National Agricultural Research Project

STATUS REPORT

OF THE

SOUTHERN ZONE

Vol. I

KERALA AGRICULTURAL UNIVERSITY

VELLANIKKARA, TRICHUR, 680 654

English

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Vol. I

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FOREWORD

The National Agricultural Research Project was launched in the early 1980's to strengthen the research capabilities of the State Agricultural Universities. The development of regional research stations in the different agro-climatic zones in terms of research manpower and infrastructure facilities was the essential feature of the NARP. The eligibility of the Kerala Agricultural University to the project was approved by the ICAR in May, 1980. The project has completed its first phase in all the five agro-climatic zones of the State. The second phase of the project was launched in March, 1988.

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

The present revised Status Report is published in three volumes for each of the five agro-climatic 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 linkage and research priorities and strategies of the zone. The Volume II embodies the conclusions drawn from the field surveys on the adoption patterns and production constraints of improved agricultural technologies. The data referred to in the narrative part of the Status Report Volume I are presented in Volume III.

A number of State Departments and organisations have collaborated with the Kerala Agricultural University in the revision of the Status Report. The Zonal Associate

Directors and their teams of scientists have spent considerable time and energy in collecting the details and pruning the information to the present form. I congratulate them for their sincere and devoted efforts.

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

E. G. SILAS
Vice Chancellor
Kerala Agricultural University

PREFACE

The first Status Reports of all the five agro-climatic zones of Kerala were prepared in the year 1984. The Kerala Agricultural University has successfully implemented the Phase I of the NARP. The NARP Phase II was sanctioned by the Indian Council of Agricultural Research in the year 1988 and the sub-projects started functioning with effect from 20.4.1988.

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

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

The Associate Directors of Research of the five zones 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. Seshadri, Consultant, World Bank in the preparation of the Status Report is gratefully acknowledged.

Kerala Agricultural University
Vellanikkara, September, 1989

M. ARAVINDAKSHAN
Director of Research

ACKNOWLEDGEMENTS

The revision of the Status Report pertaining to the southern zone of Kerala (originally published in May, 1984) has been a herculian effort. Dr. E. G. Silas, Vice Chancellor, Kerala Agricultural University, Dr. A. R. Seshadri, Consultant, World Bank and Dr. M. Aravindakshan, Director of Research, Kerala Agricultural University, have given the necessary guidance and encouragement.

Several scientists of the project were involved in the compilation of the data included in the Report. Data published by organisations like the Department of Economics and Statistics, the State Planning Board, the Centre for Earth Science Studies, the Land Use Board, the National Remote Sensing Authority, the India Meteorology Department, the Directorate of Census, the Department of Agriculture and its Soil Survey Wing, the Department of Animal Husbandry, the Department of Fisheries, the Department of Forests, the Public Works Department, the Directorate of Panchayats, the Centre of Excellence for Tropical Soils of the Kerala Agricultural University, the Kerala Co-operative Milk Marketing Federation and the Khadi & Village Industries Commission have been utilised in the report.

Prof. P. R. Ramasubramonian has taken great pains to consolidate the data and present the same as per the standards prescribed by the ICAR. Sri. R. Balakrishnan Asan helped the undersigned in editing the Report to the present form.

The voluminous report has been typed out and entered in the computer by Sri. S. Raghavan, Sri. C. Chandrakumar and Smt. P. Radha. The xerography was done by Sri. C. Madhusoodanan Nair. The figures in Chapter I were drawn by Sri. V. Chandranandan and those in Chapters II to IV by Sri. P. K. Surendran.

On behalf of the project, I wish to place on record my deep sense of gratitude to the above Organisations and Officers for their guidance and assistance in preparing the revised Status Report of the Southern Zone.

N. MOHANAKUMARAN
ASSOCIATE DIRECTOR

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CHAPTER I

1. General agricultural characteristics of the State

1.1. General description of the State: Delineation, population

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 130 km wide, between the Western Ghats in the East and the Arabian Sea in the West with a 580 km long coastal line. The State is bound by Tamil Nadu in the South and Karnataka in the North. Though the smallest state in India with a geographical area of 38863 sq. 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 rivers and streams flowing into the Arabian Sea on the West. The large number of lakes and backwaters provide a unique scenic beauty to the land.

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

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 the mean sea level (MSL) to 2694m above MSL (Fig. 2).

The land is panoramic with evergreen forests, picturesque landscapes and backwaters. The details of the rivers flowing within the State, their catchment area etc. are given in Annexure II. Out of the 44 rivers originating from the Western Ghats, 41 flow towards the West into the Arabian Sea and the remaining three, towards East into the Bay of Bengal. The rivers of Kerala are typical monsoon-fed and fast flowing ones.

Fig.1.

MAP OF KERALA
ADMINISTRATIVE DIVISIONS

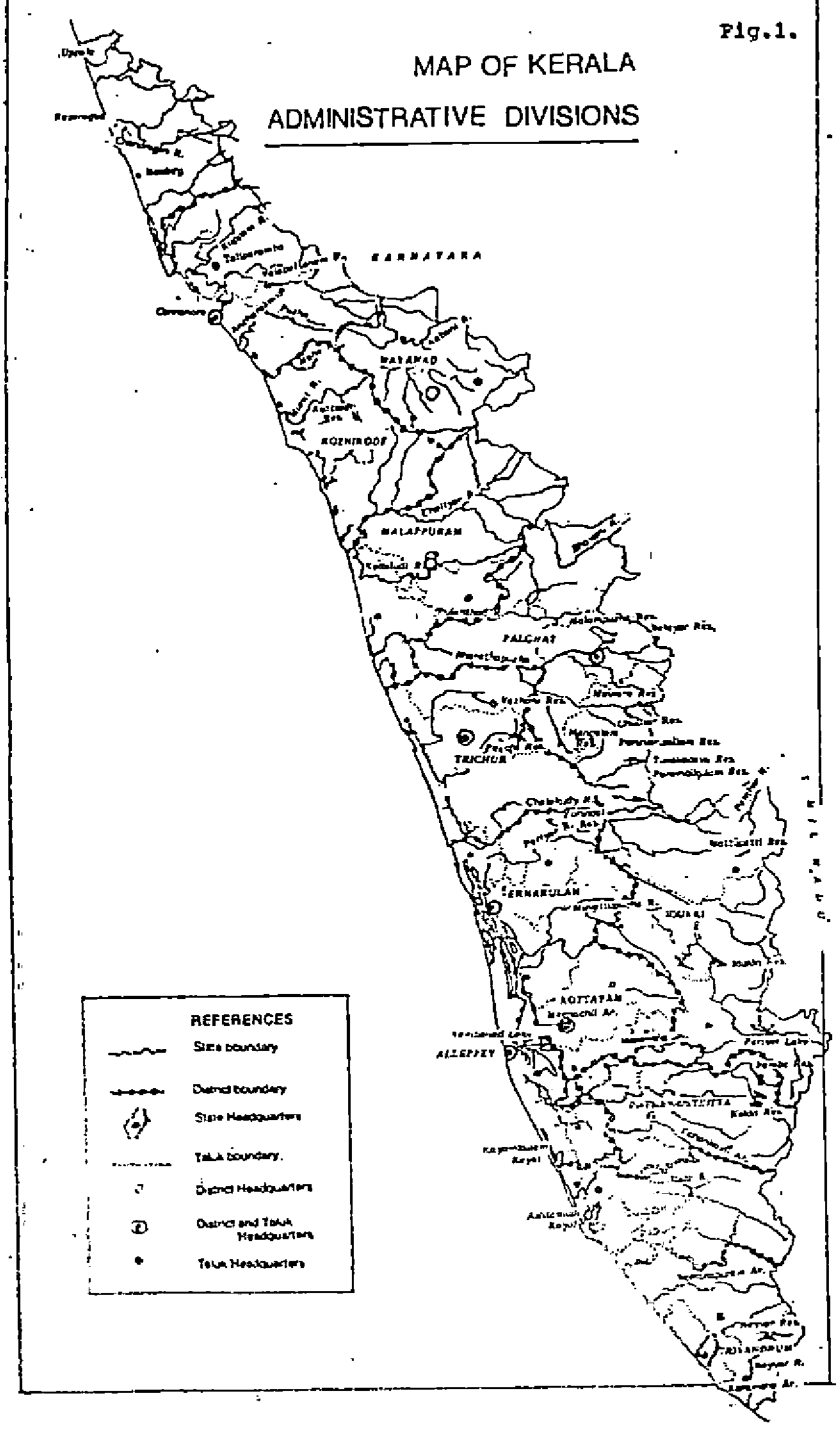
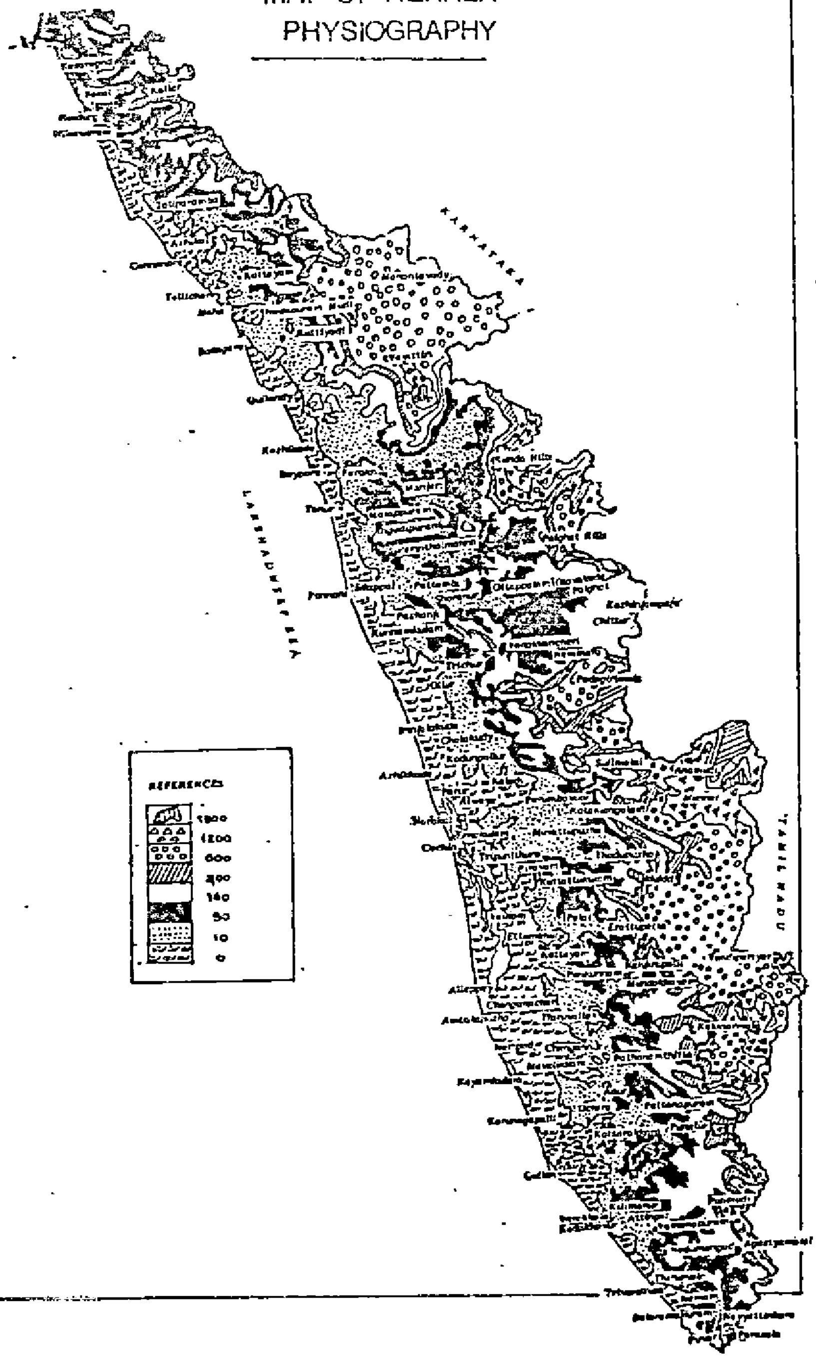


Fig. 2.

MAP OF KERALA
PHYSIOGRAPHY



The principal West-flowing rivers of the State are Bharathapuzha, Periyar, Pampa and Chaliyar. The East-flowing rivers are Kabani, Bhavani and Pambar.

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

1.2.1.High Ranges (> 750m above MSL)

The mountainous land (elevation: 750m to 2500m 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(2690m), Mukunti(2550m) and Nilgiris(2470m). The 32-km wide Palghat gap is the largest pass in the Western Ghats. In addition, there are a few other passes in the Ghats such as Aramboli, Kumili, Kambam, Thevaram, Karkken, Bodinaikannur, Periya and Perambadi. The High Range zone is dominated by plantations of tea, coffee, rubber and cardamom.

1.2.2.Highland (75 to 750m above MSL)

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

1.2.3.Midland (7.5 to 75.0m above MSL)

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

1.2.4. Lowland (< 7.5m from MSL)

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

1.3. Soil

1.3.1. Geological formations

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

Crystalline rocks

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

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

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

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

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

Precambrian system

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

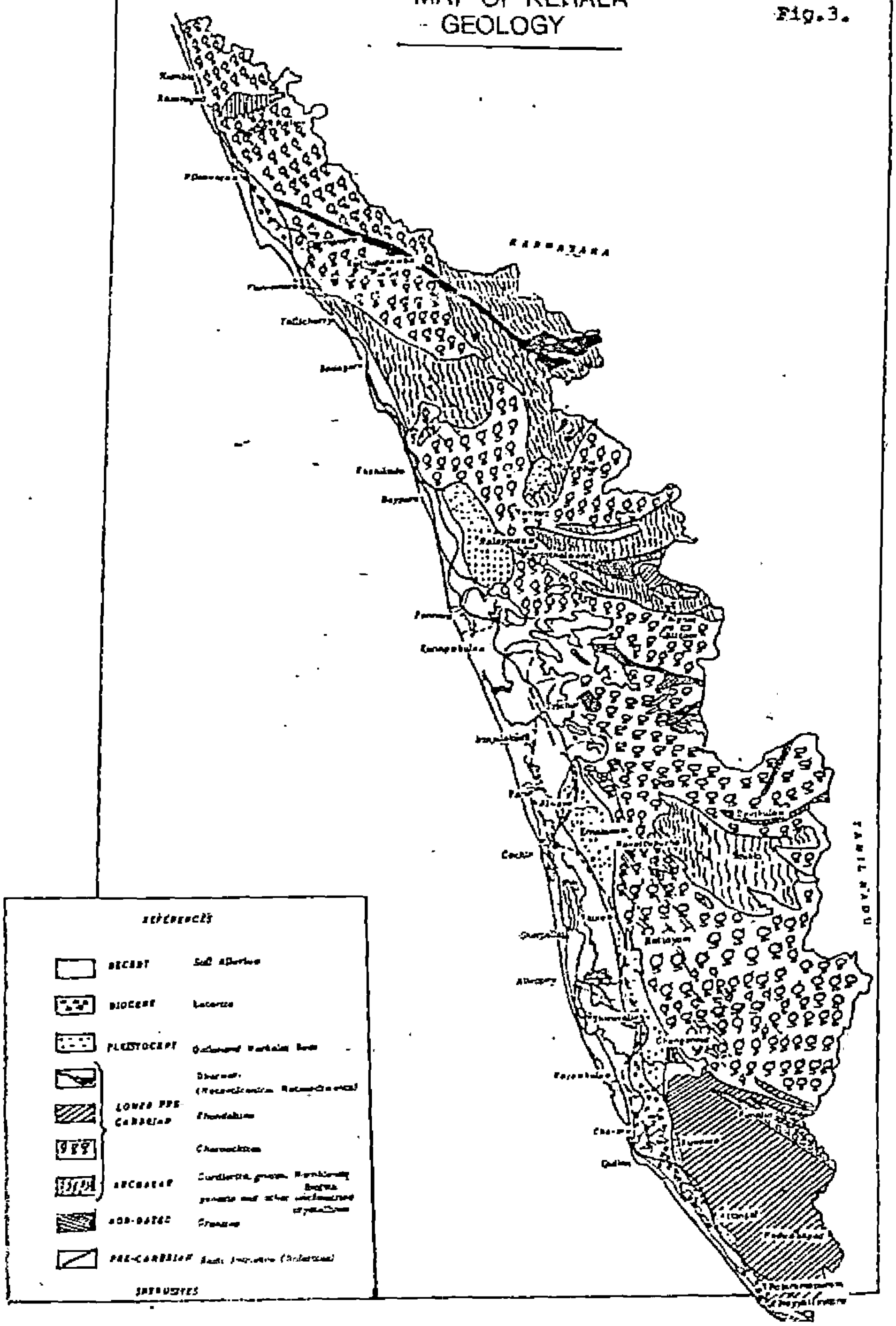
Residual laterites: A narrow zone of lateritised rock exists to the West of crystalline rocks that constitute the eastern boundary of the State. The rock exposed on the surface in this zone is a type of laterite which exhibits characteristics different from those of the laterite which caps the Warkalli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

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

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

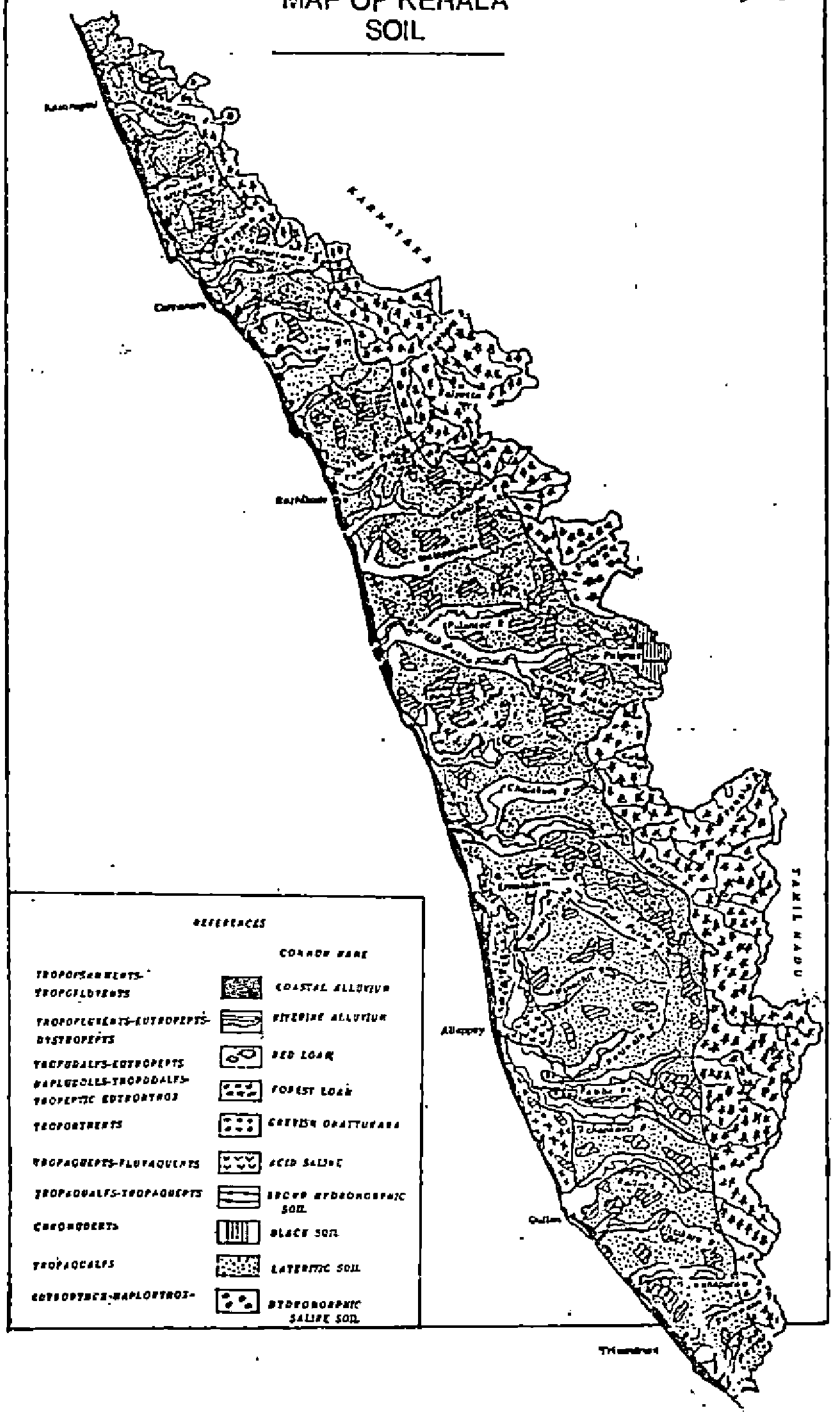
MAP OF KERALA
- GEOLOGY

Fig.3.



