The Students' statistics for 1983-'84 and 1984-'85 in 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 35.66 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 institutiions 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 census, the total number of operational holdings was 41,80,900 and the total area operated became 18,05,300 ha. Between these two census 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.

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-medium (between 2 and 4 ha)	2.96	14.00	2.68	2.76
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.

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 percentge 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, banana 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.

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 its 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, redgram 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/oilseeds/sweet potato
3. Rice-banana/tapioca
4. Rice-rice-fallow

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

1. Rice based farming system
2. Coconut based farming system
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 wide 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 agroecological 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.

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	667
	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
Cofee	Area	N.A	58	64	N.A
	Production	18	24	43	24
	Productivity	N.A	406	672	N.A.

Note:- * Figures for 1985-'86 are provisional
** Million nuts
*** Nuts/ha

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

iv. High cost, low labour productivity and constant labour problems make cultivation less remunerative.

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

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 0.6 kg nitrogen, 1.7 kg phosphorus and 2.3 kg potash per hectare for traditional varieties of rice. The recommended doses of fertilizers for HYV and local varieties 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) exploiting ground water resources for irrigation.

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

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 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 3,439 million nuts while in 1984'85 it was 3,435 million nuts. Productivity has increased from 4,963 nuts/ha to 5,023 nuts/ha. 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 lands, inadequate input usage, unscientific underplanting 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 centof 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.

There are only two distinct varieties in coconut, the tall and the dwarf. The tall, popularly known as West Coast Tall (WCT) occupies most of the area. The dwarf variety is not cultivated commercially. The hybrids involving tall and dwrf as parents are popular with the farmers but they occupy only a small area at present. Root (wilt) diseas 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 16000 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.12) 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

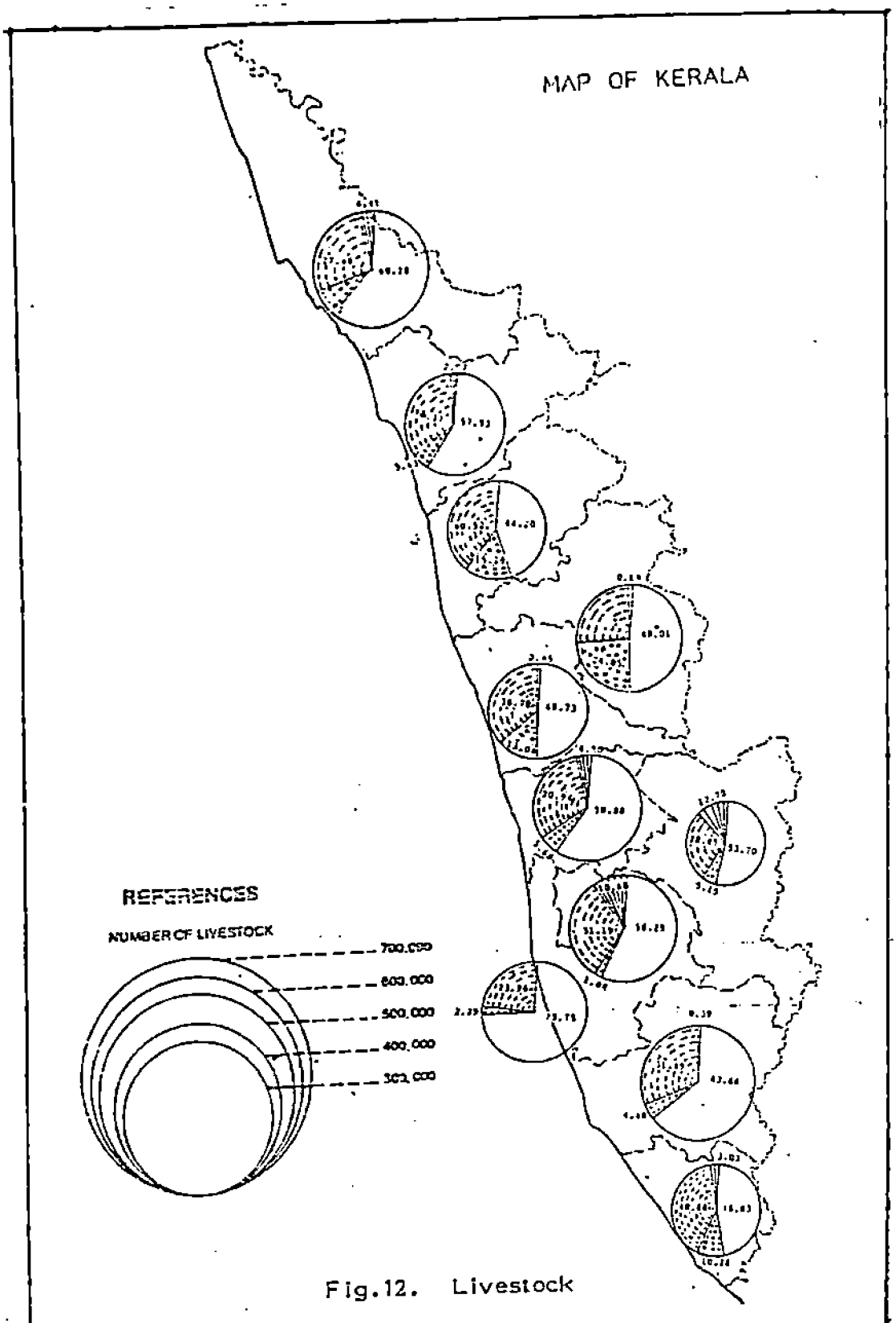


Fig.12. Livestock

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	Wyand
Ducks	Alleppey	Wynad
Total livestock	Quilon	Wynad
Total poultry	Malappuram	Wynad

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

Species	Districts with	
	Higest density	Lowest density
Cattle	Alleppey	Idukki
Buffaloes	Palghat	Idukki
Goats	Trivandrum	Idukki
Pigs	Kottayam	---
Total livestock	Allepey	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 Annexure 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 a very high density of cattle and ducks. 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.

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

Table - 20: Districts with the highest and the lowest percentage 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

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 percent) 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 of 150.83 lakh (Annexure 42). The poultry population has been steadily increasing and there was an increase of 12.66 per cent during 1977-'82 period. It is seen that density of fowls varied from 732 to 110 between districts while that of ducks varied from 109 to 1, with the State average 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

1. 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 contribution from cows, buffaloes and goats towards the total milk produced, it is seen that cows have increased their share from 80.2 per cent to 83.1 per cent betwen 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 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

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 km^2 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, 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 India's coast line and 0.7 per cent of India's land area. There are 416 fishing villages, of which 249 are marine. About 35,076 fishing boats are operated including both

mechanised and nonmechanised. Of the total Kerala fishermen population, 6,02,467 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 house . 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.

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 machanised sector had reached its peak.

During the second phase from 1978 to 1983-'84 the State

Table 21: Religion-wise distribution (in percentage) of fishermen in Kerala

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

Table 22: Percentage distribution of income groups of fishermen

Income groups (Rs. per annum)	Percentage of household
Below 500	11.7
Between 500 and 100	38.8
Between 1000 and 2000	38.6
Between 2000 and 3000	7.8
Above 3000	3.1

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 arefive 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 fisn 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, Parappanangadi, 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 Cannanore, 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 Mallippuram, 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. (Acquaculture) 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 Vallarapadam.

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 brackishwater 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 fed 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 give in Annexure 53.

1.11. Farm Implements and Machinery

At present in Kerala the homestead system of cultivation with a combination of penrennial 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 400in 1966 to 2200 in 1980 and 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. Kasaragod, Cannanore, Calicut and Malappuram with 12 taluks, 39 development blocks and 295 panchayats with a total geographical area of 10,94,600 ha, covering 28.2 per cent of the area of the State. The total population of the zone is 74.4 lakhs (1981 census) 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 popultion 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 3379 mm. 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 groth 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 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 vz. 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 973659 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 betwen 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 otner 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. Out of the 12 lakh operational holdings, 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 are 36.76°C and 21.15°C, respectively. The soils are lateritic, the

texture ranging from sandy 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 Peringammala, Aryanad and Vithura panchayats of Nedumangad taluk and Kallikkad and Amboori panchayats of Neyyattinkara 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 figures of the two disticts, viz., Wynad and Idukki are given separetely.

i. 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 2,13,200 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, charaterised 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.

ii. 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 i.e. 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 occupation 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 Devicolam 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 granary 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 group 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 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-'81. 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 Febrauary 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 areunder 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 30-12-'75. Experiments were started under AICRP in January 1977. The station islocated at Kallungal (Nedumpuram

Panchayat) on the bank of the Manimala river, 6 km south of Thiruvella 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 88.91 ha and with a paddy area of 75.238 ha. The Centre is located 10 km away from Ambalapuzha on the Ambalapuzha-Thakazhi road. The soil of the padasekharam is alluvial kari soil with high content of organic mater. 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 aspect 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 (68 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 ruber, 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 conditiions 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 mandate 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 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 overy 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 sideof 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 324 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 pineapople research was shifted to Vellanikkara in an area of 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 thestation 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-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 plaes 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 thorugh 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 ofthe 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 intercroping, 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. Regioinal Agricultural Research Station, Ambalavayal

The research station was established in 1946 as partof Wynad Colonisation Scheme to carry out research on various aspects of improvement of agriculture in Wynad, to make available quality seeds and planting materals 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, other fruits, paddy based farming systems and verification function for pepper, essential oils and medicinal plants.

The station is situated in Sultan's Battery Taluk of Wyand district an an elevation of 914 m above MSL and has an area of 87.3 ha. The geographic location is at 11°37'N latitude and 76°12'E longitude. The soil is loam, rich in humus.

21) Cardamom Research Station, Pampadumpara

The Cardamom Research Station, Pampadumpara was started in the year 1956 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 Ithe Idukki district 35 km 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 46.44 ha.

1.13.2. Research Stations under the Faculty of Veterinary and Animal Sciences

1) Livestock Research Station, Thiruvazhamkunnu

The farm was originally established in 1950 by the 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 84.37 ha is under fodder crops. The major objective of this station is to conduct research work on scientific breding of livestock 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 inseminat ion, 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 fodderproduction 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 (0.43 ha) available at Panangad, an Instructional Farm of 101 ha has also been established at Puduveypu. At Panangad 3.5 ha of private land has been taken on lease for prawn cultivation.

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	63.64
12	Aromatic & 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 Agrl.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 Statoin, Thiruvazhamkunnu	163.30
23	Cattle Breeding Farm, Thumburmuzhy	25.20
24	University Livestock Farm, Mannuthy	69.00
25	University Poultry and Duck Farm, Mannuthy	0.50
26	Pig Breeding Farm, Mannuthy	4.20
c)	FACULTY OF FISHERIES	
27	Instructional Farm, Puduveypu	101.00
	Total area under all the above farms	978.42
	Area under KAU Estate	391.43
	Total area under KAU	1369.85

CHAPTER - II

GENERAL AGRICULTURAL CHARACTERISTICS OF THE ZONE

2.1. Delineation and general description

The northern zone consisting of the 4 northern districts of Kerala viz., Malappuram, Kozhikode, Cannanore and Kasaragod is a long narrow strip of land located between 10°30' and 12°48' north latitudes and 74°52' and 76°30' east longitudes (Fig.13). It lies sandwitched between the western ghats in the east and the Arabian sea in the west. It has a coastal line of 293 km. The geographical area of the zone is 10,895 sq.km which is 28.27 per cent of the total area of the State.

The zone supports a human population of 74.5 lakhs according to 1981 census. This is 28.27 per cent of the population of Kerala (Table 24). Kozhikode leads the other 3 districts in the density of population (957 per sq.km). The percentage literacy of the zone is 62.9 as against 69.2 of the state. Cannanore has the highest literacy (70.4 per cent) among the 4 districts.

2.2. Physiography

The physical configuration of the zone is singularly diversified. From the forest-clad western ghats the land undulates to the west presenting a series of hills and valleys intersected by rivers and streams. The narrow western portion of the zone close to the Arabian sea is more or less flat. Numerous small lakes and back waters adorn this narrow coastal belt. Thus there are 4 natural divisions in the zone (Fig.14) which are popularly called as 'the low land' (-2.0 m - 7.5 m MSL), 'the mid land' (7.5 m - 75.0 m above MSL), 'the high land' (75 m - 750 m above MSL) and the 'high ranges' (above 750 m MSL).

The high land lies mainly on the western slope of the western ghats, with a geographical area of 300 sq.km. Its upper reaches are occupied by forests and the lower by plantation crops like rubber. The tracts above 750 m above MSL account for about 251 sq.km.

The low land running along the sea coast has geographical area of 4000 sq.km. It is almost level in

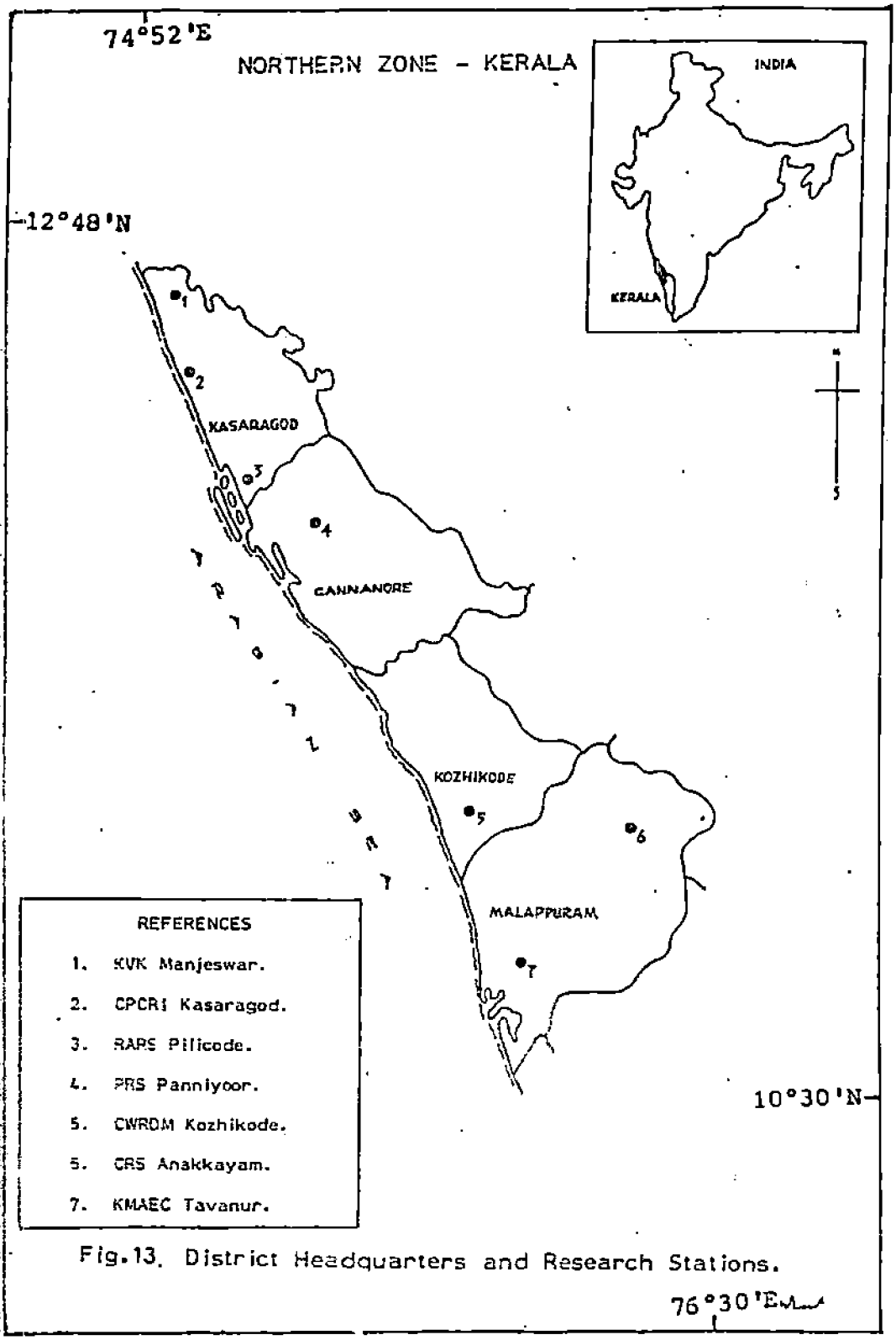


Fig.13. District Headquarters and Research Stations.

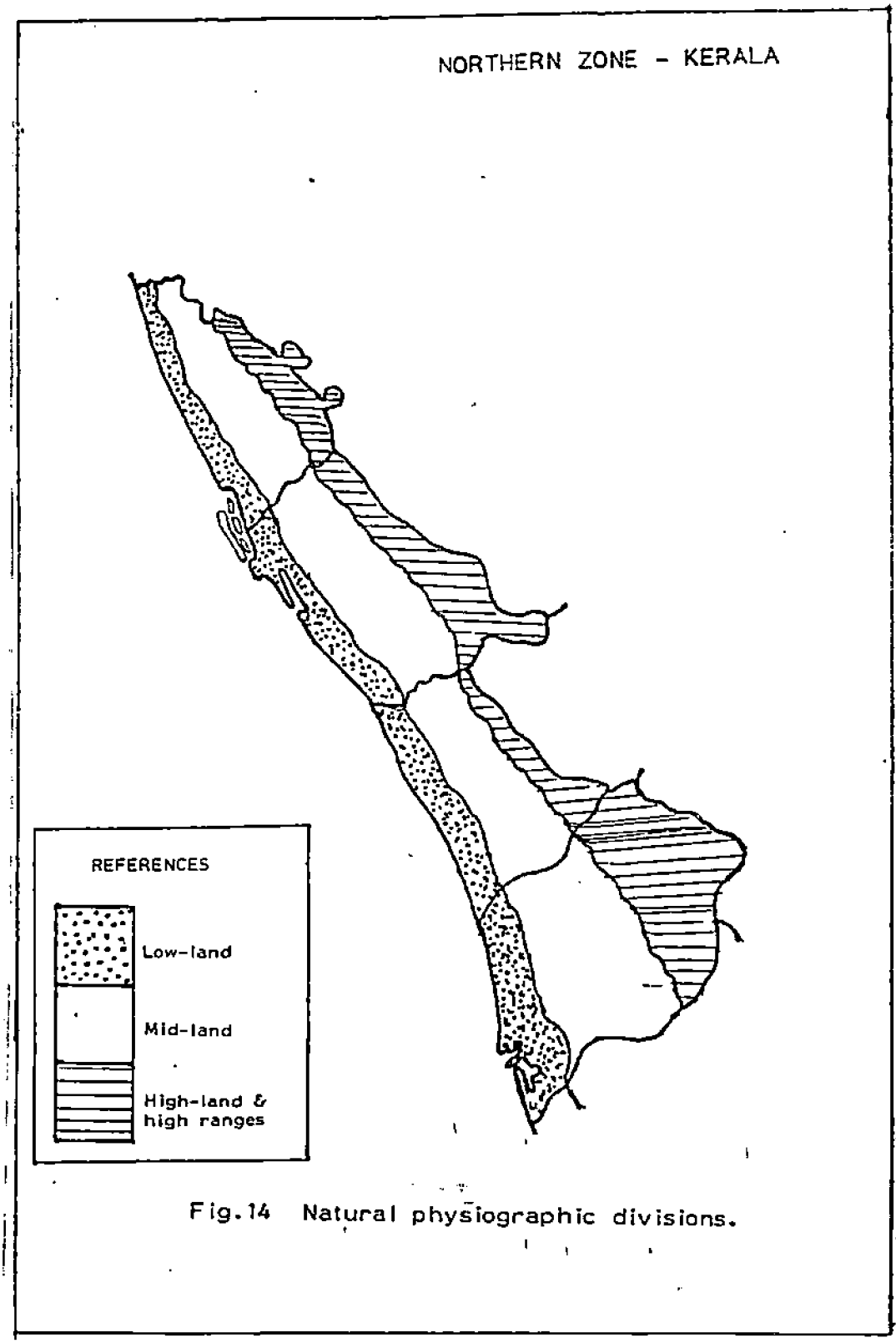


Fig.14 Natural physiographic divisions.

Table 24. Northern zone: General characteristics (1981 census)

District	Geographical area (sq.km)	Percentage to total of the state	Population (lakh)	Percentage to total of the state	Density of population (No/sq.km)	Literacy (per cent)
Malappuram	3632	9.34	24.02	9.44	677	60.3
Kozhikode	2333	6.00	22.45	8.82	957	66.1
Cannanore	2969	7.64	19.30	7.58	561	70.4
Kasaragod	1961	5.05	8.74	3.43	446	55.0
Zone	10,895	28.27	74.51	29.27	660	62.9
State	38,963	100.00	254.50	100.00	655	69.2

topography, its elevation ranging from -2 m to 7.5 m above MSL. It has extensive paddy fields and thick groves of coconut.

Sandwitched between the high land and the low land is the mid land occupying an area of 6300 sq.km. It is characterised by an undulating terrain and its elevation ranges from 7.5 m to 75 m above MSL. Agriculturally, mid land is very important tract. While rice is raised in valleys, coconut, arecanut, rubber, cassava and cashew are extensively grown on the slopes of hills.

2.3. Soils

Based on the genesis, morphology and physico chemical characteristics, the soils of the zone can be classified into the following major groups:

1) Laterites and associated soils (Oxisols - Orthox)
2) Forest loams (Inceptisols and Alfisols)
3) Coastal alluvium (Entisols - Psamments)
4) Riverine alluvium (Entisols - Hydraquents)
5) Hydromorphic saline (Entisols - Hydraquents)

Being located in a pedogenic environment highly conducive for laterisation more than 75.5 per cent of the zone is occupied by laterites and associated soils (Table 25).

These soils have been formed from acid crystalline and metamorphic rocks and they bear a long geological history. As a result in many regions of the zone, sedimentary and relic formations are seen. Highly mature concretionary and massive laterite crest formations (petroplinthite) are visible in the taluks of Kasaragod, Hosdurg, Taliparamba, Perinthalmanna and Ponnani. In these areas due to the hardness of the eroded soil, surface cultivation of common crops of the zone has become a difficult proposition and hence they are kept barren or brought under cashew plantations.

Table 25. Northern zone: Distribution of soil types

Sl. No.	Types	Geographical area of the soil type in the zone (ha)	Geographical distribution within the zone
1.	Laterite	8,02,300	74.54
2.	Forest loams	1,95,100	18.12
3.	Coastal Alluvium	63,100	5.86
4.	Reverine Alluvium	6,500	0.60
5.	Hydromorphic Saline	9,500	0.88
	Total	10,76,500	100.00

Barring the indurated laterite regions, epipedons of this soil mass are gravelly loam or sndy clay loams in texture, with a well developed B horozon rich in ferrunginous and quarts gravels embedded in a kaolinined matrix - plinthite formations. The solum of the epipedon varies from red to yellowish red and reddish brown. The solum is very deep in many areas and the bed rock is not visible indicating their detrital nature. The reaction is acidic with a pH ranging from 4 to 5. The soils are well drained and have a blocky or sub-singular blocky structure. Because of intensive laterisation they are dificient in organic matter, abundant in kaolinitic and ferritic minerals and hence have a very low cation exchange capacity (CEC) and base saturation (B.S.). The agricultural potential of these soils is very low when compared to the forest loams of the western ghat regions of the state. The major crops grown in these soils are cashew, coconut, cassava, rubber, pepper and minor tuber crops.

The coastal alluvial soils are seen along the sea coast. They occupy 5.86 per cent of the total area . The soil texture is dominated by sand fraction and is therefore highly porous with poor water holding capacity. The soils are acidic in reaction (pH 5.5 - 6.5) and extremely deficient in oraganic matter and the major plant nutrients. Coconut and rice are the principal crops grown in these soils.

Riverine alluvial soils occur along the banks of rivers and their tributories and they constitute for 0.60 per cent of the total soil area of the zone. They show wide variation in their physico-chemical properties depending on the nature of alluvium deposited. They do not exhibit well developed horizons. These are deep soils and their texture ranges from sandy loam to caly loam. The soils are rich in organic matter, nitrogen and potassium. They are acidic (pH 6.0 - 6.50) in reaction and poor in phosphorus and lime.

Coconut, rice, banana and vegetables are the important crops grown in these soils.

The hydromorphic saline soils account for 0.88 per cent of the total soil area of the zone and are confined to the coastal belts of Cannanore district. The net work of back waters and esturies bordering the coastal area serve as inlets for tidal waters to flow into these areas, causing salinity. During the rainy season, the fields are flooded and most of the salts are leached out, leaving the soil free of salts. The maximum accumulation of salts occur during summer.

The hydromorphic saline soils are generally deep and imperfectly drained. The profiles show wide variations in texture, as is common in most of the alluvial soils. In some areas undecomposed organic matter is observed in lower layers.

The forest loams are the products of weathering of crustalline rocks under forest cover. They are restricted in occurrence in the eastern parts of the 4 districts. The colour of the soils varies from reddish brown to black with loam to silty loam texture. The dark colour of the surface soil is due to the presence of organic matter derived from the vegetation. The soils are generally acidic, rich in nitrogen but poor in bases because of heavy leaching.

The forest soils account for 18.12 per cent of the total soil area in the zone.

The chemical and physical properties of these soils together with their taxonomic classification are presented in Appendix.

2.4. Climate

The zone has a tropical climate with 6 humid months. The hottest months are March, April and May. Though the zone has the highest rainfall in the state, the prolonged dry spell that occurs between December and May adversely affects the growth of perennial crops.

The agricultural seasons in the zone are Autumn or 'Viripu' (April - September), winter or 'Mundakan' (October - January) and summer or 'Puncha' (February - April). The first two seasons receive rainfall from south-west monsoon and north-east monsoon, respectively.

2.4.1. Rainfall

The mean dates of onset of effective monsoon over the Kasaragod and Cannanore districts vary from May 25 to 30 (Fig.15).

The mean annual rainfall of the zone is 3378 mm, its range being 2,800 mm in the south-eastern parts of Malappuram to 4,000 mm in the high ranges of Kozhikode and Cannanore districts. There is a decreasing trend in rainfall towards the south and south-eastern tracts of the zone. Hosdurg taluk in Kasaragod district receives the highest (3,500 mm) annual rainfall (Fig.16).

A glance through the rainfall data over a period of 50 years indicates a fall in precipitation, during the recent years when compared to the normal (Apendix 1).

The rainfall during the 'Viripu' (Autumn) season constitutes about 84.1 per cent of the total annual rainfall of the zone (Fig.17). The trend of isohyets in the 'Viripu' (Autumn) is more or less similar to the mean annual rainfall with a decrease in its amount. The percentage contribution of autumn rainfall to the total is the highest in Hosdurg taluk in Kasaragod district and the lowest in the Perinthalmanna taluk in Malappuram district.

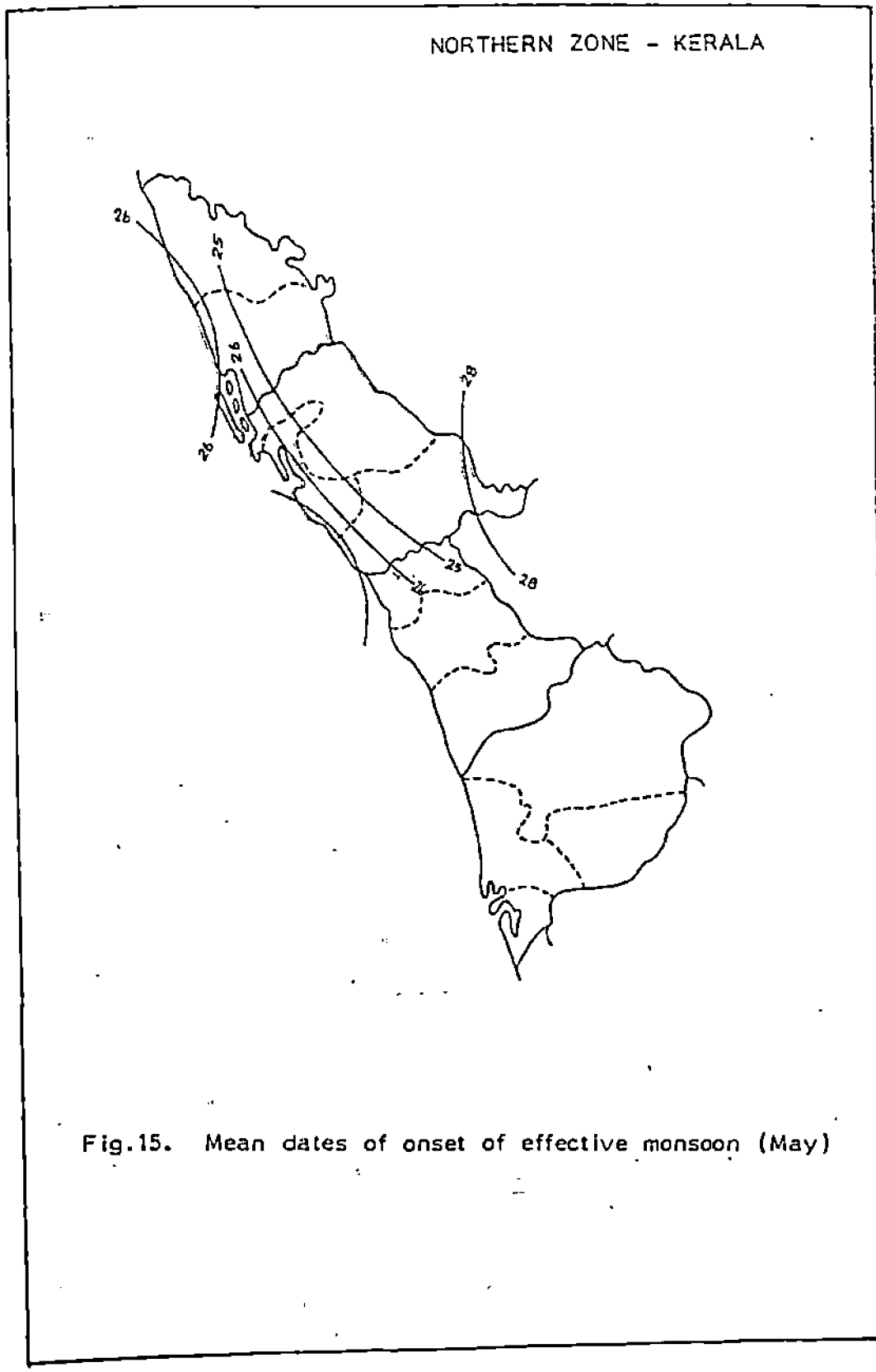


Fig.15. Mean dates of onset of effective monsoon (May)

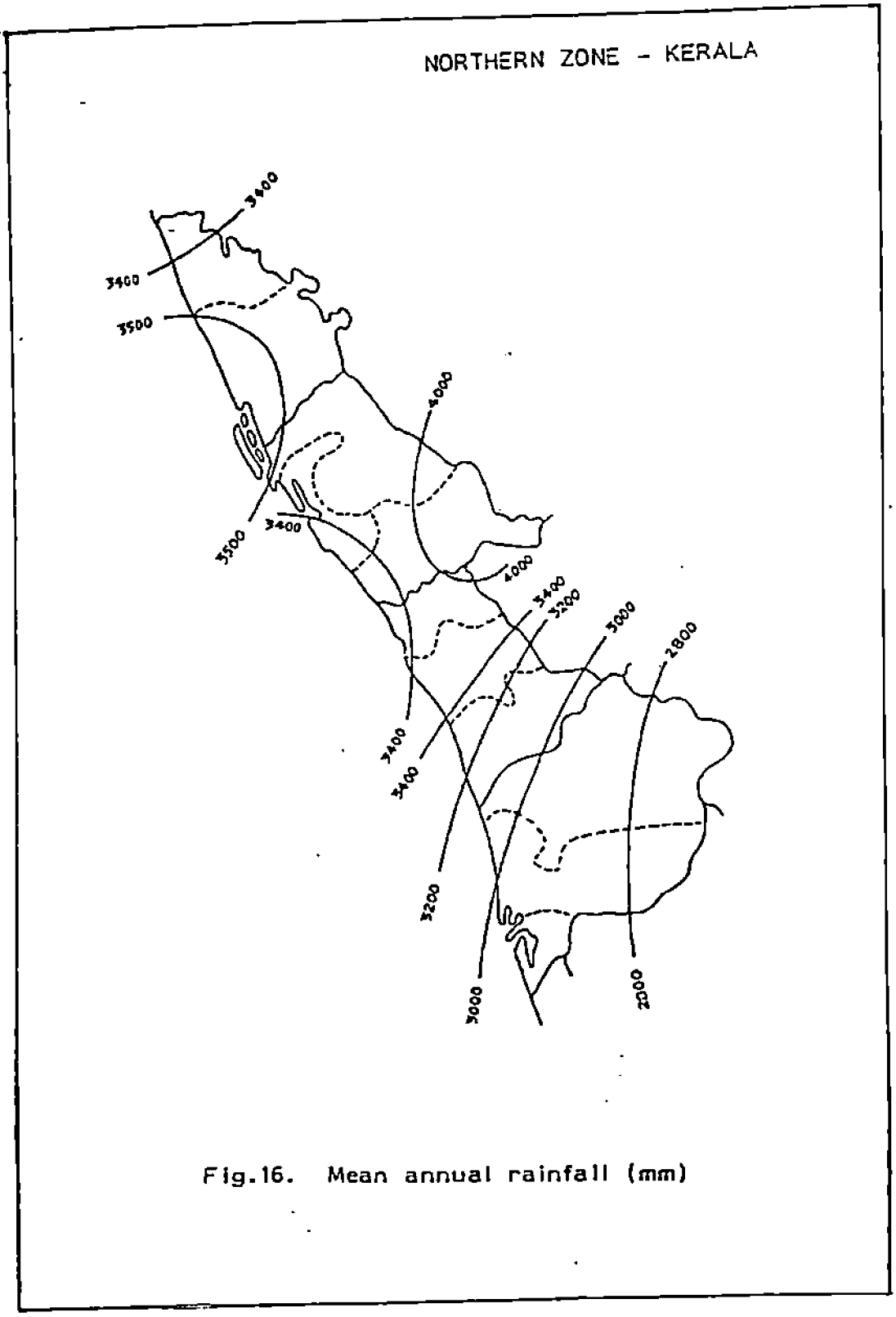


Fig.16. Mean annual rainfall (mm)

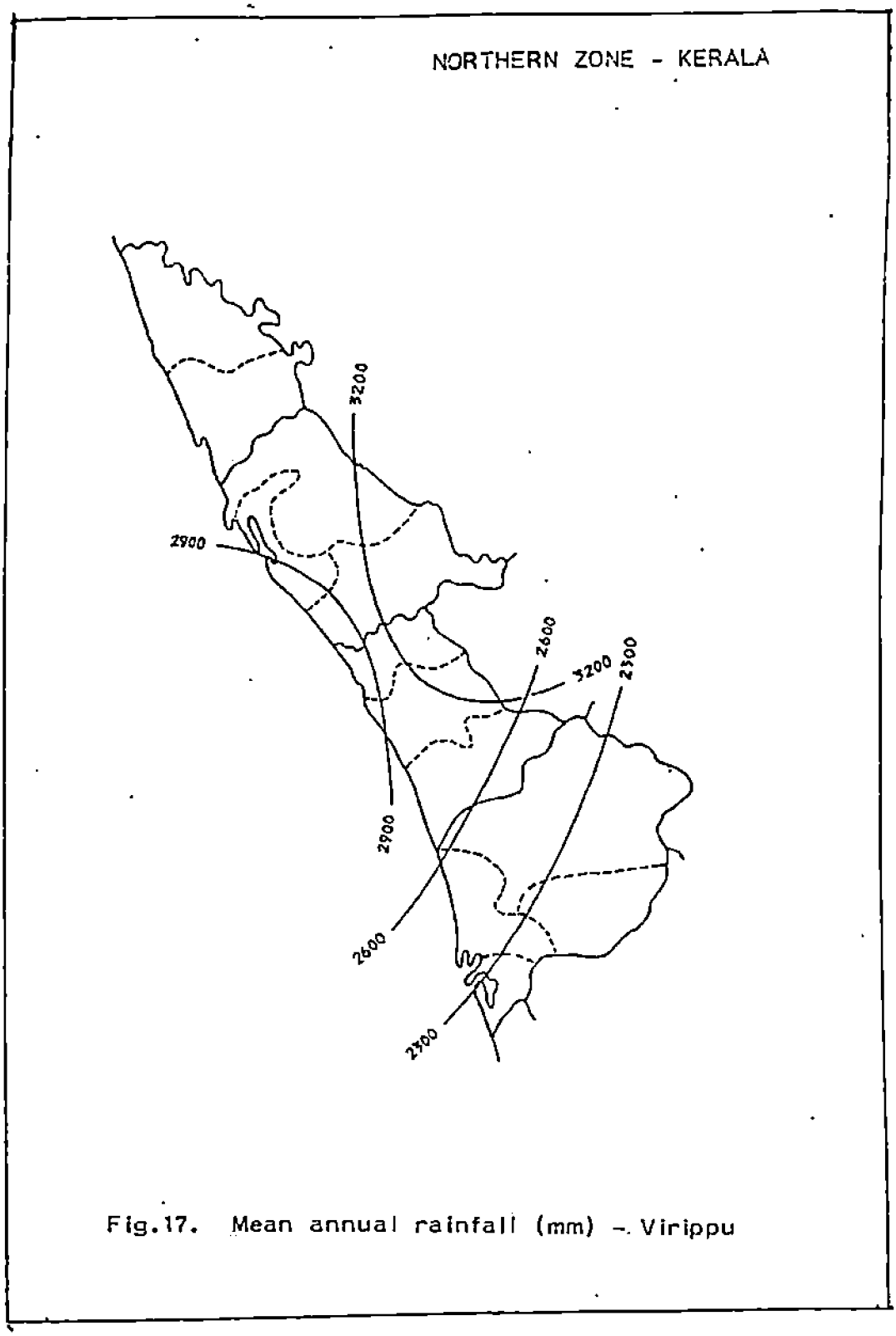


Fig.17. Mean annual rainfall (mm) – Virippu

During 'mundakan' (Rabi) and 'puncha' seasons (summer), the trend of the isohyets increases towards the south and south-eastern parts of Malappuram district in contrast to that of the 'virippu' (Kharif) season (Fig.18,19). It varies from 350 mm in the north western parts of Kasaragod district (Kasaragod taluk) to 600 mm in Kozhikode district (Badagara taluk). The trend f isohyets in puncha season varies from 60 mm in the northern parts of Kasaragod taluk to 120 mm in the Perinthalmanna taluk (Fig.19). The contribution of 'puncha' season rainfall to the total rainfall of the zone is negligible.

The mean number of rainy days (annual) varies from 117 in the low lands to 140 in the high lands (Fig.20-23) of the zone. In the virippu season, the number of rainy days increases from the south-eastern tracts of the zone (Malappuram district, Perinthalmanna taluk) to 109 in the hill tracts of Kozhikode and Cannanore districts and then declines to 94 in the low lands of Kozhikode district. The number of rainy days are relatively more in the Malappuram district during the mundakan and puncha seasons. The southern part of the zone (Malappuram district) enjoys an evenly distributed rainfall as compared to the northern parts (Kasaragod and Cannanore districts).

2.4.2. Temperature

The diurnal variation in atmospheric temperature in the zone is not of a high magnitude because of the proximity to the Arabian sea. The mean maximum and minimum temperatures are 33°C and 24°C, respectively. The warmest months are March, April and May during which the maximum temperature may shoot upto 37°C. The temperature during the winter seldom falls below 16°C.