MAP OF KERALA
SOIL

Fig.4.



1.3.2. Soil types and their characteristics

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

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

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

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

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

Red loam

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

Laterite

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

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

Coastal alluvium

These soils are seen in the coastal tracts along the West as a narrow belt with an average width of about 10 km and have been developed from recent marine deposits. They show incipient development. The texture is dominated by sand fraction with very rapid permeability. The A horizon is usually thin and the surface textures observed are loamy sand and sandy loam. These soils are acidic and of low fertility level. They are also low in organic matter, clay and CEC.

Riverine alluvium

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

Onattukara alluvium

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

Brown hydromorphic

Hydromorphic soils, as a group, occur extensively in the State. These soils are mostly confined to valley bottoms of undulating topography in the mid and and to 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, hard pans, 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 seen within the coastal tracts of the districts of Ernakulam, Alleppey, Trichur and Cannanore. The origin, genesis and development of these soils have been under peculiar physiographic conditions. They are, therefore, not comparable with the saline soils occurring in the other parts of the Country. The net work of backwaters and estuaries bordering the coast serves as inlet of tidal waters to flow into these areas, causing salinity. Wide fluctuation in the intensity of salinity has been observed. During the rainy season, the fields are flooded and most of the salt is leached out, leaving the area almost free of salts. Electrical conductivity of the soil during this season ranges from 0.1 to 2.0 mmhos/cm^2. The maximum accumulation of toxic salts is observed during the summer months from March to April when electrical conductivity rises to the range of 10 to 15 mmhos/cm^2. These soils are in general brownish, deep and imperfectly drained. The profiles 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 the lower layers, causing problems of acidity. The Pokkali (Ernakulam district) and Kaipad (Cannanore district) soils come under this category.

Kuttanad alluvium

The Kuttanad region covering about 875 km^2 is an unique agricultural area in the World. A good portion of this area lies one to two metres below the MSL and is submerged for major part of the year. The area is susceptible to seasonal ingress of saline water as a result of tidal inflow from the sea. During the monsoons, the rivers and revulets pour fresh water into the area. As the North East monsoon recedes, sea water again enters the Vembanad lake and the whole area becomes saline. Hence, the soils of Kuttanad area are faced with the serious problems of hydrology, floods, acidity and salinity. Consequent on 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, the Kayal soils, the Karappadam soils and the Kari soils, which are dealt with in the Zone of Problem Areas.

Black soils

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

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

Forest loam

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

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

1.3.3. Soil testing facilities in Kerala

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

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

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

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

1.3.4. Fertility status of Kerala soils

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

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 soils possess the least CEC, water holding capacity and nutrient retentivity. In other words, the soils are not inherently fertile. The phosphate fixation is very high.

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

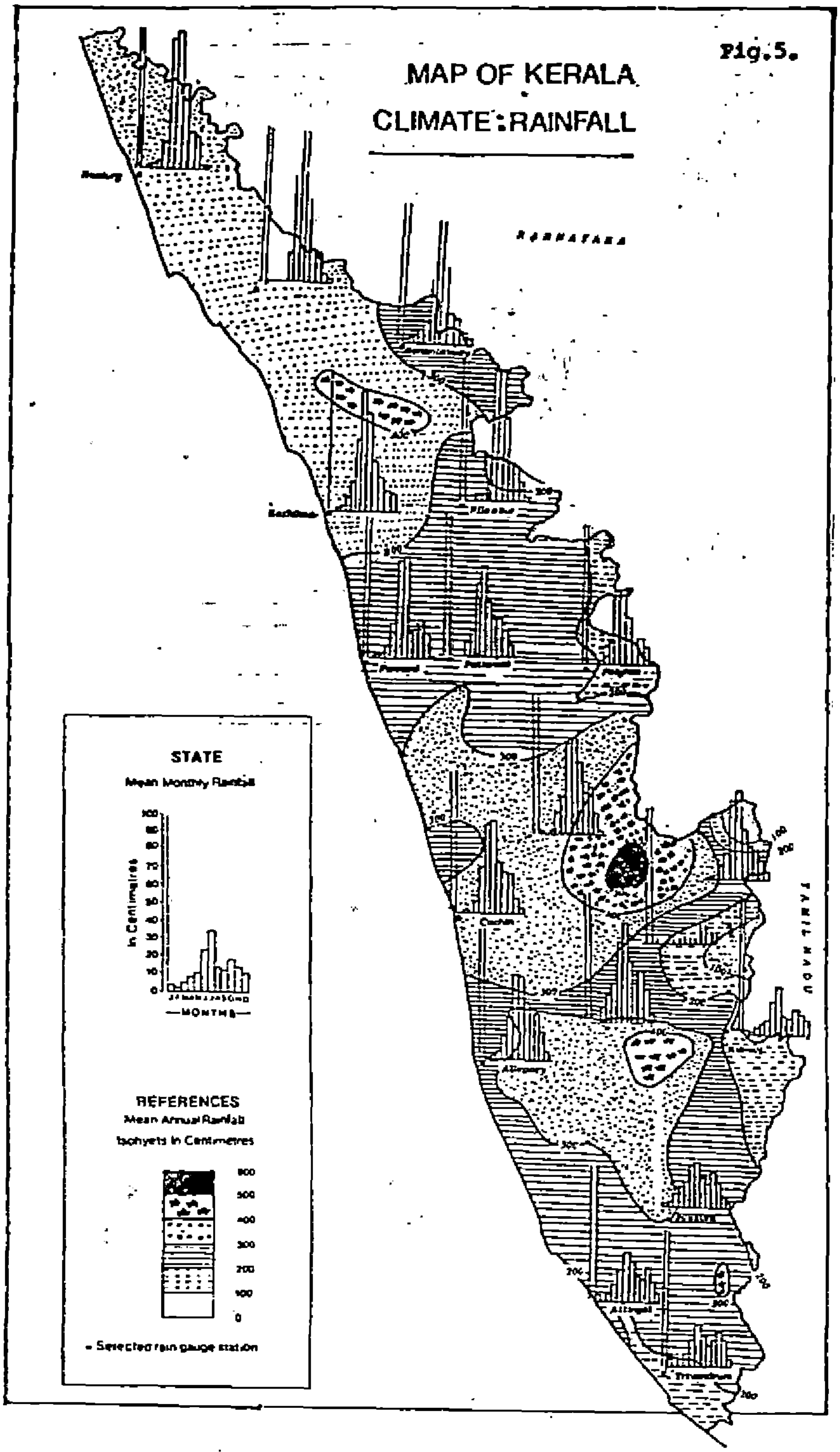
In spite of the climate and soil fertility constraints, the fertilizer consumption in the State on an average is on the increase, mainly due to the awareness of the farmers through extension and fertilizer promotion activities. Annexure VI shows the actual consumption of N, P_2O_5 and K_2O during the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

Table 3. Fertilizer consumption in Kerala predicted upto 2000 AD based on linear regression models fitted to actual fertilizer consumption data (in tonnes) for the period 1960-61 to 1985-86.

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 Fertiliser Technology, ICAR, New Delhi, 1986.

Fig.5.


MAP OF KERALA
CLIMATE : RAINFALL
KARNATAKA
TAMIL NADU
STATE
Mean Monthly Rainfall
In Centimetres
MONTHS
REFERENCES
Mean Annual Rainfall
Isohyets in Centimetres
- Selected rain gauge station
Cochin
Trivandrum

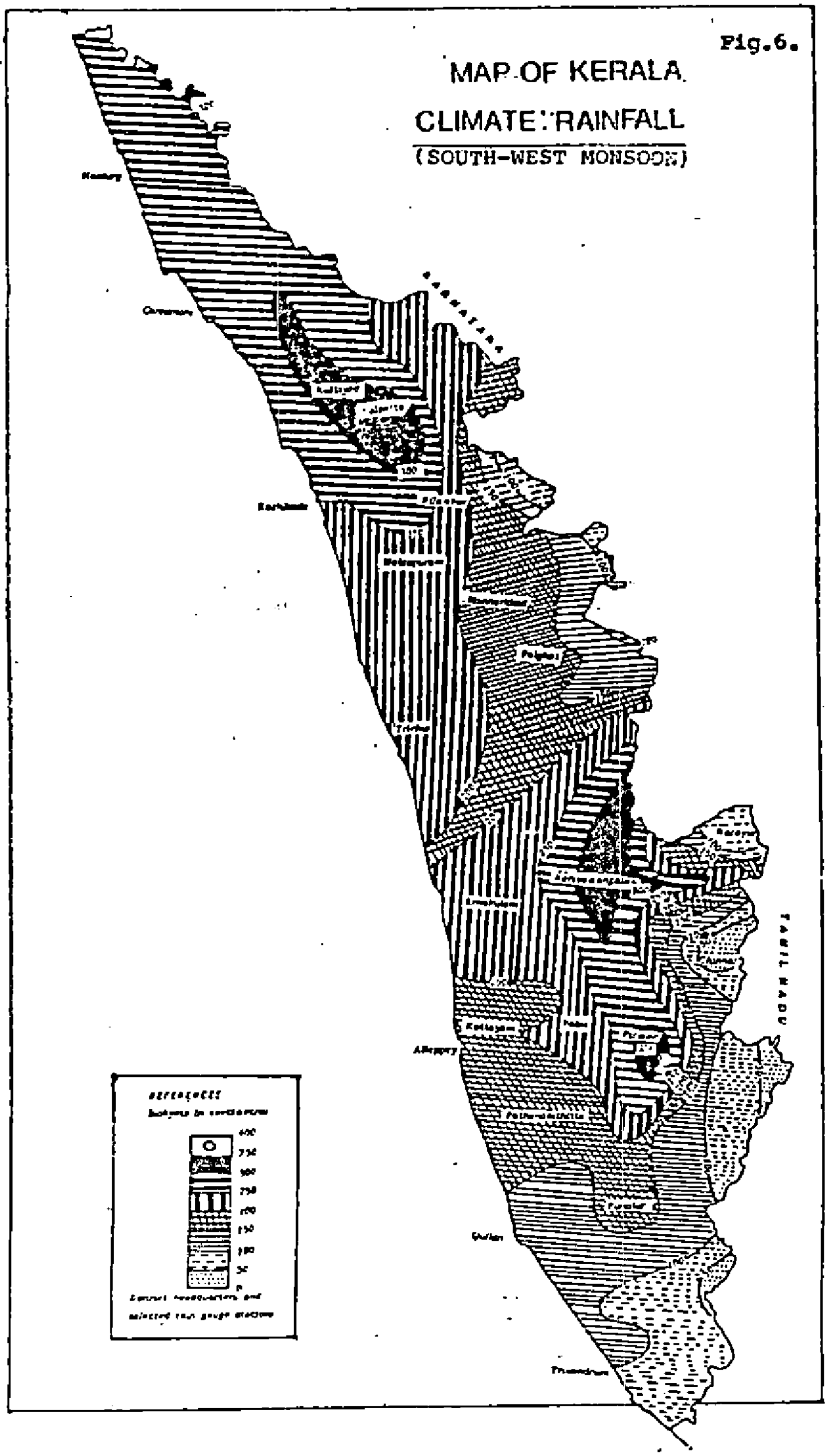


Fig.6.
MAP OF KERALA
CLIMATE: RAINFALL
(SOUTH-WEST MONSOON)

Fig.7.

MAP OF KERALA
CLIMATE: RAINFALL
(NORTH-EAST MONSOON)

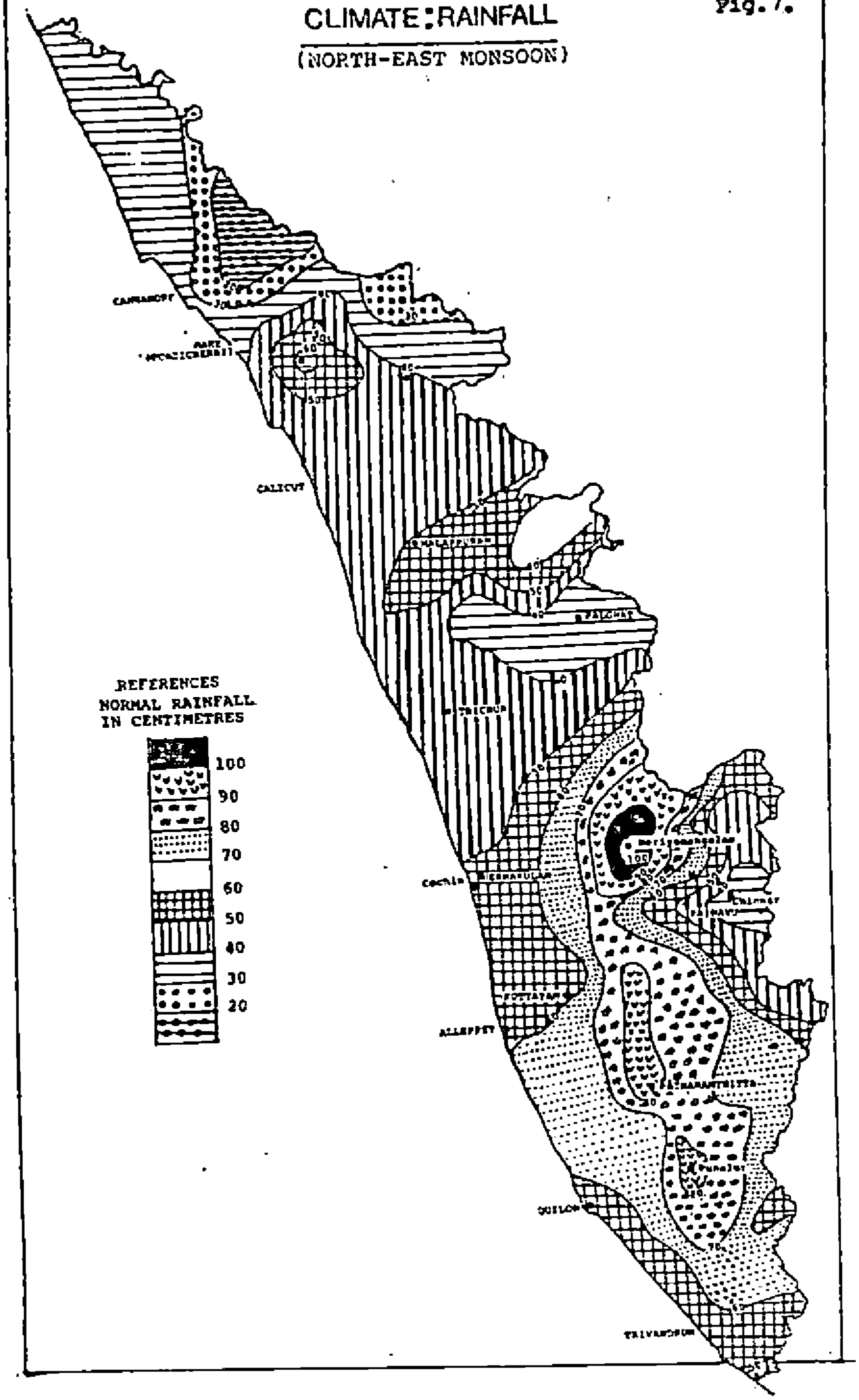
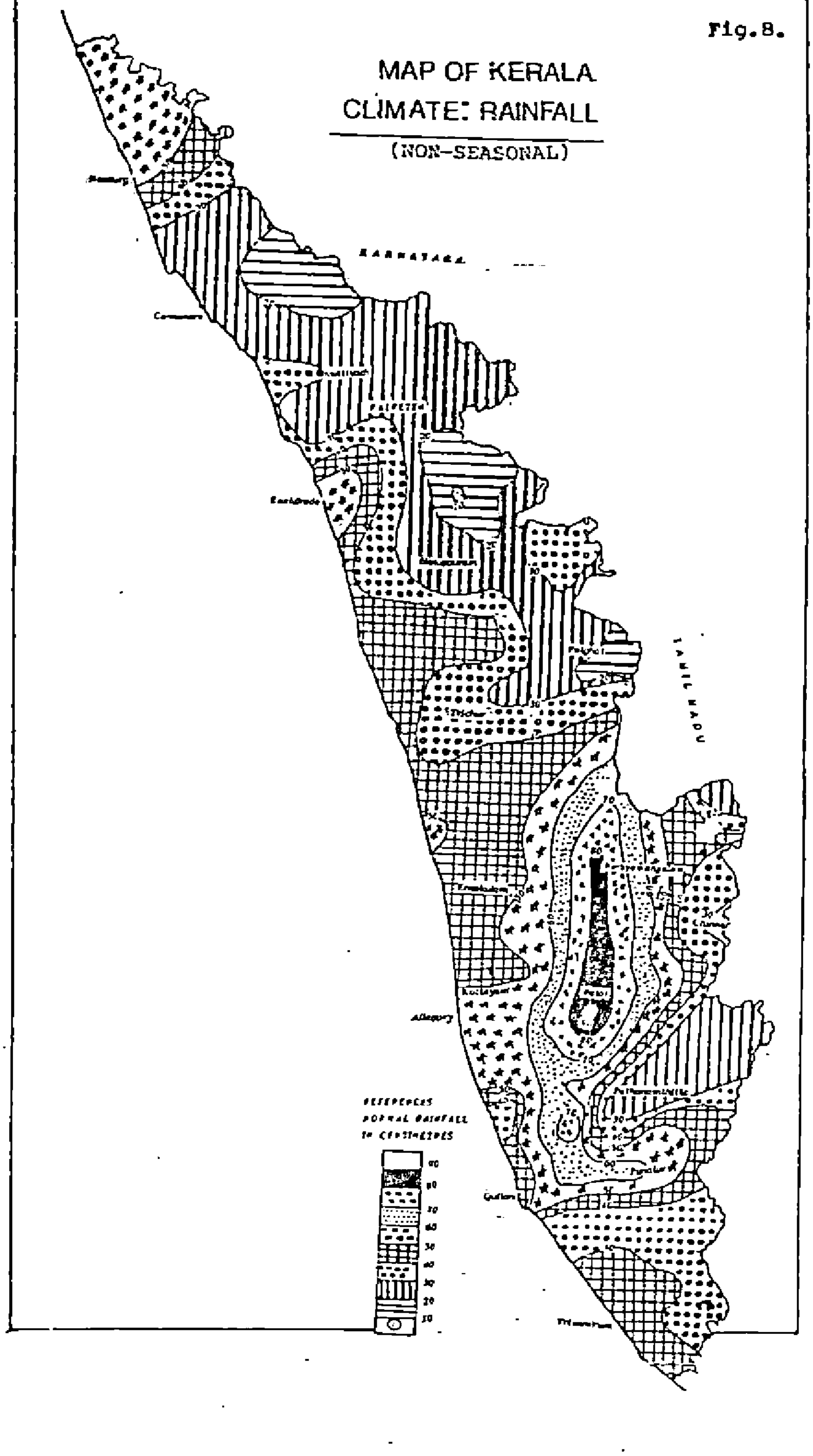


Fig.8.

MAP OF KERALA
CLIMATE: RAINFALL
(NON-SEASONAL)



The crop-wise fertiliser requirement is given in Table 4. Two important factors which have drastically influenced the consumption of fertilizers are the cost of fertiliser and the price of agricultural produce.

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

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

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

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

Table 5. NPK consumption ratios in Kerala

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

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

The 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 2:1:1 ratio. For other crops (the next important crop being 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 per-humid and humid climatic types except the southern most pockets of the State and the eastern part of the Palghat region which come under moist sub-humid climatic type. The State as a whole experiences megathermal climate which indicates that the crop growth is not inhibited by temperature; but governed by rainfall alone.

The classification of moisture availability regimes (MAR) of Kerala is given in Table 6.

Table 6. Moisture availability regimes in Kerala

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

1.4.1. Rainfall

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

The annual rainfall of the State is 2963 mm. The highest rainfall (5883.8 mm) is recorded at Neriamangalam (Ernakulam district) and the lowest (651.3 mm), at Chinnar (Idukki district). The annual rainfall increases from 1479 mm at Parassala in the South to 3562 mm at Hosdurg in the North. July is the most rainy month in the northern districts. The southern parts extending from Ponnani to Trivandrum (except Devikulam) show two peaks in the months of June-July and October during the South-West and North-East monsoons, respectively. The northern districts, especially Kasaragod and Cannanore, experience a prolonged dry spell if the pre-monsoon showers fail. In general, the rainfall 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. The effective rainfall is 80 per cent in the southern region. The mean annual number of rainy days over the State is 126 (Fig.5) with the minimum (45 days) at Chinnar and the maximum (172 days) at Neriamangalam. Nearly 60 per cent of the annual rainfall is received during the South-West monsoon (June to 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 to December) is quite different from that during the South West monsoon, as the northern parts of Kerala receive less amount of rainfall compared to the South (Fig.7). The number of rainy days are more in October and thereafter, a sharp decline occurs. The pattern of rainfall other than monsoon rains is depicted in Fig.8.

1.4.2. Water balance of Kerala

Unlike the southern zone, deficit of water is seen for longer duration in the northern region of Kerala (Kasaragode and Cannanore districts), especially in the lowland and midland regions. This is mainly because the North-East monsoon is erratic over Cannanore and Kasaragode districts.

1.4.3. Surface air temperature

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

Fig.9.

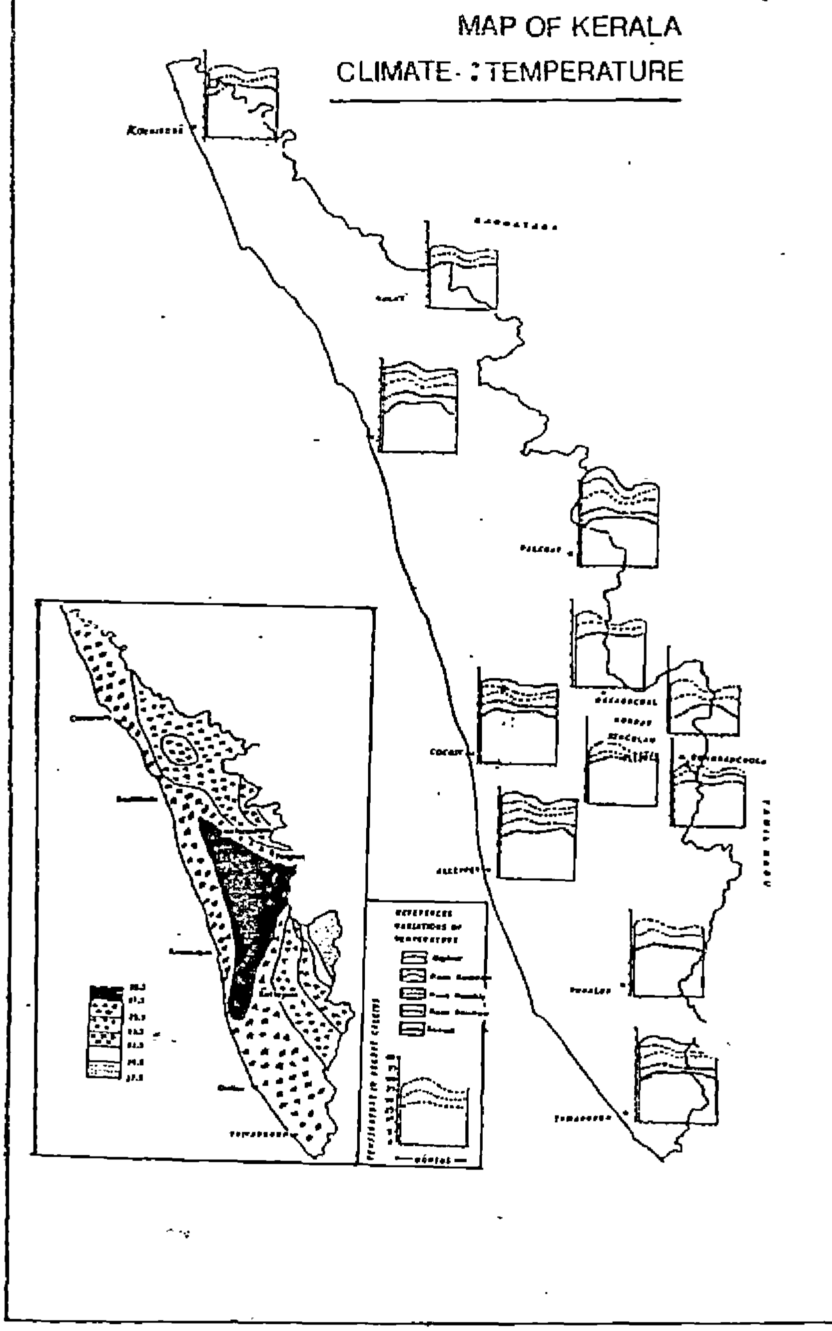
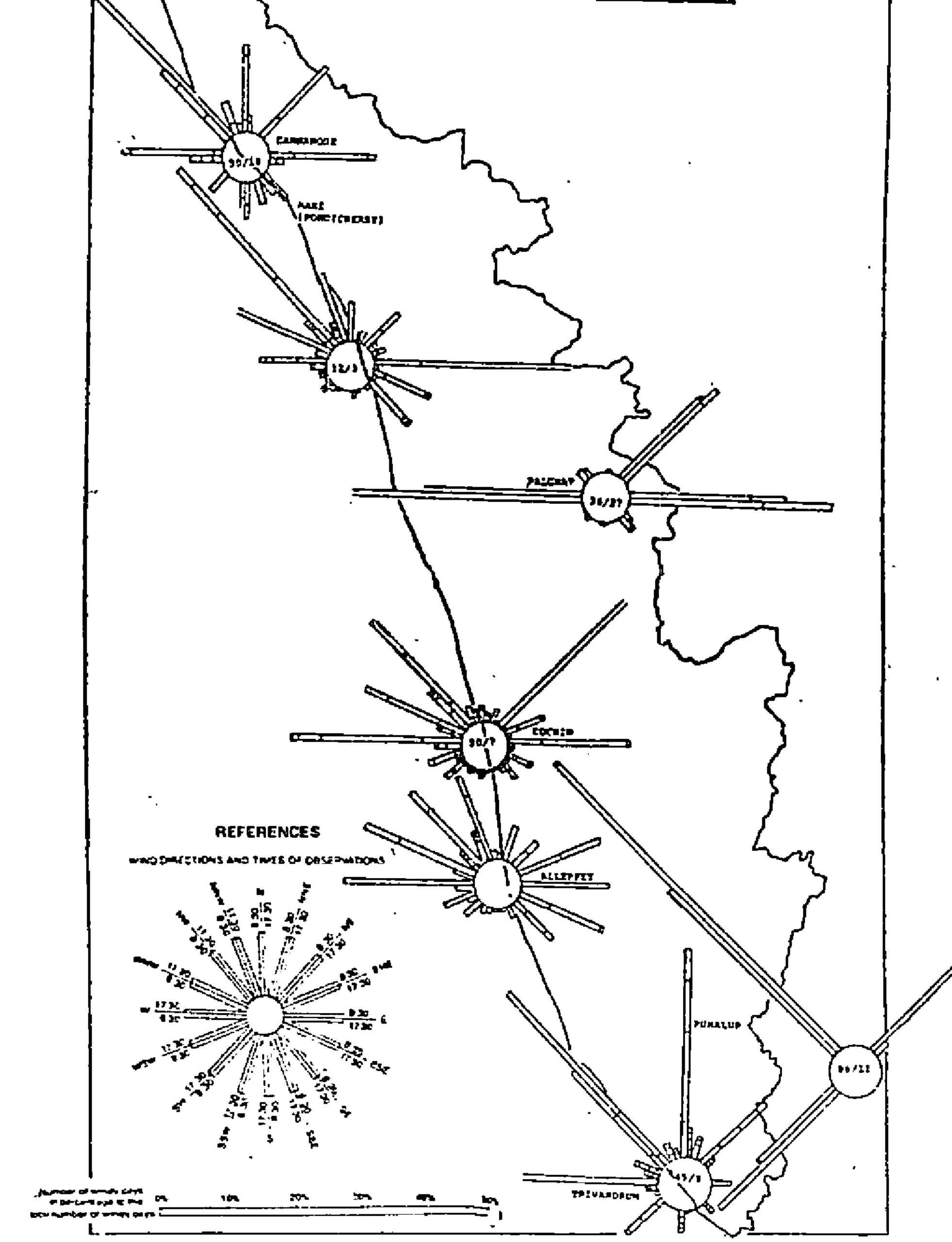


Fig.10.

MAP OF KERALA
CLIMATE : WIND



1.4.4. Cloudiness and humidity

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

1.4.5. Surface winds

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

1.4.6. Potential evapo-transpiration

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

1.4.7. Sunshine

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

1.4.8. Special weather phenomenon

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

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 or gross cropped area (GCA), there was an increase of about 23 per cent during the two decades from 1960-61 to 1980-81. The GCA was 23.49 lakh ha in 1960-61 and 28.85 lakh ha in 1980-81. This was mostly due to an incease in the cropping intensity from 122 to 132 per cent during the period. The GCA in 1984-85 was only 28.75 lakh ha. The percentage of net area sown to the gross area remained almost the same during the last five years, while there was an increase in the area of land put to non-agricultural uses. The area under permanent pastures and other grazing land, land under miscellaneous tree crops, cultivable waste, fallow other than current, fallow, and current fallow fell substantially during this period. However, during the past five years the area remained stable for all the above categories. Tables 7 and 8 give a detailed picture of the situation during the last five years and the last two decades. The total forest area of the State remained at 10.82 lakh ha for the last five years and constituted about 28 per cent of the total geographical area (Table 7 and Table 8). The district-wise distribution of the forest area for the years 1978-79 to 1980-81 are given in Annexure X. The division-wise area of reserve forests and vested forests in Kerala is given in Annexure XI. Percentage distribution of forests in Kerala by functional type and vegetational type is furnished in Table 9.

Table 7. Classification of area and intensity of cropping (1960-61 to 1984-85)

(Area in '000 hectares)

	60-61	70-71	80-81	81-82	82-83	83-84	84-85
Geographical area according to village papers	3885	3885	3885	3885	3885	3885	3885
Forests	1056	1055	1082	1082	1082	1082	1082
Land put to non-agricultural use	205	275	270	266	276	278	280
Barren and un-cultivable land	151	72	86	86	86	87	86
Permanent pastures and other grazing land	45	28	5	5	5	5	4
Land under mis-cellaneous tree crops not included in the net area sown	204	132	64	55	55	55	51
Cultivable waste	144	80	129	130	130	129	130
Fallow land other than current fallow	62	23	27	27	27	28	27
Current fallow	67	24	44	44	44	43	42
Net area sown	1924	2172	2180	2190	2180	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, Bureau of Economics and Statistics, 1975.
2. Economic Review 1985, State Planning Board, Trivandrum.
3. Progress of Kerala in three decades 1956-1985, Department of Economics and Statistics, Trivandrum.

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

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

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

The suitability of the land and climate for a number of crops has tempted the farmers to cultivate a host of crops in the same piece of land in mixed stands. This has resulted in an intensive cultivation of dry land in the State. The overall intensity of cropping in Kerala is fairly high. The ratio between gross cropped area and net area sown is 1.32 in Kerala (1984-85) as against the national figure of 1.18. But this parameter, in the context of Kerala, is deceptive becaue 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 9. Percentage distribution of forests in Kerala by functional type and vegetational type (1980)

	Percentage
A. <u>Functional type</u>	
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. <u>Vegetational type</u>	
Evergreen and semi evergreen	50.5
Moist deciduous	33.4
Dry deciduous	1.8
Montane sub tropical and temperate	1.7
Plantations	12.6
Total	100.0

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

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

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

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

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 availablity of water from these two sources mainly depends on the rainfall. Rainfed cropping system is generally followed in the State. The distribution pattern of rainfall in Kerala is not uniform and during the two monsoons, heavy rains occur resulting in floods. The State is blessed with 44 rivers (Annexure 2). The water in these rivers can be fully exploited for irrigation and raising the agricultural production to the maximum possible. The total extent of land that can be brought under irrigation in Kerala through major and medium irrigation projects is estimated at 6.0 lakh ha (net) or 14.0 lakh ha (gross). The ten completed projects together irrigate an area of 0.77 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 the major and medium irrigation projects till June 1985 was 3.57 lakh ha. A list of ongoing major and medium irrigation projects and their cumulative achievements at the end of 1984-85 are given in Annexures XII and XIII.

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

1.6.2. Irrigation potential

According to a study of the Planning Commission, the irrigation potential of Kerala was estimated at 2.5

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

1.6.3. Ground water availability

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

The systematic hydrological studies by the State Groundwater Department and the Central Groundwater Board have indicated the presence of a number of sandy belts composed of medium to coarse grained sands. These sandy pockets are found to be potential ground water resoures and suitable for development by way of shallow filter point wells. From 1982 to the end of March 1986, 548 filter point wells in Trivandrum, Quilon, Alleppey, Trichur, Ernakulam, Malappuram, Calicut and Cannanore districts have been sunk. Besides these, suitable sites were cleared and appropriate designs given for 686 open irrigation wells, 869 tube/bore wells and 233 shallow bore wells to a depth of 60 m in various parts of the State for irrigating the agricultural land. The Ground

Water Department also dug 286 borewells and 18 tube wells for providing drinking water to Harijan/Girijan colonies. The present utilisation of ground water through dug wells, dug-cum-bore wells is rather limited to certain areas. The wells are tapping the near surface aquifers in Malappuram, Kozhikode, Palghat, Cannanore and Ernakulam districts. In the other districts, it is yet to catch up. The department have so far cleared sites for 7113 open wells throughout the State. The district-wise break up of irrigation wells in the State is given in Table 11.

Table 11. District-wise break up of irrigation wells

Districts	Number of wells with pumpsets	
	Diesel	Electrical
Trivandrum	175	3889
Quilon & 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 Kasaragode		10831
Total	13578	145779
Overall total of irrigation wells		159357

1.6.4. Inland navigation system

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

Long before the development of road and railways, the coastal and inland waterways provided the main transport base in Kerala. The canal system, navigable all round the year, extends from Trivandrum in the South to Badagara in the North and is interlinked by backwaters and rivers through artificial canals. The total length of the navigable route in Kerala is 1895 km, accounting for about 20 per cent of the total inland water route in India. This can be categorised under the interior coastal canal system, the river navigation system and the inland cross canal system. The 83 km long Vembanad lake constitutes the centre of these inland waterways.

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

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

Rs.1000 million, for deep mining of rare earth and for establishing industries based on the mined material is being planned to be established here.

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

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

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

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

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

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

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

1.7. Socio-Economic characteristics, Land holding pattern

1.7.1. Area, population and literacy

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

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

Table 13. Growth of population over the last decades

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

* Projected population

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

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

The total working population in the State is 78 lakhs which is 30.7 per cent of the total population of the State. Out of this, 27.9 lakhs of people are engaged in Agriculture. It is also seen that about 13.18 per cent of the main workers are cultivators and 28.19 per cent, agricultural labourers. The population engaged in agriculture including livestock farming, fishing and forestry is 55 per cent which includes cultivators, landless labourers and fishermen (Annexure XVIII). The fishermen population during 1984-85 was 8.64 lakh constituting 3.2 per cent of the State's population. The district-wise distribution of fishermen population in Kerala is given in Annexure XIX.