2.4.3. Soil temperature

The mean annual soil temperature increases from 32°C in the surface soil (5 cm depth) to 37°C at 70 cm soil depth. It also varies with the soil type. In the laterite, which is the most important soil type, the mean maximum temperature is 35°C (surface soil) during March-April and the mean minimum, 23.6°C during January. A sudden decline in soil temperature is noticed during the south west monsoon.

NORTHERN ZONE - KERALA

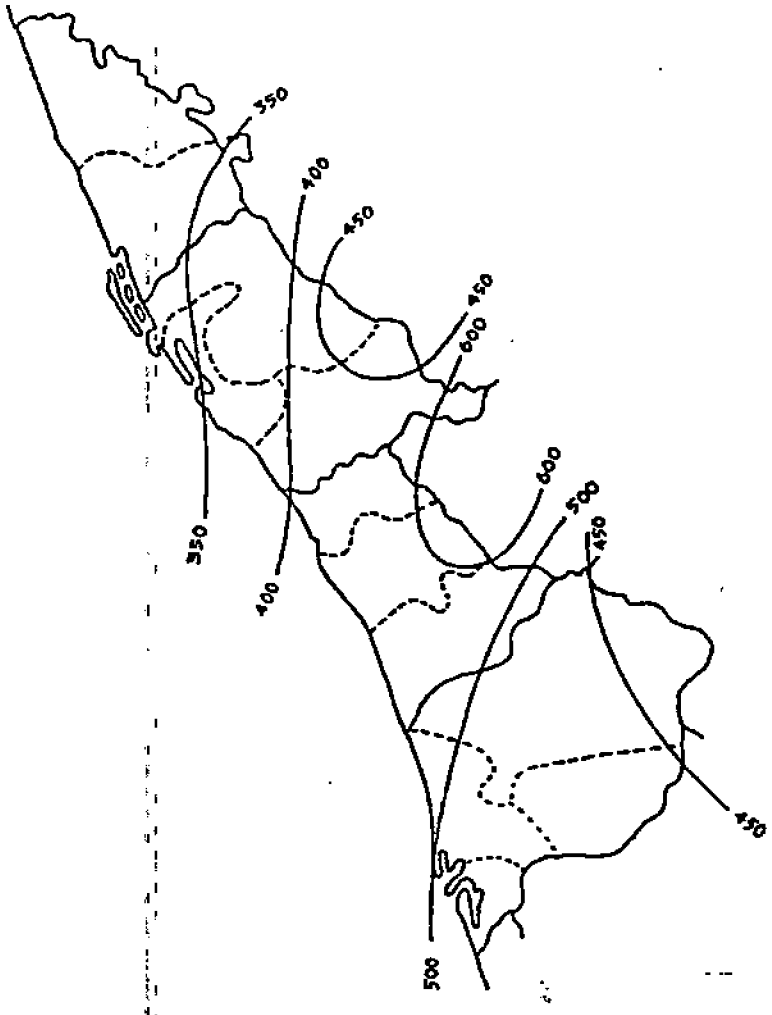


Fig.18. Mean annual rainfall (mm) - Mundakan

NORTHERN ZONE - KERALA

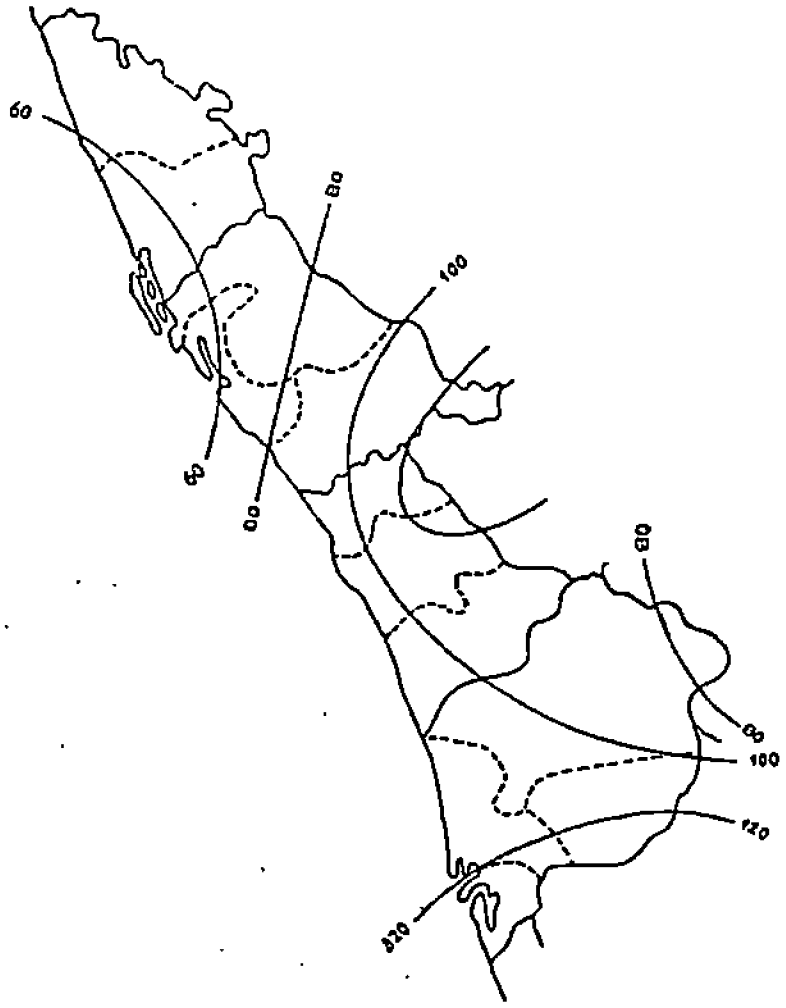


Fig.19. Mean anual rainfall (mm) - Puncha

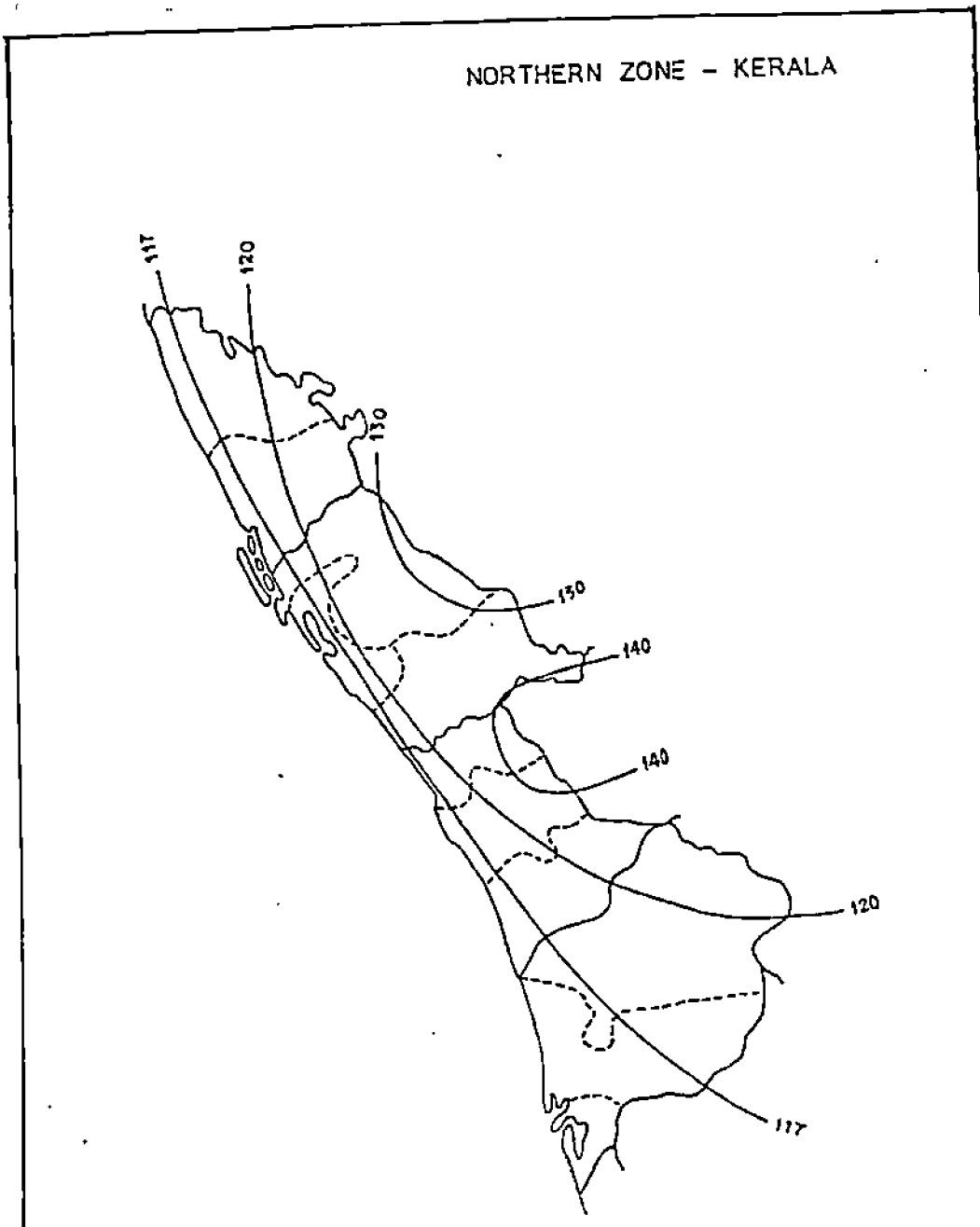


Fig.20. Mean annual number of rainy days

NORTHERN ZONE - KERALA

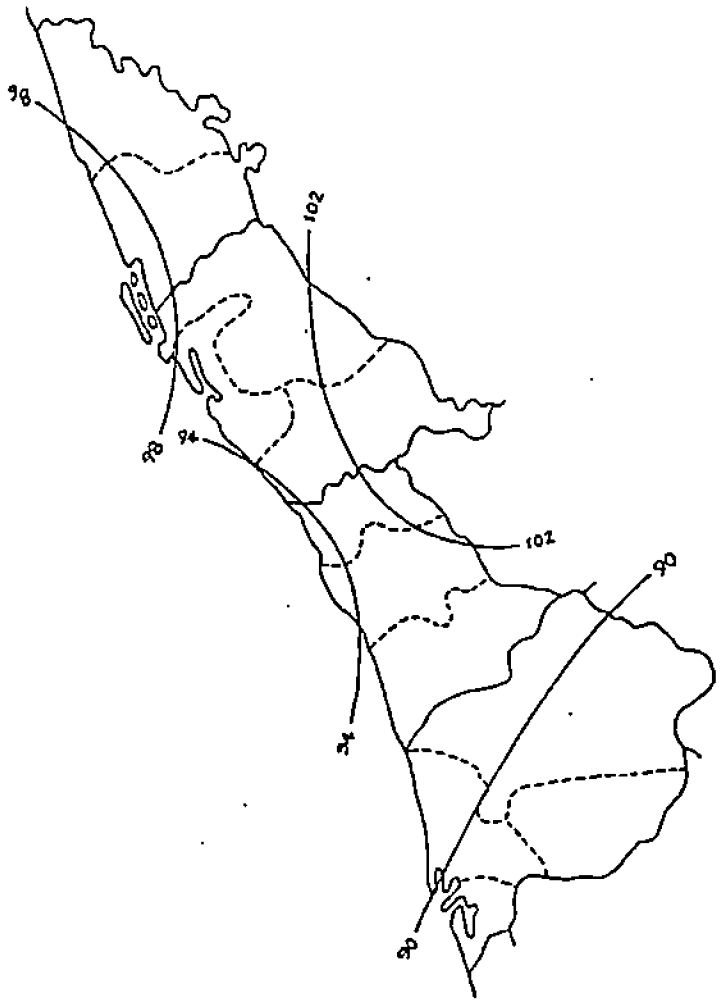


Fig.21. Number of rainy days - Virippu

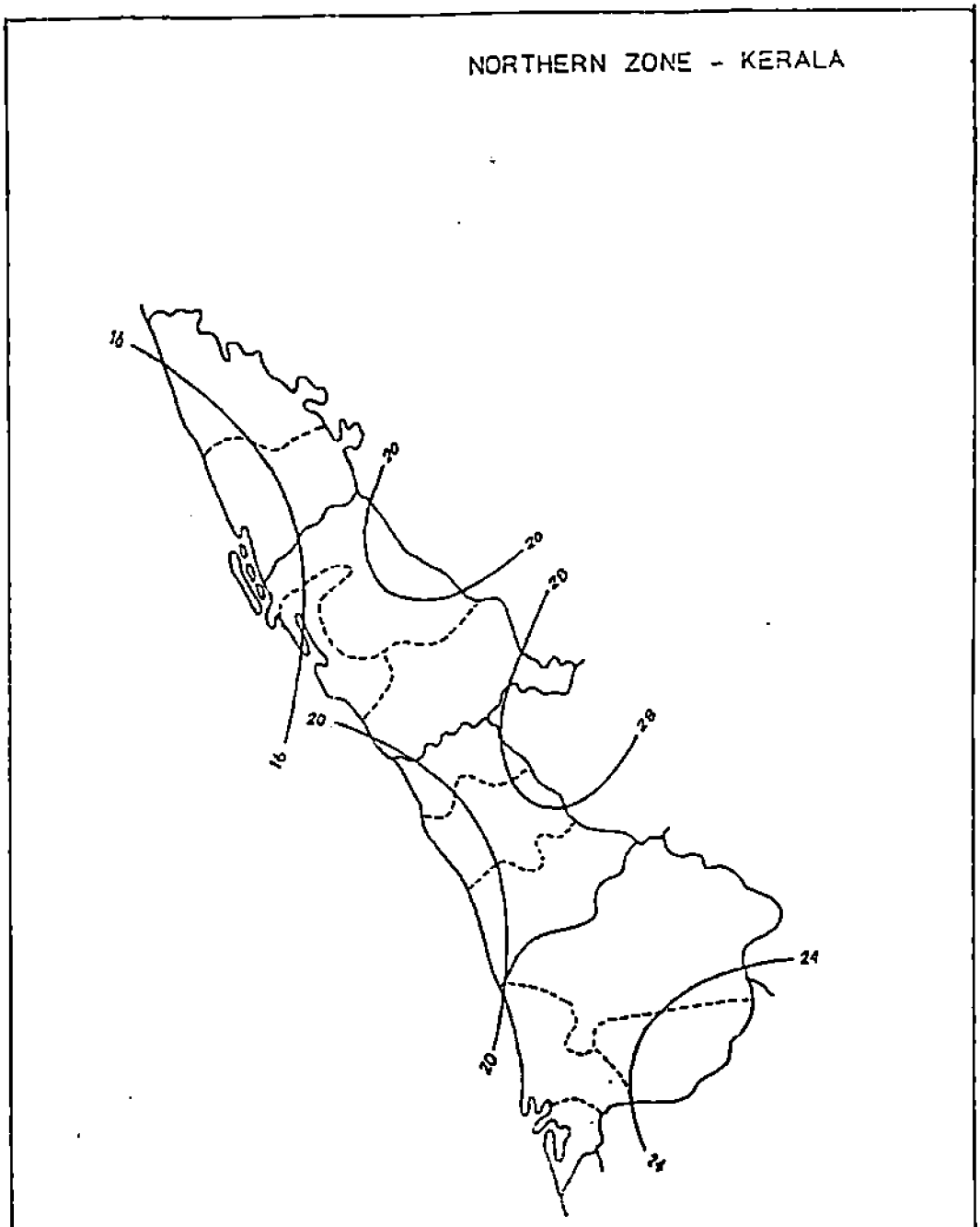


Fig.22. Number of rainy days - Mundakan

NORTHERN ZONE - KERALA

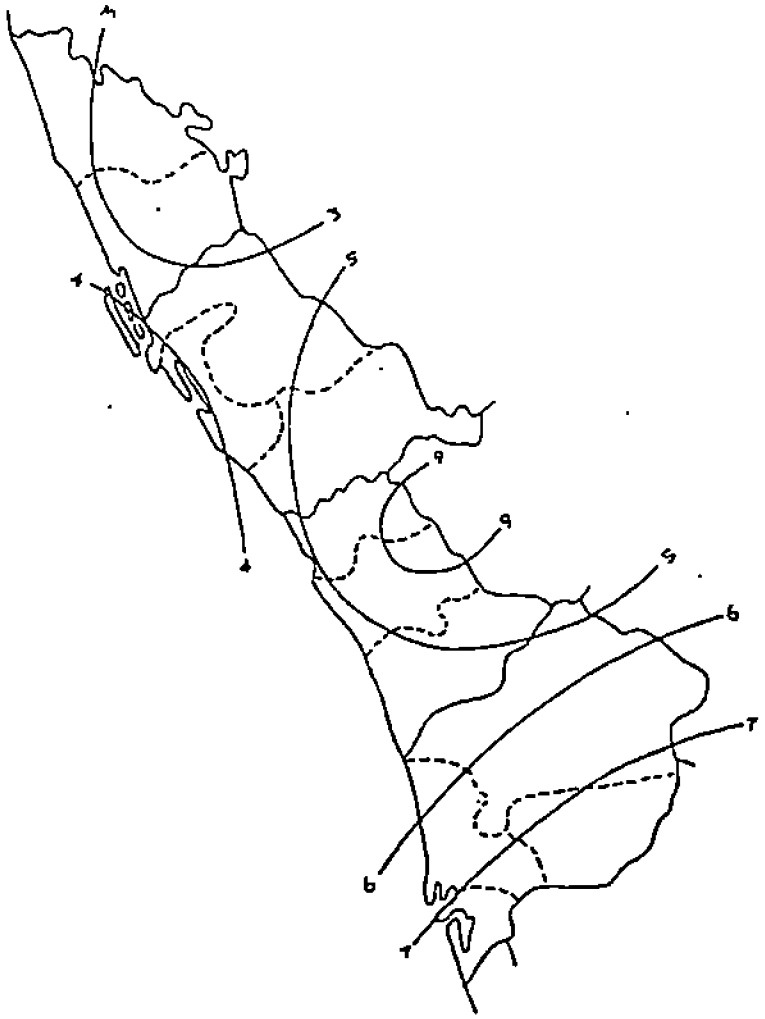


Fig.23. Number of rainy days - Puncha

2.4.4. Humidity

the entire zone is highly humid throughout the year, the maximum and minimum percentages being 90 in the south-west monsoon and 75 in summer, respectively.

2.4.5. Sunshine

The daily average hours of bright sunshine is 7.5, attaining the maximum of 10 during summer months and the minimum 3 during the months of June and July (south-west monsoon).

2.4.6. Cloudiness

Overcast sky is seen during the south-west monsoon. Moderate to heavy clouds are noticed during the pre and post-monsoon periods. The sky is clear during the winter months.

2.4.7. Dew

The dew fall varies from 5 mm at 5 cm height to 10 mm at 100 cm height from the ground level during October to April. The maximum dew fall is seen during the months of November and December.

2.4.8. Surface winds

Westerly and north-westerly winds prevail during August and easterly winds during April. During December, easterly and north easterly winds prevail in the entire zone. The wind speed varies from 5 km per hour to 15 km per hour (Fig.24-26).

2.4.9. Potential evapo-transpiration

The mean potential evapo-transpiration in the zone varies between 4 mm and 5 mm per day. It attains the maximum value of 7 mm/day during May.

2.4.10. Overview of climate

The zone is characterised by heavy rainfall during June, July and August leading to floods and waterlogging in lowland area. The prolonged dry spell from January through April coupled with high rates of surface evaporation results

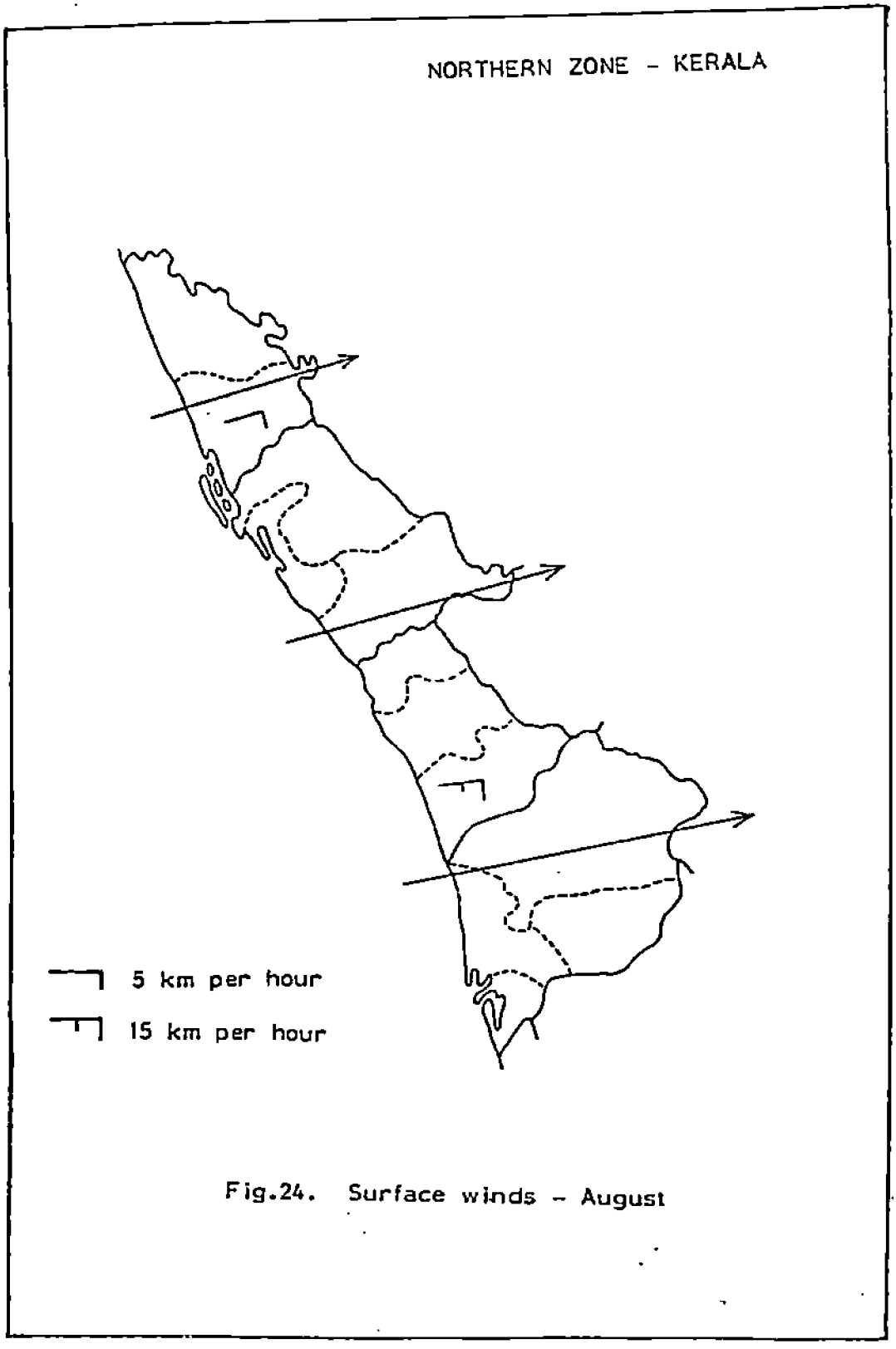


Fig.24. Surface winds - August

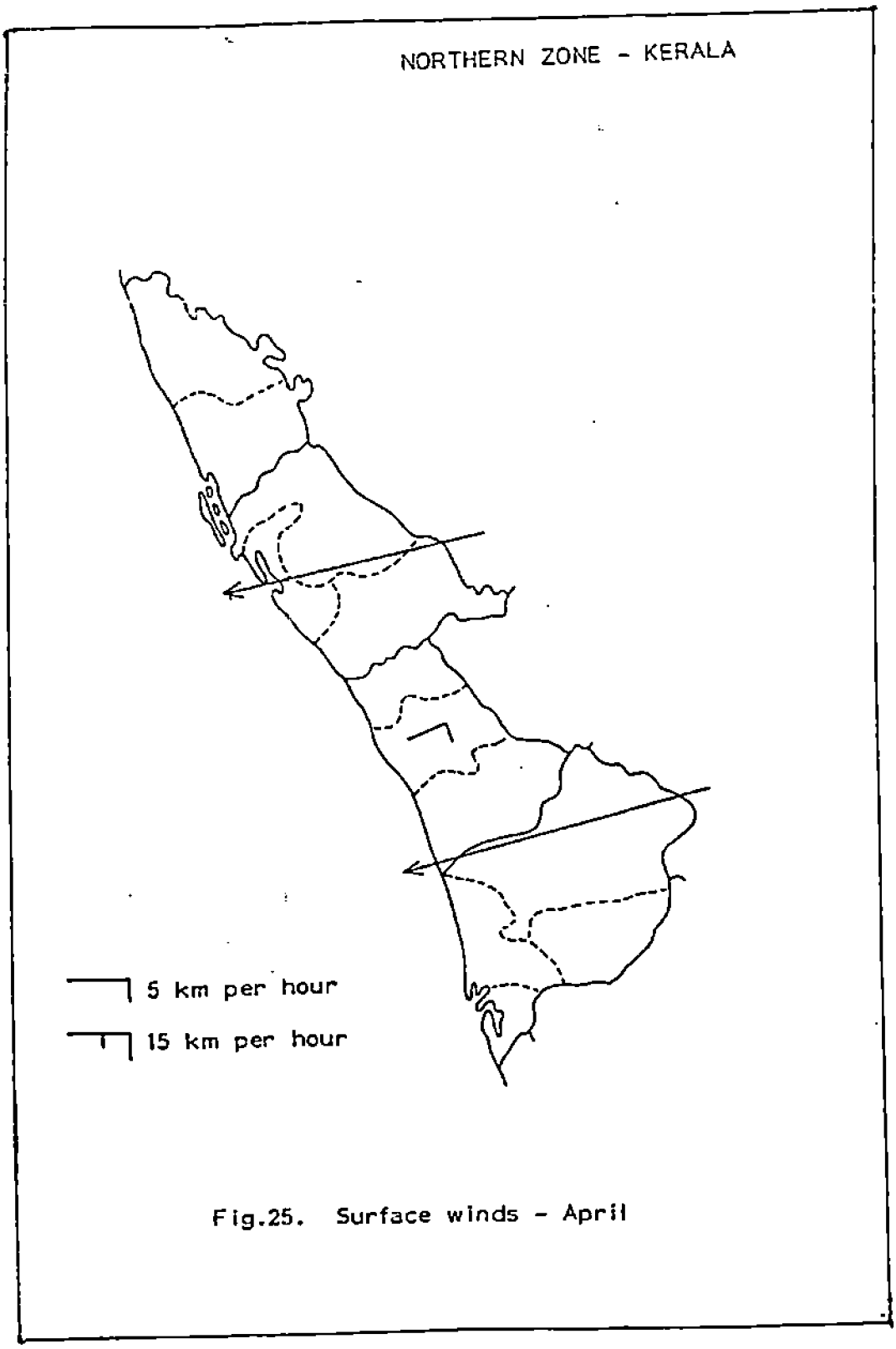


Fig.25. Surface winds - April

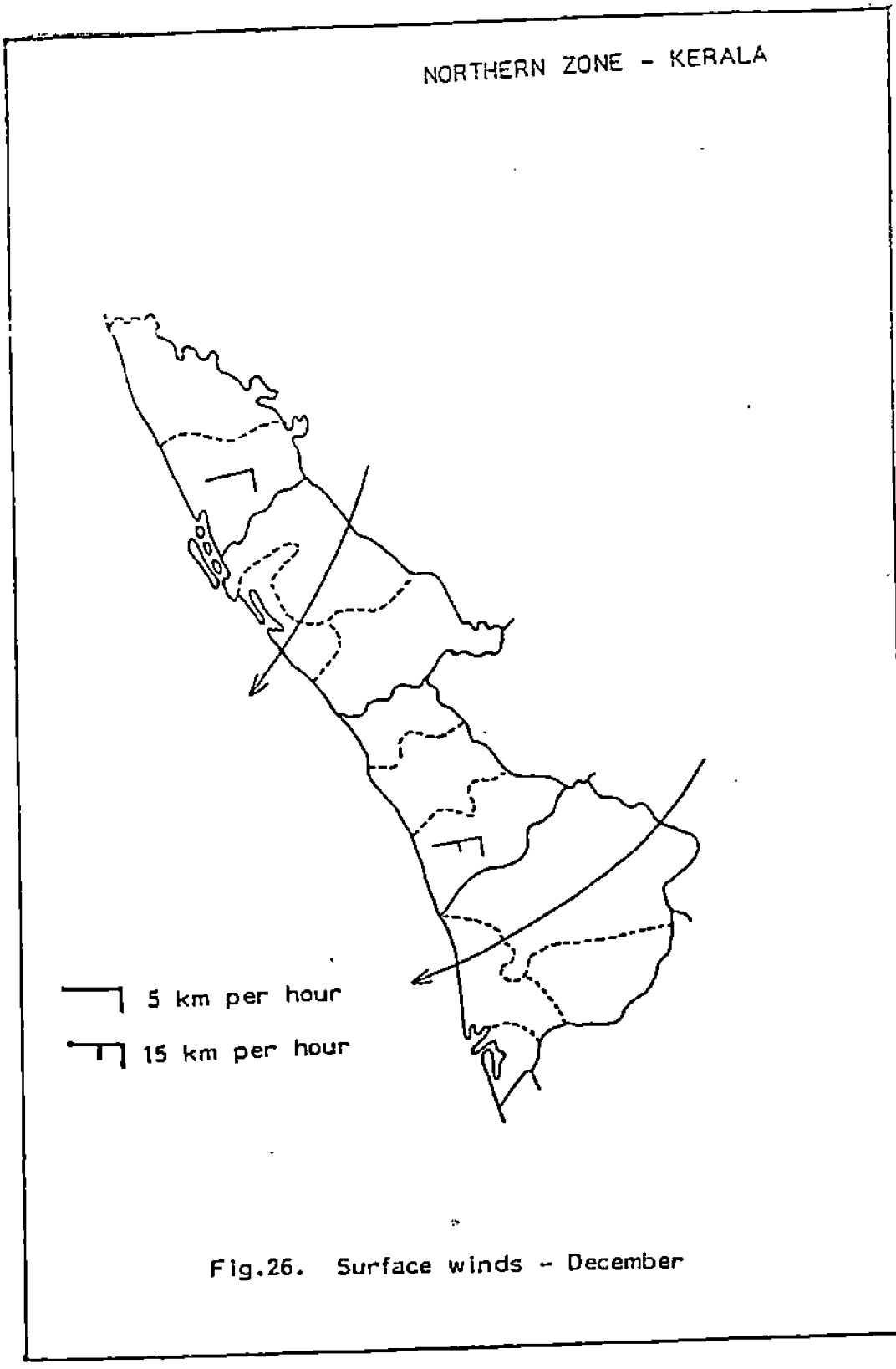


Fig.26. Surface winds - December

in the rapid depletion of soil moisture and desication of surface water sources. Both these phenomena - high water surplus during June - August and severe water deficit during December - May (Fig. 27-28) affect adversely the productivity of almost all the field and plantation crops.

2.5. Land - use pattern

The northern zone has a geographical area of 10851 sq.km. which is 28.2 per cent of the area of the State. Malappuram has the largest geographical area among the districts (3,548 sq.km.). The gross cropped area of the zone is about 7.99 lakh ha, the net area sown being 6.86 lakh ha (Table 27). Malappuram leads the districts in the gross cropped area (2.48 lakh ha; 31.04 per cent). Kasaragod has the lowest (16.9 per cent) cropped area in (1.35 lakh ha) the zone.

Table 27 Northern zone: Land utilisation (Area in lakh ha, 1984-'85)

Land use	District					
	Mala-ppuram	Kozhi-kode	Cann-anore	Kasara-god	Zone	State
Total geographical area	3.63	2.33	2.97	1.96	10.89	35.85
Forest	1.03	0.41	0.44	0.16	2.04	10.81
Land put to non Agrl. use	0.19	0.18	0.20	0.12	0.69	2.79
Barren and uncultivable waste lands	0.07	0.02	0.10	0.20	0.39	0.86
Cultivable waste lands	0.14	0.03	0.17	0.21	0.55	1.30
Current follows	0.12	0.11	0.05	0.09	0.37	0.42
Net area sown	2.08	1.59	2.01	1.18	6.86	21.84
Area sown more than once	0.39	0.44	0.13	0.17	1.13	6.90
Gross cropped area	2.48	2.02	2.14	1.35	7.99	28.75

Forests occupy 2.04 lakh ha in zone. This works out to 19.08 per cent of the forest area of the state (Fig.29). As in the case of geographical area and gross cropped area, Malppuram with an area of 1.03 lakh ha tops the list of districts (50.49 per cent) and the forests in this districts

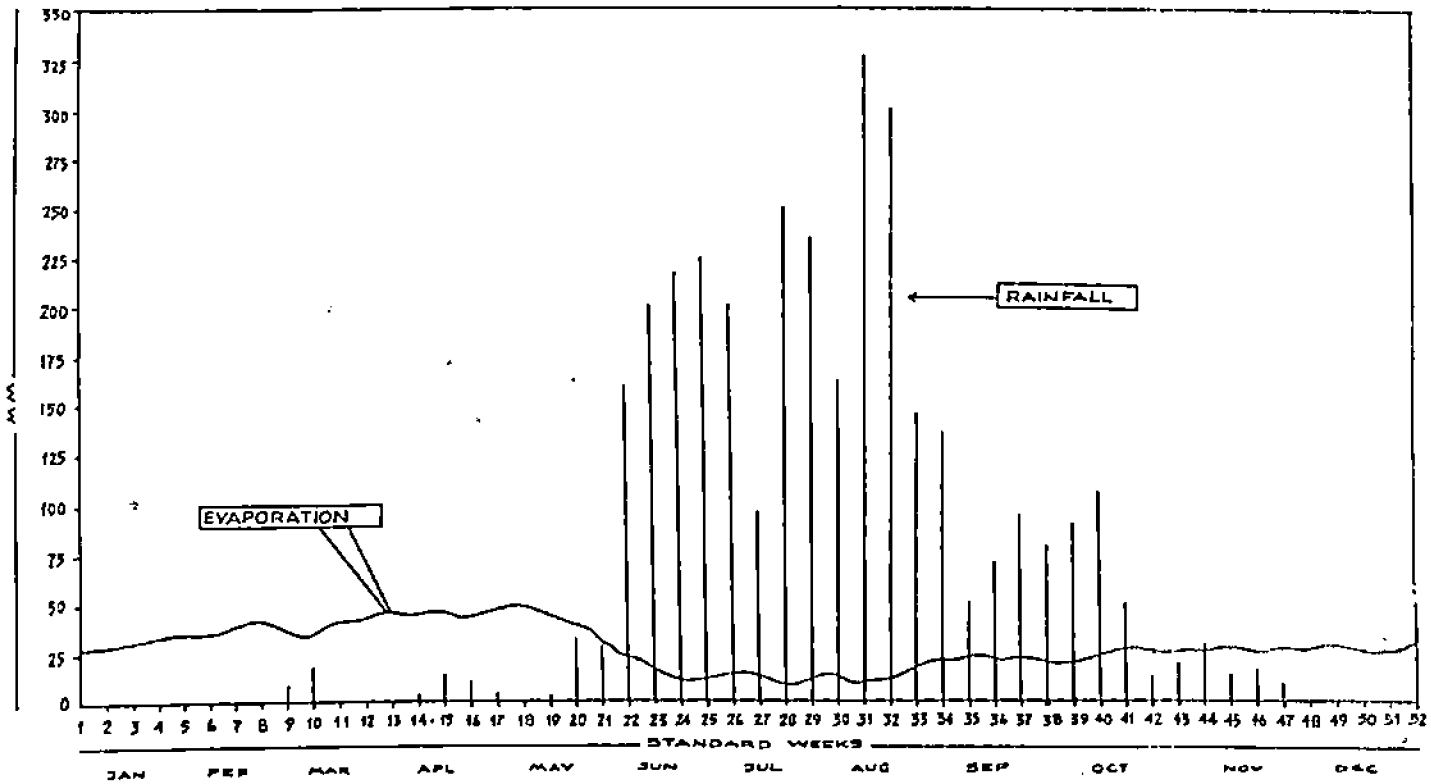


Fig.27. Weekly pan evaporation and rainfall at Pilicode.

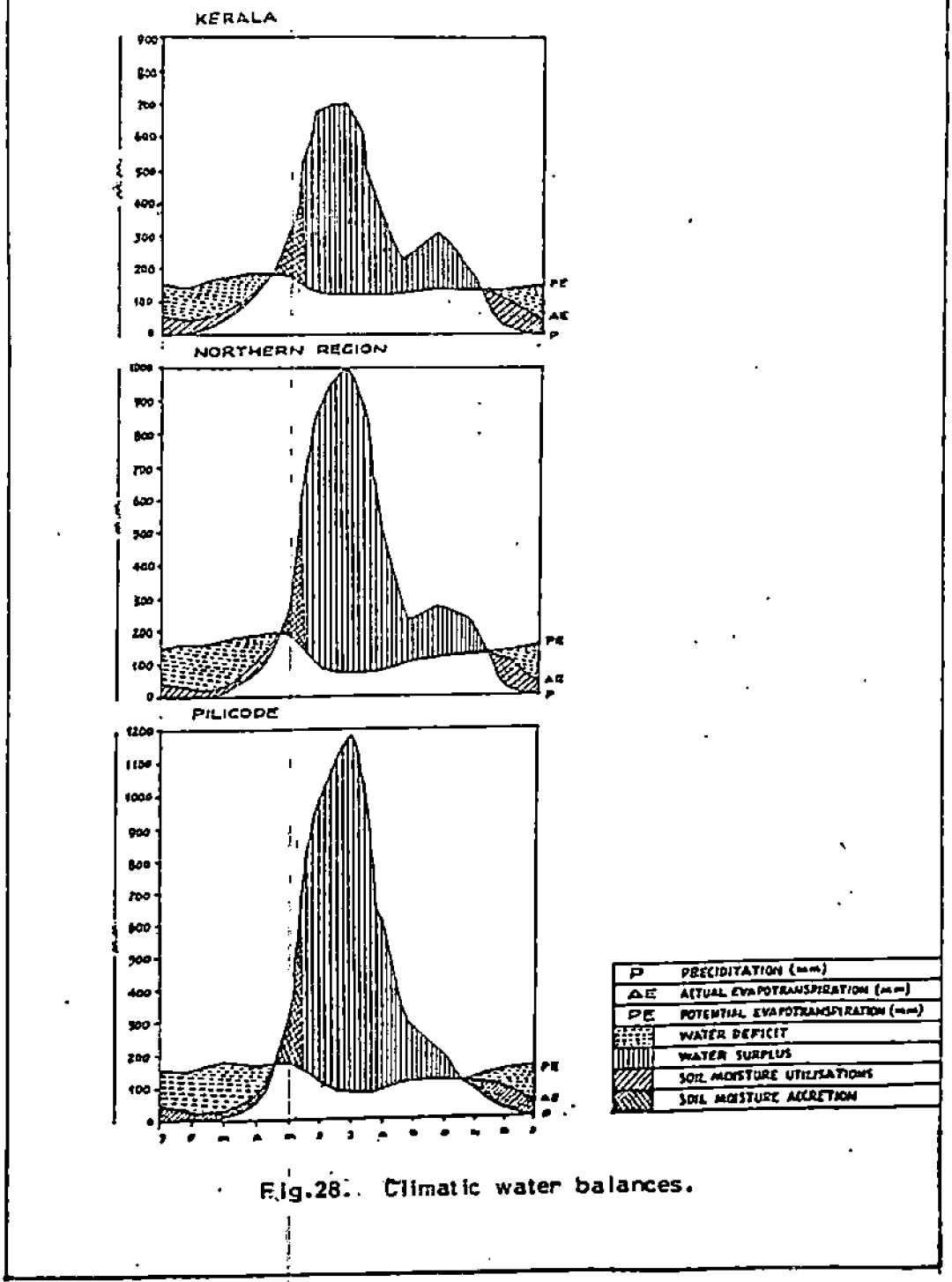


Fig.28. Climatic water balances.

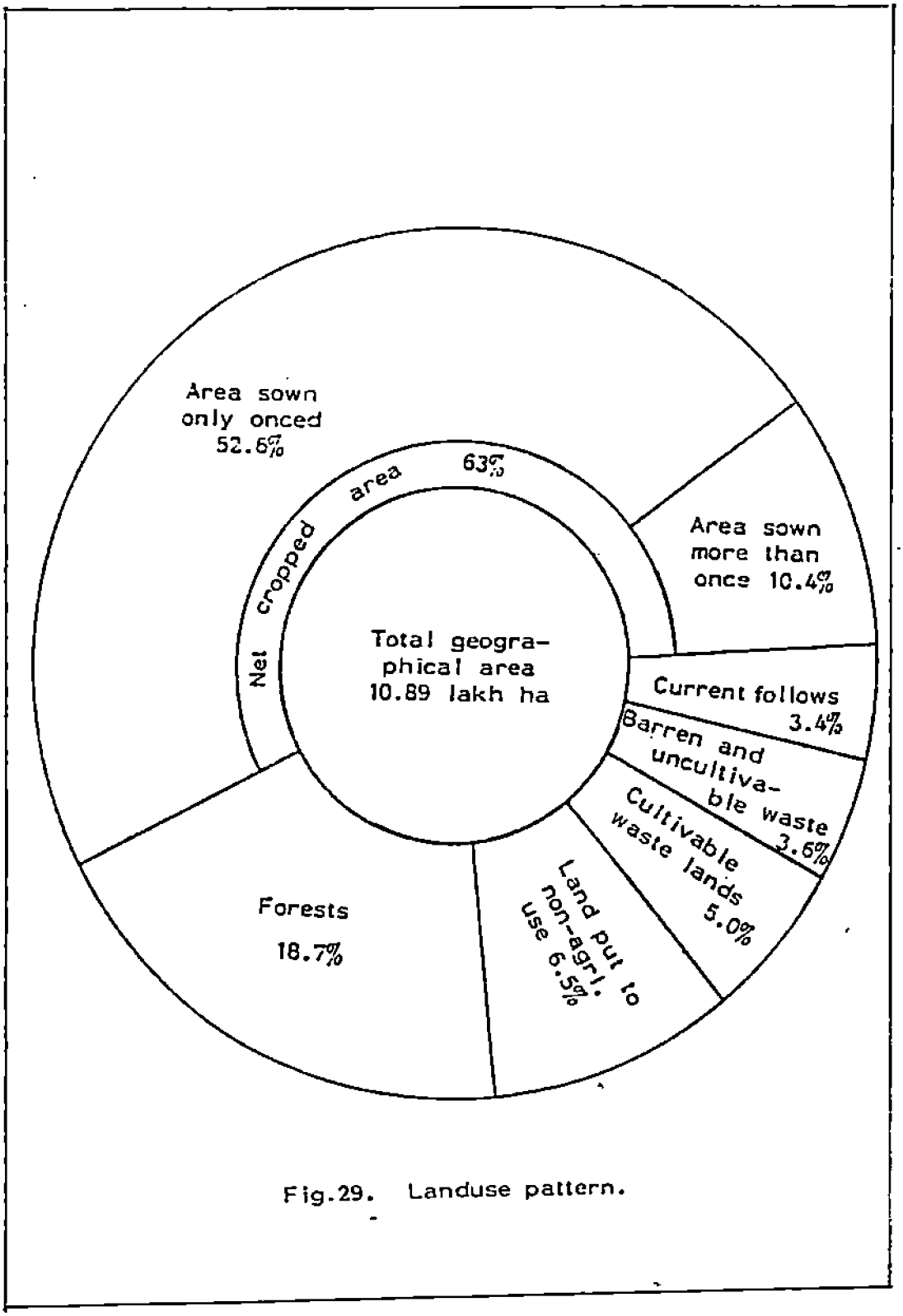


Fig.29. Landuse pattern.

Table 27 Northern zone : Area irrigation wise (1984-'85)

Crop	DISTRICT				Total
	Malappuram	Kozhikode	Cannanore	Kasaragod	
Rice	7726	3430	2551	5795	19502
Vegetables	955	--	1266	--	2221
Coconut	13074	6222	7982	14803	42081
Arecanut	5441	289	3468	15462	24660
Banana	1957	1181	1800	1116	6054
Others	2541	--	--	--	2541
Total	31694	11122	17067	37176	97059

are mostly confined to Nilambur and Wandur in Ernad Taluk. The oldest teak plantation in the world known as "Cannolly's plot" is situated at Nilambur. The forest divisions in the zone are Nilambur and Kozhikode.

The zone has the maximum area under "barren and uncultivable waste lands" in the state (38647 ha or 45.34 per cent of the state). Kasaragod district alone accounts for 51.3 per cent of the waste lands in the zone. The cultivable waste lands are also relatively more in this district (38.2 per cent).

2.6 Irrigation

The zone is endowed with a large number of rivers having a good net work of tributories. The important rivers in each district are as follows (Fig. 30-40). These rivers together have a catchment area of 11,500 sq.km.

i. Malappuram: Chaliar (168 km.), Kadalundi, Poorapuzha, Tirurpuzha, Thoothapuzha, Bharathapuzha.

ii. Kozhikode: Kutiadi, Korapuzha, Chaliyar, Kadalundi Kallayi.

iii. Cannanore: Pazhassi, Valapattanampuzha, Anjarakandi, Mahe.

Iv Kasaragod: Chandragiri Kuppom, Kariamcod, Manjeshwar

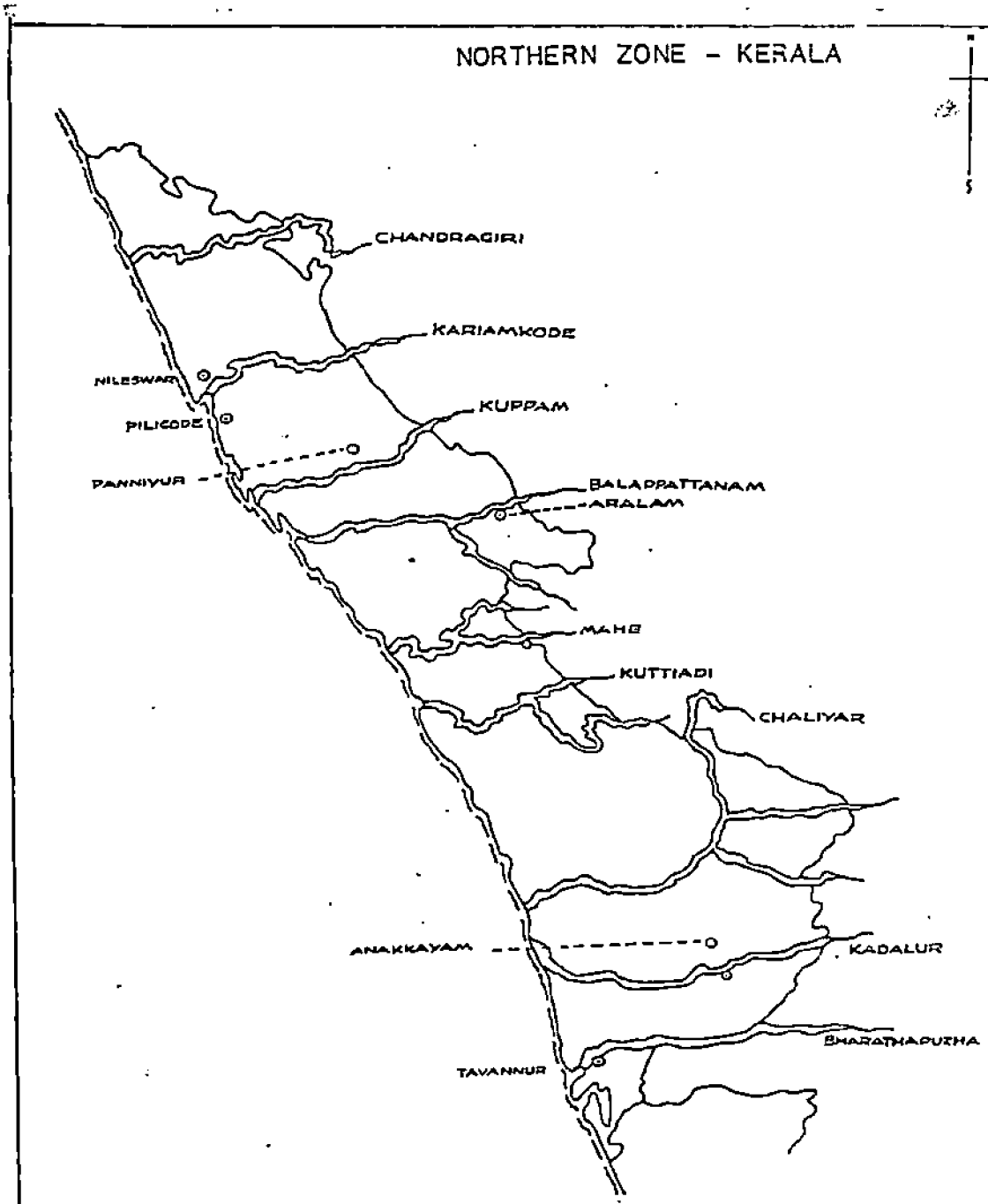
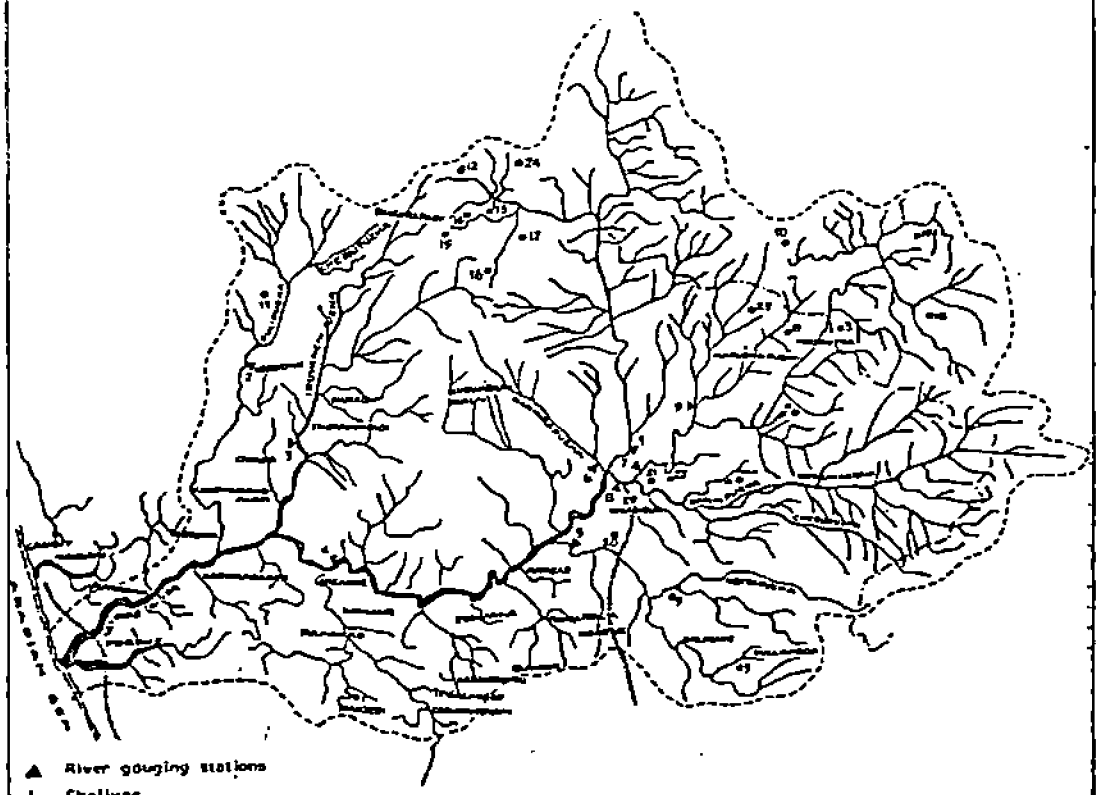


Fig.30. Rivers.

Catchment area

Tamilnadu - 375 sq.km.

Kerala - 2535 sq.km.



▲ River gauging stations

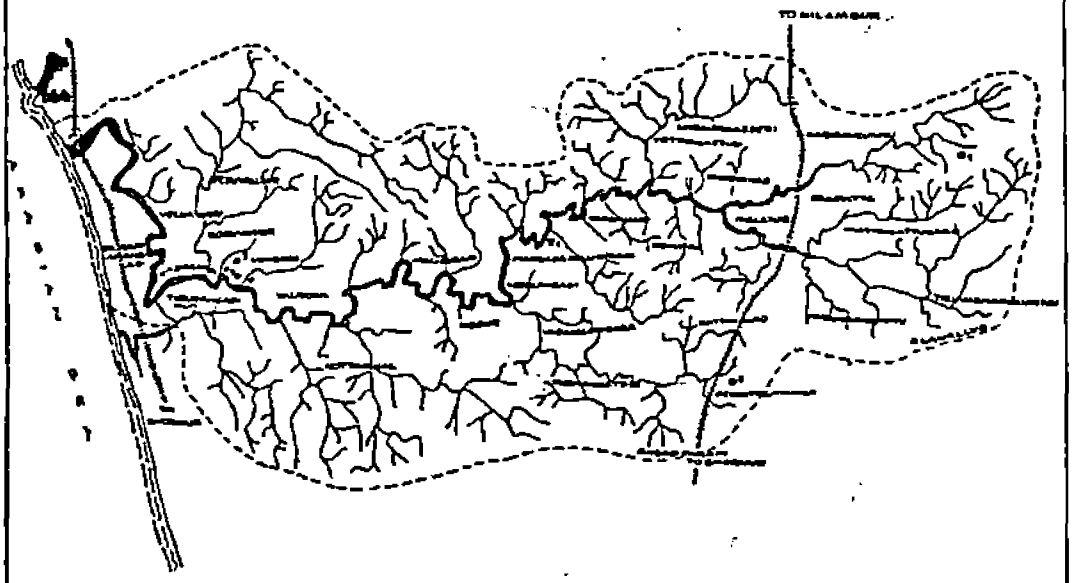
1. Chaliyar
2. Koodathai
3. Mukkom
4. Areacode
5. Kuthirapuzha
6. Kanhirapuzha
7. Punnapuzha
8. Karimpuzha
9. Marutha puzha
10. Cherupuzha
11. Nedumkayam

● Rain gauging stations

1. Manjeri
2. Nilambur F.R.O.
3. Nellikutha
4. Nedumkayam
5. Pullangode
6. Pallunde
7. Tagarapady
8. Anamari
9. Chokkad
10. Kaduvakunnu
11. Puduppady
12. Elambalari
13. Puthumala
14. Kalladi
15. Theventhoora
16. Mundakai
17. Chooralmala
18. Olikkathodu
19. Punnapuzha
20. Nilambur
21. Chungathara
22. Punnapuzha Agri.
23. Vellakkatta
24. Aranapuzha

Fig.31. Chaliyar River Basin.

Catchment area - 1114 sq.km.



REFERENCE

▲ River gauging stations

1. Anakayam

• Rain gauging stations

1. Kalikavu
2. Perinthalmanna
3. Tirungadi

Fig.32. Kadalundy River Basin.

Catchment area - 601 sq.km.

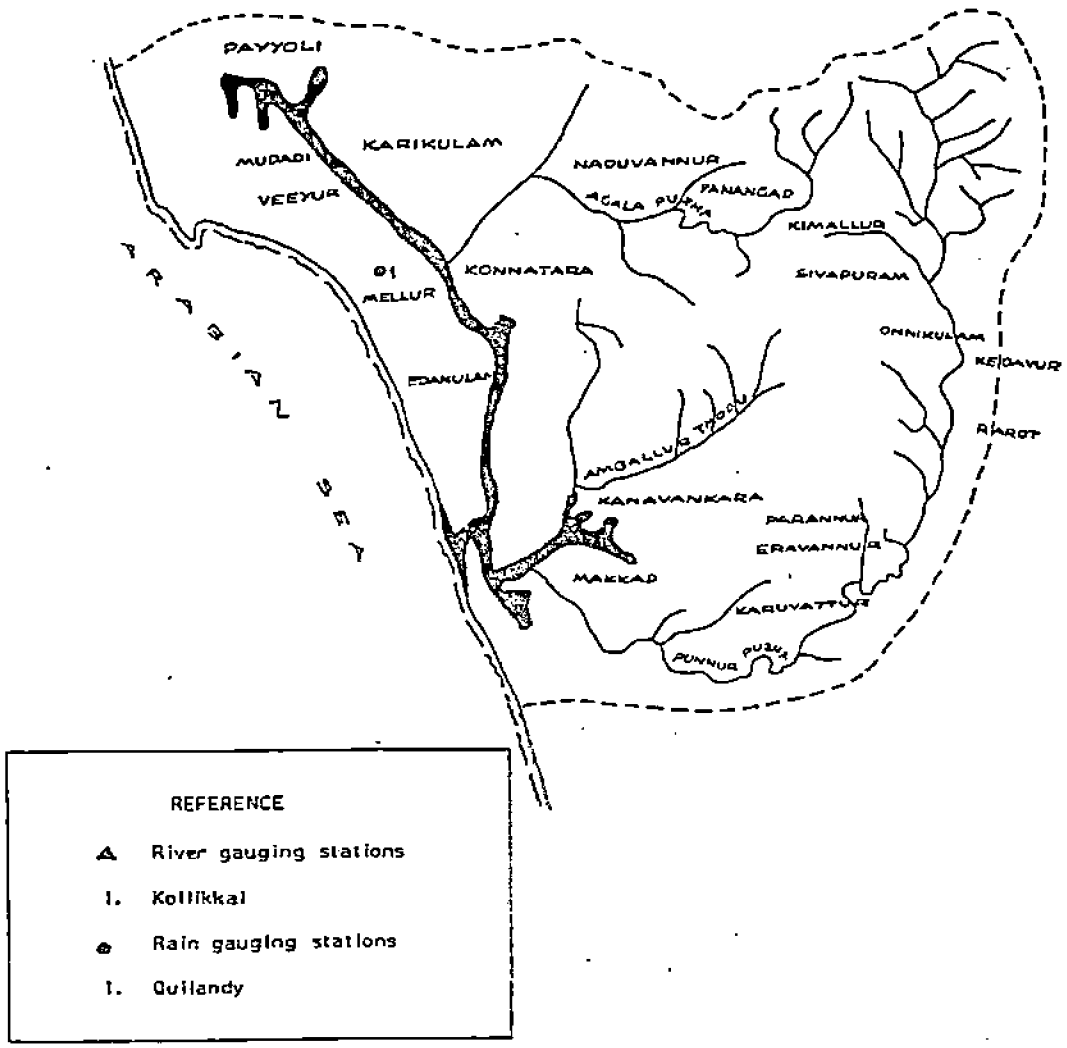
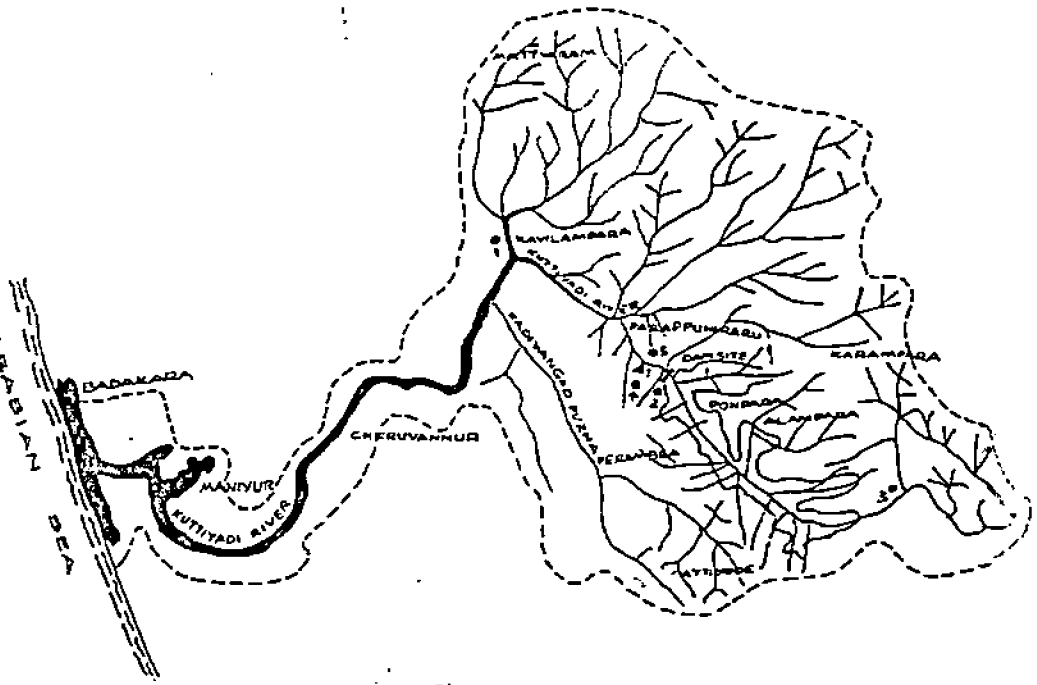


Fig.33. Korapuzha River Basin.

Catchment area - 430 sq.km.



REFERENCES

- ▲ River gauging stations
- 1. Peruvannamuzhi
- ● Rain gauging stations
- 1. Kuttiyadi S.R.O.
- 2. Kuttiyadi Dam
- 3. Kuttiyadi Power house
- 4. Peruvannamuzhi

Fig.34. Kuttiyadi River Basin.

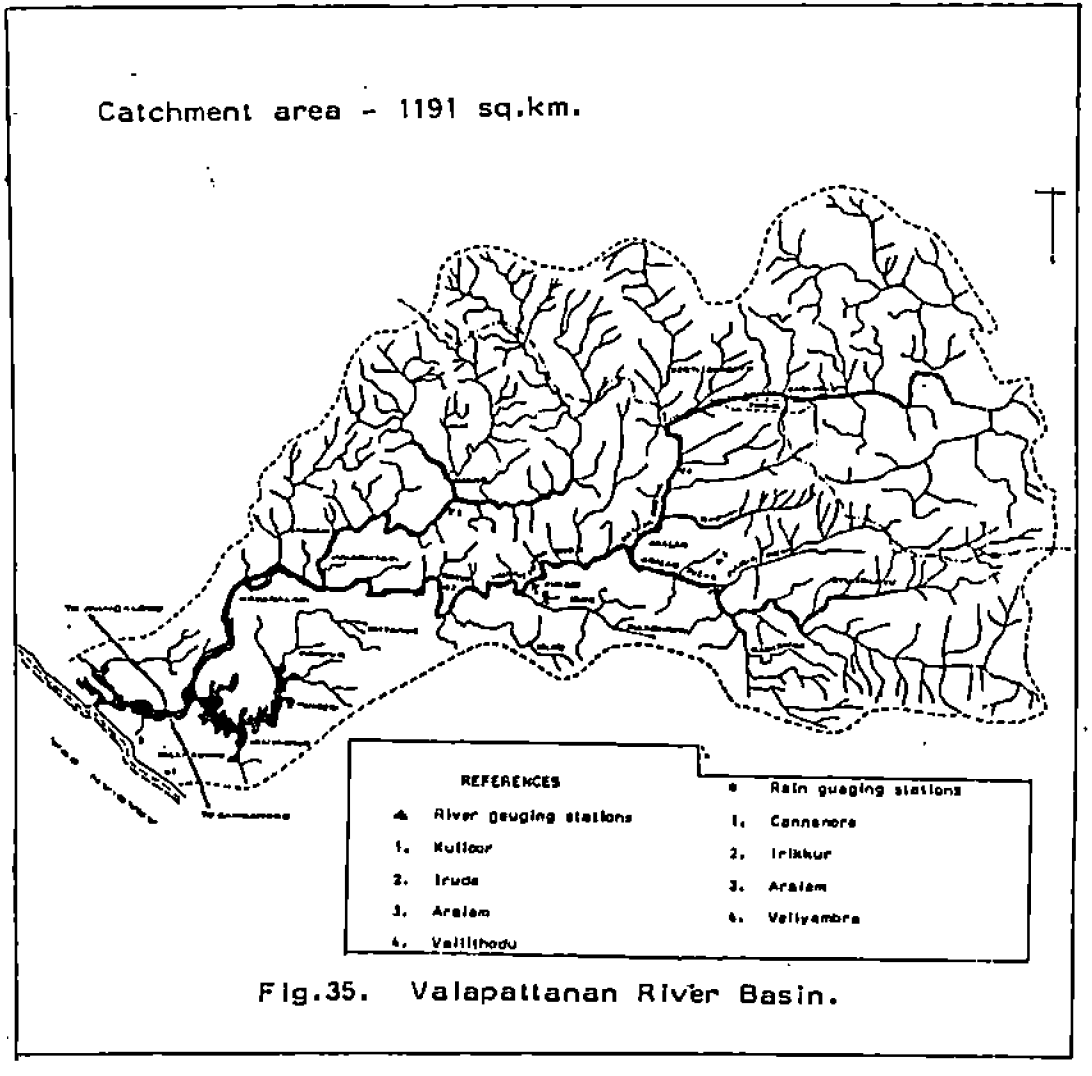
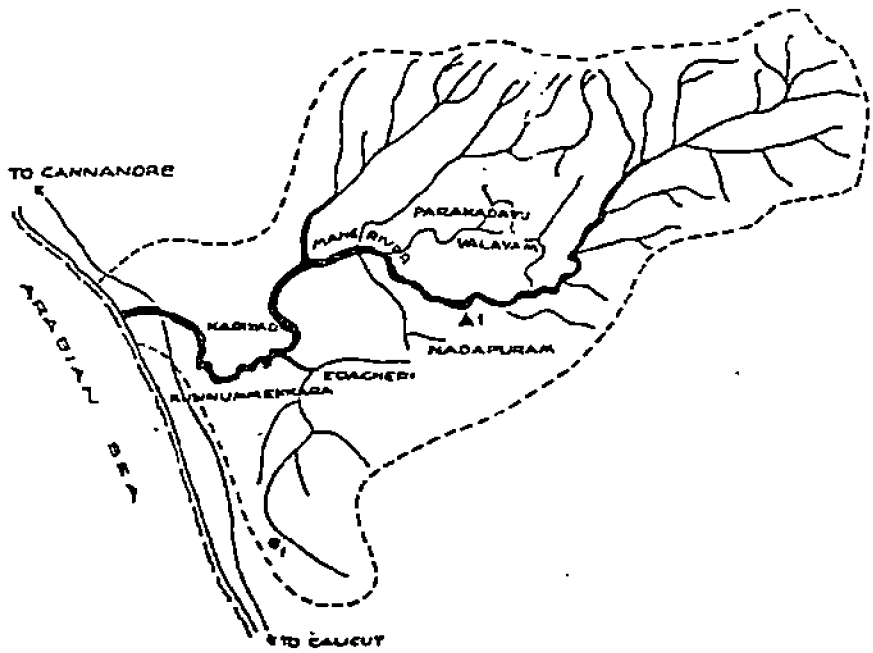


Fig.35. Valapattanan River Basin.

Catchment area - 352 sq.km.



REFERENCE

▲ River gauging stations

1. Badagara

▽ River gauging stations

1. Valayam

Fig.36. Mahe River Basin.

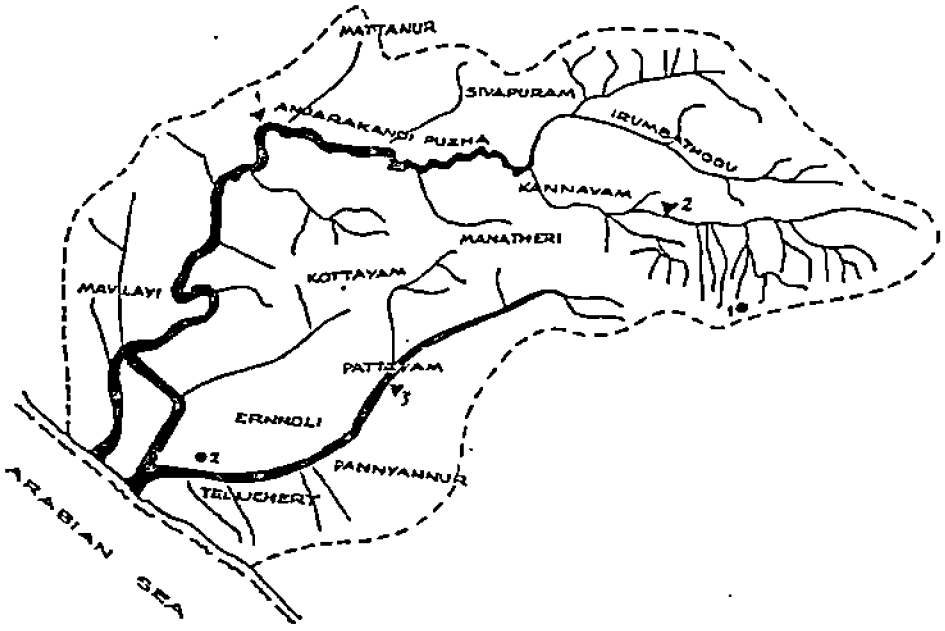


Fig.37. Anjarakandy and Tellicherry River Basin.

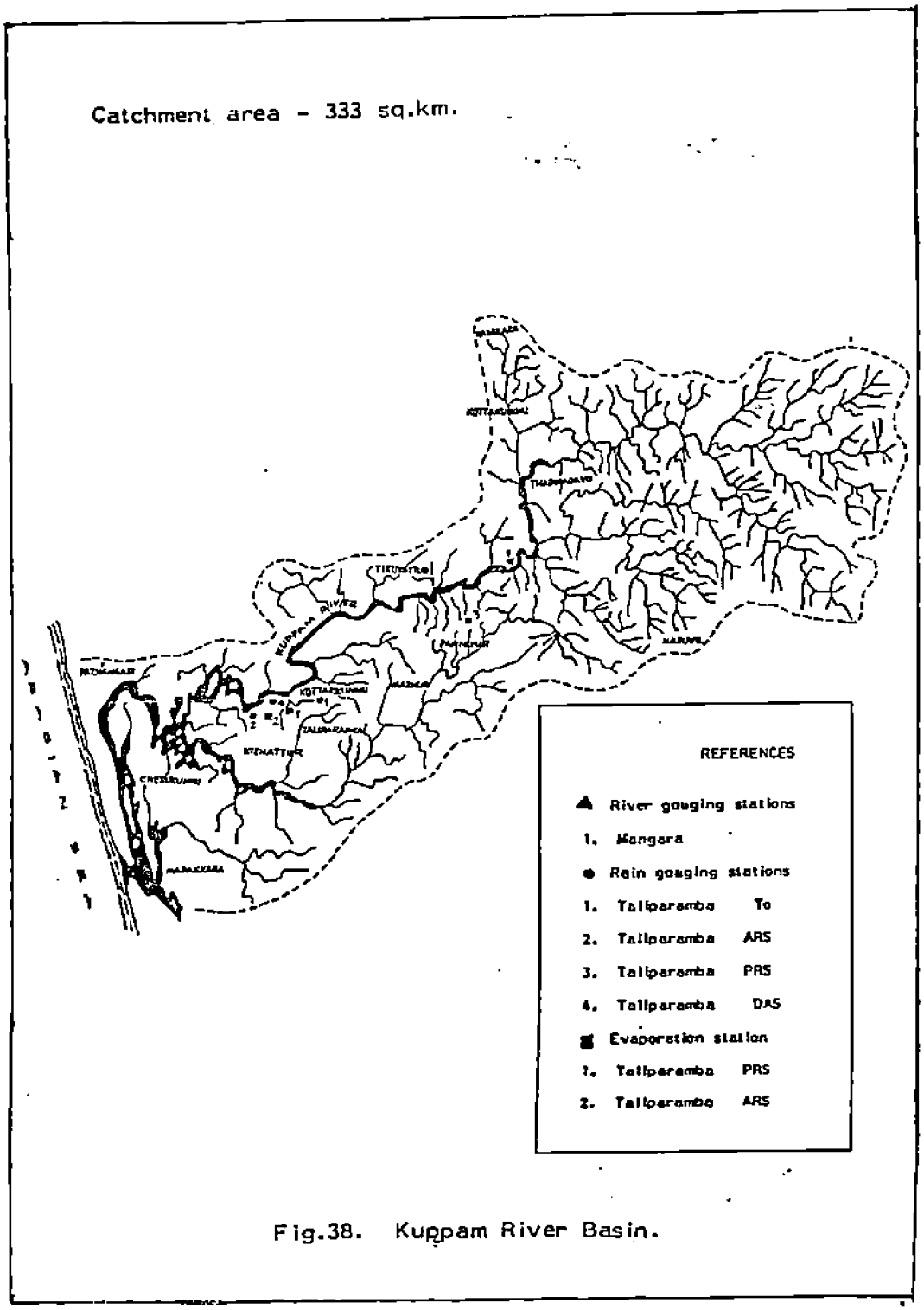


Fig.38. Kuppam River Basin.

Catchment area - 568 sq.km.

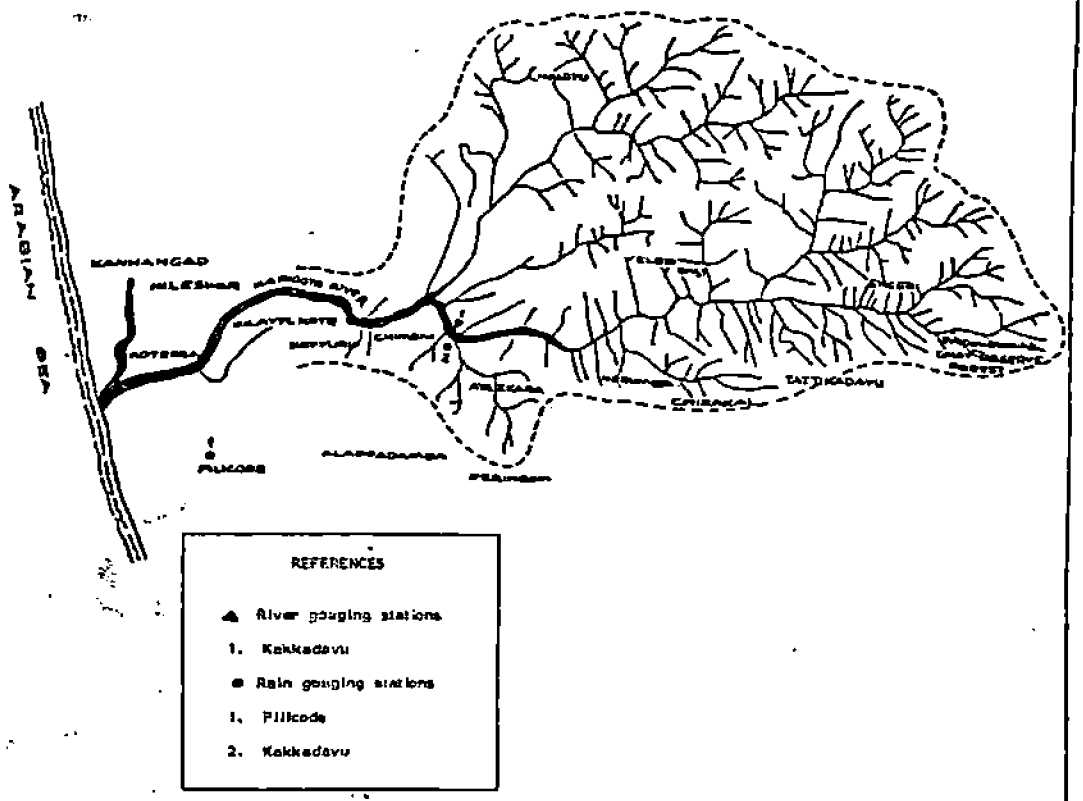


Fig.39. Karingote River Basin.

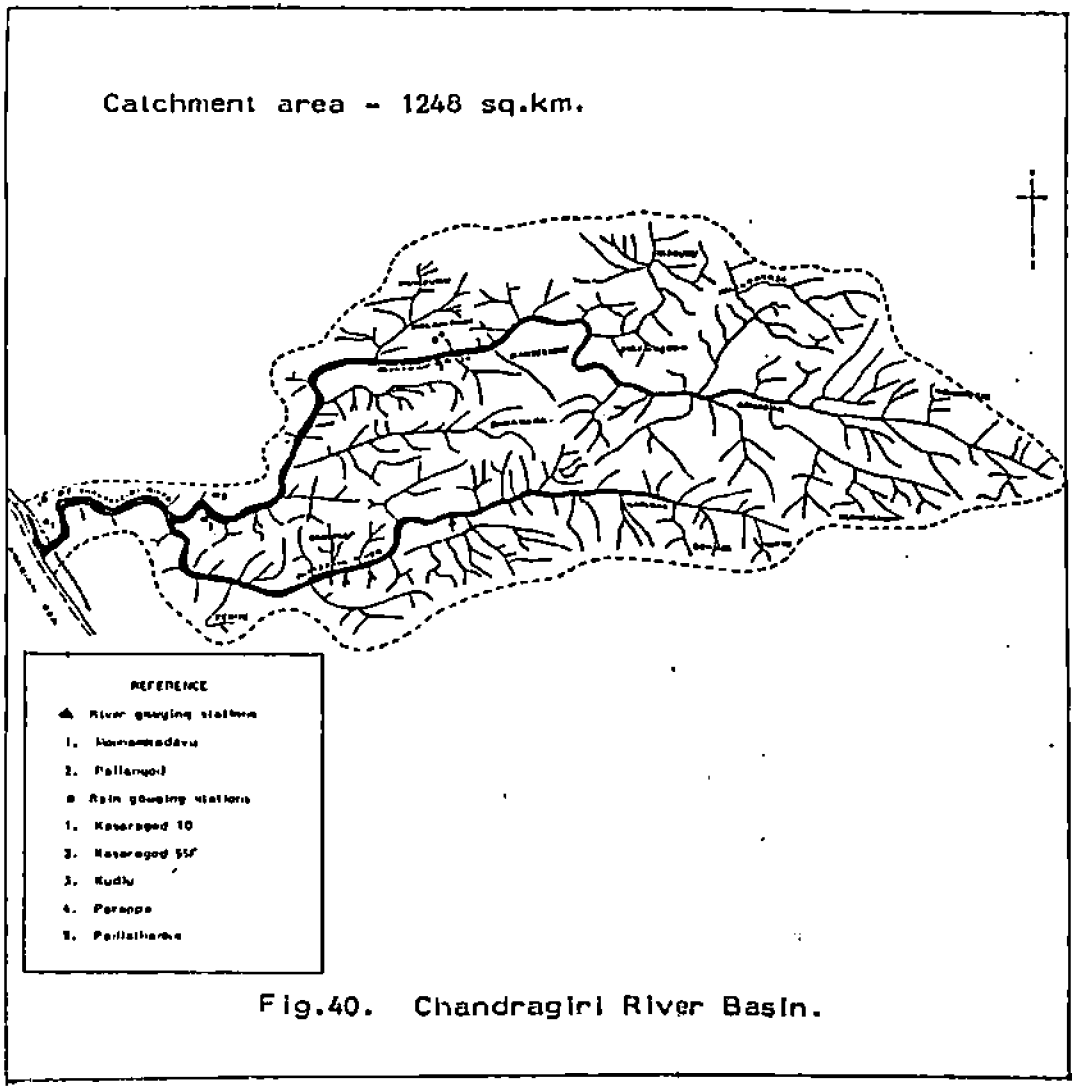


Fig.40. Chandragiri River Basin.