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

Kerala leads all the other states in India in literacy with 70.4 per cent, the national average being 36.17 per cent. Male literacy is 75.3 per cent while female literacy is 65.7 per cent. Among the districts, Kottayam has the highest literacy with 81.7 per cent and Palghat, the lowest with 58 per cent. The district-wise literacy rate is given in Annexure XX.

1.7.2. Infant mortality rate and life expectancy

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

Table 14. Infant mortality rates in Kerala

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

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

During the fifties, about one-eighth of the infants born would die before attaining one year, showing an IMR of 120 per 1000 births. There was a two-third decrease in IMR during the last quarter of the Century and the IMR reported in 1983 is only 38.9. A comparison of the infant mortality rates in 1981 among the major states shows that Kerala had the lowest rate, both in the rural and urban areas (Annexure XXI).

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

Table 15. Life expectancy in Kerala and India

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

Source: Economic Review, 1985.

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

1.7.3. Unemployment and educational status

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

1.7.4. Income of the State

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

1.7.5. Land holding pattern

It is reported that the revenue settlement of 1911 identified as many as 455 different tenures in Travancore and Cochin states. But intermediaries like Zamindars, Mahalwaries etc. found in North India, never existed in Kerala. The Kerala Agrarian Relations Act, 1960 was the first identified legislation which embodied the broad principles of land reforms. With the enactment of the Land Reforms Amendment Act of 1969, landlordism has been abolished in the State and 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 the private forests and the plantation lands belonging to religious, educational and charitable institutions from the purview of the Act. It is noteworthy that Kerala has the lowest ceiling limit among the states in India.

The total number of operational holdings 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 years, the number of operational holdings increased by 19.42 per cent (6,79,800 nos.) while the area operated increased by only 5 per cent (86,200 ha). The details are given in Annexure XXVI. It may be seen that 89 per cent of the total holdings in Kerala are marginal (ie. less than 1 ha) and that the large holdings (ie. 10 ha and above) occupy only 0.1 per cent (Table 16). The total number of operational holdings in Kerala was 4.68 per cent of the total number of operational holdings in India during the year 1980-81, whereas the total operated area accounted for only 1.11 per cent of the area operated in India.

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

Class and size of holdings	Number of operational holdings (%)		Average size of operational holdings (ha)	
	Kerala	India	Kerala	India
Marginal (below 1 ha)	89.16	56.55	0.20	0.39
Small (between 1 & 2 ha)	6.93	17.99	1.37	1.42
Semi-medium (between 2 & 4 ha)	2.96	14.00	2.68	2.76
Medium (between 4 & 10 ha)	0.85	9.05	5.45	5.98
Large (10 ha and above)	0.10	2.41	35.14	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 the large holdings (10 ha and above) together accounted for only 1.09 per cent of the total holdings in 1976-77. This was reduced to 0.95 per cent in 1980-81. The total area under these classes of holdings was 19.80 per cent of the total operated area in 1970-71 which decreased to 18.02 per cent in 1980-81. For India, the percentage of operational holdings under these classes was 11.46, which accounted for 52.50 per cent of the operated area in 1980-81.

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

1.7.6. Homesteads

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

1.7.7. Farm prices

Annexure XXVII shows the average farm price of some of the important commodities.

1.7.8. Wages

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

1.8. Major crops and crop sequences

1.8.1. Major crops

Agriculture in Kerala is unique in the sense that homestead system of cultivation is prevalent in almost all parts of the State. The homestead consists of the area surrounding the farm house. Intensive cultivation of all available crops is the main feature of this system of farming. The nature of crops in the homesteads depends mainly upon the requirements of the farmer and ranges from purely seasonal to perennial crops. One principal feature is that coconut constitutes the base crop in almost every homestead and it is intermixed with other seasonal, annual and perennial crops. Rice is the staple food of Keralites. Tapioca is a subsidiary food crop. The major crops include plantation crops like coconut, arecanut, cashew, pepper, coffee, tea, rubber; annual crops like rice, tapioca, pulses, sesamum, cotton, groundnut, ragi, tobacco; fruit crops like mango, banana, pineapple, jack and seasonal crops like cowpea, blackgram, redgram etc. In addition to these, vegetables and tubers are largely grown in the homesteads. Sweet potato, yams, colocasia etc. are some of the importat 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 XXVIII.

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 highranges are given below:

Lowland

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

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

Midland

Perennial	-	Coconut, rubber, cashew, arecanut, nutmeg, clove, pepper, betelvine and cocoa

Annual	-	Tapioca, ginger, banana, yam, turmeric
Seasonal	-	Pulses, groundnut, vegetables Rice in wet lands

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

<u>Highland</u>

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

<u>High ranges</u>

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 systems are widely practiced.

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

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

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

1. Rice-based farming system
2. Coconut-based farming system
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 XXIX. The peak marketing seasons of principal crops in Kerala along with sowing and harvesting periods are given in Annexure XXX.

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 XXVIII.

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 8.76 lakh ha in 1975-76, the area has come down to 7.30 lakh ha in 1984-85, 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. Since the population 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, which is three times the current internal production. If production does not increase adequately, there would be a yawning gap between availability and requirement, necessitating extreme dependence on outside suppliers. This shows the gravity of Kerala's food problem and the need to find urgent 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 such as in modan lands, waterlogged and flooded areas, high altitude areas, coastal saline areas etc. These areas, differing in agro-ecological conditions, pose peculiar location-specific problems which come in the way of increasing productivity at economically feasible levels of investment.

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

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

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

v. About 36 per cent of the gross area under paddy is irrigated according to reported figures. Yet, much need to be done by way of command area development for effective utilisation of the irrigation potential created.

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	1985-86a
Rice	Area	876	802	730	678
	Production	1339	1272	1256	1173
	Productivity	1520	1587	1719	1729
Coconut	Area	693	651	687	687
	Production(b)	3439	3296	3453	3149
	Productivity(c)	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(b)	13387	10805	9269	5033
	Productivity(c)	174719	176437	162614	88298
Cashew	Area	109	141	137	137
	Production	122	82	72	73
	Productivity	1122	579	527	533
Tea	Area	N.A	36	35	N.A
	Production	46	51	56	53
	Productivity	N.A	1402	1608	N.A
Coffee	Area	N.A	58	64	N.A
	Production	18	24	43	24
	Productivity	N.A	406	672	N.A

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

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

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

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

Increase the coverage of HYV in the different seasons.
Bring more area under <u>punja</u> crop (summer) [Irrigation is a major constraint here and to tackle this, ground water resources have to be exploited].
Increase productivity in areas where it is relatively low now.
Ensure optimum fertiliser use.

1.9.2. <u>Coconut</u>

India is the third largest producer of coconut in the World. The country with 1.1 million hectares under the crop, accounts for nearly 1/8th area under coconut in the World. Kerala has nearly 6.87 lakh hectares under coconut cultivation (1984-85).

The production in 1975-76 was 3439 million nuts while it was 3453 million nuts in 1984-85. The productivity has increased from 4963 nuts/ha to 5023 nuts/ha during the period. However, the increase is not found to be impressive as it is below the all India average. The incidence of root wilt disease, extending cultivation to marginal and unproductive land, inadequate input usage, unscientific underplanting in existing stands causing overcrowding of palms, inadequate management practices, unfavourable seasonal conditions, inferior genetic base of the cultivars, incidence of pests and diseases, have all contributed to the poor yield.

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

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

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

There are only two distinct "varieties" in coconut, the tall and the dwarf. The tall, popularly known as West Coast Tall (WCT) occupies most of the area. The dwarf varieties are not cultivated commercially. The hybrids involving tall and dwarf as the parents are popular with the farmers; but they occupy only a small area at present. The root (wilt) disease of coconut is the major disease which has spread over the entire southern and central parts of Kerala. No preventive / control methods have been evolved yet.

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

1.9.3. Tapioca

Tapioca (cassava) is a crop of great economic significance to Kerala. It easily fits into the cropping systems prevailing in the State. In spite of this fact, the area and production of tapioca are decreasing at a faster rate. In 1975-76, the total area under cultivation of tapioca was 3.27 lakh ha, whereas in 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 53.9 lakh tonnes in 1975-76, the total production came down to 37 lakh tonnes in 1984-85. However, the productivity increased only slightly during the decade. From 16,491 kg/ha in 1975-76, the productivity increased to 17,047 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 in Kerala.

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

i. Cultivation of low yielding varieties

ii. Slow adoption of modern production technology and lack of awareness of improved package of practices

iii. An uncertain market and fluctuation in price

iv. Poor avenues of alternate use of the produce

1.9.4. Pepper

Pepper is an important export-oriented commodity. 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 1,08,000 ha which came down to 1,06,000 ha in 1984-85. The production decreased from 25,000 tonnes in 1975-76 to 17,000 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 plantations require planting and underplanting at regular intervals to replace the old, diseased and damaged pepper vines around each standard. Systematic manuring and plant protection are not practiced by the farmers which is one of the major reasons for the low productivity.

The hybrid Panniyur-1 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 1.29 lakh tonnes in 1975-76, the production increased to 1.89 lakh tonnes in 1984-85. The productivity has 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 has increased in the State. The replacement of other crops by rubber is obvious. Coconut, cashew and tapioca appear to be the crops replaced by rubber. Probably this may be due to favourable land policy and price situation. The present trend of decreased production in coconut and the attractive returns from rubber are bound to alter the land use pattern in favour of rubber in the remaining areas as well.

1.9.6. Cashew

During the decade 1975-1985, there was an increase of about 0.28 lakh ha under cashew (an increase of about 26 per cent). From 109 lakh ha in 1975-76, the area rose to 1.37 lakh ha in 1984-85. But, inspite of the increase in area, it is disappointing to note that the production decreased by about 41 per cent during the decade. From 1.22 lakh tonnes in 1975-76, the production 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 since the State requires a large quantity of cashew for industries, the total production of the State has to be considerably increased. As there is no scope of further increase in the area under cashew, the emphasis should be on increasing the productivity through better management practices. It is estimated that about 3 per cent of the loss in production could be made up if timely plant protection measures are resorted to.

1.9.7. Arecanut

The area under arecanut has decreased during the decade 1975-1985. 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 13,387 million nuts whereas in 1984-85 it was 9,269 million nuts, a reduction of 30 per cent. The productivity declined from 1,74,719 nuts/ha in 1975-76 to 1,62,614 nuts/ha in 1984-85. The drought and other adverse weather conditions might have adversely influenced this crop to such an extent.

1.9.8. Tea

Kerala accounts for 9.5 per cent of tea production in India. The total area under tea is 35,000 ha in 1984-85 and the production, 56,000 tonnes. The productivity reached the highest level 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 increased from 18,000 tonnes in 1975-76 to 24,000 tonnes in 1980-81. The productivity figures indicated a rise 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 had 56.44 lakh livestock (Fig. 11) and 151 lakh poultry population. There was an increase of 3.25 lakh (6.12 per cent) livestock and 16.94 lakh (12.65 per cent) poultry over the 1977 census. The district-wise details are given in Annexure XXXI.

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

Table 18. Districts with the largest and smallest number of livestock and poultry in Kerala

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

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

Fig.11.

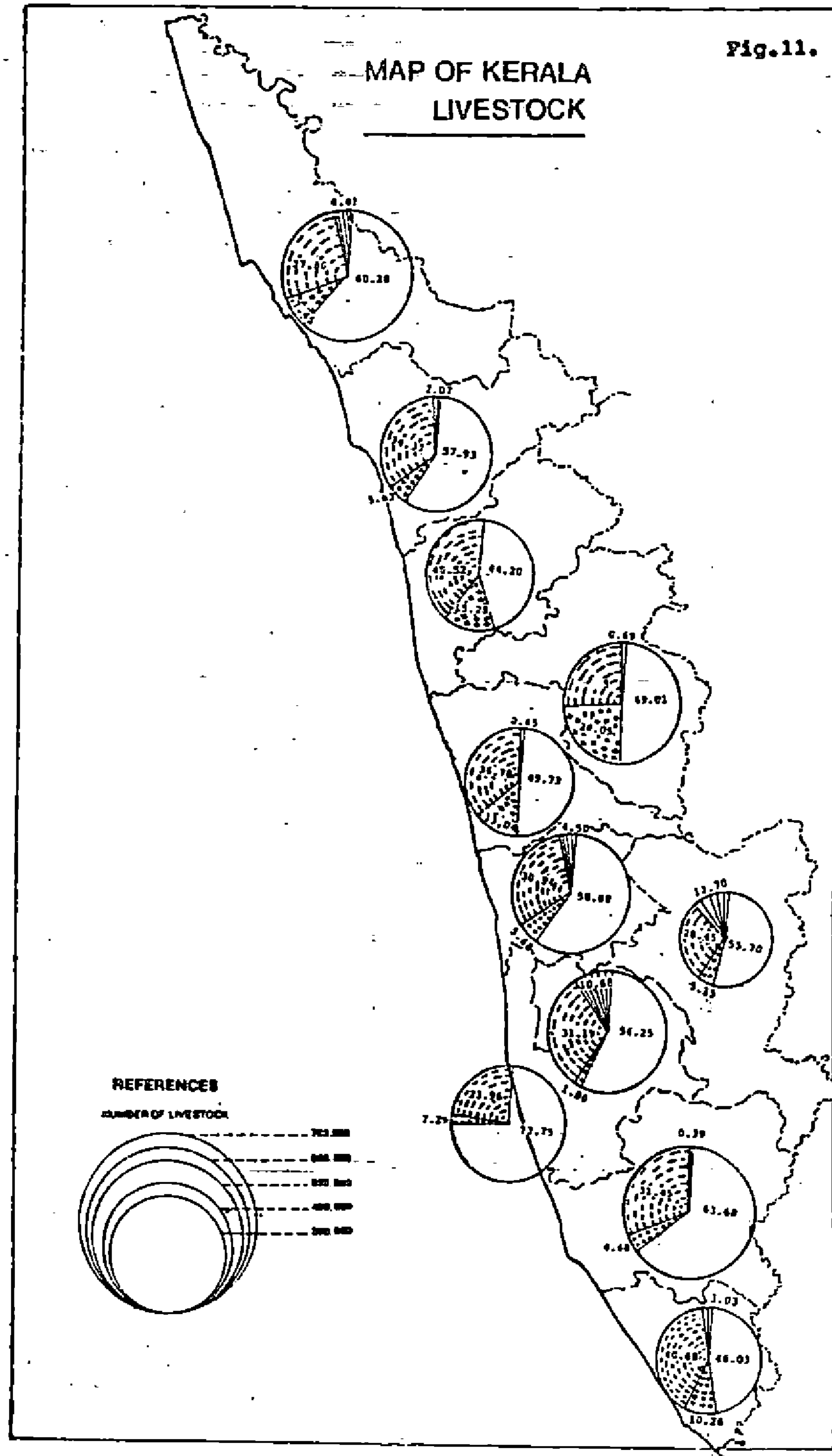


Table 19. Districts with the highest and the lowest density of livestock and poultry (1982)

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

Idukki district had the lowest density of all the major species of livestock and poultry. The dominance of Alleppey with regard to the overall livestock and poultry population is due to the very high density of cattle and ducks in the district. The density of goats increased in all the districts during the period 1977-1982. Distribution of ducks seems to be concentrated in Alleppey, followed by Ernakulam. The lagoons and backwaters in the two districts seem to favour the rearing of ducks.

1.10.2. Cattle

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

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

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

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

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

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

1.10.3.<u>Buffaloes</u>

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

1.10.4.<u>Goats</u>

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

1.10.5. Poultry

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

1.10.6. Livestock products

Milk

Milk production in the State has been rising steadily over the years. Total quantity of milk increased from 7.78 lakh tonnes in 1977-78 to 10.78 lakh tonnes in 1982-83. The production and per capita availability of milk are given in Annexures XLV and XLVI. It is also seen that milk production in the State increased by 9.29 lakh tonnes (420 per cent) during the two decades between 1964 and 1984. This has enabled the per capita per day availability of milk to increase from 30 g to 117 g, an increase of 290 per cent. Looking at the contribution from cows, buffaloes and goats towards the total milk produced, it is seen that cows have increased their share from 80.2 per cent to 83.1 per cent between 1977-78 and 1982-83. Although the supplies from buffaloes and goats also increased, their share declined by 2.2 and 0.66 per cent, respectively.

Turning to productivity, the per day yield of the species improved over the years, including that of non-descript cows. The increase in productivity between

1977-78 and 1982-83 was 18.91 per cent, 1.79 per cent, 16.46 per cent and 8.35 per cent for the cross-bred cows, non-descript cows, buffaloes and goats, respectively. The cross-breeding programme has had its contribution in the yield of cross-bred cows. It is, however, interesting to note that, in spite of the lack of developmental efforts, the yield of buffaloes showed appreciable increase in the five-year period. Milk production in the State during 1983-84 was 3.17 per cent of that of the Country as indicated in Annexure XLVII.

Eggs

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

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

Broiler chicken meat

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

Meat

Meat production in the State has been steadily rising and was 22,505 tonnes in 1984 (Annexure XLIX). The estimated meat production in the State during 1977-78 was 16,200 tonnes. The figures indicate 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 goat and sheep was 15.58 per cent, the balance of 3.75 per cent being the share of pigs. Thus, the bulk of the meat consumed in the State is beaf.

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

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 capaita 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 section. Almost 50 per cent of the earning of India through the export of fishery products is contributed by Kerala. In spite of all these, it is a fact 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 sectors. Kerala has a coast line of 580 km, with 38,000 sq. km area suitable for exploitation. The State has also got 3,55,000 ha of inland water bodies. Thus, potentially Kerala's fisheries sector is one of the richest in the Country. While the State is leading in marine fish production, it is far behind in inland fish production. When Kerala produced 3.9 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 27,011 tonnes of inland fish, forming only 2.7 per cent of the total inland producition of the Country. In the availability of area of inland water, Kerala ranked fifth, while in inland fish producition, 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 producition by three times and the inland production, by eight times.

1.10.8.<u>Fishing population</u>

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 3.0 per cent of the State's population and 14 per cent of the fishermen population of India, although the State has only 8.0 per cent of India's coast line and 0.7 per cent of India's land area. There are 416 fishing villages in the State, of which 249 are marine and the rest, inland. About 35,076 fishing boats are operated in the State, including both mechanised and non-mechanised. Of the total Kerala fishermen population, 6,02,467 are marine fishermen and 1,76,416 are inland fishermen. The proportion of women directly involved in fishing is only 1.7 per cent and all of them are employed in the inland sector. The important fishing communities are the Mopilla, Araya, Thiyya, Kukkava, Mogua, Krakka and Valan. Distribution of traditional fishermen households by religion is given in Table 21.