There are only 2 irrigation projects in the northern zone, viz., Kuttiadi in Kozhikode districts (irrigation 14,500 ha. in Kozhikode, Badagara and Quilandy Taluks) and Pazhassi in Cannanore district (irrigating 16,000 ha. in Cannanore and Tellicherry taluks).

The gross irrigated area in the zone according to the latest statistics available (1984-85) is 0.97 lakh. ha (Table-27). This is 12.4 per cent of the gross cropped area of 7.94 lakh ha. The maximum irrigated area in the zone is in Kasaragod district (0.37 lakh. ha.) the source of irrigation being private tanks and wells and minor and lift irrigation schemes.

The area irrigated in Kozhikode district is 11,122 ha with the Government canals of the Kuttiadi irrigation project catering to about 50 per cent of the irrigation needs (4,392 ha). The minor and lift irrigation sources supply irrigation water to 3343 ha. Malappuram district has an irrigated area of 31694 ha which is 33.0 per cent of the irrigated area of the zone. The bulk of this area is irrigated from private tanks and wells, private canals and other sources. There are 223 minor irrigation schemes in Cannanore district and 391 in Kasaragod district covering 3,572 ha and 1,532 ha respectively. Manjeshwar block in Kasaragod taluk alone has 112 such projects (610 ha). In the hill areas of Hosdrug and Kasaragod taluks of Kasaragod district, "Surangams" (horrizontal tunnels made in hills) supply water for irrigation and domestic purpose.

The most important irrigated crop in the zone is coconut (Fig. 41-42). Out of the total area of 2.60 lakh ha under this crop 0.42 lakh ha (16.15 per cent) are irrigated and the bulk of the irrigated coconut is confined to Malappuram (0.19 lakh ha) and arecanut (0.25 lakh ha) are the other important crops receiving irrigation. Kasaragod tops the list of 4 districts in the zone in the irrigation of arecanut.

There is ample scope for increasing the area under irrigation in this zone by utilising surface water and ground water resources. Ground water has not been tapped so far for irrigation. The coastal alluvial soils at various places would yield large quantities of water as revealed by exploratory tests.

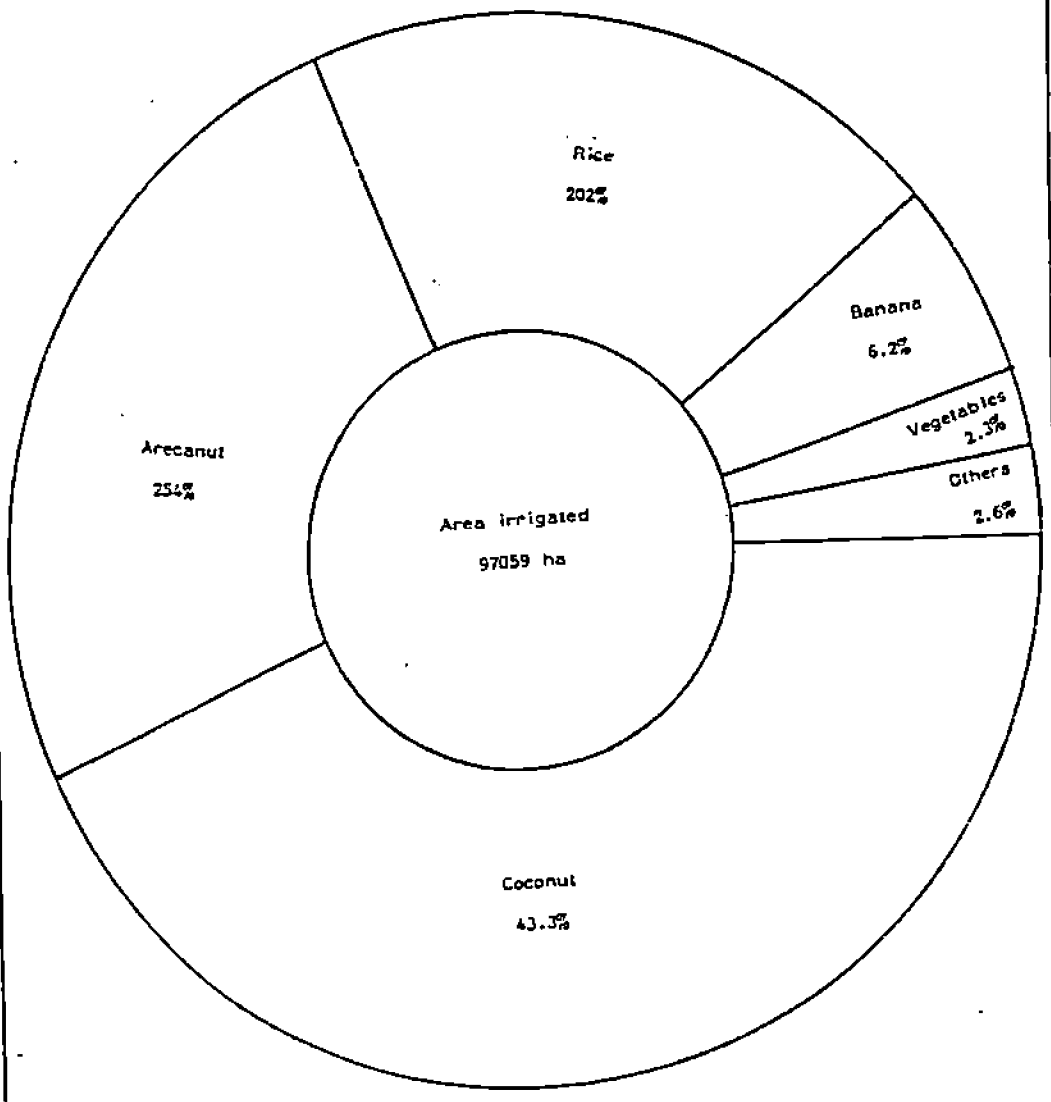


Fig.41. Crop-wise area under irrigation in Northern Zone.

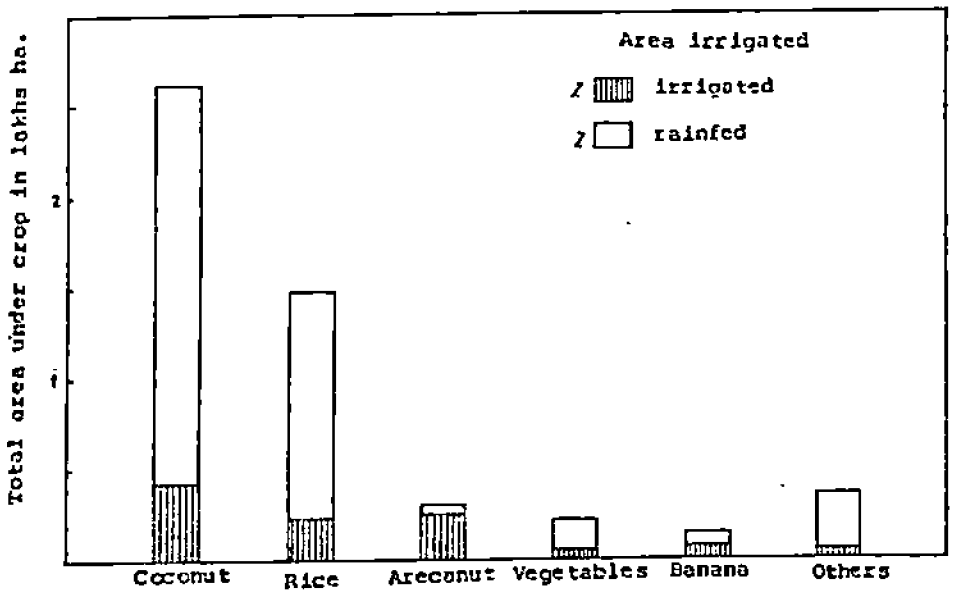


Fig.42. Crop-wise area under irrigated and rainfed in Northern zone.

2.7. Land holding pattern

Nearly 88 per cent of the population in this zone is engaged in farming and allied activities.

The number of operational holdings according to 1981 census, is 9.64 lakhs as against 32.9 lakhs in the state. Kozhikode has the maximum number of operational holdings (3.17 lakhs). The majority of the holdings (84.6 per cent) falls within the range of 0.02 ha to 0.99 ha (Table 28). Only about 0.15 per cent of the holdings has an area of more than 10.0 ha. This is slightly above the state average of 0.10 per cent.

Table 28 Northern zone: Distribution of operational holdings (per cent) 1976-77

District	Total No.of holdings (lakh)	Size of holding (ha)				
		0.02-0.99	1.00-1.99	2.00-3.99	4.00-9.99	Above 10
Malappuram	2.92	86.1	8.7	3.9	1.2	0.10
Kozhikode	3.17	87.8	7.8	3.3	1.0	0.10
Cannanore, Kasaragod	3.64	80.6	11.7	5.6	2.0	0.15
Zone	9.67	84.6	9.5	4.3	1.4	0.15
State	32.92	87.1	8.4	3.4	1.0	0.10

The number of households in the zone is 1.174 lakh with Malappuram leading the districts (359,573). The number of persons per household, on an average is 6.

There are 1.3 lakh cultivators and 4.68 lakhs agricultural labourers in the zone. The agricultural labourers form 6.28 per cent of the total population (Table 29). Malappuram district leads the other 3 districts in the number of cultivators and agricultural labourers (Table 30).

Table 29 Characteristics of population engaged in agriculture, 1981

Category	Number	Percentage to total workers	Percentage to total population
Cultivators	1,93,582	11.02	2.60
Agri. labourers	4,67,855	26.63	6.28
Total (Zone)	6,61,437	37.65	8.88
Total (State)	27,99,859	41.37	10.98

Table 30 Characteristics of population engaged in agriculture (District-wise) 1981

District	Cultivators	Agri. labourers	Total
Malappuram	68,783	1,93,739	262,522
Kozhikode	27,437	70,516	97,953
Cannanore	60,586	1,31,590	192,181
Kasaragod	36,776	72,005	108,781
Total	195,882	4,67,855	661,437

The percentage literacy of the zone is 61.9. The majority of the people speak Malayalam. People in the north and north-eastern parts of Kasaragod taluk speak either Tulu or Kannada. A small number of the people in this tract also speak Marathi. The official languages of the zone are Malayalam and English.

The zone has no major industry.

A socio economic survey was conducted in the zone during 1985. The salient findings of the survey are summarised hereunder.

2.8. Homestead farming situations

Homesteads from a unique feature in Kerala state. Unlike other states, a dwelling house surrounded with a small piece of land of 10 to 50 cents filled with different types of food crops (annuals and perennials) is the significant feature of this situation. The crops may include vegetables, a few number of coconut and arecanut trees, banana/plantains, moringa, pappaya, jack, mango and other fruit trees (Fig.43). In addition to this the presence of one or two livestock (cow/goat/buffalow) with a small unit of poultry consisting of 4 to 5 birds is another notable feature of these homesteads. On an average it is estimated that the annual income from a homestead of 50 cents may vary from 10 to 12 thousand rupees without much effort from the part of the cultivator. The maintenance of livestock, in addition to milk production also produce a sizeable quantity of organic manure to be used in the homesteads. It may be noted that the various crops grown in the homesteads are not at all maintained scientifically and the forage and wastes obtained from them, are again used as manure in homesteads. The livestock and poultry maintained in the homesteads are mainly fed by utilising the home wastes and forages grown in the homesteads. More than 80% of the produce generated in the homesteads is consumed in the home itself.

In order to get a clear picture of the homestead farming in Kerala a basic survey was conducted in the year 1985 in the zone, consisting of Kasaragod, Cannanore, Kozhikode and Malappuram districts giving emphasis to the homestead situations. The different characteristics in this study included; (1) social status of the cultivator, (2) educational background, (3) occupation, (4) residential status, (5) Livestock and fisheries management, (6) utilisation of land holdings, (7) the cropping patterns adopted, (8) implements and machinery possessed, (9) irrigation status, (10) non residential structures attached to the homesteads, (11) maintenance of boundary, (12) source of energy for the homesteads and (13) response to the various sources of knowledge.

2.9. Socio economic status of the farmer

2.9.1. Religion and caste structure

The study revealed that the majority of the residents in the zone are Hindus followed by Muslims. About 57 per

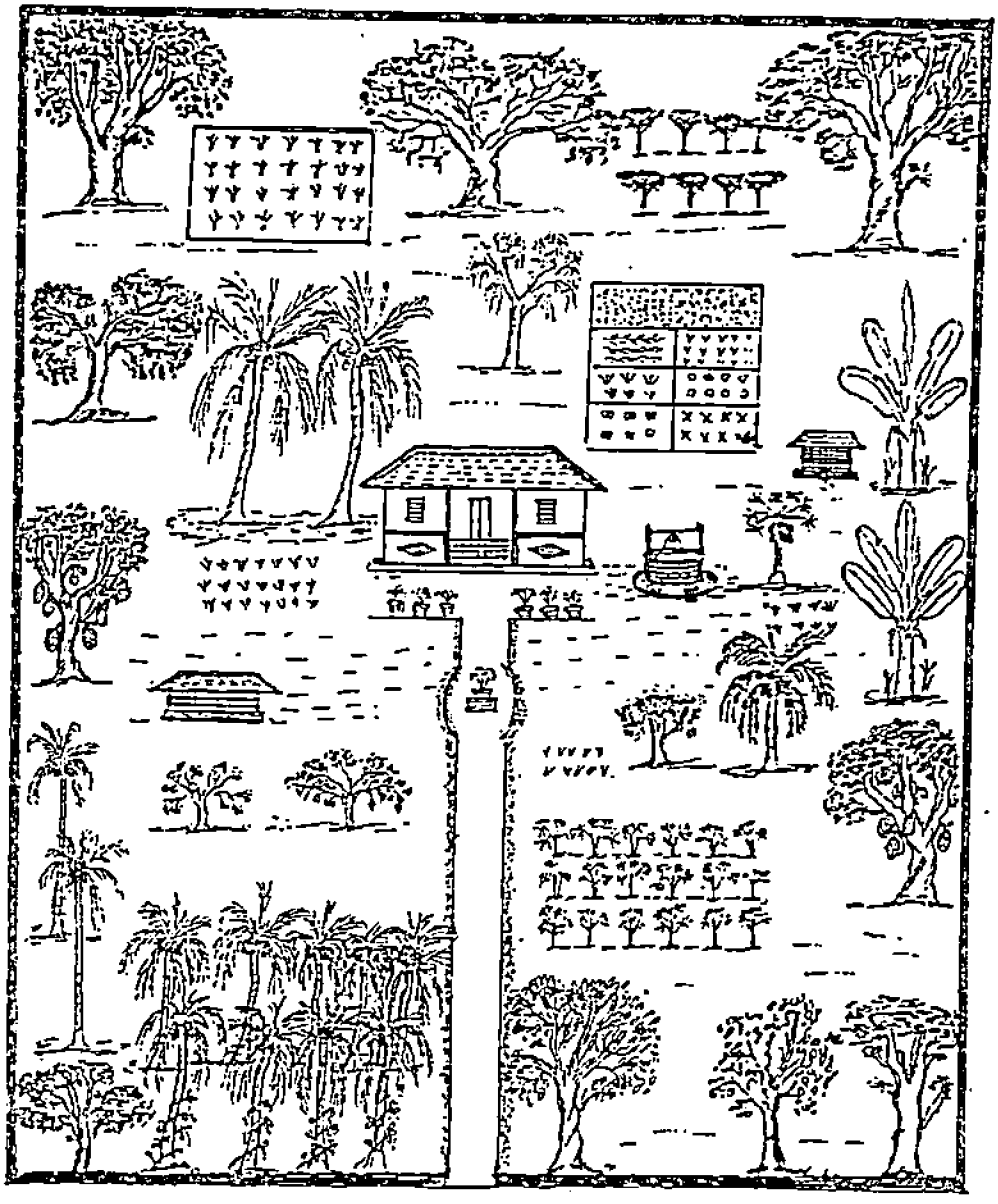


Fig.43. A typical homestead.

cent of the homesteads are of Hindu Origin and 35 per cent muslim. The Christian homesteads form only a minority of 8 per cent.

Considering the caste structure, about 44 per cent of the homesteads are found to be forward, 54 per cent backward and 2 per cent scheduled castes.

2.9.2. Population and sex ratio

The study revealed that the average size of the family in the region is about 7 to 8 numbers in the homestead, out of which 3 are children and the rest working population. The sex ratio is found to be 1:0.9 considering only the adult members, as against the state level figure of 1:1.032.

2.9.3. Size of holding

The results showed that 5.8 per cent of the farmers are having a homestead below 0.25 and 30 per cent, 0.25 to to 1.00 ha; 35.09 per cent of the homesteads extend to 1 to 2 ha. and 16.6 per cent, 2 to 3 ha. The homesteads having more than 3 ha constitutes 11.2 per cent.

2.9.4. Educational background

As in the other parts of the state literacy is very high in the zone. Only 8 per cent of the farmers are found to be illiterate. About 43 per cent of the farmers have secured secondary education and 8 per cent college level.

2.9.5. Occupational status of the farmer

As in the other parts of the state, Agriculture forms the main source of livelihood in the zone. About 81.6 per cent of the farmers in the homesteads depend exclusively on agriculture for their livelihood, 8 per cent of the homesteads conduct business and agriculture forms a secondary occupation to them.

2.9.6. Residential status

The majority of farmers are residing in tiled houses (76 per cent). About 20 per cent of the farmers possess concrete buildings and 4 per cent, thatched ones.

About 75 per cent of the farmers have their dwelling houses electrified.

2.9.7. Irrigation status of the farmer

The majority of the farmers have irrigation facilities. Sixty two per cent of the farmers irrigate the crops properly. The farmers irrigate their lands using different sources of water like; well, tube well, public ponds, public tanks, canals and rivers.

2.9.8. Nonresidential structures within the homesteads

In the homesteads besides the residence, the cultivators have cattle shed, manure pits, tank, well or poultry shed, store house, implement shed etc.

2.9.9. Maintenance and protection of boundary

Fencing of the boundary of the homesteads with live plants, deadwood or barbed wire or by erecting pucca walls is a feature of the homestead. The majority of the farmers are found to be protecting their boundaries with mud walls (31 per cent) and 23 per cent of homesteads have pucca stone walls as boundary. About 13 per cent of the farmers demarcated their boundaries by fencing with plants and live wood.

2.9.10. Source of energy for human use

The energy for home consumption is generated from different sources like electricity, bio-gas, kerosene or fire wood. Results have shown that in 37 per cent of the homesteads electricity is used as source of energy. Four per cent of the homesteads use bio-gas and 35 per cent kerosene. In addition to these different sources, fire wood is used invariably in all the homesteads. About 85 per cent of the farmers in the homesteads have fire woods produced by themselves. But in addition nearly 35 per cent of them purchase fire wood from outside to meet their demands.

2.9.11. Response of farmers to various sources of information

In order to ascertain the extent of knowledge of the farmer in agricultural technology, and his exposure to

various sources of information, enquiries were made to know his response to various information sources. The results showd that 75 per cent of the farmers read daily newspaper for acquiring knowledge. About 45 per cent of the farmers go through agricultural news which is a periodical bullettin on agricultural technology. The majority of the farmers (to an extent of 73 per cent) listen to daily radio programmes. About 42 per cent of the farmers in the homesteads try to gather information from the extension personnel. A small per cent of them (to an extent of 12 per cent) gather informtion from commercial agencies and another 15 per cent from their neighbours and friends. The number of farmers reading Kalpachenu is less than 3 per cent. About 11 per cent of farmers read Kerala Karshakan regularly. Nearly 69 per cent of the farmers in the homesteads are having membership in the nearby co-operatives which helps them to get agricultural credit and agricultural inputs for promoting production.

2.9.12. Major crops and cropping patterns

Agriculture is the main occupation of the people in the zone. Diversity of crops and heterogeneity in cultivation practices are the notable features of agriculture in the zone. As in the other parts of Kerala, polyculture is the rule in the uplands which consists of growing annual and perennial crops together in the same piece of land without much regard to their planting geometry. A typical agricultural holding in this zone will have a small dwelling house, a barn, a few coconut and arecanut palms, a few pepper plants trained on palms or other suitable live standards, one or two mango or jack trees, and a few bananas (Fig.43). Rice fields are generally situated in the low lying areas away from the homesteads.

The gross cropped area of the zone is 7.996 ha which constitute 27.82 per cent of the total cropped area of the state. The important crops grown are given in Table 31 according to their prominence and depicted in Fig.44.

Three major cropping systems can be recognised in the zone. They are:

i) Rice based cropping system
ii) Coconut based cropping system
iii) Homestead farming system

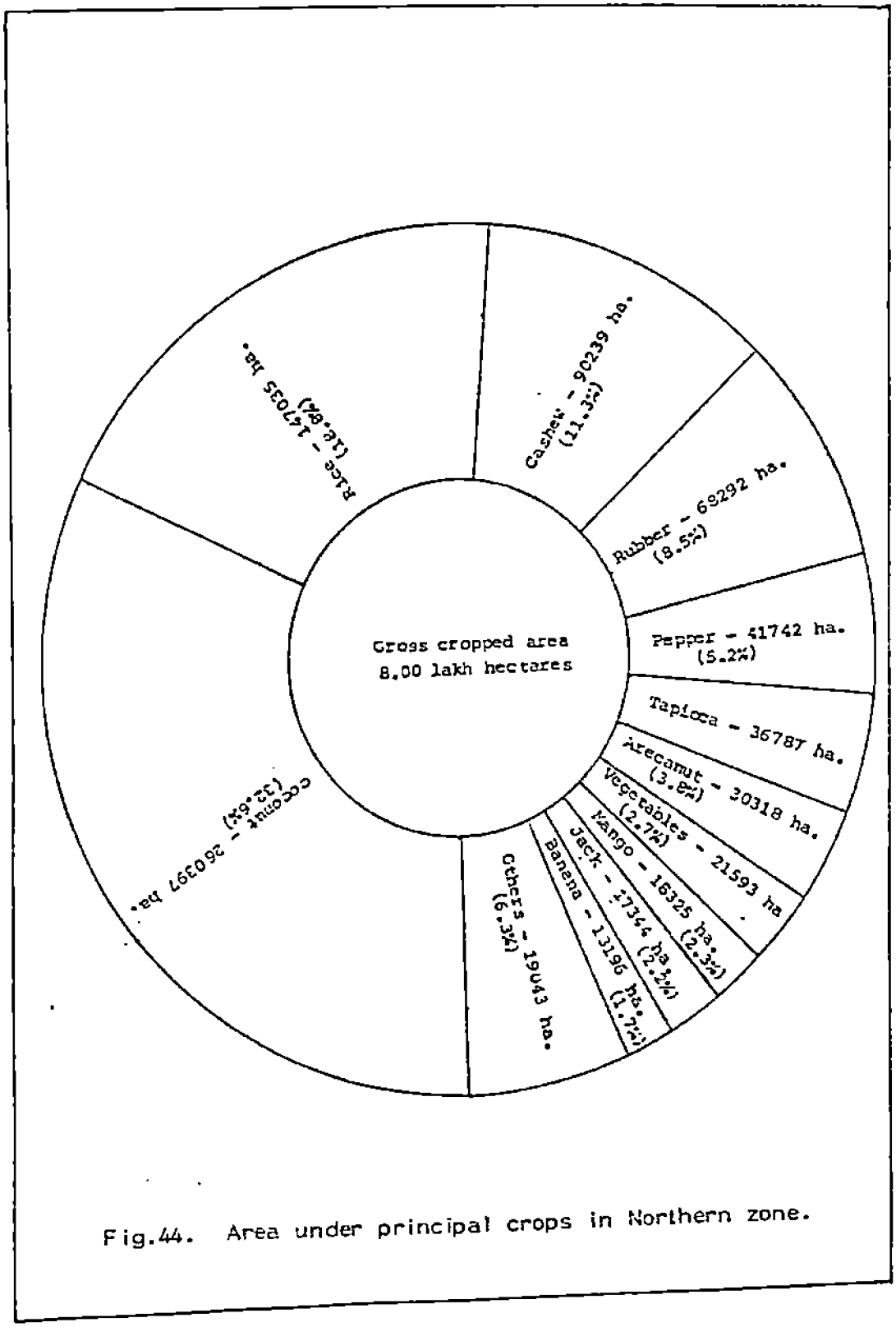


Fig.44. Area under principal crops in Northern zone.

Table 31 Northern zone : Important crops grown, 1984-85

Sl. No.	Crop	Area in the zone (ha)	% to total cropped area of the zone	% Contribution of zone to the area of the crop in the state
1.	Coconut	2,60,397	32.57	37.87
2.	Rice	1,47,035	18.39	20.13
3.	Cashew	90,239	11.29	65.93
4.	Rubber	68,292	8.54	21.89
5.	Pepper	41,742	5.22	39.44
6.	Cassava	36,787	4.60	16.97
7.	Arecanut	30,318	3.79	53.40
8.	Mango	18,325	2.29	30.59
9.	Banana (including Plantains)	13,196	1.65	25.68
10.	Pluses	7,191	0.90	25.04
11.	Vegetables	21,593	2.70	37.59
12.	Jack	17,344	2.17	29.87
13.	Ginger	3,831	0.48	26.35
14.	Sweet Potato	2,175	0.27	46.93
15.	Sesamum	2,713	0.34	18.75
16.	Cocoa	2,521	0.31	14.11
17.	Cardamom	1,379	0.17	2.35
18.	Tobacco	600	0.07	100.00
19.	Betelvine	633	0.08	-.-

Out of these, the homestead farming system is a unique feature of the state and is practised in all the physiographic divisions in the zone. Crop plus livestock is almost the general rule in the system. Pisciculture is also being introduced into this system by enterprising farmers.

The important crops and crop combinations followed in the zone are cited below in 2 broad divisions viz, rainfed and irrigated.

2.9.1. Rainfed

2.9.1.1. Perennial monocrops

Coconut
Arecanut
Rubber
Pepper
Cashew

2.9.1.2. Perennial crops with inter crops (the main crop is given first)

Coconut + arecanut
Coconut + Pepper
Arecanut + Pepper

2.9.1.3. Perennial crops with annual inter crops (main crops given first)

Coconut + Cassava
Coconut + Plantain
Coconut + root crops other than cassava
Arecanut + Plantain
Pepper + ginger/turmeric/colocasia

2.9.1.4. Polyculture of perennial and annual crops

Coconut + arecanut + jack + mango + Plantain + cocoa + vegetables.

2.9.1.5. Annual crops (Virippu - mundakan - punja)
Rice alone
Rice - sesamum - fallow
Rice - pulses - fallow (cowpea/blackgram)
Rice - Cassava
Rice - sweet potato - fallow

2.9.2. Irrigated

2.9.2.1. Perennial crops with or without inter crops
Coconut + arecanut + banana + yams + mango (Polyculture in homesteads)

Coconut + cocoa
Coconut monocrop

Arecanut + Plantain
Arecanut + cocoa
Arecanut + betelvine

Arecanut monocrop

Arecanut + Pepper + Plantain

2.9.2.2. Annual crops (Virippu - mundakan - puncha)

Rice - rice - rice
Rice - rice - fallow
Rice - rice - vegetables/pulses
Flood fallow - rice - rice

Banana (monocrop)

Rice - banana + yam
Rice - tobacco - fallow
Rice - elephant foot yam
Rice - vegetable/ginger

The cropping patterns/crop combination prevalent in the zone are not based on any scientific principles. The cultivators raise a variety of crops in the homesteads and in the coconut and arecanut gardens without considering the variations in climate, the habit of growth of crops their root spread, associations or allelopathic effects. Investigations, therefore, need to be carried out to arrive at the most suitable cropping patterns for each agroecological situation. Similarly, economically viable crop combinations (including livestock) and crop association for the homesteads as well as for the plantation areas (like coconut and arecanut) have to be identified.

2.10 Important crops: area, production and productivity

Coconut, rice, cashew, pepper and rubber are the most important crops grown in the zone. More than forty two per cent of the prduction of cashewnut are from this zone.The entire production of chewing tobacco in the state is from this area. Rubber accounts for 19.35 per cent of the state's production.

The productivity of rice, the principal food crop of this zone, is only 2,039 kg/ha which is less than the state average.

Among the 4 districts in the zone Kozhikode ranks first in area (1.08 lakh ha) and production (675 million nuts) of coconut. The lowest productivity is recorded by Malappuram (3,103 nuts/ha) which is about half of the productivity of Kozhikode. Malappuram tops the list of 4 districts in the area (0.73 lakh ha), production (1.62 lakh tonne) and per hectare yield (2,225 kg/ha) of rice. Cannanore has the maximum area under pepper.The entire

production of chewing tobacco is from the Hosdrug taluk of Kasaragod district.

The area under tree spices - nutmeg, cloves and cinnamon - is 698 ha which is 15.53 per cent of the state area under the crop. The oldest and the biggest cinnamon plantation in Asia is Anjarakandi in Cannanore taluk. Cannanore and Kasaragod taluks together have an area of 188 ha under this crop. Lemongrass, cocoa and fodder are also grown in small areas in the zone.

The area, Production and productivity of imporant crops in the zone as compared to those of the state are presented in Tables 32, 33, and 34. The cropping seasons are depicted in fig.45.

2.11. Horticulture: Status and constraints

Cashew, mango, banana and vegetables are the most important horticultural crops grown in the zone. Cashew occupies an area of 0.90 lakh ha producing annually 0.516 lakh tonnes of nuts. Nearly 71 per cent of the production of cashewnut in the state is from this zone (Table 35). Among the 4 districts, Kasaragod has the maximum area under cashew - 0.41 lakh ha. The crop is mostly grown in the marginal lands without much care and attention.

The zone is famous for its rich germplasm of table and pickle varieties of mango. The well known table variety Olour is a native of this zone. Owing to indiscriminate felling of old trees, the gemplasm of mango is on the verge of extinction. The present area under mango is 0.18 lakh ha which is 30.55 per cent of the area under mango in the state.

Bananas are grown in an area of 0.13 lakh ha. The contribution of the zone to the total production of fresh fruits in the state is 25.7 per cent. Among the bananas, the variety 'Nendran' is the most important and it is raised generally in the wetlands in rotation with rice.

Cucurbitaceous summer vegetables (cucumber, pumpkin, ashgourd and watermelon) are grown in the rice fallows during the summer months in an area of 0.21 lakh ha. The area under vegetables is steadily increasing due to an increase in demand and prices in recent years. The most important constraint to bring more areas under vegetables is

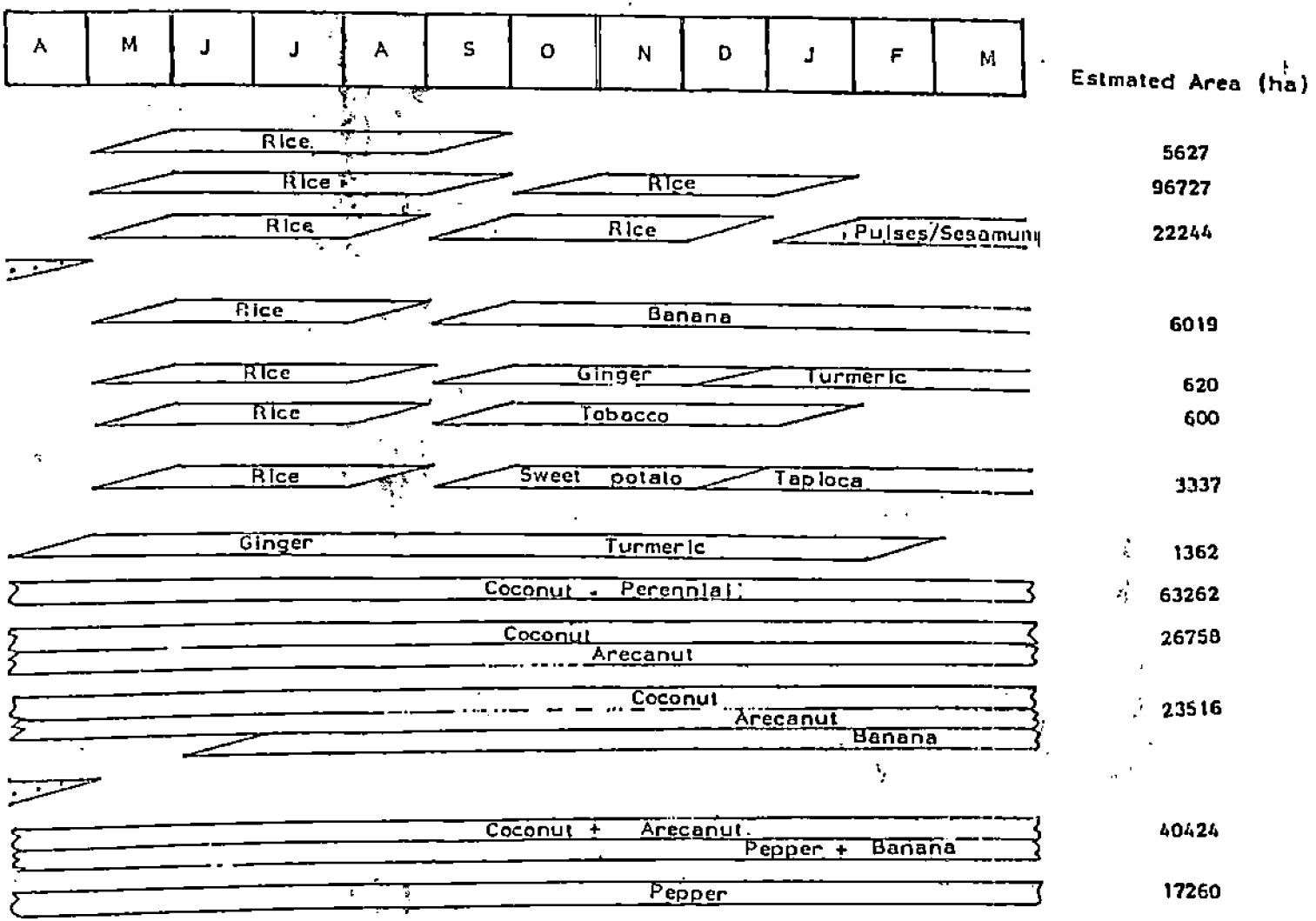


Fig.45. Cropping systems of Northern zone.

Table 32 Northern zone: Area under important crops (ha)

Sl. No.	Crop	Mala-ppuram	Kozhi-kode	Canna-nore	Kasar-agod	Zone
1.	Rice	73,185	21,784	33,594	18,492	1,47,035
2.	Coconut	62,216	1,07,500	67,203	23,478	2,60,397
3.	Banana	4,686	3,399	2,274	2,837	13,196
4.	Tapioca	15,741	3,850	8,197	8,999	36,787
5.	Cashew	19,991	4,189	25,445	40,614	90,239
6.	Pepper	4,619	13,354	15,702	8,067	41,742
7.	Sesamum	2,264	76	130	243	2,713
8.	Rubber	18,711	20,470	22,595	6,516	68,292
9.	Ginger	690	723	771	647	2,831
10.	Mango	6,315	6,844	3,035	2,131	18,325
11.	Jack	5,185	6,424	3,504	2,231	17,344
12.	Cocoa	460	934	464	663	2,523
13.	Cardamom	188	412	379	400	1,379

Table 33 Northern zone: Production of important crops (tonnes)

Sl. No.	Crop	Mala-ppuram	Kozhi-kode	Canna-nore	Kasar-agod	Zone
1.	Rice	1,62,836	39,494	58,167	39,256	2,99,753
2.	Coconut	193*	675*	329*	115*	1,312*
3.	Banana	32,039	20,839	14,314	17,859	85,051
4.	Tapioca	2,73,579	29,607	1,25,168	1,37,415	5,65,769
5.	Cashew	7,378	1,475	16,467	26,283	51,603
6.	Pepper	749	2,352	2,786	1,431	7,319
7.	Sesamum	435	13	21	40	509
8.	Rubber	9,522	11,820	11,806	3,404	36,552
9.	Ginger	1,357	1,030	2,220	1,863	6,470
10.	Mango	27,135	22,079	11,958	8,396	69,568
11.	Jack	10,018	15,026	9,566	6,091	40,701
12.	Cocoa	143	150	90	129	512
13.	Cardamom	2	3	12	12	29

* Million nuts

Table 34 Northern zone: Productivity of important crops (kg/ha)

Sl. No.	Crop	Mala-ppuram	Kozhi-kode	Canna-nore	Kasar-agod	Zone
1.	Rice	2,225	1,813	1,732	2,124	2,039
2.	Coconut	3,103*	6,293*	4,897*	4,897*	5,039*
3.	Banana	6,837	6,131	6,295	6,295	6,445
4.	Tapioca	17,380	7,690	15,270	15,270	15,380
5.	Cashew	369	352	647	647	572
6.	Pepper	162	176	177	177	175
7.	Sesamum	192	174	163	163	188
8.	Rubber	509	577	522	522	535
9.	Ginger	1,966	1,425	2,879	2,879	2,885
10.	Mango	4,297	3,226	3,940	3,940	3,796
11.	Jack	1,932	2,339	2,730	2,730	2,347
12.	Cocoa	311	161	194	194	203
13.	Cardamom	11	7	31	31	21

* Million nuts

Table 35 Northern zone : Horticultural crops : area, Production and productivity, 1984-'85

Crop	Area (ha)	Production (t)	Productivity (kg/ha)
Cashewnut	90239	51603	572
Mango	18325	69568	3796
Banana	13196	85051	6445
Jack	17344	40701	2347
Vegetables	21593	323895	15000

the non availability of quality seed materials, high cost of labour and pest and diseases.

The northern zone has immense potential for growing horticultural crops. Valuable germplasm of cashew mango and jack have to be preserved and evaluated in order to identify elite types. These elite types can be vegetatively propagated with rapid multiplication techniques. Agrotechniques have also to be developed for increasing the productivity of these crops.

2.12. Agricultural engineering status : farm machinery and implements

Not much progress has been achived in the mechanisation of agriculture in the northern zone. The wooden plough still continues to be the principal implement to till the land (29,547). Malappuram district has the largest number of iron ploughs in the zone (3,183 Nos.). There are only 948 tractors in the zone - 725 in Kozhikode, 195 in Malappuram and 16 in Cannanore and 12 in Kasaragod districts. The zone has a total number of 273 power tillers This is a clear indication of the fact that the farm operations continue to be performed in the traditional style with practically no relief for the majority of the farmers from the drudgery of physical labour. Transplanting, harvesting and processing of produce are manually done. Plant protection operations are mainly carried out with hand operated sprayers; there are altogether 22,614 such sprayers in the zone. Of the 22,614 sprayers in the zone, 8,231 are in Kasaragod district alone. Most of these equipments are used for pest control in rice, rubber and arecanut (Table 36).

Altogether the zone has 28,310 pumpsets driven by electricity and diesel oil out of which 20,209 are electric and 8,101 diesel. A total number of 20,730 irrigation units are available under other categories. The maximum number of electric motors and oil engines are used in Malappuram district followed by Kasaragod district.

Mhotes and such other water lifting devices are not in common use in the zone and their number is negligible.