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

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

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

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

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

Table 22. Percentage distribution of income groups of fishermen

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

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

1.10.9. <u>Fishery development programmes and agencies in the State.</u>

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

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

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

World Bank assistance. There is a programme for promoting aquaculture for the benefit of traditional fishermen in the inland sector.

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

Fisheries Department

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

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

Matsyafed

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

Under the Federation, there are four Ice Freezing Plants at Cannanore, Calicut, Cochin and Neendakara, one Nylon Net Factory at Cochin and one Cold Storage Plant at Azhikode. The Federation is implementing several schemes for the development of inland fisheries. The important ones are the collection and distribution of brackishwater fish seed, brackishwater fish culture demonstration farms at Narakkal and Malippuram, fishery development of Vazhani reservoir and the brackishwater fish and prawn culture farm at Poothotta. The Federation is also carrying out several projects towards the welfare of fishermen.

Kerala Agricultural University

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

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

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

Other organisations

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

Central Marine Fisheries Research Institute (ICAR)

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

Central Institute of Fisheries Technology (ICAR)

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

Marine Products Export Development Authority (Government of India)

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

Integrated Fisheries Project (Government of India)

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

Fishery Survey of India (Government of India)

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

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

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

Export Inspection Agency (Government of India)

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

1.10.10. Constraints in fish production

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

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

1.10.11. Future activities

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

Kerala is perhaps the least developed of the Indian states in the matter of 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 water-spread area of 85,000 ha, 600 km of irrigation canals, 24 reservoirs with a waterspread area of 24,137 ha, 50,00,000 ha of irrigated paddy fields, 3,300 ha of ponds and tanks, and a negligible area under fish farm. If brought under scientific management, the freshwater resources can yield 2,66,160 tonnes of fish per annum.

The State's proposal for the VII Plan has gone into greater details of the fisheries sector considering it as an employment generating sector. The proposed outlay for the VII Plan is 65 crores (Annexure LIII) against that of 2000 crores in the VI Plan. The main projects proposed in the fisheries sector during the VII Plan are (i) establishment of fresh and brackishwater fish farms, (ii) riverine fish culture, cage and pen culture, fish culture in ponds, tanks and paddy fields, culture of air-breathing fishes, (iii) trout culture, (iv) insurance cover to fish farmers, (v) establishment of a fish feed production unit, (vi) establishment of laboratories and strengthening of the survey unit, (vii) patrolling the backwaters, (viii) establishment of fishing harbours and landing facilities, (ix) organising deep-sea fishing, (x) provision of processing, preservation and marketing facilities, (xi) mechanisation and improvement of fishing crafts, establishment of service centres for outboard engines, (xii) setting up of a resource management cell, (xiii) establishment of a Central Fisheries Management Technical Institute and strengthening the Regional Fisheries Technical High Schools and (xiv) providing social amenities to fishermen and strengthening the Statistical Unit and the Fisheries Project Cell.

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

1.11. Farm implements and machinery

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

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

1.12. Agro-climatic zones

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

1.12.1. Northern zone

This zone consists of the four northern districts of Kerala viz. Kasaragod, Cannanore, Calicut and Malappuram with 12 taluks, 39 development blocks and 295 panchayats, with a total geographical area of 10,94,600 ha, covering 28.2 per cent of the area of the State. The total population of the zone is 74.4 lakhs (1981 census), constituting 29.3 per cent of the population of the State. The percentage literacy of the zone is 64.13 as against 69.17 of the State. Agriculture is the main occupation of the people. Nearly 88 per cent of the population is engaged in farming and allied activities. The zone receives rains during both the monsoons, the South-West and North-East. The annual average rainfall for the zone is 3379 mm. Although the zone is endowed with plentiful rainfall, a prolonged dry spell of four to five months duration does occur every year from December to May. Moisture stress experienced during this period affects the growth and production of perennial crops like coconut, arecanut and pepper. Similarly, the torrential rains during the months of June and July create crop hazards due to waterlogging. The mean maximum and minimum temperatures of the zone are 33°C and 23°C, respectively. Westerly and North-westerly winds prevail during the South-West monsoon and easterly winds, during December to March. The maximum wind speed lies between 10 km/hr and 15 km/hr. The major types of soils in the zone are coastal alluvium, laterite and forest loam. Rice, coconut, arecanut, pepper, banana, cashew and rubber are the imnportant crops of the zone.

1.12.2. Central zone

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

1.12.3. Southern zone

The southern zone comprises the districts of Trivandrum, Quilon, Pathanamthitta, Alleppey and Kottayam with 21 taluks, 47 development blocks and 281 panchayats, with a total geographical area of 6,517 sq. km, covering 16.8 per cent of the area of the State. Total population of the zone is 74.43 lakhs, constituting 29.2 per cent of the population of the State. Nearly 15 lakhs operational holdings exist in the four districts of the zone. Out of these, 49.0 per cent is within the size-range of 0.04 ha to 0.25 ha. The zone has a tropical humid climate, with an oppressive 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 zones of the State, rainfall is comparatively well distributed, with the result that the effective annual rainfall is more (80 per cent) than that in the other zones. The annual average rainfall for the zone is 2246 mm. The mean maximum and minimum temperatures of the zone are 34.06°C and 21.74°C, respectively. The soils are lateritic, the texture ranging from sand to sandy loam and clay loam. The major crops of the zone are rice, coconut, tapioca, pepper, cashew, rubber, arecanut, sugarcane, pulses and banana.

1.12.4. High Range zone

This zone comprises the districts of Wynad and Idukki, the Nelliampathy and Attappady hill ranges of Palghat district, Thannithode and Seethathode panchayats of Pathanamthitta district, Ariyankavu, Kulathupuzha and Thenmala panchayats of Pathanapuram taluk in Quilon district and Peringamala, Aryanad and Vithura panchayats of Nedumangad taluk as well as Kallikad and Amboori panchayats of Neyyattinkara taluk in Trivandrum district. Thus altogether, the zone comprises nine taluks, 11 development blocks and 84 panchayats, with a total geographical area of 21,77,280 ha covering 56.55 per cent of the area of the State. Since the districts of the zone are not contiguous, the agricultural characteristics differ widely. The features of the two districts, Wynad and Idukki are given separately.

Wynad Range

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

Idukki Range

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

1.12.5. Special zone of Problem Areas

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

Onattukara

This area falls in Quilon and Alleppey districts, covering three taluks and eight development blocks, with a total geographical area of 72,550 ha. In the olden days the Onattukara area was considered as the rice grannery of the erstwhile Travancore state. But recently due to various reasons it has become a problem area with low levels of production and productivity. The total population of the area is 10,94,432. Of this, about 77 per cent depend upon Agriculture for their livelihood. A very intensive cropping pattern of two rice crops and a sesamum/pulses/vegetable crop is followed in this area.

Kuttanad

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

Pokkali

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

Kole lands

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

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

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 the low lying and submercible areas and coconut, in the plains. Tuber, condiments and spices, vegetables and banana are the other important crops. Nearly 3000-3500 ha of land are now under sugarcane cultivation.

1.13. <u>Research Stations in the State</u>

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

1.13.1. <u>Research stations under the Faculty of Agriculture</u>

(1) <u>NARP centre for the southern zone</u>
<u>Regional Agrl. Research Station, Vellayani</u>

The southern zonal centre of the NARP came into being on 30.11.1981. The Special Station at Kottarakkara was started on 26.4.1986. An area of 8.96 ha of land was acquired at Sadanandapuram for this purpose. The lead function of the southern zone is to conduct research on homestead farming system and also on cassava- based farming systems.

(2) <u>Coconut Research Station, Balaramapuram</u>

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

(3) <u>Cropping Systems Research Centre, Karamana</u>

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

(4) <u>NARP centre for the zone of problem areas Regional Agrl. Research Station, Kumarakom</u>

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

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

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

(5) <u>Rice Research Station, Kayamkulam</u>

The Station was started in 1939 under the Travancore University. This was taken over by the Department of Agriculture, Government of Kerala in 1957. Till 1962, the Station functioned on leased lands. In February 1963, 11.65 ha of land were acquired on the northern side of the Kayamkulam - Punaloor road. The KAU took over the centre in 1972. The Station is situated 1.0 km east of Kayamkulam town, at 3.05 m above MSL.

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

(6) Sugarcane Research Station, Thiruvalla

This was taken-over from the Pampa River Factory on 20.12.75. Experiments were started under the AICRP in January 1977. The Station is located at Kallungal (Nedumpuram panchayat) on the bank of the Manimala river, 6.0 km South of Thiruvalla town. The gross area of the farm is 25.66 ha and the net area available for cultivation is 21.57 ha. The geographic location of the farm is 9.6°N latitude and 76.5°E longitude, and at 25.14 m above MSL. The soil is alluvial with a mean pH of 5.5. The Kerala Agricultural University scheme for intensification of research on sugarcane was taken up in 1978-79 and this was wound up in 1985-86. The ICAR ad hoc project on survey and appraisal of sugarcane diseases is under implementation, since June 1983.

(7) Rice Research Station, Moncompu

This centre was started in 1940 to cater to the needs of the Kuttanad region. The KAU took over the Station in 1972. The location is on the northern side of the Alleppey-Changanacherry road, 12 km from Changanacherry and Alleppey. The soil is alluvial clay. The total area is 8.66 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 Karappadam lands of Kuttanad.

(8) AICRP Centre on Agrl. Drainage, Karumady

This is under operation from 1.12.1981 in farmers' fields in the Kavil Thekkumpurom Padasekharam at Karumady, with a water shed area of 88.91 ha and with a paddy area of 75.238 ha. The Centre is located 10 km away from Ambalapuzha on the Ambalapuzha-Thakazhi road. The padasekharam has alluvial kari soil with high content of organic matter. The objective of the Centre is to conduct studies on agricultural drainage under actual farming situations.

(9) Rice Research Station, Vyttila

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

(10) NARP centre for the northern zone Regional Agrl. Research Station, Pilicode

Research work on coconut commenced in Kerala with the establishment of four research stations (Nileswar 1, 2, 3 and Kasaragod) in the Kasaragod taluk of South Kanara district in 1916. Regular experimental work commenced in these stations from 1930. In 1972, when the Kerala Agricultural University came into existence, the Research Stations at Nileswar 1 and 2 were brought under the University. These stations were reorganised with the headquarters at Pilicode in the year 1981 under the National Agricultural Research Project with the objective of solving the location-specific farming problems in the northern zone of Kerala. Altogether, the Station has a land area of 56.90 ha of which 4.0 ha are wet lands and 52.90 ha, garden lands. The important crops grown are coconut (44.9 ha), rice (63.30 ha in two seasons), cashew (1.0 ha), fodder (1.10 ha) and pulses (1.5 ha).

(11) Pepper Research Station, Panniyur

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

(12) NARP centre for the central zone Regional Agrl. Research Station, Pattambi

The Rice Research Station, Pattambi was established as Paddy Breeding Station in 1927, to evolve high yielding rice varieties suited to the different agro-climatic conditions of the State. In 1930, the Station was converted as the Agricultural Research Station.

In 1962, it became the Central Rice Research Station with Regional Centres at Mannuthy, Kayamkulam and Vyttila under the Government of Kerala. With the implementation of the NARP, the Station was re-organised as the Regional Agricultural Research Station of the central zone. The lead function of the Station is to conduct research on rice, pulses, oilseeds and rice-based farming systems. The Station also functions as an advanced centre for studies on laterite soil management.

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

(13) Aromatic and Medicinal Plants Research Station, Odakkali

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

(14) Agronomic Research Station, Chalakudy

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

(15) Banana Research Station, Kannara

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

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

(16) Cashew Research Station, Madakkathara

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

(17) Agricultural Research Station, Mannuthy and Instructional Farm, Vellanikkara

This Station was originally established during 1957 as the Rice Research Station, Mannuthy in the then Central Farm, as a separate research unit to study the various problems confronting rice cultivation in the middle lateritic region of Trichur and Ernakulam districts. The Station was taken over by the KAU from the Department of Agriculture in 1972. In the year 1976, this Station was converted as the Research Station and Instructional Farm of the College of Horticulture. The Station is located at Mannuthy by the side of the National Highway (NH 47), at a distance of 6.0 km East of Trichur at 10^{0} 22' N Latitude and 76^{0} 16' E longitude and at an altitude 1.5 m above MSL. The soil in the wet lands is sandy loam and that of the garden land is laterite loam. The total area is 38.19 ha. The Agricultural Research Station, Mannuthy forms a Sub-Station of the Central Zone of the NARP and also for the Special Zone for Problem Areas covering the kole lands of Trichur. Apart from the projects undertaken under NARP, experiments under the All India Co-ordinated Rice Improvement Project, the ICAR *ad hoc* scheme on annual oil seeds and University projects are also being implemented at this Station.

(18) Cashew Research Station, Anakkayam

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

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

(19) AICRP on Agroforestry, Livestock Research Station, Thiruvazhamkunnu

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

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

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

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

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

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

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

(20) NARP centre for the High Ranges Regional Agrl. Research Station, Ambalavayal

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

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

The Station is situated in Sultan's Battery taluk of Wynad district, at an elevation of 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 to undertake research programmes on various agronomical, botanical, entomological and phytopathological problems of cardamom cultivation. The Station is situated in the high ranges of Kerala in the Pampadumpara village, Udumbanchola taluk of the Idukki district, 35 km from Kumily in the Kumily-Munnar road. The All India Co-ordinated Spices and Cashewnut Improvement Project of the ICAR was initiated in the Station during 1972. The total area of the farm is 46.44 ha.

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

(1) Livestock Research Station, Thiruvazhamkunnu

The farm was originally established in 1950 by the then Government of Madras. This was transferred to the KAU in 1972. This was converted to the Livestock Research Station with effect from 14.8.1978. The farm is located in the Mannarghat taluk of Palghat district, 17 km North-West of Mannarghat town. This station is spread over an area of 163.3 ha of which 84.37 ha is under fodder crops. The major objective of this station is to conduct research on scientific breeding of livestock, livestock management and fodder production.

(2) Cattle Breeding Farm, Thumburmuzhi

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

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

(3) University Livestock Farm, Mannuthy

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

(4) University Poultry and Duck Farm, Mannuthy

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

(5) Pig Breeding Farm, Mannuthy

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

1.13.3. Research Station under the Faculty of Fisheries

Instructional Farm, Puduveypu-Panangad complex

In 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.

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

Table 23. Research Centres / Stations / Farms in the Kerala Agricultural University showing area under each Centre / Station / Farm as on 1.9.1986.

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

Sl. No.	Research Station	Area (ha)
B.	FACULTY OF VETERINARY AND ANIMAL SCIENCES	
22.	Livestock Research Station, Thiruvazhamkunnu	163.30
23.	Cattle Breeding Farm, Thumburmuzhy	25.20
24.	University Livestock Farm, Mannuthy	69.00
25.	University Poultry and Duck Farm, Mannuthy	0.50
26.	Pig Breeding Farm, Mannuthy	4.20
C.	FACULTY OF FISHERIES	
27.	Instructional Farm, Puduvaipu	101.00
	Total area of the above farms	984.14
	Area under KAU Estate	391.43
	Total area under KAU	1375.57

CHAPTER II

GENERAL AGRICULTURAL CHARACTERISTICS OF THE SOUTHERN ZONE

2.1 Delineation of the area of the zone

The southern zone of Kerala (Fig. 12) comprises the districts of Trivandrum, Quilon, Pathanamthitta, Alleppey and Kottayam. The sandy soils of Onattukara tract in the districts of Quilon and Alleppey, the saline tract in the coast, the problem soils of Kuttanad and the high ranges falling in some of these districts are, however, not included in this zone.

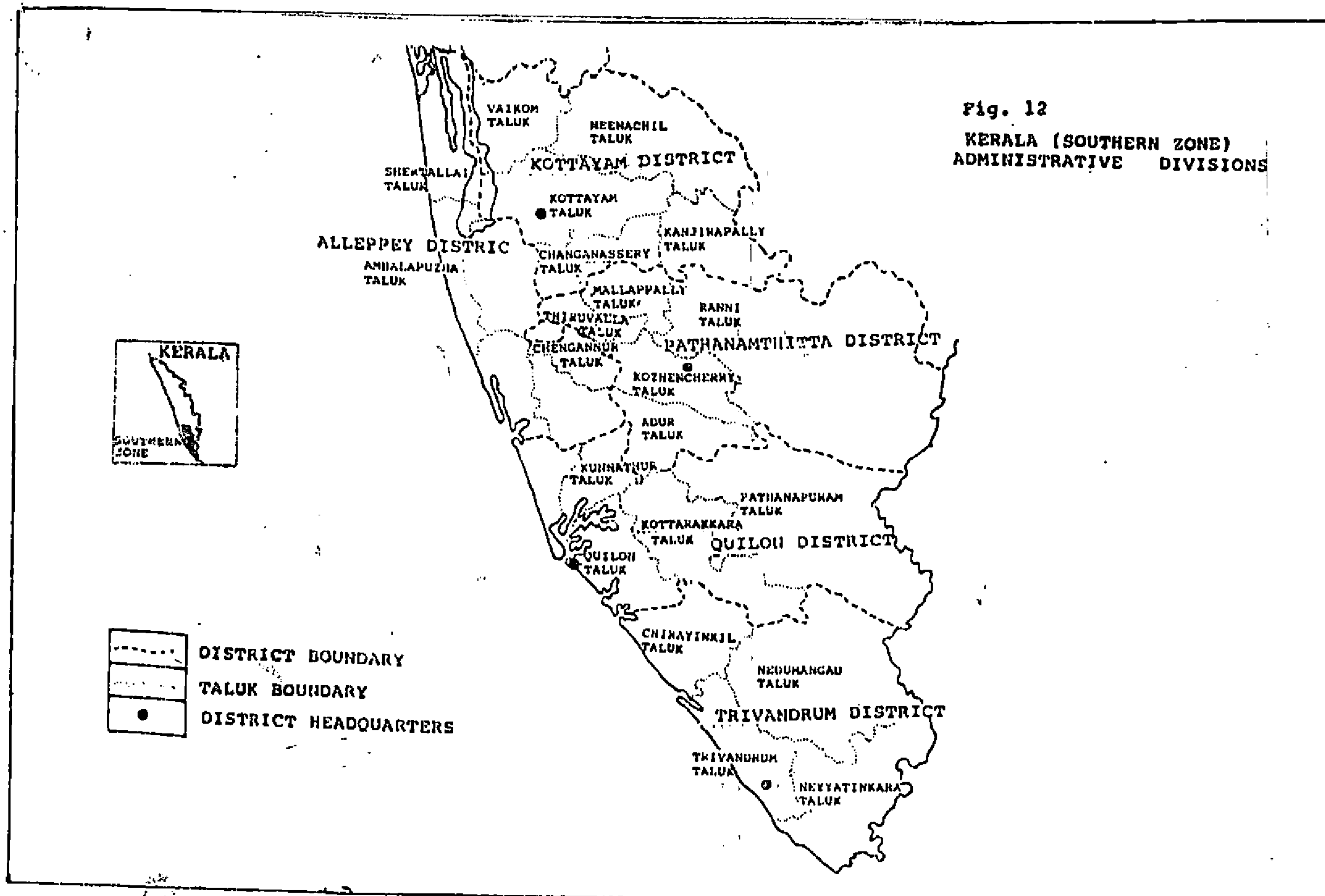
The southern zone is bound on the East by Thirunelveli district of Tamil Nadu, on the South by Kanyakumari district of Tamil Nadu, on the North by Ernakulam and Idukki districts of Kerala State and on the West by the Arabian sea. The zone lies between North latitudes $8^{\circ}17'$ and $10^{\circ}21'$ and between East longitudes $76^{\circ}17'$ and $77^{\circ}25'$. The East-West width of the zone varies from 100 km in the middle to 32 km in the extreme South. The total geographical area of the five districts constituting the southern zone is 10,962 sq. km which incudes some of the problem areas and high ranges, for which separate sub-projects have been sanctioned. After deducting the problem areas and high ranges in these districts, the southern zone has a total area of 6,517 sq. km which is 16.8 per cent of the area of the State. The zone supports a population of nearly 74.43 lakhs which constitutes 29.2 per cent of the State's population. The zone has 13,72,238 households which is 31 per cent to the State. The population statistics of the zone are furnished in Annexure LIV. Details of the urban population in the zone are contained in Fig. 13. Out of the 61 taluks and 151 Community Development Blocks in the State, the zone has 21 taluks and 47 blocks, constituting 34 per cent and 31 per cent, respectively of those in the State. The details of the taluks and blocks contained in the zone are given in Annexures LV and LVI. The administrative divisions of the zone are detailed in Annexures LVII(a) to LVII(e) and the Panchayats, in Fig. 14. Out of 1000 panchayats in the State, 281 are in the zone (28 per cent). Fig. 15 shows the rail routes, the major roads and the air connections in the zone.

The most populous and the least populous panchayats in the zone (Census 1981) are presented in Annexure LVIII. The most populous panchayat in the zone is Kottamkara in the Mukhathala block of Quilon district having a population of 53,349. The least populous is Thumpamon panchayat in the Pandalam block of Pathanamthitta district with a population of 7,574. Among the districts in the zone, Kottayam has the lowest density of population (778 persons/sq.km). The population density increases in the order, Pathanamthitta (976), Quilon (1202), Alleppey (1676) and Trivandrum (1538). As is the case with the State, the zone also has predominance of females over males. The general literacy rate in the zone is 76 per cent, as against the State figure of 70 per cent.

The population particulars of scheduled castes and scheduled tribes in the different blocks of the zone, as per Census 1981, are given in Annexure LIX. Out of the total scheduled caste population of 25,49,382 in the State, the zone has a share of 8,56,051 (33.6 per cent). The scheduled tribe population of the State is 2,61,475 out of which 38,964 exist in the zone (14.9 per cent). Scheduled castes and scheduled tribes in the zone constitute 10.7 per cent and 0.5 per cent, respectively to the zone's total population. The largest scheduled caste population is found in Kulanada block (19.3 per cent) and the lowest, in Erattupetta (3.6 per cent). Among the municipalities and Trivandrum Corporation, Palai has the lowest (2.5 per cent) and Varkala, the highest (14.9 per cent) scheduled caste population. The scheduled tribe population is the highest in Erattupetta block (7.2 per cent). The blocks of Varkala and Anchalumoodu as well as the municipalities of Attingal and Varkala have no scheduled tribe population. The zone has 1,67,421 households of scheduled castes, which is 34.7 per cent to the State. Scheduled tribes in the zone have 8,279 households (15.8 per cent to the State). Of the total households in the zone, the number of households of scheduled castes and scheduled tribes constitute 11.4 per cent and 0.56 per cent, respectively. Kulanada block has the highest percentage of households (19.7) occupied by scheduled castes while Kottayam municipality has the lowest (0.8). The households occupied by scheduled tribes is highest in Erattupetta block. Varkala and Anchalumood blocks as well as Attingal and Varkala municipalities have no scheduled tribe

Fig. 12

KERALA (SOUTHERN ZONE)
ADMINISTRATIVE DIVISIONS



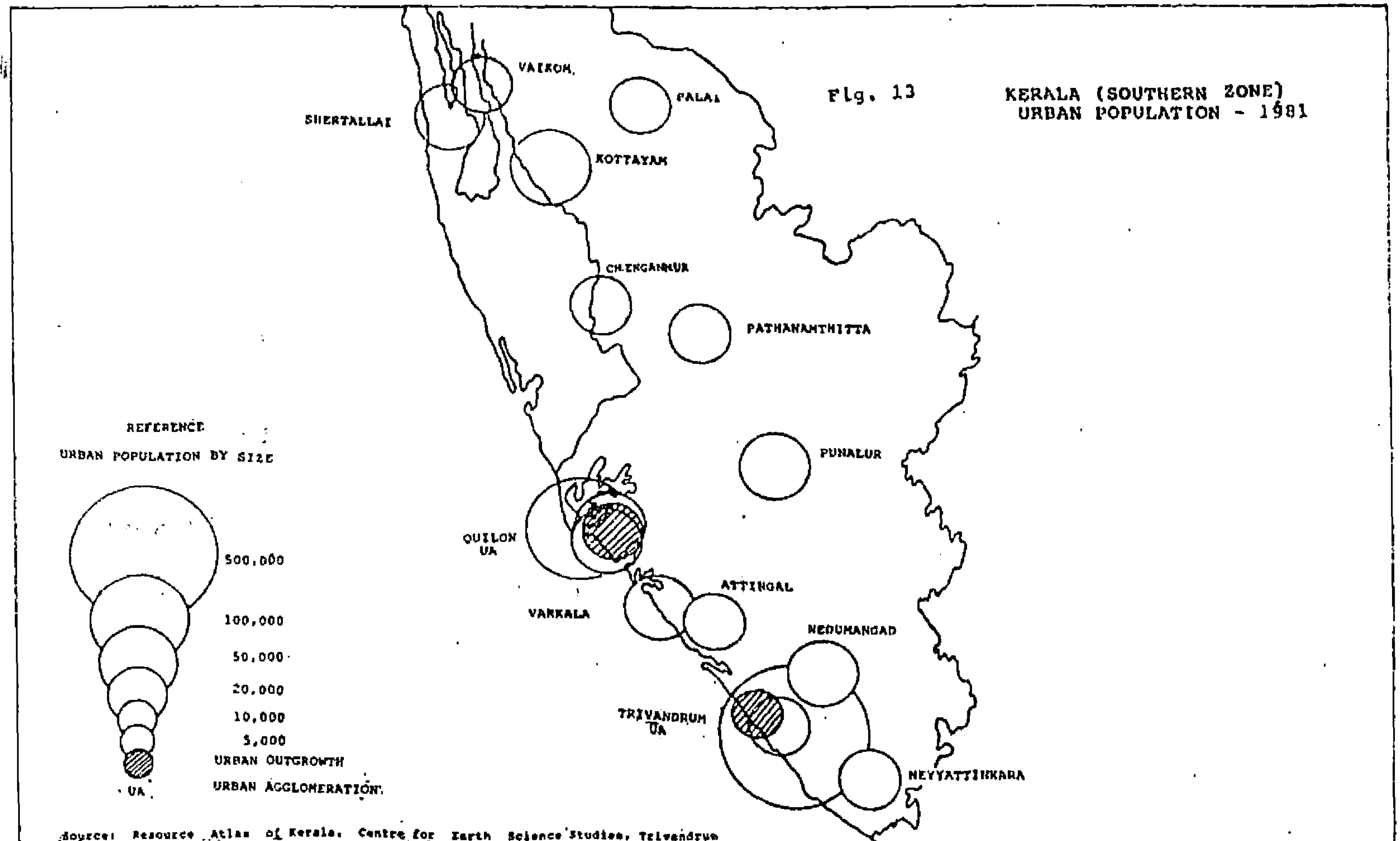


Fig. 13
KERALA (SOUTHERN ZONE)
URBAN POPULATION - 1981
VAIKOM
SHERTALLAI
PALAI
KOTTAYAM
CHENGANNUR
PATHANAMTHITTA
PUNALUR
QUILON UA
VARKALA
ATTINGAL
NEDUMANGAD
TRIVANDRUM UA
NEYYATTINKARA
REFERENCE
URBAN POPULATION BY SIZE
500,000
100,000
50,000
20,000
10,000
5,000
URBAN OUTGROWTH
UA
URBAN AGGLOMERATION
Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum

households. Literacy among the scheduled castes and scheduled tribes in the zone is above average (62 per cent and 55 per cent, respectively).

The data on the extent of forests distributed in the zone are given in Annexure LX. The area under forests in the State (10,81,509 ha) constitutes 27.8 per cent of its geographical area. In the zone, forest area (2,94,GJ4 ha) constitutes 26.9 per cent of its total area (7.6 per cent to the State). Among the districts in the zone, Pathanamthitta has the largest area under forests, followed by Quilon. Kottayam district has only 8,141 ha under forests. Alleppey district has no forest area. Timber rounds, fuel wood and charcoal, teak poles, bamboo, cane, ivory and reed form the major forest produces in the zone. Minor produces include sandal wood, honey, dammer and wax. The wild life sanctuaries at Neyyar (area 128.5 sq.km) and Peppara (area 53.4 sq.km) in Trivandrum district and Shenthuruni in Quilon district (area 100.3 sq.km) exist in the zone. Part of Periyar tiger reserve, having an area of 777 sq. km, is distributed between Idukki and Pathanamthitta districts.

2.2 Physiography

The topographical division of the State into four major zones, as described under Chapter I, is applicable to the southern zone also. The sub-zones identified are: the lowland (<7.5m from MSL), the midland (7.5-75.0m from MSL), the highland (75.0-750.0m from MSL) and the High Ranges (>750.0m from MSL). These zones form nearly parallel belts running along the North South length of the zone. The physiographical division of the zone is depicted in Fig. 16 and Fig. 17. The high ranges lie near the eastern boundary of the zone and is not discussed in this report, since a separate zone to cover the high ranges in the State has been identified. The sub-zones show considerable variation in the physiographical conditions, agricultural situations, industrial developments etc.

The lowland sub-zone (with altitudes of <7.5m from MSL) borders the western sea coast and is covered by the coastal districts of Trivandrum, Quilon and parts of Alleppey having a total area of about 100 sq.km constituting nearly 1.5 per cent of the zone. The sub-zone includes the back water areas, the river deltas,

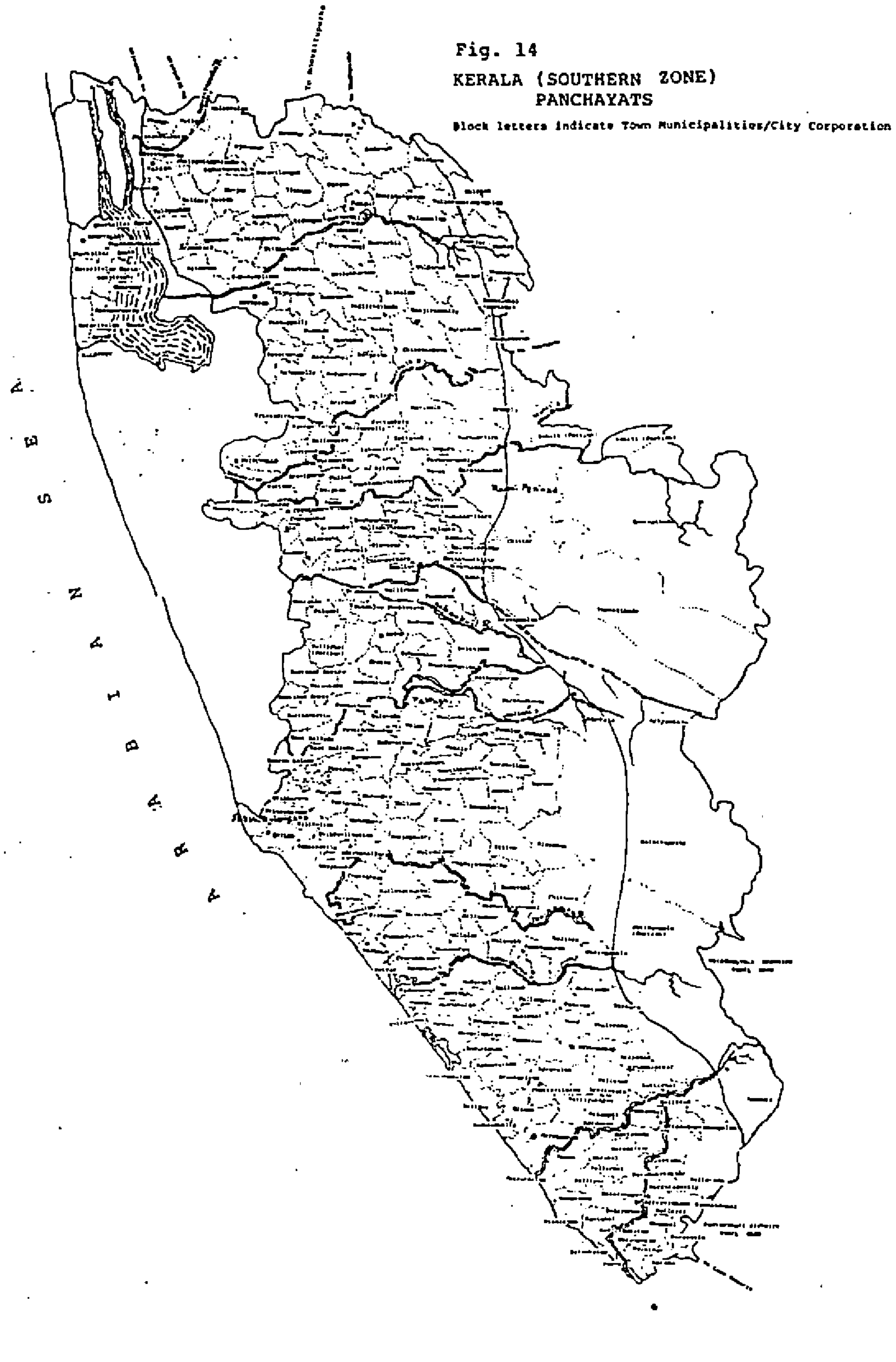
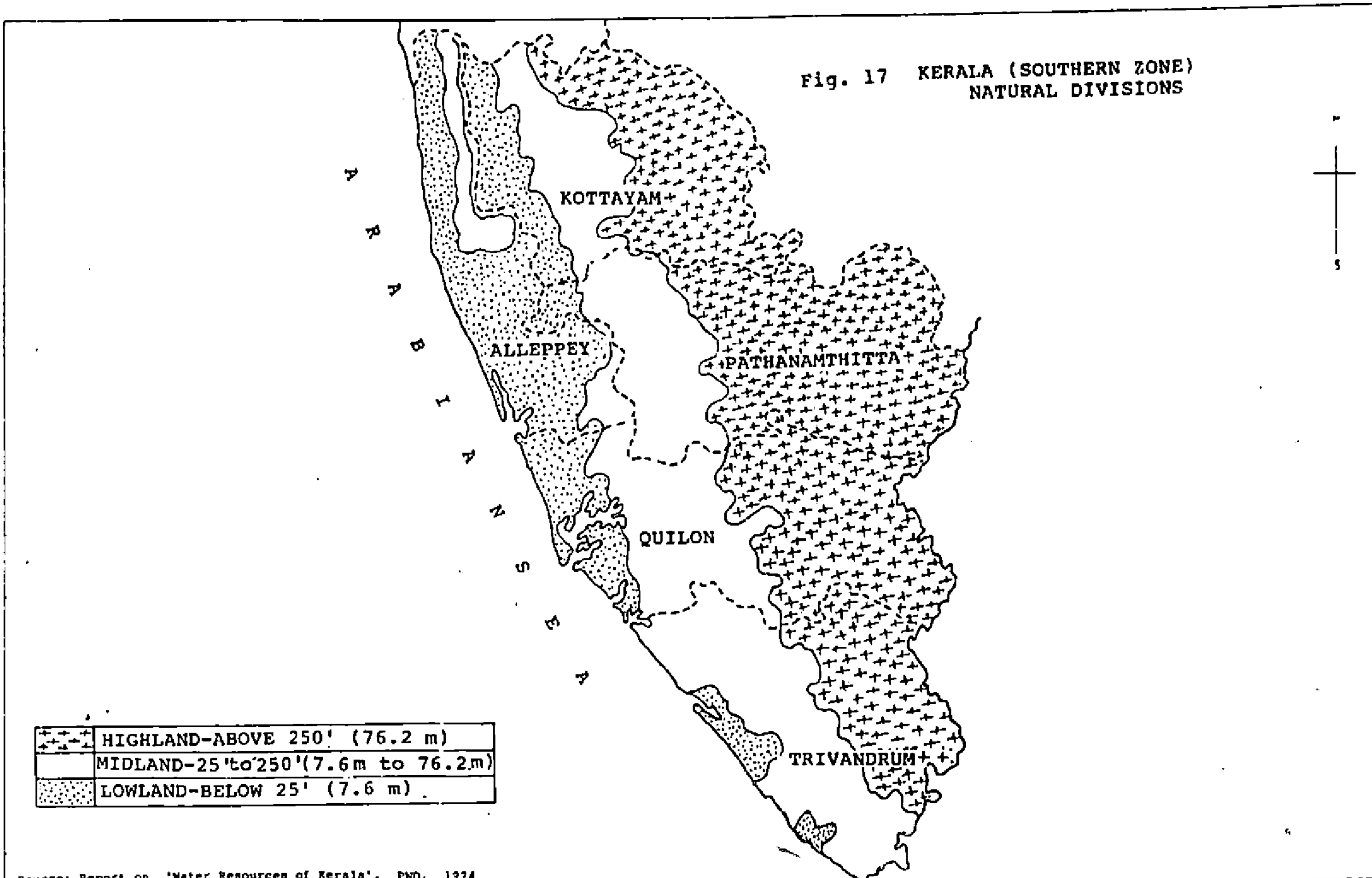


Fig. 14
KERALA (SOUTHERN ZONE)
PANCHAYATS

Block letters indicate Town Municipalities/City Corporation

Fig. 17 KERALA (SOUTHERN ZONE) NATURAL DIVISIONS



Source: Report on 'Water Resources of Kerala', PWD, 1974 shores of the Arabian sea and areas near the lakes and lagoons. Due to the lower physiographic position, the water table in the lowland is relatively high. The texture of the soil ranges from sandy loam to clay, depending on the type of soil on the adjoining slopes. Rice and rice- based cropping systems are prominent in the hydromorphic soils of the lowland sub-zone.