There is ample scope for introducing drudgery removing tools and implements in the zone. There is an urgent need for mechanisation in agriculture due to the fact that there has been a steep fall in the number of agricultural

Table 36 Northern zone : Agricultural machinery and implements, 1984-85 (Number)

Category	District				Total for the zone
	Mala-ppuram	Kozhi-kode	Canna-nore	Kasara-god	
Country plough	11,968	6,074	4,786	6,719	29,547
Improved plough	3,183	669	411	31	4,264
Sprayer	3,915	4,147	6,321	8,231	22,614
Tractor	195	725	16	12	948
Power tiller	85	42	114	32	273
Electric Motor	7,857	1,869	4,638	5,845	20,209
Diesel pumpset	3,887	755	1,956	2,003	8,101
Other items	9,999	942	1,299	8,490	20,730

labourers avilable to work on the land during the last decade. This phenomenon will continue in the years to come as more and more industries are set up in the zone.

2.13. Animal husbandry and livestock status

i. Livestock

Animal husbandry has considerable scope for development in the northern zone. At present, it is poorly developed. It is one of the sectors capable of bringing about speedy economic and social transformation in the rural areas. Many of the agricultural operations are dependent on animal power, besides, farm yard manure is the most important source of plant nutrients for the crops.

The total livestock population of the zone, as per 1982 census, is 14.85 lakhs which is 26.32 per cent of the total population of 56.45 lakhs in the state (Table 37). The density of livestock population in the zone is 1 per ha. Malappuram districts ranks first in livestock population (4.83 lakh). Among the taluks Ernad in Malappuram district with a livestock population of 35,320 tops the list.

The goat population in the zone is 5.67 lakhs as against 20.13 lakhs in the state (28.16 per cent). Sheep is rarely raised in the zone and their number is negligible due primarily to unfavourable weather conditions. Malappuram district has the largest goat population (2.24 lakhs)followeded by Kozhikode (1.54 lakhs). Among the taluks, Erand in

Table 37 Northern zone : Livestock and poultry population (1982 census)

District	Livestock population (No.)	Density (No./ha)	Total poultry population (No.)	Density (No./ha)
Malappuram	483,243	1	16,73,560	5
Koznikode	375,180	2	10,50,749	5
Cannanore Kasaragod	627,515	1	12,37,425	2
Zone	14,95,938	1	39,61,734	4
State	55,44,580	1	1,50,83,410	4
Contribution of the zone to State (%)	249.90		26.27	

Malappuram district has the maximum population of goats (0.96 lakh). Goat development can play an important role in augmenting milk and meat production. The average yield of goat milk is now very low.

Cannanore district has a pig population of 27116 which is roughly 15.7 per cent of the state pig population of 1.72 lakh. They are reared mainly for meat. In the other two districts, their number is not considerable.

The poultry population in the zone is 39.61 lakh with a population density of 4 per ha. As in the case of livestock, Malappuram district has the maximum poultry population (16.73 lakh, desity 5 per ha). A good part of the poultry population still consists of indigenous breeds. Commercial poultry rearing as a subsidiary occupation is the quickest and easiest way of increasing the farm income. In view of this, poultry industry has a special appeal in the zone. There is only one well equipped poultry farm in the zone. It is at Mundayad in Cannanore taluk in Cannanre district. The farm distributes improved strains of poultry in the zone.

A survey conducted in the zone during 1985 in different homesteads in the 4 districts showed the following statistics in respect of the livestock holding pattern of different categories of farmers:

Category	Cattle			Buffa-loe	Poultry.
	Male	Female	Total		
Big farmers	0.62	2.17	2.79	0.34	2.12
Small farmers	0.45	1.83	2.28	0.19	2.08
Marginal farmers	0.18	1.00	1.18	0.07	1.00

Unlike in the other parts of India, the cattle and goats are reared in the homesteads and not on herd basis in the villages. Poultry are reared according to backyard system. Only very enterprising farmers rear poultry according to cage and deep litter systems

2.13.2. Fisheries

The northern zone has a coastal line of 293 km. which is about 49.6 per cent of the coastal line of Kerala. The inshore waters of the zone have immense potential for fishing especially for the commercially important varieties such as prawns, makerel, sardines etc. There is also much scope for inland fisheries since there are as many as 25 rivers in the zone in addition to a large number of small lakes and ponds. The rivers have fresh water in the upper reaches and brackish water in the lower reaches adjacent to the sea. There has been little organised development of the inland fisheries resources. These need be exploited to develop inland fishery industry in the state.

The marine fish landings (1981 census) Cannanore and Kasaragod districts together accounted for 0.625 lakh tonne as against the total landings of 2.748 lakh tonnes in the state. Kozhikode ranked next (0.312 lakh tonne). The most important species of fish is lesser sardines followed by penceid prawns.

2.14. Agricultural marketing : status and constraints

Agricultural marketing in the northern zone is yet to develop on organised lines in view of the predominence of

Erand in

cash crops in the agricultural economy. The cash crops produced in the zone have not only a national market but international markets as well. The major commodities involved are coconut, pepper, cashewnut and arecanut. These commodities are not marketed through organised channels and therefore substatial price fluctuations do exist putting the producers to very great disadvantages. For example, the marketing of copra, the most important commodity of the zone, is controlled by a few dealers at Cochin and Mangalore. These dealers sell in turn to an equally small number of expeller units mostly concentrated in Maharashtra. The Kerala State Coconut Development Corporation has recently entered the field of coconut processing and they have set up a unit in Quilandy taluk in Kozhikode district. A well organised marketing system can go a long way in not only minimising price fluctuations of commodities like coconut, but it will also help producers and production.

In respect of most of the commodities, the bulk of the trade transactions take place in villages where they are produced. Their proportion, however, may vary from crop to crop. A survey conducted by the Directorate of Economics and Statistics indicates the following position in respect of some of the important commodities.

Commodity	Village	in markets	through co-operatives	Total
Rice	98.4	1.6	–	100
Coconut	81.1	17.5	1.4	100
Cassava	49.6	50.4	–	100
Pepper	37.4	69.1	5.2	100
Cashew	65.2	34.8	–	100

There are about 15 markets in the northern zone which conduct daily, biweekly or weekly sales and purchases. These makets are controlled by municipalities, panchayats and market committees. There are also about 440 primary marketing societies in the co-operative sector. There are no regulated markets in the zone.

There is immediate need to organise proper marketing in respect of such items which middlemen are able to exploit

depriving the producers a legitimate price for their produces /products. Two alternatives that suggest themselves are:

i) Introduction of regulated markets for as many commodities as possible and

ii) strengthening the co-operative institutions.

2.15. Research organisation in the zone

Organisation	Function
Regional Agrl.Reseach station, Pilicode.	Lead function for research on coconut, Verification and testing function for rice, pulses and annual oil seeds.
Pepper Research Station, Panniyur.	Lead function for research on pepper.
Cashew Research Station, Anakkayam.	Research on cashew
Kelappaji college of Agrl. Engineering and Technology (Research Component)	Testing Centre for rice, oil seeds and pulses.
Cattle Infertility Scheme, Vellimadukunnu. Kozhikode.	To study nature and magnitude of prevalence of infertility in cross bred cattle and related problems.
Central Plantation Crops Research Institute, Kudlu, Kasaragod. (ICAR)	Research on Plantation Crops.
National Research Centre for Spices, Chelavoor, Calicut.	Research on spices
Centre for Water Resources Development and Management Kunnamangalam, Calicut.	Centre of excellence for advanced research, training and extension on all aspects of water resources utilisation.

In addition to these research institutions, there is a KVK at Vorkadi, Manjeshwar and All India Co-ordinated project for the rapid improvement of agricultural technology directed for the upliftment of SC/OBC at Nilambur.

CHAPTER - III

AGRO-ECOLOGICAL SITUATIONS IN THE ZONE

3.1. Criteria for identifying agro-ecological situations:

The northern zone has a humid tropical climate in the entire range with an isohyperthermic temperature regime. The zone is characterised by a rainfall pattern of heavy down pour during June - September, occassional showers during October - November and a prolonged dry spell from December to May with a mean annual rainfall of 3378 mm. The intensity of rainfall and the duration of dry spell do not vary much from tract to tract with the result the farmers resort to cultivation of all types of crops throughout the zone either in pure or mixed stands. However, diversity of crops and heterogenity in cultivation practices do exist and they are mainly dependent on the variation in soil type and moisture regime. Altitude does not play a significant role in the selection of crops in this zone.

Depth of soil, intensity of laterisation, topography and salinity are the other factors deciding the cropping patterns in the zone.

3.1.1. The Major soil types

1) Laterite (L)
2) Coastal alluvium (CA)
3) Riverine alluvium (RA)
4) Hydromorphic saline (HS)
5) Forest loam (FL)

The depth of laterite soil (solumn) varies from shallow (less than 2 m) to deep (more than 2 m). This factor is considered for laterite soils only which is the most predominent soil type. The other soils are generally deep.

1) Shallow (S)
2) Deep (D)

3.1.2. Physiography

1) Plateau (P)
2) Valley (V)

3.1.3. Moisture regime

1) Rainfed (R)
2) Irrigated (I)

3.1.4. Salinity

Salinity problem exists in areas adjacent to sea because of salt water intrusion.

1) Saline (S)
2) Non saline (NS)

3.2. Agroecological situations

Considering the above factors, the zone has been divided into the following 9 agro-ecological situations (Table 38).

1. Alluvial (coastal alluvium), non saline, rainfed coastal tract. (ANS - RCT)

2. Alluvial (coastal alluvium), non saline, irrigated coastal tract. (ANS - ICT)

3. Alluvial (riverine), salt affected, rainfed (flood - prone) tract (RAS - RT)

4. Alluvial (hydromorphic), non saline, irrigated tract. (AHNS - IT)

5. Shallow, high level plateau laterite, non saline, rainfed tract (SHLPL - NS - RT)

6. Shallow high level plateau laterite, non saline, irrigated tract. (SHLPL - NS - IT)

7. Deep valley laterite, non saline, rainfed tract (DVL - NS - RT)

8. Deep valley laterite, non saline, irrigated tract (DVL - NS - IT)

9. Deep forest loam, non saline, rainfed tract (DFL - NS - RT)

Table 38 NORTHERN ZONE, KERALA : AGROECOLOGICAL SITUATIONS

Sl. No.	Agroecological situation	Soil type	Soil depth (Deep or shallow)	Soil Problems (saline/ nonsaline)	Moisture regime	Principal crops	Net cropped area and cropping Intensity Situation		Percentage NCA of the situation	Location (District/Taluk)
							NCA (lkh ha)	Intensity (%)	to the NCA of the zone	
1	2	3	4	5	6	7	8	9	10	11
1.	Alluvial (Coastal alluvium), Nonsaline, Rainfed Coastal Tract (ANS -RCT)	Coastal alluvium	Deep	Nonsaline	Rainfed	Coconut Rice	0.55	121	8.02	Malappuram/Tirur, Ponnani Kozhikode/Kozhikode, Badagara Cannanore/Tellicherry, Cannanore, Taliparamba Kasaragod/Hosdurg, Kasaragod.
2.	Alluvial (Coastal Nonsaline Irrigated Coastal Tract. (ANS - ICT)	Coastal alluvium	Deep	Nonsaline		Coconut	0.11	174	1.60	Malappuram/Tirur Kozhikode/Kozhikode, Badagara Cannanore/Tellicherry, Cannanore, Taliparamba Kasaragod/Hosdurg, Kasargod.
3.	Alluvial (riverine), Salt Affected, Rainfed (Flood Prone) Tract. (RAS - RT)	Riverine alluvium	Deep	Saline towards the end of rabi season as salts rise up.	Rainfed. Flooded during June - July	Rice	0.09	131	1.31	Malappuram/Ponnani, Tirur Kozhikode/Kozhikode, Quilandy, Badagara. Cannanore, Tellicherry, Cannanore. Taliparamba. Kasaragod/Hosdurg, Kasaragod.
4.	Alluvial (Hydromorphic), Nonsaline Rainfed Irrigated Tract (AHNS - IT)	Hydromorphic alluvium	Deep	Nonsaline	Irrigated	Rice	0.04	100	0.58	Malappuram/Ponnani, Tirur.
5.	Shallow high level plateau laterite, nonsaline, rainfed tract. (SHIPL - NS - RT)	Plateau Laterite	Shallow	Nonsaline	Rainfed	Coconut, Rice, Cashew, Rubber.	3.22	108	46.94	All Districts/All Taluks.

1	2	3	4	5	6	7	8	9	10	11
6.	Shallow high level plateau laterite, nonsaline, irrigated Tract. (SHLPL - NS - IT)	Plateau laterite	Shallow	Nonsaline	Irrigated		0.21	171	3.06	Malappuram/Ponnani, Tirur, Perinthalmanna Kozhikode/Kozhikode, Badagara Cannanore/Tellicherry, Cannanore, Taliparamba.
7.	Deep, Valley, Laterite, nonsaline rainfed tract. (DVL - NS - RT)	Laterite	Deep	Nonsaline	Rainfed	Coconut, Arecanut, Rubber, Cassava, Rice	1.45	21.14	2.04	Malappuram/Tirur, Ernad, Perinthalmanna Kozhikode/Kozhikode, Badagara Cannanore/Tellicherry, Cannanore Kasaragod/Hosdurg, Kasaragod.
8.	Deep, Valley, nonsaline, irrigated tract. (DVL - NS - IT)	Laterite	Deep	Nonsaline	Irrigated	Arecanut, Banana, Pepper, Cocoa, Rice	0.38	113	5.54	Malappuram/Tirur, Perinthalmanna Kozhikode/Kozhikode, Badagara Cannanore/Cannanore Kasaragod/Hosdurg, Kasaragod.
9.	Deep forest loam, nonsaline, rainfed	Forest loam	Deep	Nonsaline	Rainfed	Plantation crops	0.81	113	11.81	Malappuram/Ernad Kozhikode/Kozhikode, Badagara Cannanore/Tellicherry, Cannanore, Payyanur Kasaragod/Kasaragod, Hosdurg.

3.2.1. Alluvial, non saline, rainfed coastal tract (ANS - RCT)

3.2.1.1. Delineation

This agro-ecological situation is spread over 9 taluks in the zone along the sea coast. The net cropped area of the situation is 54,663 ha equivalent to 7.97 per cent of the net cropped area of the zone.

3.2.1.2. Soils

The soil type is deep (2-4 m), well drained littoral sand deposited by sea and wind over a period of time. The water table is high in low lying areas. The soil is low in organic matter clay content, cation exchange capacity and fertility status. the reaction is acidic (pH 5.8-6.5). The physicochemical properties of the soils are given in Annexure —1.

3.2.1.3. Climate

The total rainfall ranges from 2552 mm in Tirur to 3107 mm in Kasaragod. The precipitation from both the South West and North East monsoons is received in this situation., However, the bulk of the rains (75%) is received in three months June, July and August. The summer rains are unpredictable in this tract with the result that the crops experience a prolonged moisture strees from January to May. The mean maximum temperature varies from 33°C to 37°C and the variation in temperature between places is negligible due to the proximity to the sea.

3.2.1.4. Physiography

The situation has a level topograohy the elevation ranges from 3 to 10 m above MSL.

3.2.1.5. Irrigation

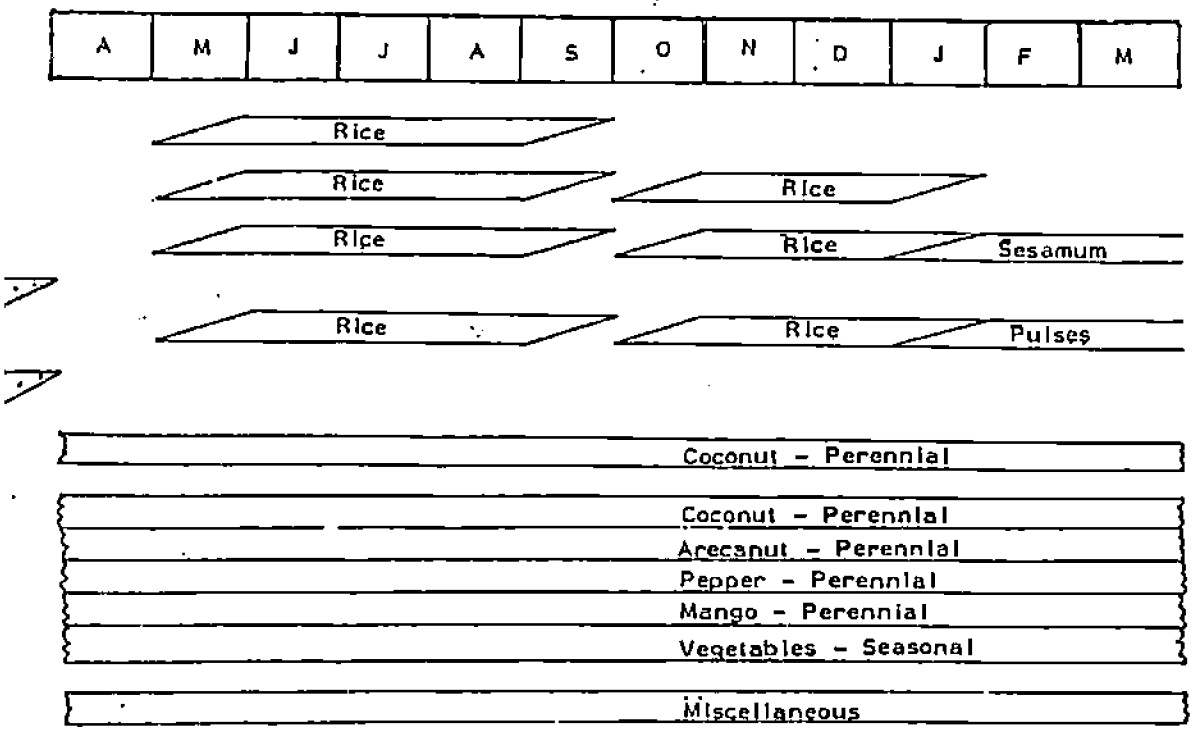
The entire tract is rainfed. However, in some areas irrigation is practiced by pumping water from shallow wells and ponds, the area being negligible.

3.2.1.6. Major Crops and cropping intensity

The gross and net cropped areas of the zone are

Table 39 Northern zone: Distribution of the net cropped area in different districts (ANS-RCT).

Districts	Taluk	Sub division	Agrl. Development Unit	Net Cropped area(ha)
Malappuram	Tirur	Tirur	Parappangadi Kalpakan-cherry, Tirur,	17,368
	Ponnani	Tavanur	Vattathami, Marancherry	
Kozhikode	Badagara	Badagara	Thikkodi, Chorode	
	Kozhikode	Kozhikode	Calicut, Quilandy, Ramanattukara, Atholi.	18,405
Cannanore	Tellicherry	Tellicherry	Mambram Tellicherry	
	Cannanore	Cannanore	Kattampally Orikkara, Cannanore	12,772
	Taliparamba	Payyanur	Trikarpur Cherukunnu, Cheruthazham	
Kasaragod	Hosdurg	Kasaragod	Cheruvathur, Nileshwar	
	Kasaragod		Vidyanagar, Uduma, Kodalamugaru, Kumbala	6,118
Total				54,663



	Rainfed crops Net cropped Area (ha)	Percent (%)
	145	0.27
	14,995	27.43
	165	0.30
	3293	6.02
	5550	10.15
	28871	52.81
	1640	3.01
Total	54,665	

Cropping Intensity 121%

Fig.46. Rainfed cropping system.
Agro-ecological situation - 1 (ANS - RCT).

66,146 ha and 54,665 ha, respectively. The cropping intensity is 121%. The important crops grown are coconut, rice, arecanut and cashew (Table 40). The area under rice during kharif and rabi seasons is almost the same. Pulses occupy 18.65 per cent of the total area under rice. Among the pulses, blackgram acounts for 75 per cent of the area and is mostly grown in summer rice fallows utilising the residual soil moisture.

3.2.1.7. Cropping systems

Rice and coconut based cropping systems are in vogue. In rice fields, rice, pulses and sesamum are grown after the harvest of the rabi crop. In coconut gardens a mixed cropping system is practiced with banana, vegetables, arecanut, pulses, mango and even cashew (Table - 41).

The important features of the cropping systems are depicted in Fig.46 and explained below.

i Rice

The Kharif rice is sown immediately after the receipt of the pre-monsoon showers in the month of May under semi-dry conditions. During the early vegetative phase, there is no standing water in the field. The fields are submerged only after receipt the S.W. monsoon in the month of June. Invariably the crop is affected by moisture stress if the monsoon is late. The crop is harvested in August-September. Very rarely the Kharif crop is transplanted in which case dry nurseries are raised in the month of May and seedlings transplanted in June-July. This is the usual practice in the Kasaragod subdivision in Kasaragod district.

Usually medium duration tall varieties are preferred by cultivators. In about 25% of the area under rice, modern dwarf varieties are grown.

Varieties

Local : Allikkannan, Thovvan, Malakkaran, Aryan Ponnariyan

Modern : Jaya, Jyothi, Bharathi

Table 40

Sandy, nonsaline, rainfed coastal tract : Crops (area in ha)

Crop	Malap puram	Kozhi kode	Canna nore	Kasar agod	Total	% to total of the crop inthe zone	% to gross cropped area in the zone
Rice	2955	5055	8926	1215	18187	12.38	2.28
Banana	60	300	175	652	1188	9.01	0.15
Pulses	174	293	2818	108	3393	52.31	0.43
Vegetables	73	147	1710	650	2580	12.04	0.33
Sesamum	135	15	110	105	365	14.81	0.05
Coconut	6896	14162	7936	3804	32796	12.61	4.10
Arecanut	581	313	445	-	1339	4.47	0.16
Cashew	117	292	578	652	1639	1.78	0.20
Mango	125	410	225	140	900	5.00	0.11
Jack	5	250	260	110	625	3.47	0.07
Misc.	1567	92	1430	296	3385	-	-
Total	12688	21079	24614	7768	66149		

Table 41

Sandy nonsaline, rainfed coastal tract: Cropping systems

Cropping system	Net cropped area(ha)	% distribution of NCA in situation
Rice (single crop)	145	0.27
Rice - rice	14995	27.43
Rice-rice-sesamum	165	0.30
Rice-rice-pulses	3293	6.02
Coconut	5550	10.15
Coconut+arecanut+pepper+ mango+jack+vegetables	28871	52.01
Miscellaneous	1646	3.01

Production potential

Local	:	2.0 t to 2.5 t ha
Modern	:	3.0 t to 4.0 t ha

Average production

Local	:	1.5 t/ha
Modern	:	2.0 t/ha

The rabi rice is transplanted in the month of September-October for which the nursery is raised according to wet systems 4-5 weeks prior to the possible date of planting.

The crop is affected by moisture stress in the ripening stage if the N.E. monsoon fails. Medium and short duration varieties are grown in the low lying and upland areas, respectively. Cultivators generally prefer a tall variety during this season owing to their dependence on straw for cattle. The harvest is generally done in the month of January.

Varieties

Local	:	Chitteni (PTB 20) Eravapandi
Modern	:	Jaya, Jyothi

Production potential

Local	:	2.5 to 3.0 t/ha
Modern	:	3.5 to 4.0 t/ha

Average production

Local	:	2.0 t/ha
Modern	:	2.5 t/ha

ii Pulses

Pulses (black gram and cowpea) are raised immediately after the harvest of the rabi rice in the month of January taking advantage of the residual moisture in the soil. The crops are harvested in March. No manuring is done.

Varieties

Black gram : T9, local
Cowpea : New era, Kanakamony, C 152
Production potential: 1000 - 1200 kg/ha
Average production: 300 - 400 kg/ha

iii Sesamum

Sesamum is also grown in a small area of 165 ha in this tract after the harvest of rabi rice. The crop has a duration of 70-80 days. The maximum area under this crop is in Tirur, Kalpakancherry and Marancherry development units in the Tirur sub division. The crop is being recently introducted in the other sub divisions of the zone.

Variety : Local
Production potential: 500 kg/ha
Average production : 300 kg/ha

iv Coconut

Coconut is grown as a monocrop in an area of 5550 ha. The variety used is mainly West Coast Tall. Hybrids like T X D, D X T, L.O. X G and exotic varieties like cochin China, Philippines, New Guinea and Lacadive Ordinary are also grown on a limited scale by elite farmers. Usually one-year-old seedlings are planted in uplands at a spacing of 5-7 metres either way in the month of June or July. The crop comes to bearing in 7-10 years. The economic yield is obtaned only after 15 years.

Coconut is planted in the low lying area and also in the traditioinal rice fields. In such areas, seedlings are planted on raised mounds during August-September and the interspaces are filled later as the plant grows. Finally the interspaces are fully filled or the crop will be maintained on the ridges of about 2 metres width and convenient length. In some areas high density planting is adopted (250-300 palms/ha.) as against the recommended density of 180 palms/ha.

Potential yield

WCT : 80-90 nuts/palm/year
Hybrids : 100-120 nuts/palm/year

Average production

WCT	:	25-30 nuts/palm/year
Hybrids	:	50-60 nuts/palm/year

Coconut is also cultivated extensively in the homesteads as a mixed crop (28871 ha). Annual crops like banana, tapioca, sweet potato and vegetables and perenneal crops like jack, mango, drumstick, papaya and a host of other crops are grown without any consideration for plant density. The planting of all these crops is undertaken in the months from June-October.

Potential yield

WCT	:	60-75 nuts/per/year
Average yield	:	20-25 nuts/ha./year

Crops like arecanut and cashew are also grown in a limited scale in this ecological situation.

3.2.1.8. Crop rotation

Rice-rice (27.4%), Rice-rice-pulses (6.02%) and rice-rice-sesamum (0.3%) are the crop rotations followed in this situation. These are one year crop rotations in the wet lands.

3.2.1.9. Mixed cropping

In the uplands mixed cropping is practiced with coconut as the main crop. The companion crops such as arecanut, banana, cashew, mango, vegetables and jack, serve as subsidiary source of income in addition to providing food materials.

3.2.1.10. Adoption pattern and production constraints

The rate of adoption of improved technologies by the farmers varies from tract to tract depending upon many socio-economic factors. The nonavailability of labour during peak seasons of cultivation and the resultant high cost of labour is a major constraint in the adoption of technologies. Lack of awareness, non-availability of water for irrigation, non-exploitation of water resources and lack of conviction of

the benefits of the new crop production technologies are some of the other constraints The extent of adoption of the recommended practices, the rationale for non-adoption and production constraints are given in Volume II of this report.

3.2.1.11. Specific production constraints

i Rice

The Kharif crop is affected by early drought and floods in the vegetative and reproductive phases. Since the crop is sown under semi-dry system, weed competition is very severe and the cost of manual weeding is prohibitive. The use of pesticides is yet to become popular. Varieties tolerant to drought and floods are not available.

The rabi crop is severely affected by drought in the reproductive and ripening phases. Pests like stem borer, brown plant hopper leaf folder and diseases like blast and sheath blight adversely affect the crops. Varieties with multiple resistance to pests and diseases are not available.

The soil is inherently poor in fertility and therefore, considerable efforts are required to improve its productivity.

ii Coconut

The nonavailability of quality planting materials, lack of irrigation during the prolonged drought period (December-May) inherent low fertility of the soil, high density planting and indiscriminate mixed planting systems are the main constraints to production of this crop.

iii Pulses

Lack of improved varieties, moisture stress, non-adoptions of production technologies, poor plant stand and serve incidence of aphids and pod borers are the major constraints.

iv Sesamum

Lack of high yielding varieties, poor plant stand due to moisture stress and non-adoption of modern production techniques are the important constraints.

3.2.2. Alluvial, non-saline, irrigated coastal tract (ANS-ICT)

3.2.2.1. Delineation

This agroecological situation has a net cropped area of 11458 ha equivalent to 1.60 per cent of the net cultivated area of the zone as summarised below:

District	Taluk	Agril Subdivision	Agri. Development unit	Net Cropped area(ha
Malappuram	Tirur	Tirur	Maranchery	1900
Kozhikode	Badagara	Badagara	Tikkoti	
	Kozhikode	Kozhikode	Kozhikode, Quilandy	
			Atholy Ramanattukara	1975
Cannanore	Tellicherry	Tellicherry	Mambaram Tellicherry	
"	Cannanore	Cannanore	Kattampally Orikkara Cannanore	
"	Taliparamba	Taliparamba	Peralassery Trikarpur Cherukunnu Cheruthazham	4354
Kasaragod	Hosdurg	Kasaragode	Cheruvathur Nileshwar Periya Uduma	3319
"	Kasaragod	Kasaragod	Kumbala Kodlamogaru	
Total				11548

3.2.2.2. Soils

The soil is deep, well drained alluvium deposited by sea over a period of time. The texture of the soil varies from littoral sand to sandy loam. The reaction of the soil is

moderately acidic with the pH ranging betwen 6.0 and 6.5. The organic matter content and nutrient status are very low. The soil properties are given in Annexure 1.

3.2.2.3. Climate

The total rainfall ranges from 3522 mm in Tirur taluk to 3107 mm in Kasaragod Taluk. About 75 per cent of the rains are received in a short span of 3 months - June July and August. The mean maximum temperature varies between 33°C and 37°C and the mean minimum temperature betwen 21°C and 24°C. There is a prolonged dry spell from December to May. Occasional summer rains are received in Kozhikode district.

3.2.2.4. Physiography

The situation has a level topography. Its elevation ranges between 3 m and 10 m above MSL. Saline water intrusion is common in areas near to the sea.

3.2.2.5. Irrigation

About 75 per cent of the net sown area is irrigated, the sources of irrigation being ponds, tanks, surface well and filter point tube wells. Water is lifted from these sources through pumpsets operated with electric power, diesel or kerosine. Pot watering is not uncommon particularly in small holdings. Vegetables, young coconut seedlings, banana, tobacco and betelvine are the crops irrigated by this method. The important crops irrigted are coconut, vegetables and tobacco. Rice is not generally irrigated due to the porous nature of soil and the large quantity of water required for flooding the fields. Basin irrigation is practised for all the irrigated crops in order to economise the use of water. In some areas as in Kasaragod and Hosdurg taluks of Kasaragod district, saline water is used for irrigating adult coconut palms. Excepting coconut and banana, all other crops are irrigated daily. The frequency of irrigation for coconut is once in four days and for banana once in two days

3.2.2.6. Major Crops and cropping intensity

This situation has a net cropped area of 11548 ha. Its gross cropped area is 20131 ha. The intensity of cropping works out to 174.32 per cent. Almost all the crops are grown in every homestead without any regard for planting geometry. Nevertheless, coconut is the predominant crop

Table 42

Sandy non saline irrigated coastal tract : Major crops (ha)

Crop	Mala-ppuram	Kozhi-kode	Cann-anore	Kasa-ragod	Total	% to total areaof the crop in the zone	% to gross cropp-ed area in the zone
Rice	258	677	731	825	2491	1.69	0.31
Banana	25	317	220	100	670	5.08	0.08
Pulses	—	—	—	60	60	0.92	0.01
Sesamum	1012	—	—	100	1112	40.99	0.14
Sweet potato	—	—	—	26	26	1.39	—
Tobacco	—	—	—	600	600	100.00	0.08
Vegetables	78	522	621	190	1411	6.53	0.18
Betelvine	67	40	—	—	107	16.90	0.01
Coconut	1612	3292	3372	2459	10735	4.12	1.34
Arecanut	125	127	113	35	400	1.32	0.05
Mango	125	—	250	110	485	2.65	0.06
Jack	—	175	515	314	1004	5.79	0.13
Miscellan-neous Crops	546	112	165	207	1030	3.09	0.13
Total	3848	5262	5967	5034	20131		

occupying an area of 10735 ha. This is 53.33 per cent of the G C A of the situation. The other crops of importance are rice (1.69 per cent) vegetables (6.53 per cent) sesamum (40.99 per cent), banana (5.08 per cent) and tobacco (100 per cent). The entire area under tobacco is in Hosdurg and Kasaragod taluks of Kasaragode district. The crops grown are summarised in Table 42.

3.2.2.7. Cropping systems

The predominent cropping system in this situation is coconut based. The rice based cropping systems in the traditional wetlands are being replaced by coconut and coconut based cropping systems due to the low net returns.

the major cropping systems are detailed in Table 43, Fig. 47.

Table 43

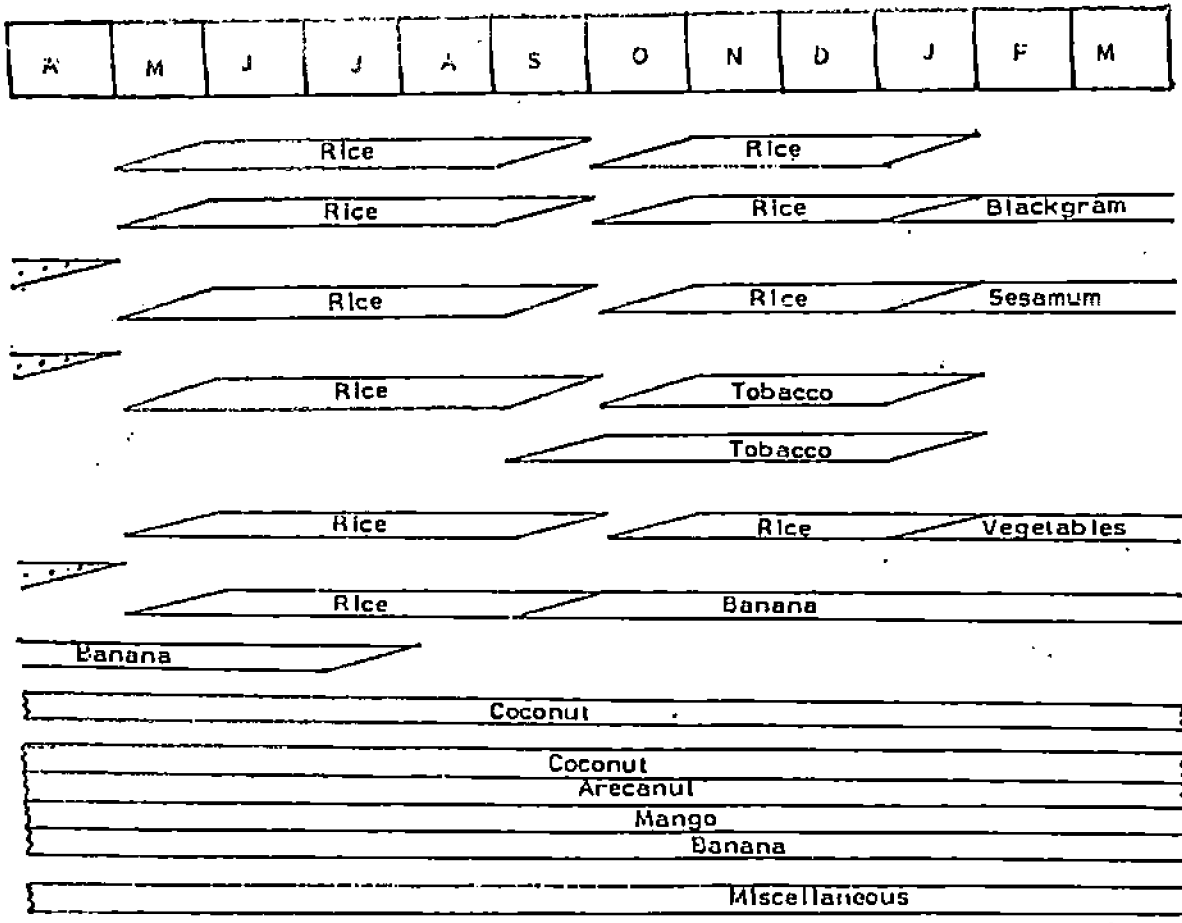
Sandy, non saline, irrigated coastal tract; cropping systems

Cropping system	Net cropped area (ha)	% distribution of NCA in the situation
1. Rice-rice	283	2.47
2. Rice-rice-black gram	60	0.52
3. Rice-rice-sesamum	812	7.09
4. Rice-tobacco	400	3.49
5. Tobacco	200	1.75
6. Rice-rice-vegetables	800	6.98
7. Rice-banana (2 yrs)	110	0.96
8. Coconut	4500	39.27
9. Coconut + arecanut + banana + mango	6735	58.78
10. Miscellaneous	2626	22.91

The salient features of the cropping systems are explained below:

1. Rice-rice

The crops of rice are raised in succession in an area of 283 ha from May to January in the low lying areas. The



Irrigated crops	Net cropped Area (ha)	Percent (%)
	283	2.47
	60	0.52
	812	7.09
	400	3.49
	200	1.75
	800	6.98
	110	96.0
	4500	39.27
	6735	58.78
	2626	22.91
Total	16,526	

Cropping Intensity 174.32%

Fig.47. Irrigated cropping system.
Agro-ecological situation - 2 (ANS - ICT).

Kharif crop is usually direct-sown under the semi-dry system in the month of May. The rabi crop is transplanted in September/October. Usually medium duration varieties are preferred by cultivators during both the seasons. About 30 per cent of the area is covered by modern rice varieties and the rest by local tall cultivars.

ii. Kharif crop

Varieties:

Local	:	Allikannan, Thovan, Malakkaran, Ponnarayan.
Modern	:	Jaya, Jyothi, Bharathi
Production potential	:	Local : 2.0 - 2.5 t/ha Modern: 3.0. - 4.0 t/ha
Average production	:	Local: 1.5 t/ha Modern: 2.0. t/ha

iii. Rabi crop

Varieties

Local	:	Chitteni, Eravapandi, Mundakan
Modern	:	Jaya, Jyothi, I.R.8
Production potential	:	Local: 2.5 - 3.0 t/ha Modern: 3.5 - 4.0 t/ha
Average production	:	Local: 2.0 t/ha Modern: 2.5 t/ha

iv. Rice-black gram

Blackgram is raised in rice fallow mostly in Cannanore and Kasaragod districts of the zone immediately after the harvest of the rabi rice crop in the month of January utilising residual moisture. The crop has a duration of 75-80 days. No manuring is done.

Varieties	:	T9, local
Production	:	1000 - 1200 kg/ha
Average production	:	300 - 400 kg/ha

v. Rice-sesamum

Sesamum is cultivated mostly in Malappuram and Calicut districts. The cultivation is confined to rice fields and raised as a monocrop during January - March. The crop has a duration of 70-80 days. Plant protection and manurial practices are not generally adopted.

Varieties	:	Local
Production	:	600-700 kg/ha
Average production	:	250 to300 kg/ha

vi. Rice-tobacco

Cultivation of this crop is confined to Hosdurg taluk of Kasaragod district in an area of 26 ha. The crop is raised in rice fallows after the harvest of the kharif rice crop on ridges. Organic manures are usually applied. The growers seldom apply fertilisers.

Variety	:	Kanhangad local
Production potential	:	10-12 t/ha
Average production	:	8-9 t/ha

vii. Rice-vegetables

Cucurbitaceous summer vegetables are raised in rice fallows after the harvest of rabi crop. The crops are profusely irrigated. They include pumpkin, ash gourd, bottle gourd, watermelon, cucumber, bitter gourd and snake gourd.

Varieties	:	Local
production potential	:	25 t/ha
Average production	:	15 t/ha

viii. Banana

Banana var. Nendran is raised in rotation with rice as well as in uplands as a monocrop or as a mixed crop in coconut and arecanut gardens. The planting of banana in the rice fields is done in the month of August and September after the harvest of kharif rice. Irrigation is done once in 3 to 4 days in basins. Heavy manuring with organic as well as inorganic manures is practised.

Varieties	:	Local
Production potential	:	15 t/ha
Average production	:	8-10 t/ha

ix. Coconut

Coconut is cultivated in the entire tract as a monocrop and as a mixed crop. The mixed cropping system is the predominent one, particularly in the homesteads. One-year-old seedlings are planted in the month of May before the onset of heavy south-west monsoon or after the cessation of the monsoon in September. Seedlings are planted in shallow pits of size 50 cm X 50 cm X 50 cm. The cultivators have a tendency now-a-days to raise coconut in rice fields. Here, the seedlings are planted on mounds, the interspaces of which are filled subsequently. The crop is irrigated in summer months from December to May. Fertilisers are applied only by a very small section of the farmers.

varieties	:	WCT and Hybrids
Production potential	:	WCT : 80-100 nuts/palm/year Hybrids: 100-120 nuts/palm/year
Average production	:	WCT: 30-35 nuts/palm/year Hybrids: 60-80 nuts/palm/year

x. Arecanut

Arecanut is cultivated mostly as a mixed crop in coconut gardens and in homesteads. The seedlings are planted in June-July.