The midland (7.5 to 75.0m above MSL) forms the major part of the cultivated land of the zone and covers an area of 4,225 sq.km constituting 65 per cent of the zone. The alluvial plains with flat relief and patches of depression are also contained in this sub-zone. Most of these very gently to gently sloping lands are coconut gardens. The sub-zone is rich in vegetation. Laterite is the dominant soil type. The soils of the area are well matured with well-defined horizonization and high amount of clay in the subsoils underlain by quarriable and non-quarriable type of laterites. They are moderately deep to very deep with varying amounts of ferruginous and laterite granules depending upon the nature of topography. Riverine alluvium found on river banks and red loam soils found in the southern part are the other soil types of this sub-zone. The characteristics of these soils are discussed in detail under 2.3. This physiographic tract includes low hills, with steep side slopes enclosing narrow valleys and undulating plains bisected by numerous drainage channels. Paddy, coconut, tapioca, pepper, ginger and banana are the major crops grown. Cultivation of spices is also practiced though on a small scale. Rice is grown in the low-lying patches throughout the sub-zone. The valleys are very narrow in the districts of Trivandrum and Kottayam. On the other hand, in the districts of Quilon and Alleppey, they are broader.

Highlands or the mid uplands (75.0 - 750.0 m above MSL), covering an area of 2000 sq.km and constituting 28 per cent of the zone, are located at the foot hills of the Western Ghats and other isolated, small hill tops. Though many of the crops grown in the mid lands, are grown in the high lands also, this sub-zone is mostly under rubber, nutmeg, clove etc. The other cultivated crops are coconut, arecanut, jack, banana, pepper and cocoa. The soils are generally matured with boulders and stones in the profile. They are moderately deep to deep, depending upon the topographical position, except the very deep soils in footslopes. The soil is clay loam of lateritic origin with an admixture of gravel and sand. The valleys in the highlands have loamy clay soils occasionally with high sand content.

The high ranges (>750.0m from MSL), with mountainous tracts and thick evergreen tropical forests existing on the eastern side of the zone and included under the High Range zone, are beyond the scope of this report.

2.3 Soils

Climate, topography, vegetation and hydrological conditions are the dominant factors of soil formation. Elevation or physiographic position as a pedogenic factor brings about characteristic differences in the physical and chemical properties of the soil. Moderate or drastic changes in topography, giving rise to differences in elevation of about five to ten metres within a short distance of one kilometre, is very common in the slopes and foot hills of the hilly tracts of the midland sub-zone.

2.3.1 Geology

The main geological succession and rock types in the zone are crystalline rocks, Warkalli formation, residual laterites and recent deposits (Fig. 18).

Archaeans

They comprise the crystalline rocks and cover mostly Trivandrum, Quilon and Kottayam districts. They include granites and gneisses like hornblende-gneiss, charnockite-gneiss, garnetiferrous - cordierite gneiss, garnet-sillimanite gneiss and calc-granulite. Dolerite and gabbroic dykes cut across the rock. Swarms of thin, impersistent quartz and pegmatite veins also traverse the gneiss. In the Trivandrum area, the gneiss belongs to the peninsular suite, the most widespread rock type. Charnockite and leptynites are the most common gneisses in this area.

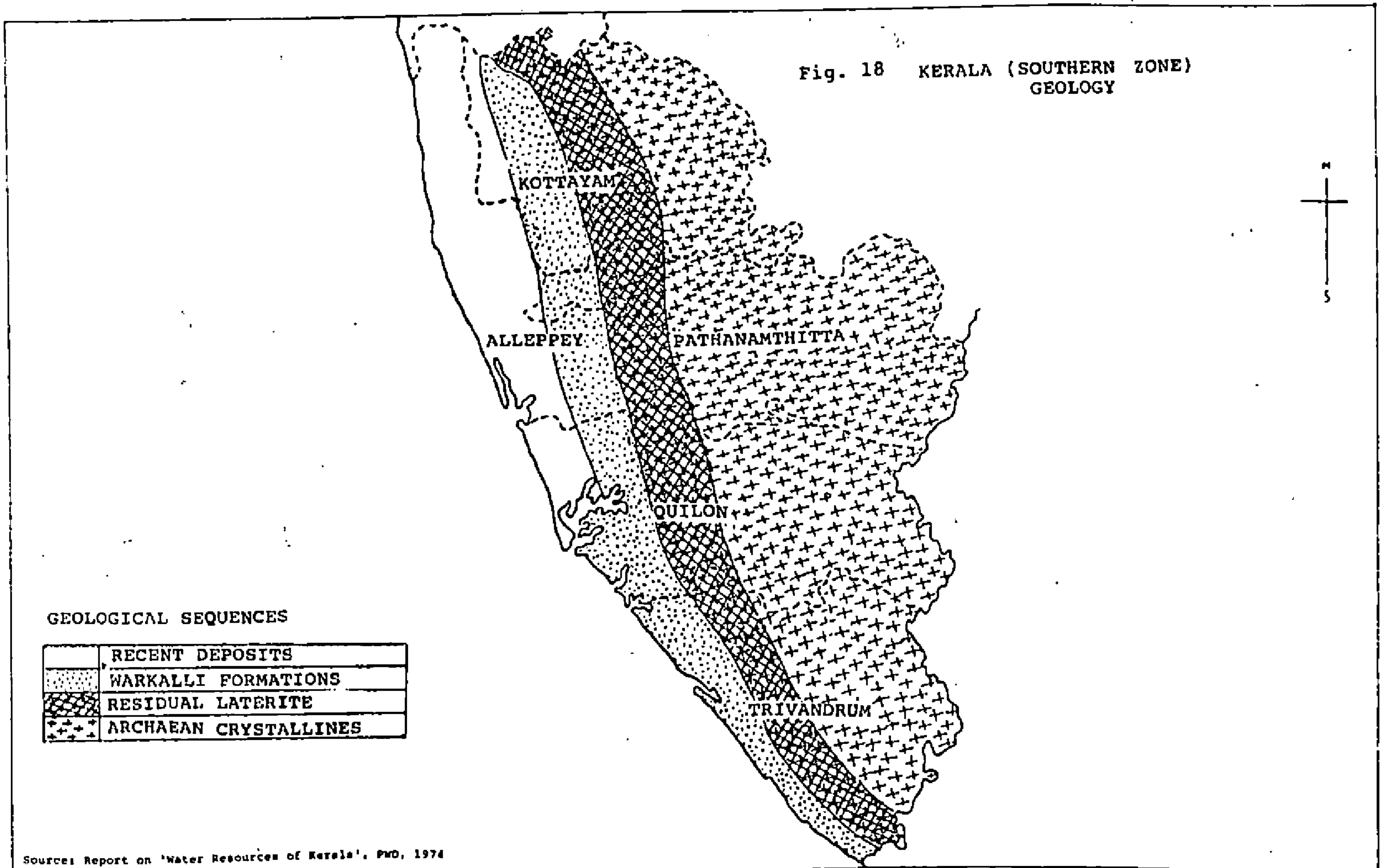


Fig. 18 KERALA (SOUTHERN ZONE)
GEOLOGY
KOTTAYAM
ALLEPPEY
PATHANAMTHITTA
QUILON
TRIVANDRUM
N
S
GEOLOGICAL SEQUENCES
RECENT DEPOSITS
WARKALLI FORMATIONS
RESIDUAL LATERITE
ARCHAEAN CRYSTALLINES
Source: Report on 'Water Resources of Kerala', PWD, 1974

The Warkallis

Warkalli beds form part of the tertiary formation of Kerala coast, first studied and described by King (1982) in the type locality at Varkala. Varkali was spelt as Warkalli in the original paper. They occur in Trivandrum and Quilon areas. They comprise medium grained, semi-consolidated, variegated, sand stones and clays, white plastic clays and carbonaceous clays, and associated lignite seams. Some exposed sections are over 80 m in thickness. They are believed to have developed in a transitional, lagoonal and littoral environment. Varkala (Chirayinkil taluk) and Poruvazhy (Kunnathur taluk) come under the Warkalli beds. Most of these areas are lateritised and occur as ridges along the coast. The Warkalli formation represents the most conspicuous sedimentary bed occurring in Varkala. They are best exposed at Varkala in the cliffs near the seashore and carry lenticural patches of lignite.

Quilon beds

They comprise mainly limestone, sand and clay. Sometimes, they carry corals, molluscs and foraminifera.

Laterite

They are found extensively as residual formation in the midland zone and form low flat-topped ridges and hills between the Western Ghats and the Arabian sea. The lateritised rock exposed on the surface is a type of laterite which exhibits characteristics different from those of the laterite which caps the Warkalli formation. The laterite preserves the structure of the parent rock and is less compact. Below the laterite layer, is the kaolin layer, the depth of which to the undecomposed rock shows gradation.

Recent formations

The recent formations include alluvium and beach sands which occupy the valleys and the sea shore. This zone is rich in mineral resources such as limestone, nickel ore, chrysoberyl, mica, marcasite, graphite, clay and bauxite which are economically important. Along the sea coast of Chavara, ilmenite and monazite occur in plenty, while extensive structures of glass sand occur in

Alleppey-Shertalai belt. Lime shells in the Vembanad lake are collected for use as raw material for the white cement industry at Kottayam. Apart from the geological formation, the wide variations in the topography influence the differences in soil properties and soil profile development.

2.3.2 Soil series and soil associations

Data on the area (in the zone) covered by detailed soil survey by the Soil Survey Wing of the Department of Agriculture, are furnished in Annexure LXI. Of the five districts of the zone, detailed soil survey has been completed in Trivandrum and Quilon. However, detailed soil survey map is available only for the district of Trivandrum. With regard to the other districts, the soil survey information available is incomplete. In Pathanamthitta district, survey work has been completed in Thiruvalla, Ranni (excluding forest portion) and Kozhencherry taluks and in parts of Adoor taluk. In Alleppey district, Chengannoor taluk which comes under the zone, has been partly covered. In Kottayam district, the survey work has been completed in Kottayam and Changanassery taluks. From the climatological data it is seen that the mean annual temperature variation during winter and summer is less than $5^{o}C$ and the mean average temperature is more than $22^{o}C$. Hence the soil temperature class is Isohyperthermic and the soil in the zone enjoys mainly udic, ustic and aquic moisture regime. The soil associations and the soil series identified in Trivandrum, Quilon and Kottayam districts are described in Annexures LXII(a) to LXII(c). The tentative taxonomical classification of these soil series is furnished in Annexures LXIII(a) to LXIII(c), along with their families and the sub groups. Utilising the soil survey information and the soil survey map of Trivandrum district, crop suitability studies have been carried out and village-wise crop suitability maps have been prepared by the Department of Soil Science & Agrl. Chemistry, College of Agriculture, Vellayani. Based on soil survey information and other agronomic details, classification of rice lands in the district has been made and taluk-wise maps have also been prepared indicating the suitability for rice cultivation.

2.3.3 Soil types

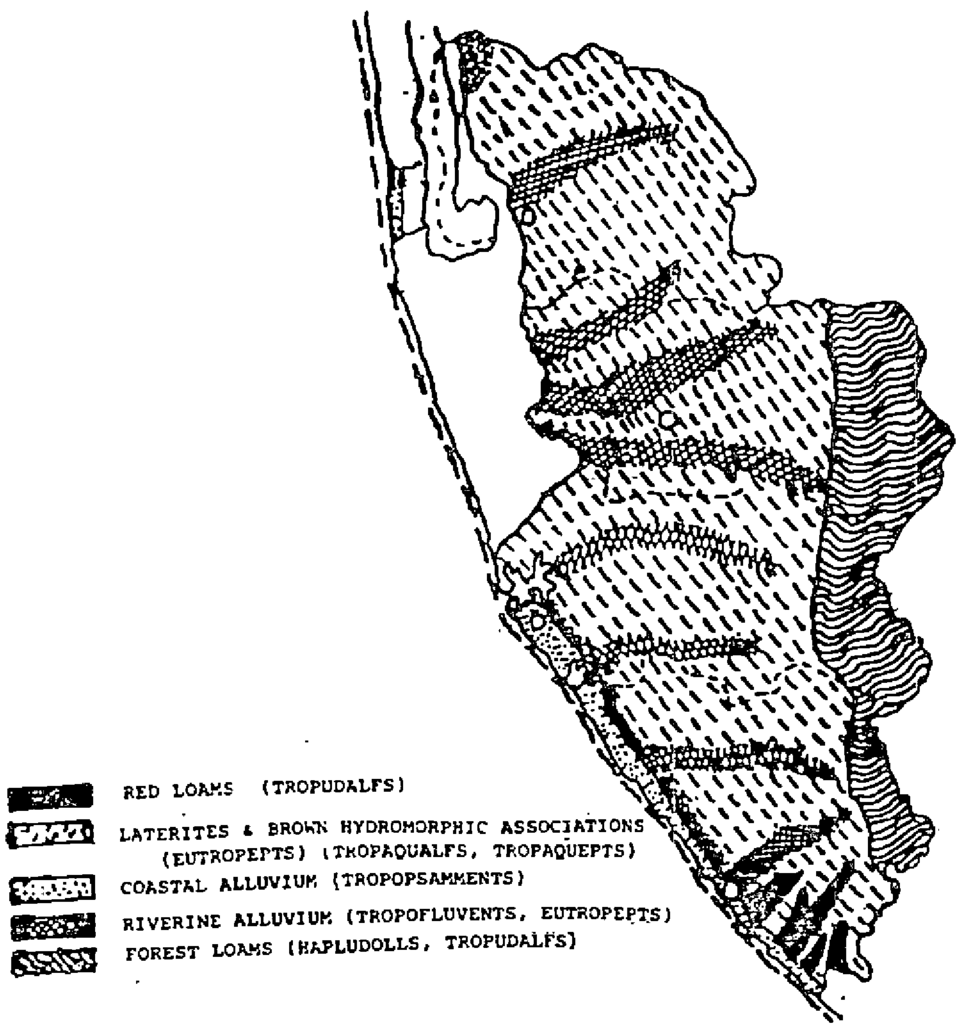
The uneven topography of the zone has contributed towards the varied nature and properties of its soils. In general, the soils of the zone are acidic, kaolinitic and gravelly with low CEC, low WHC and high phosphate fixing capacity. On the basis of the morphological features and physico-chemical properties, the soils of the southern zone have been classified into red loam, laterite, coastal alluvium, riverine alluvium, brown hydromorphic and forest loam. The soil types of the southern zone (Fig. 19) and their corresponding recent but tentative taxonomic classification upto the great soil group level are presented in Table 24.

Table 24. Tentative taxonomic classification of the soils of the zone

Soil type	Order	Sub-order	Great soil group
Red loam	Alfisol Ultisol	Udalf Udult	Tropudalfs Tropudult
Laterite	Ultisol Oxisol	Udult Ustult Ustox	Tropudult Kandiustult Rhodic-haplustox
Coastal alluvium	Entisol Inceptisol (in lesser extents)	Psamment	Tropo-psamment
Riverine alluvium	Entisol Inceptisol (in lesser extents)	Fluvent	Tropo-fluvent
Brown hydromorphic	Entisol Alfisol Inceptisol	Fluvent Aqualf Aquept	Tropo-fluvent Tropaqualf Tropaquept
Forest loam	Mollisol	Udoll	Hapludoll

*Classification provisional

Fig. 19 KERALA (SOUTHERN ZONE) SOIL MAP



Source: Centre of Excellence for Tropical Soils, KAU, Vellayani

The important features of these soils are given below:

Red loam

Red loam soils, formed by a process of imperfect laterisation, occur in the southern parts of Trivandrum district, with typical red loams in Trivandrum and Neyyattinkara taluks. Trivandrum district has red loam sub-zone in about 31,699 ha, comprising Nemom block (13,323 ha), Neyyattinkara municipal area (970 ha), Athiyannur block (9,118 ha) and Parasala block (8,288 ha). The red colour of these soils is due to the presence of haematite (anhydrous ferric oxide). No clear horizon differentiation can be seen. These soils occur in catenary sequence along with the laterites 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. These soils are essentially kaolinitic in nature, acidic in reaction (pH 4.5 to 5.5), highly porous and friable. They are deficient in organic matter and low in the major nutrient elements and lime. Coconut is the major crop grown in these soils and intercrops of cassava, banana, vegetables and pulses are also grown. A brief description of a typical red loam profile is given in Annexure-LXIV.

Laterite

Laterites of the zone are typical kaolinitic weathering products of gneissic and granitic rocks developed under humid tropical conditions. These are formed by the weathering of these acidic rocks due to heavy rainfall, high temperature and leaching away of the bases, and are characterised by accumulation of hydrated oxides of iron and aluminium. This soil covers about 65% of the total area of the State and about 70% of the southern zone, occupying a major portion of the midland and the highland. Under the influence of undulating topography, the laterite material has given rise to different soil groups. Laterite soils are the most extensive of the soil groups found in the southern zone. Washed down by rains and accumulated as local alluvium in the depressions between the hills and hillocks, it has given rise to the swampy soils with heavy texture and with imperfect drainage where rice is cultivated. The surface soil, which is reddish brown to yellowish red, often contains an appreciable proportion of gravel. The profiles have well developed B horizon with abundant ferruginous and quartz gravels. Coarse fragments vary widely between 20 and 75 per cent. The plinthite is characterised by a compact vesicular mass below the B horizon, composed essentially of a mixture of hydrated oxides of iron and aluminium. The plinthite includes quarriable type which can be cut into blocks and non-quarriable type which breaks into irregular lumps. The texture ranges from sandy to sandy loam to sandy clay loam, with an admixture of surface gravel. The valleys in the midland have loamy clay with high sand content. The laterites found on hills are gritty and shallow. Those in the plains are deep and of finer texture. The soil reaction is acidic (pH 4.5 to 6.2). In view of this, the addition of soluble phosphorus to this soil results in the fixation of phosphorus as insoluble iron and aluminium phosphate, thereby affecting the immediate availability of this nutrient to plants. Electrical conductivity of the soil is well within the safe range. The soil is, in general, deficient in organic matter and plant nutrients. In some locations in the southern-most part of the zone, ill drained soils rich in iron, often reaching toxic concentrations, are observed. Poor drainage in certain areas of the lowlands aggravate the problem. Laterite soils with hard pans are found in the southern midlands of this zone. A laterite formation of a particular nature seen at Varkala extends to Pallippuram, Kazhakkuttom etc. In the cliffs close to the sea shore at Varkala, the soil consists of clayey sand stone, white and varigated clay and carbonaceous clay containing thin lenses of lignite. Most of these areas are lateritised. Laterites are, in general, poor in available nitrogen, phosphorus and potassium, and low in bases. They are porous and well drained with poor WHC, low CEC and high P fixing capacity. Organic matter content is low. They respond well to management practices. Coconut, cassava, banana, vegetables, pulses etc. and in the depressions, paddy are grown. The constraints in rainfed Agriculture in this soil are low fertility, high acidity, low WHC and preponderance of iron and aluminium, often leading to their toxicity to crops. A brief description of a typical laterite profile is given in Annexure LXV.