Varieties	:	Local
Production potential	:	2 lakh nuts/ha/year
Average production	:	1.5 "

Mango, jack, pappaya, tamarind and drumstick are also grown in homesteads as mixed crops or as border crops. No manuring, plant protection measures or cultural practices are adopted for these crops.

3.2.2.8. Crop rotation

Rice-rice, Rice-rice-pulses, Rice-sweetpotato, Rice-banana and Rice-rice-banana are the crop rotations followed in the situation.

3.2.2.9. Mixed cropping

Mixed cropping is practised in almost all the homesteads with coconut as the pivotal crop.

3.2.2.10. Adoption pattern and production constraints

Since the crops are raised under irrigated conditions, adoption of the recommended practices are comparatively more in this tract as compared to that of the sandy non-saline rainfed coastal tract. The extent of adoption of the recommended practices are given in Vol.2 of this report

3.2.2.11. Specific production constraints

i Rice The varieties now available are susceptible to major pests and diseases. Varieties with built in resistance to BPH and sheath blight are a felt need. The cultivators have a preference for nonlodging semitall varieties since they depend upon straw as the major cattle feed. The soils are inherently low in nutrient status, and addition of organic manures becomes essential to improve their physical condition. Pests like rice gall midge and leaf roller and diseases like blast and sheath blight are important maladies affecting crop production.

ii. Black gram Lack of improved varieties and nonadoption manurial pracitces are the major constraints in the production of the crop.

iii. Sweet potato No improved varieties are available at present.

iv. Vegetables Non availability of high yielding varieties and quality seeds constitute the major constraints in the production of vegetables. Pests like fruit fly and disease like powdery mildew and leaf spot also affect crop production. Irrigation schedules and fertiliser practices are yet to be developed for vegetables in this tract. very often the crops are affected by moisture stress at the flowering and fruiting phases due to the desication of water sources in the field.

v. Coconut Nonavailability of good quality seedlings of WCT and hybrids is a major constraint. In Cannanore and Kasaragod districts, cultivators have a tendency to adopt high density planting. This delays flowering and reduces the

yield. Inadequate manuring is yet another constraint in tapping the yield potential. Rhinoceros beetle is a major pests affecting the crop.

3.2.3. Alluvial (Riverine), salt affected, rainfed tract (flood prone) (RAS - RT)

3.2.3.1. Delineation

This is the smallest agroecological situation in the zone having a net cropped area of 9308 ha.

District	Taluk	Sub-division	Agrl. Dev.Units	Net cropped area (ha)
Malappuram	Ponnani	Tirur	Tavanur	
	Tirur	Tirur	Tirur Mancherry Parappanangadi	1050
Kozhikode	Kozhikode	Kozhikode	Ramanattukara	
"	Quilandy		Kozhikode	379
"	Badagara	Badagara	Tikkodi	
Cannanore	Tellicherry	Tellicherry	Tellicherry Mattannur	
"	Cannanore	Cannanore	Kattampally Orikkara Mayyil Anjarakandy Paralassery Sreekandapuram	3664
"	Taliparamba	Payyanur	Cherukkunnu Mathil Taliparamba Trikarpur Cheruthazham	
Kasaragod	Hosdurg	Hosdurg	Nileshwar Periya Uduma	
	Kasaragod		Kumbla Kodlamugara	1215

3.2.3.2. Soils

The soil is deep reverine alluvium heavy in texture. The depth is more than two meters. The pH of the soil varies from 5.2 to 6.2 and the organic matter content from 0.62 to 1.53 per cent. The conductivity of the soil may go upto 18 mmhos/cm during the summer and it will come down to 0.1 mmhos/cm during the actual cropping season (June-October). The fertility status of the soil is low.

3.2.3.3. Climate

Being at or below the sea level and due to the proximity to the sea, the tract has a warm and humid climate. The annual rainfall ranges from 2685 mm in Malappuram to 3492 mm in Kasaragod districts. The bulk (60 Per cent) of these rains is received from June to August. The summer showers are sparse and unpredictable. The maximum temperature may go upto 37°C in May. The minimum temperature may go down to 18°C in December-January. The relative humidity remains in betwen 80-90%.

3.2.3.4. Physiography

The tract is situated in river mouths and back water areas at or below sea level. The land is flat in topography and is inundated with water, saline or sweet. In summer months, saline water from the sea intrudes the area during high tides. With the onset of south west monsoon the saline water is pushed out into the sea by the onrushing fresh waters and the land remains under sweet water all throughout the period from June to October. Due to this special condition, a unique system of rice cultivation is being practised in the area which has problems of its own. In this situation, there are also areas where salt may come upto the soil surface after the cessation of the North East monsoon causing severe salinity problem.

3.2.3.5. Irrigation

Irrigation is not practised as water is not a limiting factor. However, water level is maintained in such a way that the crop is not submerged.

3.2.3.6. Major Crops and cropping intensity

This agroecological situation has a gross cropped area of 12,228 ha the net cropped area being 9308 ha. The intensity of cropped is 131.37 per cent. Rice is the most important crop grown in this tract. Prawn culture is practised on a limited scale after the harvest of the Kharif crop. Coconut is grown on the outer bunds of the rice fields and also in homesteads (Table 44).

Table 44

Alluvial saline - acid rainfed situation : Major crops

(area in ha)

Crop	Mala-ppuram	Kozh-ikode	Cann-anore	Kasa-ragod	Total	% to total area of the crop in the zone	% to gross cro-pped area in the zone
Rice	1983	330	3112	1577	7002	4.76	0.88
Banana	70	-	20	14	104	0.79	0.01
Coconut	2418	160	512	610	3700	1.42	0.46
Arecanut	53	-	20	15	68	0.29	0.01
Misc.	784	90	150	310	1334	4.01	0.17

Table 45

Alluvial saline-acid rainfed situtaion : Cropping System

Cropping system	Net cropped area (ha)	%distribution to NCA in the situation
Rice	2390	25.68
Rice-rice	4612	49.55
Coconut	2500	26.86
Coconut + Banana + arecanut	1288	13.84
Miscellaneous	1334	14.33

3.2.3.7. Cropping systems

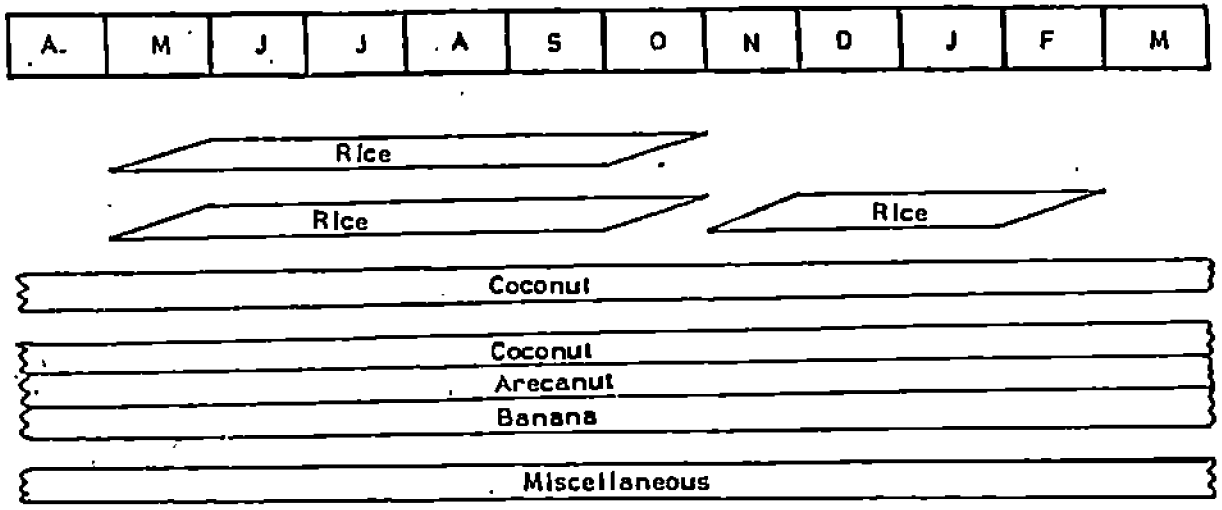
The cropping systems followed are mainly rice-based (75.2 per cent). Coconut based mixed farming system is adopted in the homesteads. The details are furnished in Table 21, Fig. 48.

The important features of the different cropping systems are given hereunder.

i Rice

The cultivation of rice in this situation is unique. The crop is raised in fields adjoining the river mouths which are subjected to salt water intrusion. This system of rice cultivation is known as "Kaipad". In this system, only a single crop of rice is taken in the Kharif season in the Tellicherry, Cannanore and Taliparamba taluks of Cannanore district. Mounds are formed (2500 nos/ha) in the fields during February - March when they are dry. On receipt of a few soaking rains, the salts concentrated on the mounds will be washed down leaving the soil saltfree. At this juncture, sprouted seeds are sown on the mounds. When the seedlings attain an age of 35-45 days, the mounds are dismantled and seedlings distributed in the field with the help of spades. By this time the main field will be free from salinity. Thereafter, the rice crop is managed without any manuring or plant protection till harvest. Harvesting is done in September-October. Only local tall varieties tolerant to salt are grown. A high seed rate of 140-150 kg/ha is used. After harvest, the field is flooded for prawn culture or left as fallow.

In the other areas, two crops are raised in succession in the usual manner. The kharif crop cultivated during May - September is subjected to intermittant flooding. The rabi crop is raised during October - January. This crop is sometimes affected by salinity at the fag end of the cropping season due to shortage of water in the field and consequent rising of the salts from below. Salt water may also enter the rice fields from the nearby rivers (in which the water is salty) during high tides. This type of rice fields occur in the Tirur taluk of Malappuram district, Kozhikode, Quilandy and Badagara taluks of Kozhikode district, Tellicherry and Cannanore taluks of Cannanore district, and Hosdurg and Kasaragod taluks of Kasaragod district.



	Rainfed crops Net cropped Area (ha)	percent (%)
	2390	25.68
	4612	49.55
	2500	26.86
	1288	13.84
	1334	14.33
Cropping Intensity		131.37%

Fig.48. Rainfed cropping system.
Agro-ecological situation - 3 (RAS - RT).

Varieties 'Kaipad'	:	Ezhome Ball Orkayama Kuthiru Allikannan
Other areas: Kharif	:	Malakkaran Chenneliu Thowan Kozhivalan Thonnooran
Rabi	:	Orpandi Chitteni Kondrotti

Kaipad

Production potential	:	2 t/ha
Average production	:	1.5 t/ha

Other areas:

Production potential	:	Kharif 2 t/ha
Average production	:	Kharif 1.5 t/ha
Production potential	:	Rabi 2 t/ha
Average production	:	Rabi 1.2 t/ha

ii Coconut

Coconut is grown on outer bunds of paddy fields as a pure crop wherever possible. The bunds are strengthened by depositing silt once in 2 or 3 years. Manuring is seldom practised.

Variety	:	WCT
Production potential	:	60-70 nuts/Palm/year
Average production	:	30-40 "

3.2.3.8. Crop rotation

Kaipad

Rice is raised as a mono crop. In other salt affected arees; Rice-rice is the rotation system.

3.2.3.9. Mixed cropping

Mixed cropping with coconut as the main crop is practised in homesteads.

3.2.3.10. Adoption pattern and production constraints

i Rice

No new technology has been developed and recommended to farmers of this situation. The varieties of rice now available are poor yielders, but they have the added advantage of salinity tolerance. improved varieties with high yield potential and tolerence to salinity hazards, have to be developed. Agrotechniques suited to these situation are also to be evolved.

ii Coconut

High humidity prevalent in the tract predisposes the palms to serve incidence of but rot disease and leaf-eating caterpillars. Farmers are reluctant to apply fertilisers as they are not fully convinced of the benefits. These are the major constraints in the production of the crop.

3.2.4. Alluvial (Hydromorphic) non-saline irrigated area (AHNS - IT)

3.2.4.1. Delineation

This situation existed in the Tirur Agricultural Sub division of Tirur and Ponnani Taluk of Malappuram district. This is an extension of the 'Kole' lands of Trichur and comprises of an area of 3860 ha. All the details pertaining to this agroecological situation are dealt within the status report of the special zone, (RARS Kumarakom).

3.2.5. Shallow high level plateau laterite nonsaline rainfed tract (SHLPL - NS - RT)

3.2.5.1. Delineation

This is largest agroecological situation in the zone spread over all the 4 districts Agriculturally, it is the most important tract with a net cropped area of 3.22 lkh ha equivalent to 46.94 per cent of the net sown area of the zone.

District (1)	Taluk (2)	Sub division (3)	Agrl.Dev. Unit (4)	Net area sown(ha) (5)
Malappuram	Ponnani	Tirur	Irumblam Kottakkal, Vattathani, Edapal, Tirur.	98,360
	Ernadu	Nilambur	Karuvarakundu, Pookottupadam, Nilambur, Wandoor, Edakkara, Mampad.	
	Manjeri	Manjeri	Malappuram, Areakode, Pulikkal, Pallikkal, Moorkanadu, Thazhakkodi	
	Perinthalmanna	"	Perinthalmanna, Pulamamthol, Melattur	
Kozhikode	Kozhikode	Kozhikode	Chelannur, Naduvannur, Narikkuni, Chathamangalam,	64,505
Kozhikode	Kozhikode	Thamarassery	Kodencherry, Mukkom, Karassery, Tiruvampady, Pannikode, Omassery.	
Kozhikode	Badagara	Badagara	Perambra, Cheruvannur, Kayanna, Thottilpalam, Kunnummal, Vanimel, Purameri, Chorode.	

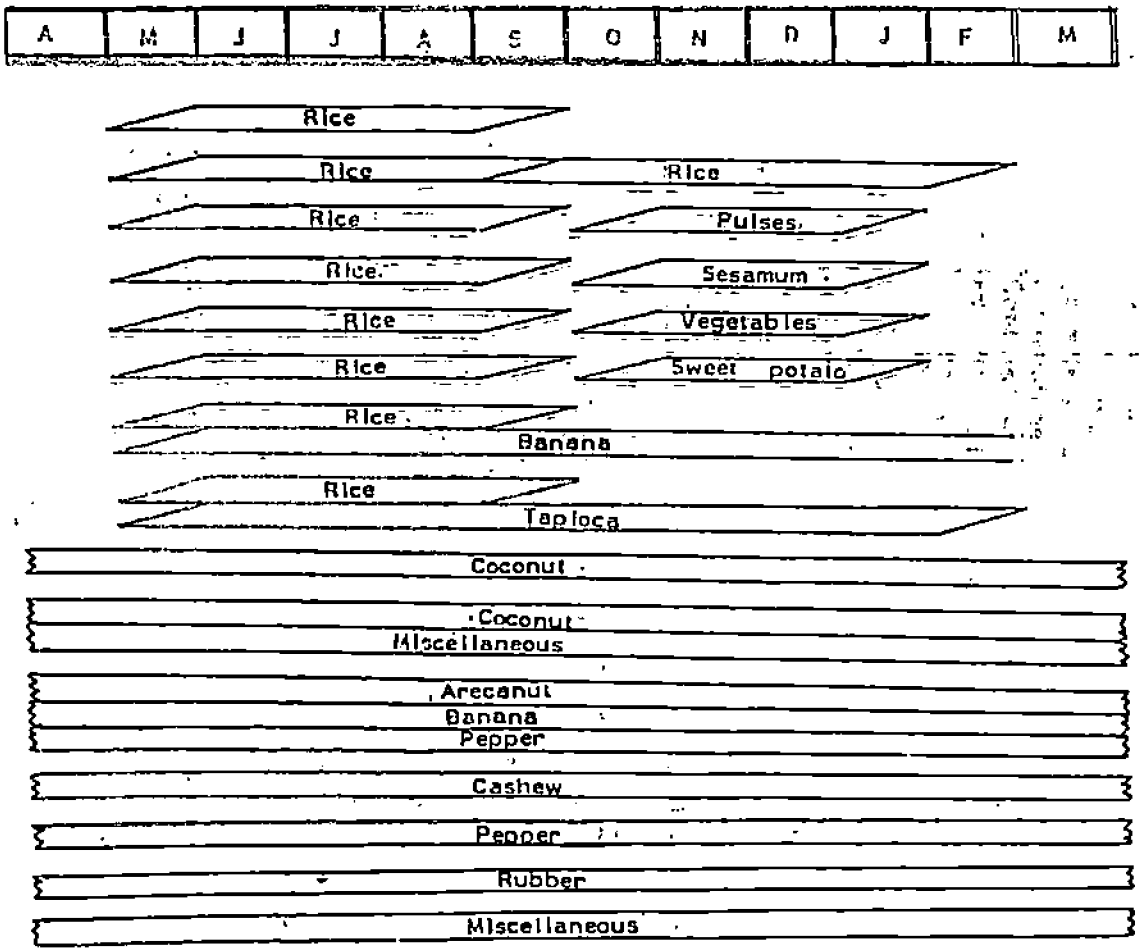
(1)	(2)	(3)	(4)	(5)
Cannanore	Tellicherry	Tellicherry	Karikkottakkary, Kolayad, Panoor, Mambaram, Iritty, Peravoor, Kelakam Mattannur, Tellicherry, Chalode	
Cannanore	Cannanore	Cannanore	Kattampally, Orikkara, Cannanore, Mayyil, Anjarakandy, Peralassery, Sreekandapuram	
Cannanore	Taliparamba	Payyanur	Taliparamba, Trikarpur, Cherukunnu, Cheruthazham, Naduvil	1,35,658
Kasaragod	Hosdurg	Kasaragod	Cheruvathur, Nileshwer Kanhangad, Periya, Uduma	23,522
Kasaragod	Kasaragod	Kasaragod	Badiadukka, Karadukka	
	Total (Net cropped area)			3,23,045

3.2.5.2. Soils

The laterite soils of this situation are usually loam of some kind. They are acidic in reaction with a pH of 5.0 to 6.5. The surface layers of the soil contain appreciable amounts of gravel. The laterite found on the hills are of a residual type subjected to high erosion. They are gritty and shallow, poor in organic matter and deficient in all the plant food elements. These laterite soils are well drained and respond to good cultural and manurial practices. The soil depth varies from 50 cm to 2.0 m.

3.2.5.3. Climate

The tract receives plentiful rainfall ranging from 2242 mm in Malappuram district to 3816 mm in Cannanore district. About 2134 mm of rains are received during June and July



rainfed crops	Net cropped area (ha)	Percent (%)
	3092	0.96
	48043	14.92
	1200	0.37
	103	0.03
	4277	1.33
	512	0.16
	1000	0.31
	1625	0.50
	6240	1.93
	118553	36.81
	17345	5.39
	56525	17.56
	9625	2.99
	31492	9.78
	11529	3.58
Cropping Intensity		108.24%

Fig.49. Rainfed cropping system.

Agro-ecological situation - 5 (SHLPL - NS - RT).

alone out of the total annual rainfall of 3600 mm. The continuous heavy downpour in June and July which causes heavy erosion of the top soil and leaching of bases and the prolonged dry spell experienced from November to May coupled with the high temperature (upto 35°C) help the process of laterisation. The rainfall during the North East monsoon is scanty and is concentrated in the month of October.

3.2.5.4. Physiography

The tract extends from Malappuram to Kasaragod sandwitched between the sandy coastal low lands in the west and the highland in the east. This agroecological situation has a rolling topography, the altitute varying from a few metres in the west to about 400 metres in the east. Water table comes close to the ground level during the South West monsoon and recedes to about 40 M during the peak summer months. In labout 75 per cent of the area, water for drinking or irrigation is a problem in summer.

3.2.5.5. Irrigation

Irrigation is not generally practised in the situation except for vegetables and such other crops.

3.2.5.6. Major Crops and cropping intensity

The agro ecological situation accomodates a variety of crops, the most important being coconut, rice, cashew and rubber. The gross and net cropped areas are 348585 ha and 322045 ha, respectively. The intensity of cropping is 108.2 per cent (Table 46).

3.2.5.7. Cropping systems

The important cropping systems are mentioned in Table 47, Fig. 49.

i Rice (Single only)

Rice is cultivated as a monocrop in an area of 30 ha during the Kharif season. A second crop of rice is not possible in this area due to scarcity of water. About 30 per cent of this area is planted to modern varieties and the re-

Table 46

Shallow high level plateau laterite nonsaline rainfed tract: Crops (ha)

Crop	Mala-ppu-ram	Kozhi-kode	Canna-nore	Kasa-ragod	Total	% to total area of the crop in the zone	% to gross cropp-ed area in the zone
Rice	34590	8241	12442	6579	61852	42.07	7.07
Banana	2218	1804	832	163	5017	38.02	0.63
Pulses	421	523	200	957	2101	29.22	0.26
Sesamum	61	61	20	38	180	6.63	0.02
Sweet potato	1200	72	227	550	2049	94.21	0.26
Tobacco	—	—	—	—	—	—	—
Vegetables	440	445	4685	1550	7120	32.97	0.89
Betalvine	—	—	—	—	—	—	—
Tapioca	3228	1417	1789	125	6559	17.83	0.82
Ginger	190	123	85	—	398	10.39	0.05
Coconut	25560	48797	46013	4423	124793	47.92	15.61
Arecanut	4878	824	896	125	6728	22.19	0.84
Cashew	14369	3375	22317	19427	59488	65.92	7.44
Mango	3290	2710	1124	873	7997	43.64	1.00
Jack	30	1187	1314	1126	3657	21.09	0.46
Pepper	2485	3505	11481	154	17625	42.82	2.20
Rubber	12713	2714	15040	1025	31492	46.11	3.94
Misc.	5360	168	4775	1206	11529	34.63	1.44

to the local ones. The cropping period is from May-September

Direct sowing under semidry system is practiced

in the area. Chemical manuring has become a common practice but seldom do the cultivators adopt balanced manuring.

Varieties: Local : Aryan, Ponnaryan, Chenkayama, Thowan, Allikannan, Malakkaran, Thavalakannan

Table 47

Shallow high level plateau laterite, nonsaline rainfed: Cropping system

Cropping system	Area (ha)	% distribution of NCA in the situation
1. Rice	3092	0.96
2. Rice - Rice	48043	14.92
3. Rice - pulses	1200	0.37
4. Rice - sesamum	108	0.03
5. Rice - vegetables	4277	1.33
6. Rice - sweet potato	512	0.16
7. Rice - banana	1000	0.31
8. Rice - tapioca	1625	0.50
9. Coconut	6240	1.93
10. Coconut + miscellaneous crops	118553	36.81
11. Arecanut + banana + pepper	17345	5.39
12 Cashew	56525	17.56
13. Pepper	9625	2.99
14. Rubber	31492	9.78
15. Miscellaneous	11529	3.58

Modern : Jaya, Jyotni, Bharathi, IR 8, Triveni, Pavizhom

Production potential :
Local : 2.5 to 3.00 t/ha
Modern : 3.5 to 4.00 t/ha
Average production : 2.0 to 2.5 t/ha

In the rice-rice cropping system two crops are raised one after the other in the Kharif and rabi seasons from May - June to August - September and September - october to January, February. During the fag end of the rabi season especially at the dough stage of the crop water shortage is experienced in the field. During drought period, heavy crop-loss occurs.

Varieties:
Kharif season: Local : As in the monocropping system

Modern	:	As in the monocropping system
Production potential:		
Local	:	2.5 to3.5 t/ha
Modern	:	3.5 to 4.0 t/ha
Average production:		
Local	:	2.0 to 2.5 t/ha
Modern	:	2.5 to 3.0 t/ha
Rabi season: Local	:	Vellari, Chitteni, Kodiyan, Mundakan
Modern	:	IR 8, Jaya, Jyothi, Bharathi, Pavizhom.
Production potential		
Local	:	2.5 to3.0 t/ha
Modern	:	4.0 to 5.0 t/ha
Average production:		
Local	:	2.0 to 2.5 t/ha
Modern	:	2.5 to 3.0 t/ha

ii Pulses

Under pulses, black gram, cowpea and horsegram are cultivated. In the uplands cowpea is lthe predominent crop. The crop is sown with the receipt of early South West monsoon showers. Horse gram is cultivated both in paddy fields and uplands in the rabi and summer seasons. No manuring is done for the crop.

Varieties:

Cowpea	:	New era, Kanakamony, Krishnamony, C 152, S 488
Blackgram	:	T9, local
Horsegam	:	Local
Production potential	:	Cowpea 1500 kg/ha Blackgram 800 kg/ha Horsegram 500 kg/ha

Average production : Cowpea 450 kg/ha
Blackgram 350 kg/ha
Horsegram 200 kg/ha

iii. Vegetables

Vegetables are cultivated in the tract throughout year. During the kharif season Amaranthus, Chillies, brinjal, bnindi, colocasia, yams, dioscorea etc. are grown in the uplands either as mixed crop or as monocrop. These crops together occupy 20 per cent of the area under vegetables. Organic manures are used in plenty. The cultivation of these vegetable crops is mostly concentrated in Manjeri, Malappuram, Kondotti, Tirur (Malappuram district), Temarasseri, Badagara (Kozhikode district), Tellicherry and Cannanore (Cannanore district).

In the rabi season, cucurbitaceous vegetables occupy 50 per cent of the total area under vegetables spread over all the 4 districts. The important crops grown are cucumber, ash gourd, watermelon, bitter gourd, snake gourd, ridge gourd and coccinia. Kodur, Irumbuzhi, Pookottur in Malappuram district, Pallikkara, Kanhangad and Kasaragod in Kasaragod district and Edakkad in Cannanore district are famous for the cultivation of cucurbitaceous vegetables.

During the summer months also cucurbitaceous vegetables are extensively grown in the above areas and they occupy about 30per cent of the are under vegetables.

Cultivators often resort to heavy manuring of vegetables in large number of split doses. Insecticides are also frequently applied to protect the crop from fruit flies and borers.

Varieties grown : Local
Production potential : 15-20 t/ha
Average production : 12-24 t/ha

iv. Sweet potato

The crop is raised in rabi season under rainfed condition in an area of 2049 ha both in uplands and rice fallows; the major portion (75 per cent) being in terraced uplands. Generally no fertiliser is applied. Kanhangad in Kasaragod district is a potential area for sweet potato

cultivation and the Kanhangad local variety is famous throughout Kerala.

Production potential	:	20 t/ha
Average production	:	12 t/ha

v. Tapioca

Tapioca is grown as a pure crop in the uplands, as a mixed crop in coconut gardens and as a rotational crop in rice fields after the harvest of the kharif rice. Seventy five per cent of the area under the crop is in uplands. In the uplands 25 per cent of the crop is in coconut gardens. No manuring is practised by 80 per cent of the farmers while the rest apply only partial level of the recommended dose. In the Malappuram district better attention is bestowed to this crop and an average yield of 17 t/ha is obtained.

Varieties	:	M4 and local
Production potential	:	20 t/ha
Average production	:	12 t/ha

vi. Banana

The crop is cultivated in uplands as well as in paddy fields, but the majority of the area is in uplands (82 per cent).

A large number of cultivars are grown. The variety Nendran is cultivated in the uplands with the receipt of the summer showers and the other cultivars with the receipt of south west monsoon.

Production potential	:	30-35 t/ha
Average production	:	15-20 t/ha

vii. Coconut

The crop occupies a total area of 1.25 lakh hectares constituting 47.92 per cent of the gross areaof the crop in the situation and 15.61 per cent of the gross cropped area of the zone. The major contribution to coconut productionin the zone is from this situation. This crop is more or less free of the deadly root wilt disease prevalent in the southern areas of the state. The crop is grown in almost all parts of the situation. However, the most important tract growing coconut

are Kuttiadi in Badagara taluk of Kozhikode district and Malappuram in Tirur taluk of Malappuram district. Seednuts for the Departmental (DOA) coconut nurseries are procured from the elite gardens of these tracts.

The usual planting season of coconut is June-September. For planting seedlings deep pits of 1x1x1 m are taken at a spacing of 6-8 metres either way, the recommended spacing being 7.5x7.5 m. In the hard laterites, cultivators apply common salt in the pits @ 3-4 kg per pit, five to six months prior to planting in order to soften the laterite beneath. As the plants grow, the pits are widened by trimming the sides and by the end of the 5th year the pits will be filled with the soil so trimmed. Deeper planting helps to tide over the drought situation that follows after the monsoon. The palms usually take 8-10 years to come to bearing and the economic bearing stage is reached by the 15th year of planting. Organic manures are invariably applied by the farmers every year in the months of June and July but fertilisers are applied only by about 25 per cent of the farmers.

Varieties	:	WCT, Hybrids (90 % of the area is occupied by WCT)		
Production potential	:	WCT	:	60-80 nuts/palms/yr.
		Hybrids	:	80-100 "
Average production	:	WCT	:	30-40 "
		Hybrids	:	50-60 "

Invariably a numberof crops are grown in coconut gardens. Tapioca, banana, vegetables, pulses, fodder grass, cocoa, arecanut, mango, pepper, jack etc. are grown in the coconut gardens without any regard for plant geometry. This is particularly true for homesteads. In situations the yield from individual palms goes down to the extent of 18-20 nuts/palm/year. The intercrops are not individually manured excepting vegetables and banana.

viii. Arecanut + Banana + Pepper mix.

In this system arecanut is the main crop and others are subsidiary. Pepper is trained on arecanut. This system is followed in the relatively low lying areas where the water

table is fairly high. No consideration is given for plant density in this crop mix. No special attnetion is also paid to manuring but plant protection measures are adopted against the Mahali disease (nut fall) of arecanut.

Variety

Arecanut	:	Local
Banana	:	Local
Pepper	:	Karimunda Kuthiravaly Balankotta Panniyur 1

Production potential

Arecanut	:	1.5 lakh nuts/ha
Banana	:	10 t/ha
Pepper	:	500 kg/ha

Average production

Arecanut	:	0.75 to 1 lakh nuts/ha
Banana	:	7 t/ha
Pepper	:	200 kg/ha

ix. Cashew

Cashew occupies 65.92 per cent of the total area of the crop and 7.44 per cent of the gross cropped area in the zone. The crop is extensively grown in the highly eroded laterites where no other crop is possible. However, the crop is cultivated in other areas also including homesteads. Planting of cashew (seedlings or layers) is done in June - July in pits of size 0.5x0.5x0.5 m. The spacing varies from 5 m to 10 m either way. Regular bearing starts from the 7th year onwards. Generally no manuring or plant protection is done by cultivators. But in large scale plantations owned by elite farmers and Govt. corporations (in Cannanore and Kasaragod districts) these operations are regularly done.

Varieties	:	Local, BLA-1
Production potential	:	1000-1200 kg/ha
Average production	:	500-600 kg/ha

x. Pepper

Pepper occupies 42.6 per cent of the total area of the crop in the zone. The potential areas for pepper are Kottiyur, Alakkode, Iritty and Mattannur in Cannanore district. It is grown as a monocrop in about 9625 ha. The planting season is June-July with the receipt of monsoon showers. Generally unrooted cuttings are planted at the base of standards planted in April-May with the onset of pre-monsoon showers. The recommended spacing is 3mx3m. The standards used ae Erythrina, Garuga and Ailanthis. Pepper is also trained on other standards like jack, mango, coconut, arecanut and gravelia. The cultivators plant rooted cuttings also if they are available from Departmental nurseries and there is a great demand for the same. While organic manures are invariably applied, seldom do the cultivators apply inorganic fertilisers.

Varieties : Karimunda, Panniyur-1, Kottanadan, Kuthiravaly, Narayakodi, Arakulamunda, Balankotta, Kaliuvally.

Panniyur-1 is preferred for growing in comparatively open areas.

Production potential : 750 kg/ha
Average production : 250-300 kg/ha

x i. Rubber

Rubber occupies 46.1 per cent of the total area of the crop in the zone. It is grown as a monocrop. However, in the early stages of the crop (up to two years) intercropping with banana and tapioca are practiced by small growers. Hill slopes and high lands are preferred for growing rubber. The maximum area under the crop is in Nilambur and Manjeri in Malappuram district, Tamarassery in Kozhikode district and Alakkode and Kuthuparamba in Cannanore district and Panathadi in Kasaragod district. The cultivation of rubber is governed by the Rubber Board under the Ministry of Commerce. Since the Rubber Board extends liberal financial assistance by way of subsidies and loans, farmers have taken up rubber cultivation in a very systematic manner in the entire tract.

The planting of rubber is done in the months of June and July. Budded stumps or polybag seedlings are planted in prepared pits of size 90x90x90 cm. Tapping of latex starts when the plants grow to a girth of 50 cm which is generally attained by the seventh year. The economic life span of the crop is 40 years.

Varieties	:	RRII 105, 300, 203, 600, 605. PB 5-51, PB 86, GL-1, GT 1 NAGO
Production potential	:	800-1000 kg/ha
Average production	:	500-550 kg/ha

3.2.5.8. Crop rotation

Rice-rice (14.92 per cent) rice-pulses (0.37 per cent), rice-vegetables (1.33 per cent) and rice-tapioca (0.5 per cent) are the crop rotations followed in the situation.

3.2.5.9. Mixed cropping

Mixed cropping with coconut as the main crop is followed in 36.8 per cent of the area, while arecanut-banana-pepper-crop mix is taken in 5.39 per cent of the area. About 3.6 per cent of the area in this situation is occupied by crops like jack, tamarind, mango and medicinal plants either as mixed crops or border crops.

3.2.5.10. Adoption pattern and production constraints

i Rice

Modern varieties occupy only about 30 per cent of the area under rice. Cultivators have a preference for tall varieties since straw is the main source of cattlefeed. Further, the available modern varieties are susceptible to maladies like iron toxicity, floods and droughts and pest and disease incidence.

Eventhough chemical manuring is an accepted practice, the plant nutrients are seldom applied in balanced proportions. This may be owing to the lack of awareness of the benefits of balanced manuring and also due to the vagaries of weather which make timely application of

fertilisers impossible. Technologies for fertilising rice under intermittant floods are yet to become popular.

ii Coconut

Lack of quality seedlings, high density planting, inadequate application of manures and fertilisers and moisture stress from January-May are the major constraints to production of the crop. The rate of adoption of fertiliser application is only 30 per cent and that too, only at a partial level. Lack of conviction of the beneficial aspect of fertilising coconut palm is the main reason for the above. The tendency on the part of the farmers to grow coconut everywhere without any consideration to the suitability of the area results in the low productivity of the crop.

iii Pepper

Moisture stress during the prolonged dry spell, disease like quick wilt and slow wilt (wilt complex) and inadequate application of plant nutrients have been identified as the major constraints for tapping the production potential of the crop.

The only high yielding variety now available (Panniyur-1) does not perform satisfactorily under shade. Varieties with shade tolerance is a must for pepper cultivation in mixed cropping situations. Varieties resistant/tolerant to wilt disease complex are also to be identified since the northern zone is an endemic area for the malady.

iv. Cashew

Practically there is no adoption of scientific crop production practices in cashew owing to the fact that reasonably good income without much investment and care is available from the crop. Tea mosquito and stem borer are serious pests of cashew inflicting heavy loss on production.

3.2.6. Shallow high level plateau laterite, nonsaline irrigated tract (SHLPL - NS - IT)

3.2.6.1. Delineation

The situation is scattered over Ponnani, Tirur, Perinthalmanna and Ernadu taluks in Malappuram district,

Kozhikode and Badagara taluks in Kozhikode district and Tellicherry, Cannanore and Taliparamba taluks in Cannanore district covering a net cropped area of 20905 ha or 3.1 per cent of the net cropped area of the zone.

District	Taluk	Sub division	Agrl. Dev.Unit	Area (ha)
Malappuram	Ponnani	Tirur		
	Tirur	Manjeri		
	Perinthal-manna	Nilambur		9980
Kozhikode	Kozhikode	Tamarassery		1205
	Badagara	Badagara		
Cannanore	Tellicherry	Tellicherry	Karikotta-kkary	9810
	Cannanore	Cannanore	Mambram Peravoor, Kelakom, Iritty, Chalode	
	Taliparamba	Payyanur	Mattannur Tellicherry Ancharakandy Ulikkal Sreekandapuram Payyanur Taliparamba Alakode Mathil Cheruthazhom Naduvil	
			Total	20995

3.2.6.2. Soils

The laterite soils of this situation is usually loamy, the depth varying from 0.30 m to 2.0 m. The soil is acidic (pH 5.0 - 6.5). The surface layers of the soil contain appreciable amounts of gravel. The soils are poor in organic matter and fertility status. However, these soils respond to management practices. The physico-chemical

characteristics of the soil are given in Annexure 1.

.3.2.6.3. Climate

The average rainfall of the situation is about 3000 mm the range being 2139 mm in Tirurangadi in Malappuram district to 3600 mm in Cannanore taluk in Cannanore district. The process of laterisation is speeded up by the erosion of top soil during torrential rains in June and July and high atmospheric temperature (up to 37°C) in the subsequent dry spell of about six months and indiscriminate removal of vegetation .

3.2.6.4. Physiography

The area is scattered over the three districts of Malappuram, Kozhikode and Cannanore. The terrain of the land is undulating, sometimes with extensive plain lands. The altitude varies from 10 m to 300 m above MSL.

3.2.6.5. Irrigation

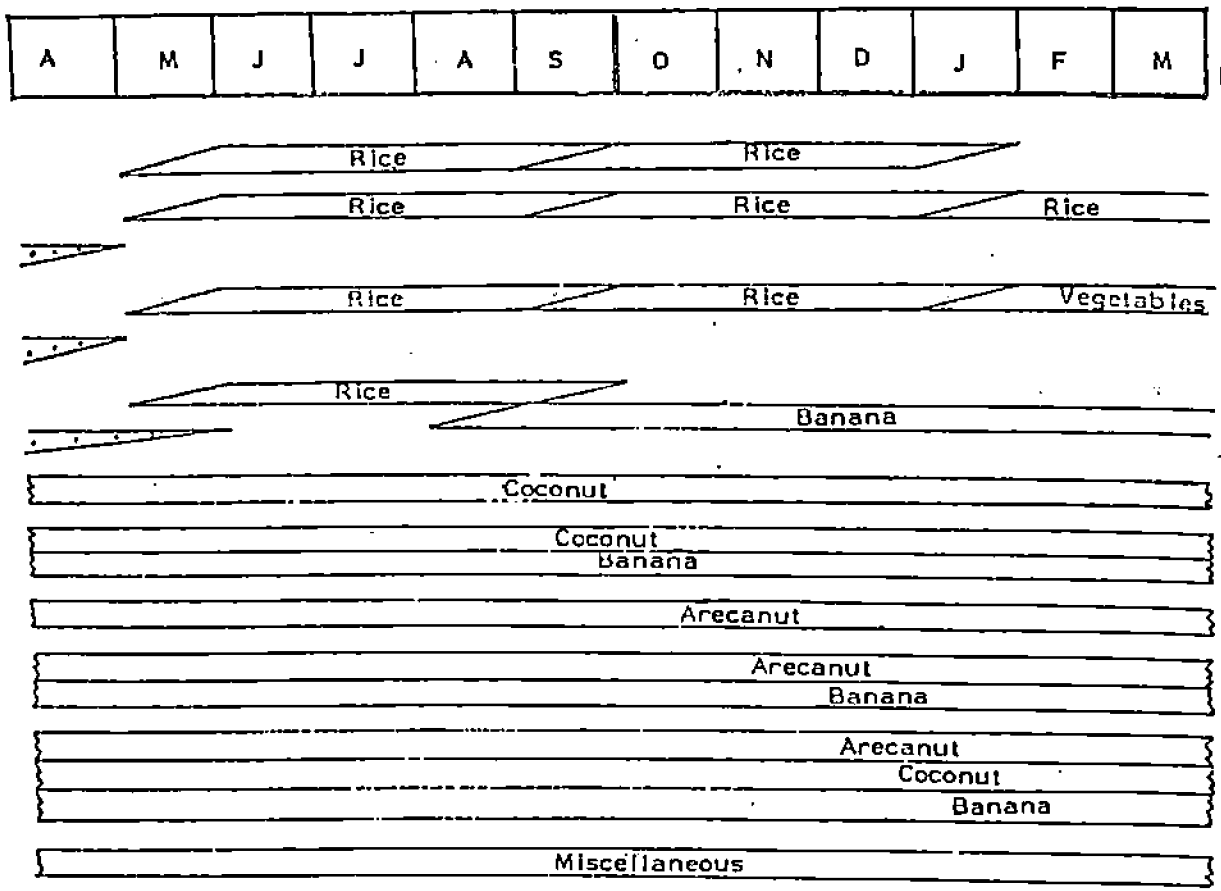
The sources of irrigation are Bharathapuzha and Chaliyar rivers in Malappuram district, Kuttiyadi Irrigation Project in Kozhikode district and Pazhessy project in Cannanore district. In addition, there are a large number of tanks, wells, canals and borewells catering to the irrigation needs. The important crops irrigated are rice (rabi and summer), banana, vegetables, betelvine, coconut and arecanut.

3.2.6.6. Major Crops and cropping intensity

Rice (8.4 % of the total area of the crop cultivated i the zone), banana (11.9%), vegetables (8.1 %) arecanu (19.2%) and coconut (4.54 %) are the major crops grown this agroecological situation. The gross cropped area of th tract is 35,818 ha and the net croped area 20,995 ha. Th intensity of cropping works out to 170.6 per cent (Table 4 Fig.50)

3.2.6.7. Cropping systems

The important cropping systems in the situation a rice-based, coconut-based and arecanut-based as detailed i Table 25.



Irrigated crops	Net cropped area (ha)	Percent (%)
Rice – Rice	7500	35.72
Rice – Rice – Rice	2200	10.48
Rice – Rice – Vegetables	1650	7.86
Rice – Banana	1059	5.04
Coconut	950	4.52
Coconut + Banana	573	2.73
Arecanut	975	4.52
Arecanut + Banana	525	2.72
Arecanut + Coconut + Banana	4331	20.63
Miscellaneous	1567	7.46
Cropping Intensity		170.6%

Fig.50. Irrigated cropping system.

Agro-ecological situation - 6 (SHLPL - NS - IT).

Table 48

Shallow highlevel plateau laterite, nonsaline irrigated tract: Crops (area in ha)

Crop	District			Total	% to total area of the crop in the zone	% to gross cropped area in the zone
	Mala-ppuram	Kozni-kode	Cann-anore			
Rice	7477	2529	2403	12409	8.44	1.55
Banana	565	436	566	1567	11.87	0.20
Sweet potato	100	—	—	100	4.60	0.01
Vegetabies	20	550	1190	1760	4.60	0.22
Betalvine	10	—	—	10	0.81	-
Tapioca	43	144	32	219	0.60	0.03
Coconut	7226	3804	793	11823	4.54	1.48
Arecanut	2984	18	2829	5831	19.23	0.73
Cashew	43	--	14	57	10.06	0.01
Mango	5	—	150	155	0.85	0.02
Jack	—	100	127	227	1.31	0.03
Pepper	10	--	—	10	0.02	-
Misc.	1127	200	240	1567	4.71	0.20

i Rice

Two or three crops of rice are taken in quick succession in the traditional wet lands depending upon the availability of irrigation water. With the commissioning of Pazhassi and Kuttiadi irrigation projects and many lift irrigation units in this tract, it has become possible to raise a third crop also where two crops only were taken. The planting seasons and cultivation practices for the kharif and rabi seasons are almost similar to those of the other situations. However, the crop is transplanted in the majority of the areas unlike in the other situations. The third crop is raised from January/February to April/May. Usually short duration varieties are grown in the season. High yielding varieties are preferred and their coverage is about 90 per cent.

Table 49

Shallow high level plateau laterite nonsaline irrigated tract : Cropping systems

	Cropping system	Area in ha.	% distribution of NCA in the situation
1.	Rice-rice	7500	35.72
2.	Rice-rice-rice	2200	10.48
3.	Rice-rice-vegetable	1650	7.86
4.	Rice-banana	1059	5.04
5.	Coconut	950	4.52
6.	coconut + Banana	573	2.73
7.	Arecanut	975	4.52
8.	Arecanut + banana	525	2.72
9.	Arecanut + Coconut + banana	4331	20.63
10.	Miscellaneous	1567	7.46

Varieties: Third crop : Triveni, Jyothi, Annapurna, Ptb 10

Production potential : 3.0 to 3.5 t/ha

Average production : 2.5 to 3.0 t/ha

Vegetables

Vegetables are cultivated during the summer season by small and marginal farmers since they make a higher profit from these high value crops. The important vegetables are cucumber, ash gourd, snake gourd, bottle gourd, bitter gourd, watermelon, amaranthus, bhindi and vegetable cowpea. High doses of fertilisers and P.P. chemicals are applied by farmers in these areas.

Varieties : Local

Production potential : 18-20 t/ha

Average production : 13-15 t/ha

ii. Banana

Banana is cultivated in rotation with rice in alternate years. The cultivation practices followed are the same described in the previous situations. However, in the Malappuram district, a unique system of planting is seen

wherein suckers of a particular Nendran variety, viz., 'Chethu nendran' are planted in the puddled rice fields after transplanting the rabi rice. The banana plants have a slow growth rate till the rice crop is harvested in December-January. After the harvest of rice, the crop (banana) is earthed up by forming ridges and a heavy dose of organic and inorganic manures is given. Very often colocasia, dioscorea and pulses are also cultivated in the interspaces as companion crops. The Pookottur area of Malappuram district is famous for this practice. About 500 ha are cultivated in this method.

variety	:	Local
Production potential	:	30-35 t/ha
Average production	:	20-25 t/ha

Banana is also cultivated as an intercrop in coconut and arecanut gardens.

Coconut and arecanut are cultivated in pure and mixed stands. Since irrigation is practised, higher yields are obtained from these crops. The cultivation practices etc. are the same as given in the previous situation.

Average yield: Coconut	:	50-60 nuts/palm/year
Arecanut	:	1.75-2 lakh nuts/ha

3.2.6.8. Crop rotation

Rice-rice (35.72%), rice-rice-rice (10.48%), rice-rice-vegetables (7.86%) and rice-banana (5.04%) are the rotations followed in this situation.

3.2.6.9. Mixed cropping

Coconut + banana (2.73%), coconut + arecanut + banana (20.63%) and arecanut + banana (2.72%) are the important mixed cropping systems followed in this situation.

3.2.6.10. Adoption pattern and production constraints

The rate of adoption of recommended practices in respect of choice of varieties, fertilizer application and plant protection is relatively high in this situation due to the availability of irrigation water and high net returns. The specific production constraints for different crops are given below.

i Rice

Soil health problems like iron toxicity associated with impeded drainage in the project areas (where continuously 3 crops are taken), severe incidence of pests (BPH) and diseases (sheath blight, blast) and non-availability of labour in time are the major constraints experienced.

ii. Vegetables

Non-availability of improved varieties, lack of specific irrigation and fertiliser schedules and severe incidence of pests are the constraints to production of vegetables.

iii. Banana

Non-availability of quality suckers, incidence of rhizome weevil, kokkan disease and imbalanced fertiliser application constitute the major constraints.

iv. Coconut

Coconut is planted indiscriminately in all types of land without consideration for depth of soil, number of trees per unit area, and quality of the seedlings. Imbalanced fertiliser application, wherever manuring is practised, and non-application of fertilisers are the other factors contributing to low production. Cultivators seldom adopt plant protection measures due to high cost of labour.

v. Arecanut

The crop is very severely affected by Mahali, Yellow leaf disease and spindle bug in these areas. Inadequate manuring and high plant density are the other factors affecting crop production.

3.2.7. Deep valley laterite non-saline, rainfed tract (DVL - NS - RT)

3.2.7.1. Delineation

This is the second largest agroecological situation in the zone constituting 21.13 per cent of the net cropped area. The tract is spread over all the four districts as detailed below.

District	Taluk	Sub division	Agrl.Dev. Unit	Net cropped area (ha)
Malappuram	Tirur	Tirur	Nannamukku, Tavanur, Marakkara, Chammarath Parappanangadi	39683
	Ernad	Nilambur	Tirurangadi Nilambur. Karuvarakudi	
	Perinthal-manna	Manjeri		
Kozhikode	Kozhikode	Kozhikode	Kuruvathoor Narikuni, Naduvannur Chethamangalam Peruvayal Chelannur	50072
		Tamarassery	Mukkom Karassery Pannikode Puthupady Kodenchery Tiruvampady Omassery	
	Badagara	Badagara		
Cannanore	Tellicherry	Tellicherry	Panoor	8585
	Cannanore	Cannanore	Ullikkal Srekandapuram	46674
Kasaragod	Hosdurg	Kasaragod	Periya,Uduma, Rajapuram, Cheruvathur, Bhimanadi, Nileshwar, Kanhangad.	
Kasaragod	Kasaragod	Kasaragod	Vidyanagar,Kumbala Kudlamugaru, Bedadukka;Kardukka Bediadukka	
	Total			1,45,014

3.2.7.2. Soils

The soils of this situation are deep (more than 2 meters) loams formed in situ by weathering of parent rock and also by transportation of soils from hills and hill slopes during heavy rains. The process of laterisation is slow due to their positional advantage in the valleys. They contain moderate amounts of organic matter. The reaction of the soil is acidic (pH 5.5 to 6.5). These soils have an R2 03 ratio of 25.7, on an average. Impeded drainage is a problem associated with these soils. The physio chemical properties of the soil are furnished in Annexure 1.

3.2.7.3. Climate

The area is endowed with a heavy rainfall of 3300 mm annually, the bulk part (75 per cent) of which is received in the months of June. July and August.

3.2.7.4. Physiography

This situation occurs in the valleys of hills and hillocks and their slopes. The land is flat as well as slopy and occasionally undulating.

3.2.7.5. Irrigation

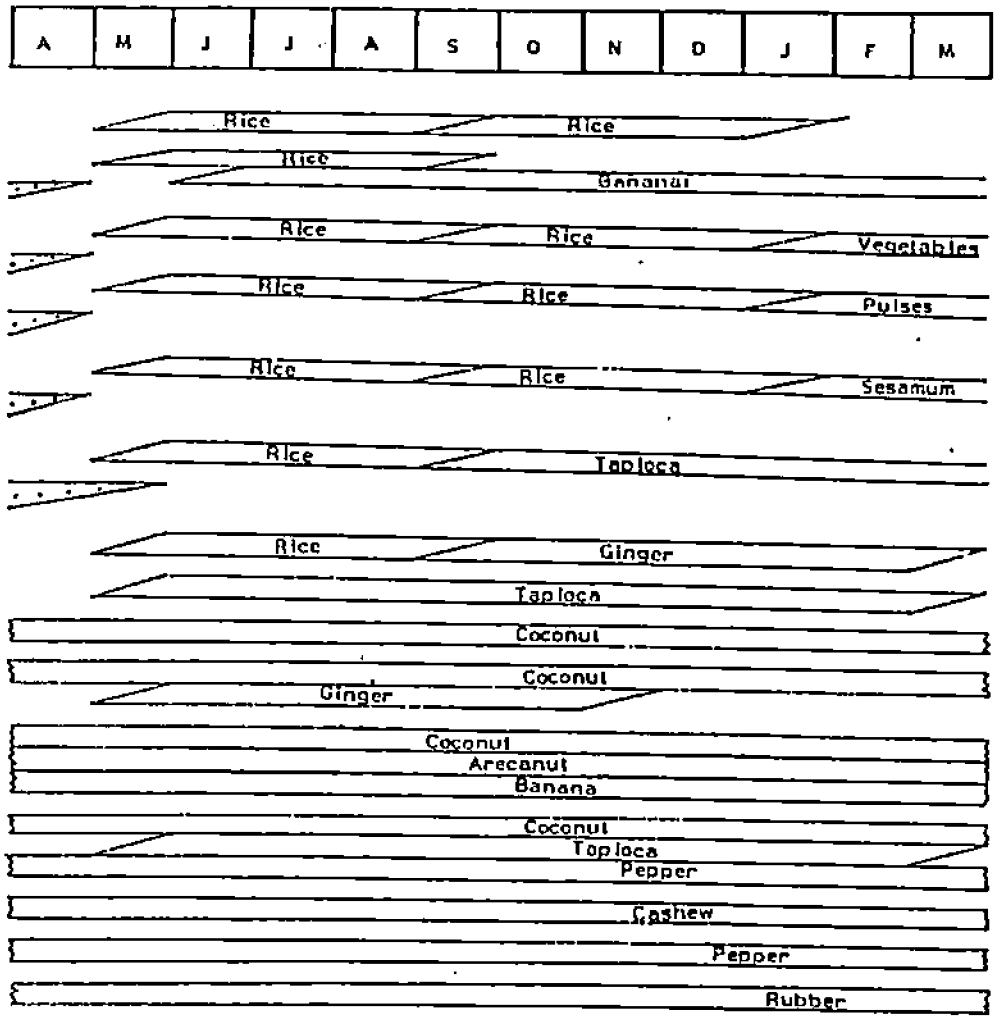
The crops are grown under rainfed condition except high value crops like vegetables.

3.2.7.6. Major Crops and cropping intensity

The situation has a gross cropped area of 1.92 lakh ha, the net cropped area being 1.45 lakh ha. The intensity of cropping is 132.4 per cent. The important crops grown are listed in Table 50.

3.2.7.7. Cropping systems

The cropping systems followed in the situation are listed in Table 51. They are mainly rice based and coconut based Fig.51.



Net cropped Area (ha)	Percent (%)
19,951	13.76
1600	1.10
5000	3.45
604	0.42
1036	0.71
1200	0.83
620	0.42
4600	3.17
33,210	22.84
617	0.42
9160	6.63
2350	1.62
14500	10.00
7500	5.17
17,500	12.07
Cropping Intensity	132.4%

Fig.51. Rainfed cropping system.

Agro-ecological situation - 7 (DVL - NS - RT).

Table 50

Deep Valley laterite nonsaline rainfed tract : Crops (area in ha)

Crop	DISTRICTS				Total	% to total area of the crop in the zone	% to gross cropped area in the zone
	Malappuram	Kozhikode	Cannanore	Kasaragod			
Rice	16492	4513	5090	3916	30011	20.41	3.75
Banana	1704	203	140	227	2274	17.23	0.28
Pulses	150	212	62	180	604	8.40	0.08
Sesamum	1056	--	--	--	1056	38.92	0.13
Vegetables	57	1459	2330	2192	6038	27.94	0.76
Tapioca	6107	1716	2256	5823	15902	43.39	2.00
Ginger	500	1246	326	165	2237	58.39	0.78
Coconut	9550	27238	2540	6368	45696	17.55	5.71
Arecanut	1412	3384	1182	1239	7212	29.80	0.90
Cashew	5400	190	200	18870	24460	27.33	3.08
Mango	1233	2343	15	600	4191	22.87	0.52
Jack	2100	2369	1200	600	6269	36.15	0.78
Cocoa	460	80	--	113	653	25.90	0.08
Pepper	1047	2143	1203	3703	8096	19.40	1.01
Rubber	4065	8041	1420	4040	17566	25.72	2.20
Misc.	2100	315	1840	1410	5665	17.01	0.71

i. Rice and rice based cropping systems.

The cropping seasons, varieties and agro-techniques adopted in the cropping systems given above are similar to those described in the situation 6.

Production potential

Rice Kharif — Local 2.5 to 3 t/ha; Modern 3.5 to 4 t/ha

Rabi — Local 3.0 to 3.5 t/ha; Modern 3.5 to 4.0 t/ha

Average production

Kharif — Local 2.2 to 2.5 t/ha; Modern 2.5 to 3.0 t/ha

Table 51

Deep valley laterite, nonsaline rainfed tract : Cropping systems

Cropping system	Area (ha)	% distribution of NCA in the situation
1. Rice - rice	19951	13.76
2. Rice - banana	1600	1.10
3. Rice - rice -vegetables	5000	3.45
4.Rice - rice - pulses	604	0.42
5. Rice - rice - sesamum	1036	0.71
6. Rice - tapioca	1200	0.83
7. Rice - ginger	620	0.42
8. Tapioca	4600	3.17
9. Coconut	33120	22.84
10. Coconut - ginger	617	0.42
11. Coconut + arecanut + banana	9160	6.63
12. Coconut + tapioca + pepper	2350	1.62
13. Cashew	14500	10.00
14. Cashew + tapioca	7812	5.39
15. Pepper	7500	5.17
16. Rubber	17500	12.07
17. Miscellaneous	6500	4.48

Rabi	Local 2.5 to 3.0 t/ha Modern 2.5 to 3.0 t/ha
Banana	
Production potential	20 t/ha
Average production	15-20 t/ha
Vegetables	
Production potential	30-35 t/ha
Average productipn	12-15 t/ha
Pulses	
Production potential	1200 kg/ha
Average production	500 kg/ha
Sesamum	
Production Potential	500 kg/ha
Average production	300 kg/ha
Tapioca	
Production potential	25 t/ha
Average production	16-20 t/ha

Ginger

Production potential	6000 kg/ha
Average production	2500 kg/ha

ii. Coconut based cropping systems.

Coconut and coconut based cropping systems occupy 31.57 per cent of the net cropped area in the situation. The system is followed in all the four districts. The seasons, varieties and cultivation practices of all the crops cultivated in this system are identical to those followed in the other areas.

iii. Cashew based cropping systems.

In the new plantations of cashew, the crop occupies hardly 10 per cent of the area during the early growth phases. The open interspaces are utilised for cultivation of tapioca.The planting season is in May-June, with the receipt of pre-monsoon showers. This practice is continued for 2 or 3 years.

Cashew is also planted in the boundaries of the homesteads as well as in rocky patches.

Cashew : Variety : Local		
	Production potential	: 1200 kg/ha
	Average yield	: 500-600 kg/ha
Tapioca: Variety local and M4		
	Production potential	: 20 t/ha
	Average production	: 12 t/ha

iv. Pepper

Pepper occupies 5.17 per cent of the net cropped area in the situation and is cultivated either as a pure crop or as a companion crop in coconut and arecanut gardens and also with the other perennial trees like jack, mango etc.

Varieties: Karimunda, Kottanadan, Panniyur-1, Kalluvally, Narayakodi, Poonjarmunda etc.

Production potential	: 750 kg/ha
Average production	: 300 kg/ha

v. Rubber

Rubber is cultivated as a monocrop in about 12 per cent of the net sown area in the situation.

Varieties : RRII - 105, 300, 203, 600, 605

Production potential : 800 - 1000 kg/ha
Average production : 500 -600 kg/ha

3.2.7.8. Crop rotation

Rice-rice (13.76%), rice-vegetables (3.45%), rice-banana (1.17%), rice-pulses (0.42%), rice-sesamum (0.71%), rice-tapioca (0.83%) and rice-ginger (0.42%) are the important crop rotations followed in the situation.

3.2.7.9. Mixed cropping

Mixed cropping is practiced in 14.1 per cent of the net cropped area in the tract. Out of this Coconut + arecanut + banana system accounts for 6.63 per cent and cashewnut + tapioca system 5.39 per cent. In these 2 systems, coconut and cashewnut are the pivotal crops.

3.2.7.10. Adoption pattern and production constraints

i Rice

Improved varieties are cultivated in only 33 per cent of the Kharif rice area. The adoption of these varieties is about 25 per cent in the rabi season. The rate of adoption is low mainly because of the following reasons.

i) the modern dwarf varieties succumb to floods during the kharif season.

ii) these varieties are highly susceptible to diseases like sheath blight and soil health problems like iron toxicity

iii) cultivators have a preference for tall varieties since straw is the main feed for their cattle.

The rice farmers do apply manures and fertilisers, but seldom the plant nutrients are applied at balanced proportions. This is due to lack of awareness of the benefits.

ii Coconut

The adoption of fertiliser practices is only partial.

This is owing to lack of conviction about the benefits of fertiliser application. Further, planting materials of elite varieties are not available in time.

iii. Pepper

Generally no fertilisers are applied for Pepper. This is due to the lack of conviction of the benefits. Moreover, even without manuring, a reasonably good income is received by the growers from this crop. The wilt complex disease is a serious malady affecting pepper. The available technology to control the disease is expensive and therefore, growers are hesitant to adopt it.

iv. Ginger

The existing varieties are highly prone to soft rot and bacterial wilt diseases. There is no effective technology to control bacterial wilt. Varieties tolerant to these maladies have to be identified.

v. Rubber

The most common variety used is RRII 105. It is highly prone to pink disease and powdery mildew. The available technologies are laborious and cost - intensive and therefore, cultivators find it difficult to adopt control measures. Varieties resistant to these diseases are to be identified and popularised.

3.2.8. Deep valley laterite, nonsaline irrigated tract (DVL - NS - IT)

3.2.8.1. Delineation

The situation occurs in the Tirur and Perinthalmanna taluks of Malappuram district, Kozhikode and Badagara taluks of Kozhikode district, Cannanore taluk of Cannanore district and Hosdurg and Kasaragod taluk of Kasaragod district with a net cropped area of 38001 ha. This is 5.54 per cent of the NCA of the zone. The distribution of the area in the different districts are as follows.

District	Taluk	Sub division	Agrl.Dev. Unit	Net cropped area (ha)
Malappuram	Tirur Perinthal-manna	Tirur Manjeri	Kalpakanchery	7,252
Kozhikode	Kozhikode	Kozhikode Tamarassery	Perambra	2,180
Cannanore	Badagara Cannanore	Badagara Cannanore	Sreekanda-puram Payyavur	2,310
Kasaragod	Hosdurg	Kasaragod	Cheruvathur Nileshwar Kanhangad Uduma Periya Rajapuram	26,257
	Kasaragod	Kasaragod	Vidyanagar Kumbla Kodlamugaru Bediadukka Bedadukka Karadukka	
Total				38,001

3.2.8.2. Soils

The soils in the situation are deep loams, derived from low level laterite similar to the ones described in the agroecological situation 7.

3.2.8.3. Climate

The climatic conditions prevalent in the situation are typical of the agroecological situation 7. Since irrigation facilities are available, the crops do not experience moisture stress from December to May.

3.2.8.4. Physiography

The area is flat as well as undulating. The undulating lands are terraced to facilitate irrigation.

3.2.8.5. Irrigation

Irrigation is made possible with the help of impounded water in surface ponds and tanks, small streams and surangams. Surangams are water source bored horizontally into laterite hills. Water is tapped from the water bearing strat of these hills and stored in small earthen tanks. From these tanks irrigation is done by gravity flow. These irrigation structures are seen in Hosdurg and Kasaragod taluks of Kasaragod districts.

The crops irrigated are rice, banana, betelvine, vegetables, coconut and arecanut.

3.2.8.6. Major Crops and cropping intensity

The situation has a gross cropped area of 43163 ha.The cropping intensity is 113.6 per cent. The important crops grown are coconut, arecanut, rice, banana and pepper (Table 52).

Table 52

Deep valley laterite nonsaline irrigation : Crops(area in ha)

Crop	DISTRICTS				Total	% to total areaof the crop in the zone	% to gross cropped area in the zone
	Mala-ppuram	Kozni-kode	Cann-anore	Kasa-ragod			
Rice	4500	415	506	4334	9755	6.63	1.23
Banana	44	205	114	1673	2036	15.43	0.23
Pulses	16	120	20	107	271	3.77	0.03
Vegetables	10	385	145	1309	1849	8.54	0.23
Betelvine	576	—	—	—	516	41.85	0.16
Tapioca	559	—	38	838	1435	3.90	0.18
Ginger	—	—	90	361	451	11.77	0.06
Coconut	2446	2265	1232	5914	11757	4.52	1.47
Arecanut	1417	513	585	4364	6869	22.69	0.86
Mango	500	—	615	308	1423	7.77	0.18
Jack	—	500	50	81	631	3.64	0.08
Coco	—	394	250	250	894	35.46	0.11
Pepper	—	471	800	1068	2336	5.60	0.29
Misc.	1812	100	165	850	2927	8.78	0.37

3.2.8.7. Cropping systems

The important cropping systems prevalent in the situation are (1). Rice-rice-rice (2) Rice-rice-vegetables (3) Rice-banana (4) Rice-betelvine (5) Coconut + arecanut + banana and (6) Arecanut + pepper + banana (Table 53, Fig. 52).

Table 53

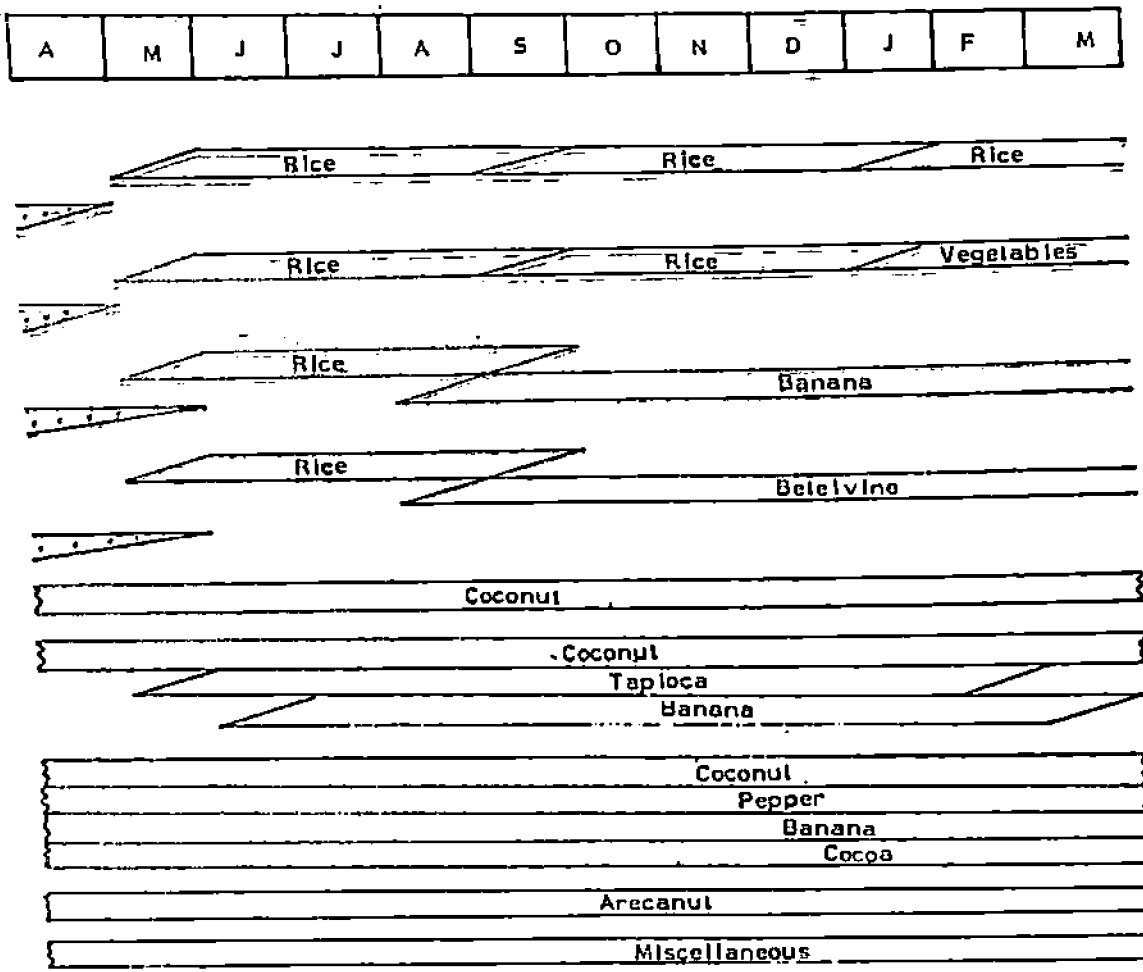
Deep valley laterite nonsaline irrigated cropping systems

	Cropping systems	Area (ha)	% distribution of NCA in the situation
1.	Rice-rice-rice	6005	15.80
2.	Rice-rice-vegetables	1500	3.95
3.	Rice-banana	1800	4.74
4.	Rice-betelvine	450	1.18
5.	Coconut	6200	16.32
6.	Coconut + tapioca + banana	1435	3.78
7.	Cocont + pepper + banana + cocoa	4500	11.84
8.	Arecanut	2100	5.53
9.	Miscellaneous	2927	7.70

i. Rice and rice based cropping systems.

In the monocropping system of cultivation in the wet lands 3 rice crops are taken in quick succession. The kharif and rabi crops are cultivated with medium duration varieties and the summer crop with short duration varieties. The varieties grown in this situation are the same as in situation 7.

Rice		Production potential	Average Production
Kharif	Local	2.5 to 3 t/ha	2.0 t/ha to 2.2 t/ha
	Modern	3.5 to 4 t/ha	2.5 t/ha to 3.0 t/ha
Rabi	Local	3.0 to 3.5 t/ha	2.2 to 2.5 t/ha
	Modern	3.5 to 4 t/ha	2.5 to 3.0 t/ha



	Net cropped Area (ha)	Percent (%)
Rice – Rice – Rice	6,005	15.80
Rice – Rice – Vegetables	1,500	3.95
Rice – Banana	1800	4.74
Rice – Betelvine	450	1.18
Coconut	6200	16.32
Coconut + Tapioca + Banana	1435	3.78
Coconut + Pepper + Banana + Cocoa	4500	11.84
Arecanut	2100	5.53
Miscellaneous	2927	7.70
Cropping Intensity		113.6%

Fig.52. Irrigated cropping sytem.
Agro-ecological situation - 8 (DVL - NS - IT).

Summer	Local	2.0 to 2.5 t/ha	1.5 to 2.0 t/ha
	Modern	2.5 to 3.0 t/ha	2.0 to 2.5 t/ha

In the rice-betelvine system, betelvine is rotated with rice once in two or three years. Being a very paying crop betelvine is cultivated by small and marginal farmers in small plots of 300 to 500 m^2. Betelvine cuttings are planted on ridges taken at one meter apart in the month of May-June or August-September. Very heavy manuring with green leaf and F.Y.M. is done (upto 50 t/ha). The plants are trained on poles or coir ropes and the tender leaves are plucked twice in a week. Manuring is done frequently and irrigation is practised daily during summer months. The crop is lowered when they attain a height of more than 3 m; the main stems are coiled and covered with soil to rejuvenate vegetative growth and profuse branching to yield more tender leaves. No fertiliser application or plant protection measures is adopted. The duration of the crop is generally three years. sometimes vegetables like amaranthus, chillies and brinjal are also grown in the interspaces of betelvine which fetches additional income to the farmer.

ii. Coconut and Coconut based cropping systems.

This cropping system is more or less similar to that described in earlier situation 7. Since irrigation is practised, the cultivators resort to timely manuring and other operations as a result of which a higher income is obtained. Crops like tapioca, banana, arecanut and pepper are grown as companion crops in coconut gardens.

Varieties : WCT and hybrids. Nearly 90 per cent of the area is planted with WCT.

Production potential	Monocrop	Mixed crop
WCT	60-80 nuts/palm	40-60 nuts
Hybrids	100-120 "	80-100 "
Average yield		
WCT	40-50 "	20-30 "
Hybrids	50-60 "	40-50 "

iii. Arecanut and arecanut based cropping systems.

This system occupies about 17 per cent of the net area sown in the situation. The arecanut crop is profusely irrigated and successful crops are raised. Kasaragod district dominates the other districts in the area undr arecanut. Pepper, banana and cocoa are also cultivated as inter crops in arecanut gardens. This mixed cropping system is concentrated in Badiadukka, Peria, Kumbla and Orkadi areas in Kasaragod taluk of Kasaragod district. Arecanut pepper crop mix is also dominant in Bandadukka and Bediadukka areas of the Kasaragod Taluk. Only ripe arecanuts are harvested in Kasaragod district whereas in the other areasof the zone, tender nuts are harvested for making chali nuts.

Varieties: Local and mangala. Mangala is cultivated in about 10 per cent of area in Vidyanagar of Kasaragod taluk in Kasaragod district.

Production potential : 3.0 lkh nuts/ha
Average production: 2.0 to 2.5 lkh nuts/ha

3.2.8.8. Crop rotation

Rice-rice-rice (15.8%), rice-rice-vegetables (3.95%), rice-banana (4.74%) and rice-betalvine (1.10%) are the main crop rotations followed in the tract.

3.2.8.9. Mixed cropping

Mixed cropping is practiced in coconut and arecanut gardens to utilise effectively the vacent space available. A variety of crops - both annual and perennial - are grown. Among the mixed cropping systems, coconut + tapioca + banana (3.8%), coconut + pepper + arecanut and arecanut + pepper + banana + cocoa (1.84%) are the most important.

3.2.8.10. Adoption pattern and specific production constraints.

i Rice

There is only a partial adoption in respect of choice of varieties, fertiliser application and plant protection. The production constraints are similar to those discribed for the situation 7.

ii Coconut

Nearly 30 per cent of the farmers apply fertilisers.

However, balanced manuring is seldom done. Lack of conviction of the benefits of balanced manuring is the most important constraint to the adoption of the recommended fertiliser does.

iii. Arecanut

Adequate attention is paid to the crop by the elite farmers in the Kasaragod taluk. The cropis manured, irrigated and well protected. The most important constraints are mahali and yellowing diseases affecting the crop. There is no technology to contain yellowing disease. Variaties tolerant to the disease have to be identified and popularised. Nut splitting is another malady of unknown etiology.

In the mixed cropping system, a large number of crops are accommodated without any regard for the planting geometry with the result that the field looks like a jungle of crops. The optimum plant density for all the crops in a mix has to be work out and technology to manage the system as a whole evolved.

3.2.9. Deep forest loam, nonsaline, rainfed (DFL - NS - IT)

3.2.9.1. Delineation

This situation extends over an area of 80,700 ha in all the four districts of the zone. Malappuram district has the maximum area of 25,790 ha followed by Cannanore (24,255 ha), Kozhikode (19,658 ha) and Kasaragod (10,997). The tract lies adjacent to the western ghats and comprises of cleared forest lands, cultivated over a period of 50-75 years.

3.2.9.2. Soils

The soils are generally charaterised by a surface layer which is dark brown in colour due to the presence of organic matter derived from luxurient forest vegetation. The depth of the forest litter varies from place to place. The soil reaction is generally acidic (pH 5.0 - 6.5). These soils are rich in total nitrogen but poor in the bases due to heavy leaching. Well defined profiles can be seen in these soils. The main crop grown are rubber, pepper, tapioca and cardamom.

District	Taluk	Sub-division	Agrl. Dev. unit	Net cropped area (ha)
Malappuram	Ernadu	Nilambur	Karuvarakundu Pookottupadam Wandoor Edakkara Mambad Chunkathara	25,790
Kozhikode	Kozhikode	Thamara-ssery	Kodencherry Koodaranji Tiruvambadi Pudupadi	19,658
	Badagara	Badagara	Kayanna Thottilpalam Vanimel Kolayad Panoor	
Cannanore	Tellicherry	Tellicherry	Kelakam	24,255
"	Cannanore	Cannanore	Sreekanda-puram	
"	Taliparamba	Payyanur	Naduvil Mathil	
Kasaragod	Hosdurg	Kasaragod	Rajapuram Bendadukka	10,977
"	Kasaragod	"	Karadukka Bhimanadi	
Total				80,700

3.2.9.3. Irrigation

The crops are mostly grown under rainfed conditions.

3.2.9.4. Climate

the area has a perhumid, megathermal climate. The rainfall varies between 2345 mm in Nilambur to 3049 mm in

Kasaragod. About 170 per cent of rains are received from the south-west monsoon during June and July, the rainest month being July. The maximum temperature varies between 27°C and 37°C while the minimum varies between 15°C and 18°C. The elevation of the tract varies from 400 m to 1000 m above MSL.

3.2.9.5. Physiography

The tract comes under the physiographic classification of high land with an attitude ranging from 400 m to 1000 m above MSL. It lies close to the western ghats and has level as well as undulating topography.

3.2.9.6. Major Crops and cropping intensity

The tract accomodate a wide variety of crops but perennials predominent to the scene (Table 54). The gross cropped area is 91478 ha. The intensity of cropping is 113.3 per cent.

i. Rice and rice based cropping systems.

Rice cultivation is restricted to areas liable to submergenceduring the monsoons. Two crops of rice are taken in succession during May - December. Local as well as modern varieties are grown. Since the soils are fertile, chemical fertilisers are not usually applied.

Banana and vegetables are also grown in low lying fields in rotation with rice.

Rice

Production potential	:	4 to 5 t/ha
Average production	:	3.0 to 3.5 t/ha

Banana

Production potential	:	20 t/ha
Average production	:	15 t/ha

Vegetables

Production potential	:	20 t/ha
Average production	:	15 t/ha

Table 54

Deep forest loam, nonsaline, rainfed tract: crops (ha)

Crop	DISTRICTS				Total	% of the crop to the total area of the crop in the zone	% to gross cropped area in the zone
	Malappuram	Kozhikode	Cannanore	Kasaragod			
Rice	1070	24	374	—	1468	1.00	0.18
Banana	—	134	206	—	340	2.58	0.04
Pulses	712	50	—	—	762	10.60	0.10
Vegetables	60	120	—	665	835	3.87	0.10
Tapioca	5804	513	4082	2213	12612	34.28	1.58
Ginger	—	354	270	121	745	19.45	0.09
Coconut	6508	7782	4805	—	19095	7.33	2.39
Arecanut	204	—	1632	—	1836	6.06	0.23
Cashew	162	332	2336	1665	4395	4.87	0.55
Mango	1037	1381	656	100	3174	17.32	0.40
Jack	3050	2093	38	—	5181	29.87	0.65
Cocoa	—	460	274	300	974	38.64	0.12
Cardamom	188	412	375	400	1379	100.0	0.17
Pepper	1067	7235	2145	3142	13589	32.5	1.70
Rubber	1933	9715	6135	1451	19234	28.16	2.41
Misc.	5125	—	234	500	5859	17.60	0.73

ii. Tapioca

Tapioca is grown in all the 4 districts, but Malappuram ranks first in area followed by Cannanore. The crop is grown as a mixed crop in coconut gardens and as a monocrop in drylands. Planting starts with the receipt of premonsoon showers in April-May. Chemical fertilisers are not generally applied. A number of varieties are grown, the dominant one being M4.

Production potential : 30 t/ha
Average production : 20 t/ha

3.2.9.7. Cropping systems

Table 55

Northern zone : Cropping systems

	Crop	Area (ha)	% distribution of NCA in the situation
1.	Rice-rice	1343	1.66
2.	Rice-banana	450	0.56
3.	Rice-vegetables	375	0.46
4.	Tapioca	8500	10.53
5.	Coconut-ginger	745	0.92
7.	Coconut +arecanut + banana	6500	8.05
8.	Coconut + arecanut + banana + pepper	7745	9.60
9.	Arecanut + banana	340	0.42
10.	Arecanut + cocoa + pepper	1500	1.86
11.	Cardamom (monocrop)	1379	1.71
12.	Pepper (monocrop)	9760	12.12
13.	Rubber (monocrop)	19234	23.83
14.	Miscellaneous	5859	7.26

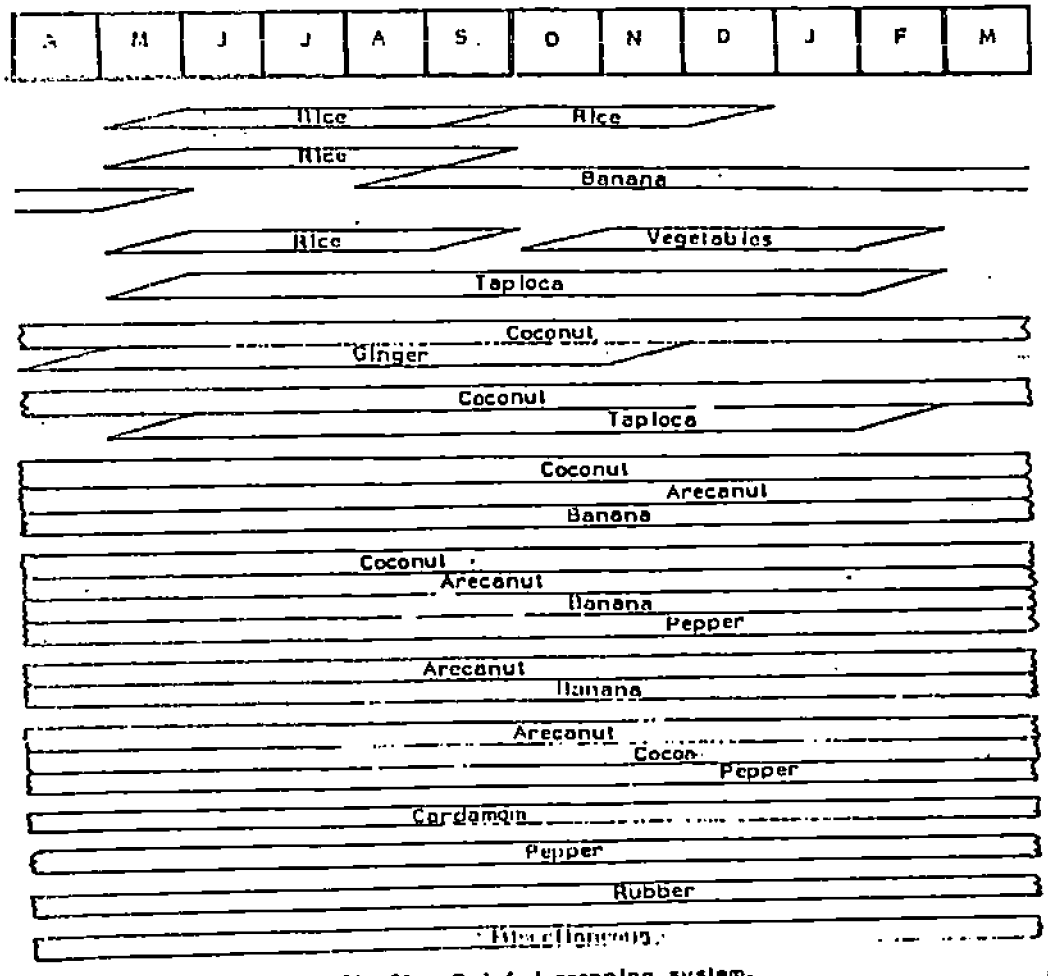
The salient features of the cropping systems (Table 31) are mentioned nereunder. Fig.53

ii. Coconut based cropping systems.

Mixed cropping of annual and perennial crops are practised with coconut as the main crop in about 19,100 ha in the four districts. The other crops in this mix are ginger, tapioca, banana, cocoa, arecanut, pepper, mango, jack, cashew etc. The season of planting and cultivation practices followed are similar to those described in situation 7 and 8.

iii. Arecanut and arecanut based cropping systems.

Arecanut is not planted as a monocrop in this situation. Cocoa, banana and pepper are grown as companion crops in arecanut plantations.



Net cropped Area(ha)	Percent (%)
1343	1.66
450	0.56
375	0.46
8500	10.53
745	0.92
4112	5.09
6500	8.05
7745	9.60
340	0.42
1500	1.86
1379	1.71
9780	12.12
19234	23.83
5859	7.26
Cropping intensity	113.3%

Fig.53. Rainfed cropping system.
Agro-ecological situation - 9 (DFL - NS - IT).

iv. Cardamom

The cultivation of cardamom is confined to this tract in an area of 1,379 ha equal to 1.79 per cent of the net cropped area of the situation. It is grown in the partially cleared lands. The growers receive financial assistance from the Cardamom Board for raising the crop. Nurseries are raised in September and the seedlings transplanted in June-July in the main field under the shade of tall trees after clearing the undergrowth. The spacing adopted is 2m x 2m or 3m x 3m or 1.5m x 1.5m depending upon the variety cultivated. Organic manures and chemical fertilisers are invariably applied. The plants start to bear in the third year of planting. Picking is carried out at 30-day intervals from October to February. Peak harvesting season is November - December.

Varieties	:	Vazhukka, Malabar, Mysore
Production potential	:	100 - 120 kg/ha
Average yield	:	50 kg/ha

v. Pepper

this tract is ideal for the cultivation of pepper owing to the high fertility status of the soil and favourable climatic conditions. The crop is grown as a monocrop in an area of 9,780 ha. Further, it is aiso grown in almost all the homesteads in association with coconut, arecanut, mango, jack etc. The planting and other operations are done as in the other tracts.

Varieties:		Karimunda, Kottanadan, Arakkulamunda, Poonjarmunda, Panniyur-1
Production potential	:	600-800 kg/ha
Average production	:	400-500 kg/ha

vi. Rubber

Rubber occupies 28.16 per cent of the total area of the crop in the zone. The maximum area is in the Tamarassery sub division of Kozhikode taluk (50.51%). Rubber growers receive liberal financial assistance from the Rubber Board and therefore, scientific crop production technologies are adopted almost in full.

Varieties	:	RRII 105, 300, 600and 605

Production potential	:	800-1000 kg/ha
Average production	:	600-700 kg/ha

3.2.9.8. Crop rotation

Rice-rice (1.66%), rice-banana (0.56%) and rice-vegetables (0.46%) are the prevalent crop rotation in the tract.

3.2.9.9. Mixed cropping

Coconut +' ginger (0.92%) coconut + arecanut + banana (8.0%), coconut + arecanut + banana + pepper (9.6%), coconut + tapioca, arecanut + pepper and arecanut + cocoa + pepper are the main mixed cropping systems found in the situation.

3.2.9.10. Adoption pattern and production constraints

i Rice

Since the soil is inherently fertile not much attention is paid to the application of chemical fertilisers. However, more yield can be realised if balanced fertiliser application is resorted to and modern varieties are used.

ii Cardamom

The major constraints to cardamom production are, moisture stress at flowering and fruit setting, Azhukal disease and pests like thrips and borers.

iii Rubber

The high incidence of pink disease and powdery mildew on the most commonly cultivated variety viz; RRII 105 is a specific production constraint faced by rubber growers.

The specific production constraints listed for the crops in situation 7 and 8 hold good for this agroecological situation also.

Typical/innovative agricultural practices with rationale

Some of the farming practices evolved by farmers over a period of time are cited below. Many of these practices need further research to find out the scientific reasons for their adoption or acceptance by other farmers.

Farmers' practice	Rationale
Rice seeds are dipped in cowdung solution (20 g/1) of water) before sowing. Cowdung solution is also sprayed on the rice crop to control diseases like BLB.	The efficacy of cowdung in the control of BLB has since been proved. This is a very old practice not involving high cost and can be practised with ease. Cowdung also leaves no residue hazards in the environment.
Arecanut growers in Kasaragod and Hosdurg taluks smear arecanut seed nut seed nuts with cowdung to improve viability and germination.	This is a cheap technology. There is no experimental evidence on this, however.
The vegetable growers all over the zone preserve seeds of cucumber, bitter gourd and ash gourd in cowdurung. Seeds, immediately after extraction, are mixed with with fresh cowdung paste and the mixture so prepared is affixed on the wall of the kitchen above the oven. The dung paste and the seeds dry up in due course. The seeds are protected from insect attack. The viability of seeds is also good when preserved as per this practice.	This is ageold practice. It is a cheap and effective method for preservation of vegetable seeds.
The cut rhizomes of Amorphophallus and dioscorea (seed material) are dipped in cowdung slurry, dried in the shade and stored before	The cultivators have been adopting this practice as it is a cheap technology to obtain vigorous plants. Pest and disease incidence is also

sowing. This helps in faster and vigorous germination.	less in the initial stages.
Ginger rhizomes (seed material) are usually stored in pits dug under shade. Cultivators spread leaves of panel (Glycosmis Pentaphylla) on the floor of the pits before storing ginger. The seeds are also covered with panal leaves or coconut fronds.	Panal leaves prevent white ant attack. It is believed to preserve the seeds from harmful micro-organisms also. This has become an accepted practice, being cheap and effective.
Application of ash	
The vegetable growers in Cannanore and Tellicherry taluks sprinkle a mixture of leaf ash and burnt soil on cucumber plants when plants are young (7-15 days after sowing). This ensures vigorous growth and prevents pest incidneces in the initial stages of growth.	The beneficial effect of this practice is appreciated by farmers at large. The plants may be receiving macro and micro nutrients accumulated in the soil due to burning of leaves. This needs further investigation.
Nut splitting in arecanut	
Nut splitting is considered as a physiological disorder. Symptoms appear as pre-mature yellowing of the nuts when they are $\frac{1}{2}$ to $\frac{1}{4}$ mature. The practice of making a longitudinal side slit at the base of inflorescence is being adopted as a control measure by cultivators.	The split at the base cause exudation of plant sap. The draining of excess sap is supposed to give some control to nut splitting.

Bud rot control in coconut	
Bud rot is a severe disease in coconut. Cleaning the affected portion and Bordeaux paste application at the cleaned site is the practice recommended. Some cultivators instead of Bordeaux paste, apply Sodium chloride after cleaning the affected portion at 100-150 g per palm.	This is becoming popular with the farmers. The effect of sodium chloride on bud rot control, however, needs further investigation.
Crop rotation with ginger, amorphophallus and tapioca	
This is a 3 year rotation with ginger in the first year, amorphophallus in the second year and tapioca in the third year. This practice increases the soil fertility and the net income from the unit area. This rotation is popular in the deep valley laterite areas.	The large amount of organic matter (15-30 t/ha) applied to Ginger benefits the amorphophallus and subsequently tapioca which is a soil exhausting crop. The economics of such a system needs to be worked out.
Application of Sodium chloride for coconut	
Sodium chloride at the ratio of 3-5 kg per palm is applied in coconut basins during September-October. The cultivators believe that sodium chloride will improve the moisture absorption and retention capacity of the soil. This practice is very popular in the laterite belt.	The beneficial effectof NaCl has been proved experimentally also. It promotes flowering and increases yield in coconut. Studies have also revealed that Na could substitute K to the extent of 50% of the present recommendation of 1.20 kg K_2O/palm per annum. The cultivators' belief that NaCl improves soil moisture status, however, has no scientific basis.

Application of NaCl to soften hard laterite	
When laterite stones are encountered with while taking pits for planting coconut, NaCl is applied on the stones at the fag end of North-East monsoon.	NaCl causes speedy disintegration of the laterite stones allowing early root penetration.

CHAPTER IV

RESEARCH AND EXTENSION LINKAGE

4.1. Linkage between research activities

The Regional Argicultural Research Station, Pilicode maintains constant linkage with the other research institutions in the zone, state and also other research organisations within the country. The lead function of the station being state wide research on coconut, constant consulation and guidence are being offered by our scientists to the other research stations functioning as testing and verification centres. We have also established close linkages with instituations responsible for research on pulses, annual oil seeds and rice.

4.1.1. Linkage within the zone

This research station is keeping constant linkage with the following research stations of the zone.

	Research Station	Research activity	Funding Agency
1.	Central Plantation Crops Research Institute, Kasaragod	Plantation Crops	I.C.A.R.
2.	Pepper Research Station, Panniyur	Pepper	K.A.U.
3.	National Research Centre for Spices, Calicut	Spices	I.C.A.R
4.	Centre for Water Resources Development and Management, Calicut	Water Management	Kerala Govt.
5.	Kelappaji College of Agricultural Engineering &Technology, Tavanur.	Rice, Coconut, Banana, Agri. implements	K.A.U.

Discussions with the scientists of these stations are arranged during the zonal workshops as well as during the formulation of location specific research projects of the

station. The Associate Director of the staton is a special invitee to the research council of the CPCRI as well as other organisations. The research activities of the zone is finalised after discussion with the concerned scientists of these research stations.

4.1.2. Linkage between different zones and Headquarters

The Associate Director as well as the scientists of the station are in constant touch with the scientists of the other zones. Associate Directors as well as senior scientists of other zones and also of the Headquarters regularly participate in the zonal workshops conducted once in every six months. This is reciprocated in the zonal workshops of either zones also. The research projects formulated are aslo reviewed by the Director of Research. The Associate Director (M & E) from the Headquarters makes periodical visits to the station and provides suggestions of improvement of research activities. The Director of Research also makes periodical visits to the station for discussions with the scientists and for performance appraisal.

4.1.3. Linkage with other central and other institutes and Universities.

The station is keeping linkage with the following research centres/departments and Universities for the various research activities being carried out.

In addition, the station is having close liaison with the various research stations of the Kerala Agricultural University in the formulation of research programmes and implementation. The scientists of the station participate regularly in conferences, seminars, symposia and workshops organised by various agencies in India. This helps them to attain latest information in their respective fields of research.

The scientists keep national and international contacts for updating scientific knowledge and exchange of ideas through various means.

Research Centre/University	Research activities
1. Central Tuber Crops Research Institute, Trivandrum.	Tuber crops
2. Central Plantation Crops Research Institute, Vittal.	Plantation crops
3. Central Plantation Crops Research Institute, Kayamkulam.	Plantation crops
4. National Bureau of Plant Genetic Resources, Regional Station, Trichur.	Germplasm collection
5. Kerala Livestock Development and Milk Marketing Board, Trivandrum.	Fodder crops
6. Department of Soil Survey and Land Use Planning, Trivandrum.	Soil survey
7. Department of Forestry, Trivandrum.	social Forestry
8. Department of Economics and Statistics, Trivandrum.	Agricultural Statistics
9. Coconut Development Board, Cochin.	Coconut
10. Tamil Nadu Agricultural University, Coimbatore.	Horticulture and Microbiology
11. Indian Agricultural Research Institute, New Delhi.	Horticultural crops and Microbiology
12. Commonwealth Mycological Institute, London.	Mycology and Plant Pathology
13. Commonwealth Entomological Institute, London.	Entomology

4.2. Linkages with extension agencies

The station maintains close linkage with the following extension agencies for effective transfer of technology generated in the station to the farmers.

1. Department of Agriculture
2. Development Department
3. Nationalised and other Banks
4. Department of Education
5. Farmers' Organisations
6. Input Agencies

The technology generated in the station are regularly passed on to these agencies through periodical meetings and discussions.

In addition, the new technologies developed are passed on to the farmers through mass media like All India Radio as well as the News papers.

The Associate Director is a member of the Programme Committee of All India Radio which helps in planning effective transfer of technology to farmers.

4.2.1. Pre-seasonal workshops

The pre-seasonal workshops are arranged twice an year, before the advent of the cropping seasons - kharif and rabi. Our scientists participate in these workshops to impart the latest crop production technologies to the personnel of the DOA.

4.2.2. Monthly workshops

The officers of the Department of Agriculture in Kasaragod and Cannanore districts meet every month in this station for the monthly workshops under the training and Visit Programme, (NAEP). The Associate Director is the Chairman for these meetings. Another senior Professor of the station chairs the workshop at Calicut for the DOA personnel of Calicut district. Scientists of the station act as resource personnel for these monthly meetings. These meetings provide a platform for bringing the problems of the farmers to the

scientists and finalise the messages to be passed on to the latter to solve such problems. This workshop is a good avenue for effective feed back. Fortnightly messages on routine farm operations are also formulated in these meetings.

4.2.3. Zonal workshops

These two-day workshops are organised twice a year one each for rabi and kharif seasons in collaboration with the DOA. The participants in the workshops include extension personnel of the Department of Agriculture from the four districts of the northern zone, scientists of the resarch stations in the zone, the Heads of Departments of the College of Horticulture, Kerala Agricultural University and scientific personnel from Central plantation Crops Research Institute, Kasaragod, CWRDM, Calicut, National Research Centre for spices, Calicut and the National Research Centre for Cashew, Santhgodu, Vittal.

During these workshops , the research highlights of the station are reviewed and future programmes drawn up based on the locaion specific problems presented by the DOA personal. The priority for research areas is fixed in these meetings. The proposals for farm trials are also finalised in these workshops. Further, the results of farm trials conducted in the previous season are reviewed in these meetings.

4.2.4. Short training programes

Various training programmes are organised in the station for the benifit of farmers as well as the personnel of the Department of Agriculture and the Development. The training programmes include:

1. Training on Social foresty
2. Training on Plant protection
3. Inservice Training for Agricultural Demonstrators of the DOA.

The Farm training is also given to the Diploma and Degree students of the Kerala Agricultural University.

4.2.5. Joint field visits

A diaganostic team has been constituted comprising the scientists of the station and personnel of the DOA. This team makes visits to the problem areas of Kasaragod, Cannanore,Calicut and Malappuram districts. These field visits enable the scientists to identify specific production constraints faced by the farmers.

In addition to the routine visits, scientists of the station, whenever called upon by the farmers or the extension personnel make visits to the field for identification of field problems and suggest control measures.

4.3. University's extension oriented activities

The scientists of the station are actively engaged in the various extention activities of the University. Under this programme they make frequent cont acts with the farmers to study the problems faced by them as well as pass on the technologies developed in the station.This is achieved through discussions, seminars, exhibitions, kissan melas etc. The scientists participate banks and other agencies in the northern zone. Exhibitions depicting the recent developments and innovations in agriculture are organised in schools and other public organisations which help in the transfer of newer technologies to the farming community.

Two villeges have been adopted under the village Adoption programme. Crop demonstrations are laid out in these villages to bring home to the farmers the benefits of modern crop production technologies. One-day seminars are also organised in these villages with the active co-operation and support of the farmers' organisations, Co-operative banks and the Agrl. Development Units of the DOA.

4.3.1. Krishi Vigyan Kendra

A Krishi Vigyan Kendra under the Kerala Agricultural University is functioning at Manjéshwar in the Kasaragod district. Scientists of the station render thier services in the activities of this Kendra.

4.3.2. Lab-to-Land Programe

The programme was started in 1980 and a total of 172 farmers were the beneficiaries. These farmers included the marginal farmers, scheduled castes and landless labourers. The selected farmers were supplied with inputs such as seeds,fertilisers, feed for cattle, poultry birds, goats, seed bins, plant protection chemicals etc. depending upon the individual production programme.

4.3.3. Publication programme

Research papers are regularly published in the scientific journals of both national and international origin.Those are based on the results emulated from the various research projects of the station.

The scientists regularly contributes popular articles to leading dailies and other periodicals. Small pamphlets and information bulletins are prepared and published by the scientists for the benefits of the farmers. A book on coconut cultivation has also been published.

4.3.4 Radio/T.V. programme

Radio talks by the scientists of the station on various aspects of crop production, management and protection as well as topics of every-day agriculture like kitchen gardening,roof gardening, cultivation of ornamental plants and medicinal plants are broadcasted over All India Radio,Calicut and Trichur. Relevant information on seasonal agricultural operations are passed on to the extension wing of the University for favour of broadcasting over the All India Radio.

4.3.5. Krishi Darsan Programme

This programme was started in 1984-85 with the ultimate objective of creating an awareness among the farmers about the modern methods in agriculture and allied subjects. As per this prgramme, farmers sponsored by banks, voluntary organisations and farmers' club visit the station for an on the spot study of the various scientific agricultural practices and improved technologies developed in this station.

4.4. Feed back

The scientists obtain necessary feed back from the farmers through the extension personnel. The monthly workshops and zonal workshops provide ideal opportunities to transmit this to the scientists. This feed back is essential for the proper plannig and implementation of need based research on priority basis. Monthly workshops, joint visits of the scientists and extension personnel to farmers' fields, zonal workshops, visit of farmers to research stations etc.create opportunities for research workers to obtain necessary feed back for organising their research programme.

4.5. Strategy for strengthening research extension linkages

A strong linkage between the research and extension agencies is the back bone of agricultural development. This alone can help in achieving the goal of increased agricultural production using latest scientific production technologies. The very goal of agricultural research becomes futile if the innovations are not brought to the farmers and scientists working hand in hand with extension personnel alone can help to achieve this goal.

Presently the linkages are achieved through various seminars and workshops, joint field visits, joint farm trials, Krishi Vigyan Kendra activities and other transfer of technology programmes. However, there is need for strengthening these linkages through intensifying the joint visits, farm trials etc. which will enable the farmers to acquire more confidence in scientific innovations.

The strategies to strengthen research-extension linkages are:

1. The ZARC should meet regularly before the advent of Kharif and rabi seasons. A few selected farmers from each agroecological situation may also be invited to participate in the meeting.

2. The Head of the Department should take part in the ZARC.

3. The reports of diagnistic team should be throughly discussed in the ZARC and, if necessary, research programmes may be formulated for solving new problems.

4. The number of joint field visits may be increased. More funds may be provided to meet propulsion charges and travelling allowances.

5. Training materials like slides, audio casettes etc. may be made available to the RARS to conduct training programmes effectively.

6. Definite working guide-lines may be drawn up for conducting farm trials.

7. A management information service may be set up in the RARS for the speedy transfer of technology to the farmers at large. Trained personnel and equipments should be made available to this service.

CHAPTER V

RESEARCH PRIORITIES AND STRATEGIES

5.1. Research needs

The National Agricultural Research Project was launched in the year 1980 with the ultimate objective of solving location specific problems in the agroclimatic zone of the regional agricultural research station. This was a new approach, altogether different from the one followed prior to 1980. Accordingly farming situations were identified, problems enumerated after joint field visits of research and extension personnel and research projects formulated with a multidisciplinary approach. Many of the problems could be solved by evolving new technologies but much remains to be done. Research efforts have to be concentrated to solve these problems fixing the priorities. Some of the important areas of research are listed below, crop-wise and discipline wise.

5.1.1. Rice

The popular modern varieties are highly prone to pests like BPH and diseases like sheath blight and blast. Varieties with multiple resistance should be evolved. This will help rapid spread of the new varieties and reduce the dependence of farmers on costly pesticides.

Nearly 80 per cent of the kharif rice is sown under semidry conditions. This crop is affected by intermittent floods during the vegetative as well as reproductive phases in many of the farming situations. High yielding, lodging resistant, semitall varieties have to be evolved for these areas. Such varieties could also be of immense help to the farmers who depend on straw as the main source of fodder for their cattle.

In the deep laterite areas, iron toxicity is a serious soil problem. Identification of varieties resistant to iron toxicity is a felt need.

Technology has to be evolved for fertilising rice in the areas subject to intermittent floods and saline water intrusion.

More research is also necessary to develop viable and economic rice-based cropping systems.

5.1.2. Vegetables, pulses and annual oil seeds

Vegetables, pulses (cowpea, black gram) and annual oil seeds (sesamum, groundnut) are grown in about 31,497 ha in the zone, mostly in the traditional rice fields in rotation with rice. Adequate attention is paid to vegetables; the other crops are left uncared due to the low net returns from them. The growers are also not convinced of the need for adopting fertiliser practices and plant protection measures in these crops. The existing local varieties are shy yielders and due to the suboptimal edaphic conditions available, their yields are miserably low as compared to the yields obtained in the other areas. Efforts have to be made to identify high yielding, drought tolerant varieties in these crops and low cost agrotechniques developed.

Lack of availability of improved varieties is the most important constraint to vegetable production. This is particularly true in the case of cucurbitaceous vegetables. The breeding programme should be intensified to isolate/identify varieties with high yield potential. Water fertilizer interaction studies should also be takenup in order to fix optimum fertilizer doses and economic irrigation schedules. At present, large quantities of water and fertilisers are wasted on these crops. Pesticide residue in vegetables is another important area requiring attention since the chemicals are applied unscrupulously with the objective of harvesting pest-free produces.

5.1.3. Coconut

Stem bleeding disease continues to be a disease baffling the scientists. This is becoming serious in the northern districts of the zone. The disease expression is more serious in areas endemic to the cyclic effects of frequent droughts and floods. Multidisciplinary research efforts have to be concentrated to contain this disease.

The variety commonly cultivated is the WCT which is a shy yielder. Its alternate bearing tendency is another disadvantage. It has been proved that hybrids and

introduced cultivars like Lakshadweep ordinary, Philippine Ordinary, Cochin China etc. have higher yield potential. The planting materials of such hybrids and elite varieties must be produced in large numbers and distributed among coconut growers to replant the senile palms of the low yielding WCT.

5.1.4. Arecanut

There is no technology to combat the yellowing disease which is spreading fast. Research efforts should be concentrated to find out the etiology of the disease and to evolve technology to control it.

5.1.5. Pepper

The contribution of the zone to the black pepper production of the state is substantial (42%). However, the area under this crop is on the decline due to the rapid spread of the devastating disease, 'foot rot' (wilt complex). No cultivar is tolerant to the malady nor there are areas free from it. There is an urgent need to evolve control measures against this disease. Equally importantis the identification of varieties tolerent to wilt complex. A rapid survey of the forest regions of the western ghats is suggested to collect valuable germplasm of pepper with the ultimate objective of identifying wilt tolerant varieties. These can be used in future hybridization programmes. The survey will throw light on natural crop association also.

There is only one high yielding variety available now viz; Panniyur-1. It fails to exhibit its yield potential when planted under shade, as in coconut gardens. Since cultivation of pepper in coconut garden is an accepted practice, there is need to identify high yielding varieties tolerant to shade. Further, research efforts are also necessary to find out alternate standards for pepper, the commonly utilised standard, erythrina being highly susceptible to nematode infection.

5.1.6. Cashew

There is a rich germplasm of cashew in the zone, the area under this crop being 65.9 per cent of the total area in the state. The area can be further increased as barren lands suitable for cashew cultivation are available in plenty. No systematic survey has been undertaken in this tract to identify elite types. Once identified, these types can be

popularised utilising rapid multiplication techniques like tissue culture. The existing uneconomic gardens can also be rejuvinated adopting available technology (by top working etc.). On farm trials are needed in this line. Studies should also be intensified to evolve control measures against the serious pest, stem borer.

5.1.7. Mango

Mango occupies an area of 0.18 lakh ha in the zone. This is 30.6 per cent of the total area of the crop in the state. There is a rich germplasm of table and pickle varieties of this crop in the zone. However, these types/ varieties are on the verge of extinction due to the indiscriminate felling of mango trees for timber and firewood. A survey to identify elite types of pickle and table varieties is a real need. The germplasm can be collected, preserved and evaluated at Pilicode and the elite types multiplied and distributed.

Studies have also to be taken up on the utilisation of mango stones which go as waste.

5.1.8. Tobacco

Chewing tobacco is cultivated in the Hosdurg and Kasaragod taluks of Kasaragod district in about 600 ha. The area under this crop is steadily increasing. The crop receives heavy dressings of fish manure which creates public health problems due to the rapid breeding of housefiles in the fish manure. Technology has to be developed for water and fertiliser management of tobacco.

5.1.9. Cropping systems

Cropping systems based on coconut is the rule in almost all the homesteads. Pure plantations of coconut and arecanut are being converted into mixed ones with the ultimate objective of increasing the total income from unit area. In this process, the necessity for maintaining planting geometry is overlooked with the result, most of the farms look like a jungle of crops. There is need to work out viable crop associations and their density optima for maximum growth and production of crops in the mix. The cultural and manurial requirement of the system as a whole should also be estimated based on sound experimentation. Economically

viable crop combinations for marginal, small and large farmers should also be found out.

5.1.10. Water management

No systematic studies have been undertaken so far in this zone on water requirement of crops. Irrigation schedules for all the important crops in ayacut areas of irrigation projects as well as in tank and well irrigated areas need to be worked out for the judicious use of this scarce input.It is also necessary to identify methods of irrigation suitable for water scarcity areas. Studies have also to be initiated on structures like suramgom which provides irrigation water for crops grown on small farms in the Kasaragod district.

Studies have also to be initiated to evolve short and long term measures to combat agricultural drought which occurs frequently in the zone.

5.1.11. Agricultural implements

Agricultural operations still continue to be performed with traditional tools and implements in the zone. There is a dire need for testing and refining available farm implements in order to reduce the drudgery of farm operations. This is particularly important in the present context of nonavailability of agricultural labourers and raising cost of farm wages. Research programmes are, therefore, to be drawn up to test, modify and popularise drudgery removing tools and implements. Some of the suggestions are given below:

(i) Rice

Transplanting and harvesting of rice

These operations are manually done involving huge cost. Rice transplanters and harvesting machines developed in PAU, IRRI and elsewhere could be tested.

Winnowing and drying of rice

Wind winnowing is the traditional practice. If low-cost winnowers are popularised, the cost of winnowing can be reduced. Considerable difficulty is being experienced by the farmers to process kharif rice since frequent rains are received during the harvesting operations. Low cost dryers

using farm wastes as source of energy can be developed and tested.

(ii) Coconut

Harvesting of coconut is a tiresome operation for which there is severe shortage of trained labourers. Mechanical climber now developed by one enterprising farmer in Taliparamba may be modified and improved so as to make it acceptable to the other farmers. Husking of coconut is another operation requiring much labour. The CPCRI, Kasaragod has developed a mechanical husker which needs to be tested and modified, if necessary. Dryers using farm wastes as fuel for processing copra has also to be tested. Portotypes are available with the CPCRI, Kasaragod. Such dryers will be of help to small farmers for drying copra during the rainy season.

(iii) Arecanut

A low cost mechanical device for husking arecanut is now available with the CPCRI. This can be tested and popularised.

(iv) Cashewand mango

Considerable human energy is wasted for harvesting these crops. Simple, low cost mechanical devices need to be developed, tested and popularised to make harvesting operations easier.

5.1.1 2. Animal management

Abortion in cattle is an important problem in the northern zone. Various toxic and biological factors have been attributed to cause abortion. No systematic study has been undertaken so far to delineate the factors associated with abortion. Investigations have to be undertaken into this problem which has a multifactorial etiology.

The northern zone has its own brand of goat viz; 'Malabari'. It is the poor man's milch animal. All aspects of goat management needs to be studied so as to realise better income from these animals.

Cattle rearing is undertaken in almost all the homesteads as a complementary enterprise. Economic and efficient crop-livestock systems have to be evolved by fitting suitable fodder crops in the mixed farming pattern and by efficient organic recycling. Mixed farming patterns for different holding sizes need to be worked out in order to enable the farmer to choose the most profitable one depending on his holding size and family requirement.

Feasibility studies have also to be undertaken for growing fish in the rice fields. The technology already developed on integrated farming (crop-livestock-fish) at RARS Kumarakom can be tested in the influence area of RARS Pilicode. The vast 'Kaipad' lands of Cannanore district have good potential for adopting this system.

5.1.13. Soil management

Problem soils occur in almost all the farming situations. The saline-acid soils of situation 3, hydromorphic soils of situation 4, littoral sands of situation 1 and 2, hard laterites of situations 5 and 6, ill-drained and highly degraded soils of situation 7 and 8 are examples. Location specific technologies should be developed for improving the productvity of these soils.

5.1.14. Agroforestry

Vast areas suitable for developing agroforestry exist in the northern zone. Agroforestry systems suitable for these lands need to be developed. This will not only help to convert the unproductive lands into productive ones but also improve the socio-economic conditions of the small and mariginal farmers and the weaker sections of the rural society. The aspects of study should include the following:

i) identification of tree/crop species that will yield fuel, fodder, fruit and timber suitable for marginal lands.

ii) study of crop species associations

iii) evolution of agro-forestry systems natural to the rural and tribal areas.

5.1.14. Agro-economics

There exists a wide gap between the potential productivity and the realised productivity at the farm level. The magnitude of the gap may vary from situation to situation. The economists should undertake agro-economic surveys to elucidate more information on critical constraints to production, slow growth in productivity, economics of integrated farming systems etc. Such aspects of study did not receive attention during the phase I of the NARP.

5.2. Research priorities

5.2.1. Rice

Breeding high yielding semitall varieties with multiple resistance to sheath blight, blast, brown planthopper and leaf roller.

Identification of elite varieties tolerant to intermittant floods and salinity.

5.2.2. Pulses

Evolution of varieties with good yield potential and drought tolerance suitable for rice-based cropping systems and also for cultivation in the partial shade of coconut.

5.2.3. Sesamum

Identification of early duration high yielding varieties having tolerance to moisture stress for summer rice fallows.

5.2.4. Vegetables

Water and fertiliser schedules for cucurbitaceous vegetables grown in summer rice fallows.

Identification of elite varieties of curcurbitaceous vegetables like watermelon, pumpkin, cucumber, ashgourd etc.

5.2.5. Tobacco

Developing manurial and irrigation schedules for chewing tobacco in-lieu of the present system of manuring which creates public health hazards.

5.2.6. Coconut

Studies to control stem bleeding disease in coconut.

Developing technology for the control of abnormal buttonshedding

Evolution of high yielding varieties.

Developing coconut based cropping systems for different holding sizes.

5.2.7. Arecanut

Research on the control of yellowing disease. Developing arecanut-based cropping systems.

5.2.8. Pepper

Research on the control of foot rot (wilt complex) disease of pepper.

Germplasm collection, preservation and evaluation.

Crop association in pepper with particular reference to standards for training pepper.

Breeding varieties tolerant to shade for cultivation in homesteads.

5.2.9. Cashew

A survey to identify elite types of cashew and rapid multiplication of such types after yield testing.

Developing agrotechniques for cultivation of cashew in hard laterites.

On farm studies to rejuvenate old cashew plantations.

Investigations on the control of cashew stem borer.

5.2.10. Mango

A survey for the collection, preservation and evaluation of the table and pickle varieties of mango in the zone.

Rapid multiplication of elite types through tissue culture.

5.2.11. Cropping systems

Developing cropping systems ideal for homesteads of varying sizes.

Studies on the economics of mixed farming in homesteads.

On farm trials on integrated farming with crops live-stock and fish.

5.2.12. Water management

Initiating systematic studies on the water management of all the important crops in the zone.

5.2.13. Agricultural implements

A survey to identify agricultural implements used in the zone.

Developing technology to improve the efficiency of these implements.

Testing the tools, implements and equipments developed in the other institutions (coconut/arecanut husking machine, rice and copra drying equipments, rice transplanter, etc.).

5.2.14. Animal management

Developing technology for the efficient management of 'malabari' goats.

5.3. Research strategies

5.3.1. Inventory of research efforts

In the light of the thrust areas of research identified (See 5.1, Chapter 5) and the priorities fixed (See 5.2, Chapter 5) a thorough review of the ongoing research programmes will be made so as to streamline research efforts of the RARS. The projects which lack multidisciplinary approach and those which have no relevance to field problems will be dropped. An inventory of the research efforts of the other institutions within the zone (like CPCRI, CWRDM, NRCS) and also those in the other zones within the state will be prepared and utilised for making the research programmes of the RARS more meaningful and effective. This will also help to avoid duplication of work and reduce the time lag in the transfer of technologies to the farmers at large. In order to achieve this, the research results gathered from identical situations outside the zone or from the other stations within the zone will be put to test in different locations and productive results popularised immediately.

5.3.2. 'On farm' research

'On farm research' will be given more importance and attention. This is necessary because the RARS Pilicode and its sister institutions P.R.S. Panniyur represent only one of the 9 farming situations viz., rainfed shallow plateau laterite. In the other areas we do not anticipate to start research centres, but technologies developed at the RARS and elsewhere which have relevance to these situations will be put to test. These trials are also necessary to refine the technologies which have low adoption rates. It will be the responsibility of multidisciplinary groups of scientists to conduct the 'on farm' trials. They will enlist the services of the DOA personnel in the selection of plots and cultivators.

5.3.3. Field surveys

Field surveys did not receive adequate attention in the past. These programmes will be intensified. The aspects of survey will include:

i) Collection of germplasm of cashew, mango and pepper.

ii) Agroeconomic surveys to elucidate information on critical constraints to production in the different farming situations.

iii) Delineation of drought-prone areas in the zone.

iv) Collection of farm implements now in use in the zone.

5.3.4. Basic research

The emphasis so far has been on the evolution of technologies and practices which are of immediate use to the farmer. Simultaneously basic research has to be strengthened in order to solve problems at the micro level. Some of the areas suggested are:

i) Tissue culture for the rapid multiplication of planting materials (cashew, mango, pepper)

ii) Diazotrophic rhizocoencsis in plantation crops

iii) bio-degradation of pesticides (herbicides, fungicides and insecticides)

(iv) Pesticide residues in vegetables and fruits

v) forecasting pest outbreaks in field and plantation crops.

5.3.5. Diagnostic teams

Diagnostic teams have been constituted in the 4 districts in the zone to probe into the field problems and to suggest remedial measures. The teams comprise of scientists and extension personnel. The function of the diagnostic teams

will be enlarged, and their visits made more frequent. These teams will not only study the field problems but assess the constraints in the adoption of technologies by farmers as well.

5.3.6. Training

Training is an important component in any successful development programme. Training needs increase as more and more technologies are developed and more people are lured to take up agriculture as an enterprise. The programmes proposed to be taken up include:

i) Short term training course in the management of plantation crops for extension workers (one month).

ii) Short term training in the repair and maintenance of agricultural machinery and implements for agricultural workers and farmers (2 weeks)

iii) Inservice training (6 months) for the field staff of the DOA.

iv) Post graduate trainig (leading to M.Sc. (Ag). The research manpower and infrastructural facilities available at the RARS could be profitably utilised for post graduate training. This is a long range programme.

5.3.7. Linkage with extension

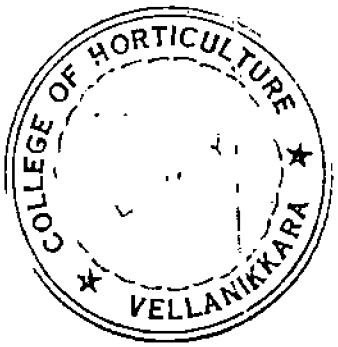
Close linkage exists between the scientists in the RARS and the DOA personnel. This will be further strengthened. Linkages will also be established with the farmers' co-operatives, lead banks and input agencies in the public and private sectors. This will help ensure timely supply of inputs and credits to the farmers.

Intimate liaison will also be established with the Department of Irrigation and Electricity (Electricity Board) for their help in water use planning.

Agricultural productivity improvement is the ultimate goal of the NARP. This can be achieved by improving the quality of research in the research centres and the rapid transfer of information from laboratory to land.

Northern zone, Kerala : Taluks and Blocks

District	Taluk	Block
Malappuram	Perinthalmanna	Mankada, Perinthalmanna, Malappuram
	Ponnani	Ponnani, Andathode
	Tirur	Tirur, Tanur, Tirurangadi
	Ernad	Nilambur, Wandur, Manjeri, Kondotti, Vengara
Kozhikode	Kozhikode	Chevayur, Koduvally, Kunnamangalam, Kozhikode
	Quilandi	Meladi, Perambra, Panthalayani, Balusseri
	Badagara	Badagara, Kunnummel, Thuneri, Thodannur
Cannanore	Tellicherry	Kuthuparamba, Peravoor, Iritty, Tellicherry
	Cannanore	Edakad, Irikkur, Cannanore
	Taliparamba	Taliparamba, Payyanur
Kasaragod	Hosdurg	Nileshwar, Kanhngad
	Kasaragod	Kasaragod, Manjeshwar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