Coastal alluvium

These soils occur as narrow strips all along the west coast of the zone, covering an average width of about 1.0 km from the sea shore. These are developed from the recent marine sandy deposits. They are highly porous with very little capacity to retain water and fertilisers. Split application of N and K fertilisers is, therefore, recommended for crops in these soils. The texture is dominated by sand fraction. The coastal sand get mixed with varying proportions of the adjoining laterite soil, thus leading to the formation of different groups of sandy soils in different locations, varying in colour from greyish white through yellow and brown to dark brown and even red. "A" horizon is usually thin and the surface textures observed are loamy sand and sandy loam. The water table is high, particularly in low lying areas, where the profiles show mottling in the lower layers. They are acidic in reaction (pH 5.0 to 6.0) and deficient in organic matter and clay, and hence have very low CEC. They are poor in the plant nutrients. Coconut is the major crop and it thrives well in the coastal belt. Rice, banana and other annual crops are also grown. Low fertility, poor WHC and waterlogging in the rainy season and absence of clay are the major problems facing crop production in these soils. Valuable mineral deposits such as Ilmenite, Rutile, Zircon, Sillimanite and Monazite occur in the beach sands of Neendakara and Chavara areas in the Quilon district as well as in Trivandrum and nearby coastal areas, which are being separated and put to industrial use. Disseminated graphite occurs near Punalur. Large deposits of China clay are available at Kundara, Karimbaloor, Mulavana, Muthupilakad and Thevalakkara in Quilon district and Akkulam, Thonnackal, Kazhakkuttom, Murukumpuzha and Varkala in Trivadrum district. Limeshell deposits occur in Ashtamudi lake and in Vembanad lake. A brief description of a coastal alluvium profile is given in Annexure LXVI.

Riverine alluvium

These are the laterite soils of the midland and highland, washed down by running water over long distances and deposited by the sides of rivers, producing rich alluvial soils on which a variety of field crops are successfully grown. They show wide variation in physico-chemical properties, depending 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 (pH 5.0 to 6.0) and low in phosphorus and lime. Coconut, arecanut, sugarcane, rice, cassava, banana, pulses and vegetables are the crops grown. A brief description of a typical riverine alluvium profile is furnished in Annexure LXVII.

Brown hydromorphic

These soils are confined to depressions or bottom areas of undulating topography in between the hills and hillocks found in the midland as well as in the low lying areas. They are developed on the local alluvium as a result of transportation from the adjacent uplands and hill slopes by monsoon rains, sedimentation and also through deposition by rivers. These areas may be submerged under water during the rainy season which results in the development of the soil profiles under conditions of impeded drainage. The texture varies from sandy loam to clay. The soil reaction is acidic (pH 5.0 to 5.5). Due to the restricted drainage, the soils exhibit characteristic hydromorphic features like gley horizons, mottling streaks, hardpans, organic matter depositions, iron and manganese concretions etc. Rice is grown in large areas and coconut on the bunds. They are moderately supplied with organic matter, nitrogen and potassium; but are deficient in lime and phosphorus. Acidity and waterlogging are the major problems in some areas. A brief description of a typical brown hydromorphic soil profile is presented in Annexure LXVIII.

Forest loams

These soils, which are found on the eastern parts of the zone, are the products of weathering of crystalline rocks under forest cover. Though this type of soil is predominant in the High Ranges, parts of Ranni, Pathanamthitta, Nedumangad, Kulathupuzha, Thenmala, Meenachil and Kanjirappally which fall under the highland sub-zone have also soils with high content of organic matter. They have medium to fair levels of nitrogen; but are deficient in phosphorus, potash and bases due to leaching. The soil is acidic in reaction (pH 5.0 to 6.0). The surface soil is dark reddish brown with clay loam, loam or silty loam texture. Plantation crops such as oil palm and rubber are grown in the area after denudation or clear felling of trees. Vast areas of forest lands have been cleared and brought under cultivation by the settlers due to the pressure of population on land. Soil erosion along the slopes and high acidity are the major constraints to agricultural production. A brief description of a typical forest soil profile is given in Annexure LXIX.

The data on the mechanical composition and chemical analysis of the surface samples of the six soil types explained earlier have also been given in the Annexures LXIV to LXIX.

2.3.4 Soil testing facilities in the southern zone

Table 25. Soil testing laboratories in the zone under the State Department of Agriculture

Location	Installed capacity (Samples per year)	No. of samples analysed 1985-86	1986-87
Trivandrum(Pettah)			
Stationary Laboratory	20,000	17,774	16,051
*Mobile Laboratory			
Quilon(Kureepuzha)			
Stationary Laboratory	18,000	9,300	17,401
*Mobile Laboratory			
Alleppey(Sanathanapuram)			
Stationary Laboratory	20,000	12,041	19,212
Mobile Laboratory	10,000	5,176	7,297
Kottayam (Ettumanoor)			
Stationary Laboratory	16,000	8,524	15,082

* Started in October 1986, not yet fully commissioned.
Source: Central Soil Testing Laboratory, Trivandrum.

Four out of the twelve stationary Soil Testing Laboratories and three out of the seven mobile Soil Testing Laboratories in the State are functioning in the southern zone under the Department of Agriculture, Kerala (Table 25).

Samples are tested for pH, TSS, organic carbon, available P_2O_5 and K_2O by routine procedures and fertiliser recommendations for specific crops are made. Soil fertility maps have also been prepared for some districts of the zone, based on soil test summaries. The soil fertility maps for the Trivandrum and Quilon districts thus prepared are shown in Fig. 20 and Fig. 21. Similar maps for Pathanamthitta and Kottayam districts are not available.

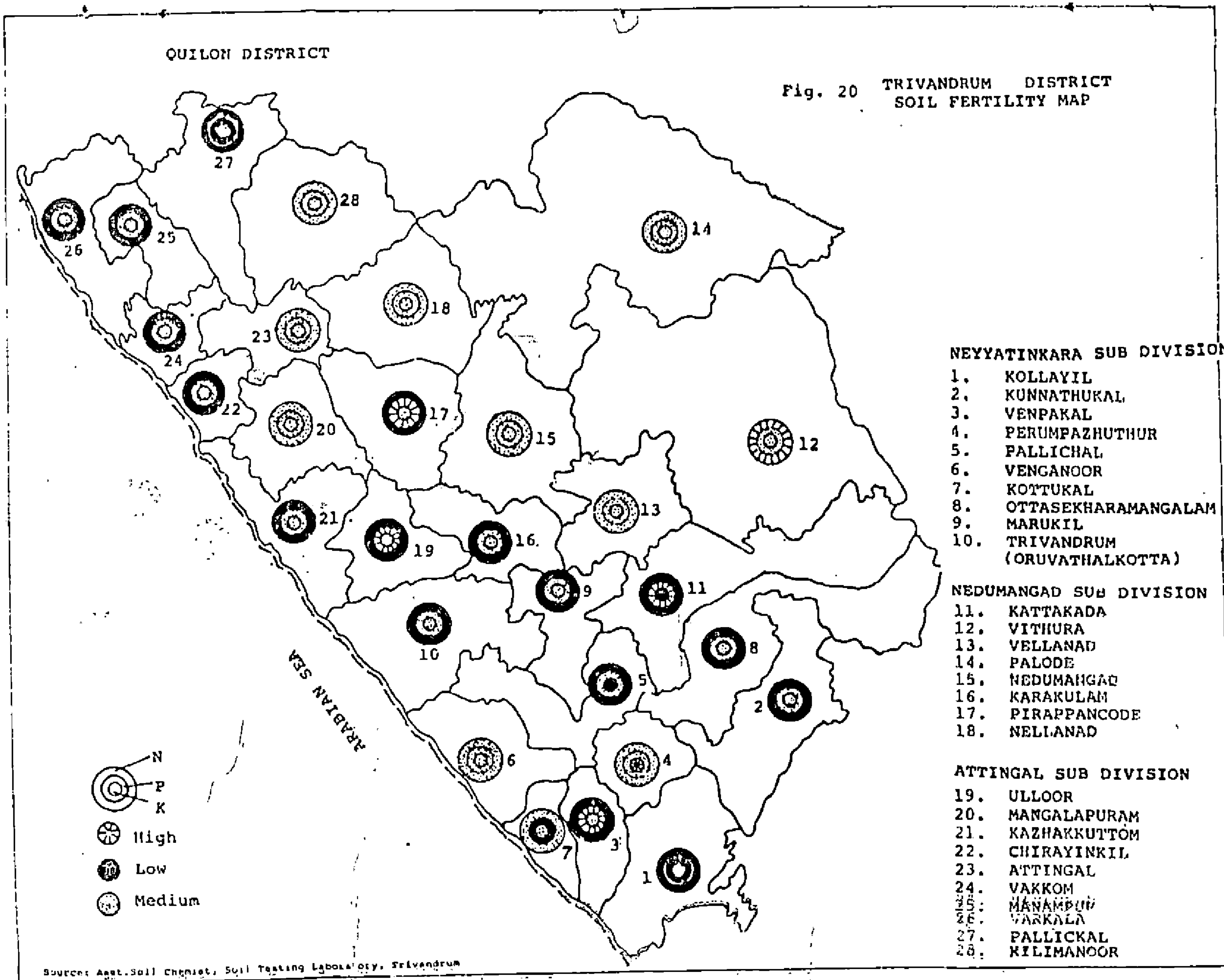
The nutrient status of the soils of the zone, in general, as assessed by the Soil Testing Laboratories on district-wise basis, are indicated in Table 26.

Table 26. Nutrient status of the soils of the zone

District	Nutrient status		
	N	P	K
Trivandrum	Low	Low	Medium
Quilon	Low	Medium	Low
Alleppey	Medium	Medium	Low
Kottayam	Medium	Low	Low

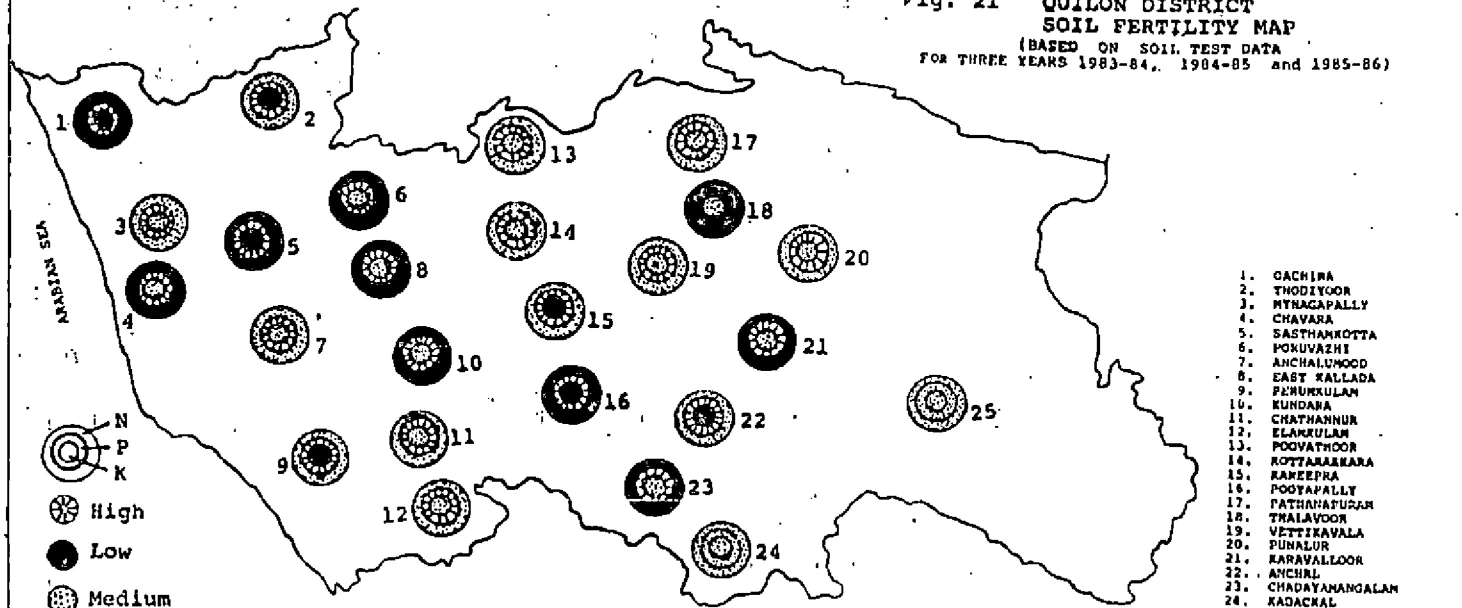
Each laboratotry is under the immediate control of an Assistant Soil Chemist who is assisted by other technical staff. A Central Soil Testing Laboratory is functioning in Trivandrum since 1978 headed by a Deputy Director of Agriculture (Chief Soil Chemist), who controls and co-ordinates the activities of the Soil Testing Laboratories in the State. The Chief Soil Chemist is also responsible for the maintenance of quality control of the district laboratories and training to the staff of the different Soil Testing Laboratories.

Fig. 20 TRIVANDRUM DISTRICT SOIL FERTILITY MAP



Source: Asst. Soil Chemist, Soil Testing Laboratory, Trivandrum

Fig. 21 QUILON DISTRICT
SOIL FERTILITY MAP
(BASED ON SOIL TEST DATA
FOR THREE YEARS 1983-84, 1984-85 and 1985-86)



Source: Asst. Soil Chemist, Soil Testing Laboratory, Quilon

Facility for micro-nutrient estimation in soil samples using Atomic Absorption Spectrophotometer exists in the Central Soil Testing Laboratory.

Three Soil Testing Laboratories other than those of the State Department of Agriculture, also function in the southern zone (Table 27).

Table 27. Soil testing laboratories other than those of the State Department of Agriculture

Location	Organisation	Installed capacity
Kottayam (Puthuppally)	Rubber Research Institute of India	
	Stationary Laboratory	2000
	Mobile Laboratory	3000
Kottayam (Kanjirappally)	Kerala State Rubber Marketing Federation	1200

2.3.5 Micronutrient status

Although in acid soils, the micronutrient availability is normally expected as satisfactory, the heavy leaching consequent on high rainfall, low nutrient retentivity of the soil, waterlogging in some areas etc. have modified this picture. The studies so far conducted on the micronutrient status of the soils of the zone and the requirement of each nutrient by crops grown in these soils are very limited. There is need for detailed survey of the zone for the characterisation of micronutrient deficient areas. The micronutrient deficiencies so far reported by some workers have not been corroborated by deficiency symptoms in plants.

2.3.6 Soil problems

The soils of the midland and lowland are poor in base status with high acidity. The soils are generally deficient in available nitrogen, phosphorus and potash, and respond to management practices. These soils offer problems of aluminium and manganese toxicity in the midlands and of iron toxicity in the lowlands, especially under conditions of waterlogging and restricted drainage which limit crop production. The poor water retentive capacity of the coastal alluvium, its low organic matter and the soil erosion in the highland areas are the other major constraints.

2.3.7 Consumption of fertilisers

The data relating to the season-wise consumption of NPK fertilisers in the zone during 1981-86 are furnished in Annexure LXX. In general, consumption of fertilizers per unit of cropped area in the zone appears far less than the recommended dose of NPK at 90:45:45 kg/ha for HYVs and 40:20:20 kg/ha for local varieties of paddy. The consumption of fertilisers in the zone was higher during the rabi seasons till 1983-84. Thereafter, kharif consumption was more. However, the figures for the State indicate, in general, higher consumptions in kharif during all the years except during 1982-83. The rainfall data presented in Fig. 27 indicate 1982-83 to be a drought year with an average rainfall of 73.87 mm and a total rainfall of 886.39 mm, against much higher values for the succeeding as well as previous years. The monthly rainfall for July, August and September was also low. The share of the zone's total consumption of NPK to the State ranged between 35 and 30 per cent for the kharif and between 41 and 45 per cent for the rabi seasons till 1984-85. The percentage of NPK annually consumed by the zone to that of the State remained more or less steady and between 38.6 to 40.9 till 1984-85. During 1985-86 however, the total NPK consumption in the zone was only 31.4 per cent of that of the State. This reduced consumption by the zone is reflected in the kharif and rabi consumptions of the year as well. Floods in the autumn season (1st crop) and drought in the late winter season (2nd crop) discourage many farmers from taking risks in using the recommended dose of fertilizers to paddy. Moreover, several farmers who are small or marginal, cannot afford to spend more on fertilisers. The data relating to the consumption of NPK fertilisers in the zone and in the State during 1980-86 are presented in Fig.22.

2.3.8 Soil erosion

The undulating topography with alternating hills and valleys, the high intensity of rainfall spread over the South-West and North-East monsoon seasons and the denudation of forests arising from the increased demand for arable land have accentuated the problem of soil erosion in the zone. Due to soil erosion, many rivers get silted up annually thereby reducing their utility.

Of the five districts in the southern zone, Pathanamthitta has the largest area of undulating to folding and steep terrains, susceptible to soil erosion. Soil conservation measures are needed at Kottarakkara, Ranni, Pathanamthitta, Kozhencherry, Pathanapuram and parts of Kunnathur taluks in the Quilon and Pathanamthitta districts, Nedumangad and Neyyattinkara taluks in Trivandrum district and Meenachil and Kanjirappally taluks in Kottayam district which are subjected to soil erosion hazards to varying extent. Contour bunding and rarely contour cultivation, are the management practices now followed by the Soil Conservation Department. The soil conservation schemes are implemented by the Soil Conservation Department under the State Government in collaboration with the Land Development Committee. A State Soil Conservation Research Station is functioning at Konni in Pathanamthitta district. A Soil Analytical Laboratory is also functioning at Konni, catering to the needs of soil survey. Details of soil conservation schemes implemented by the Soil Conservation Department are given in Annexure LXXI. A combination of mechanical, agronomic and agrostological methods alone would be feasible. Silting and sedimentation problems in hydel projects, watershed hydrology, flood forecast, flood control, stream bank protection and sediment control need attention.

During the year 1983-84, the State Soil Survey Organisation intensified its activities on watershed basis, under the Western Ghat Development Programme. During the course of soil survey, priority water sheds were identified, delineated and codified on maps, based on the immediate requirements of each watershed. So far,

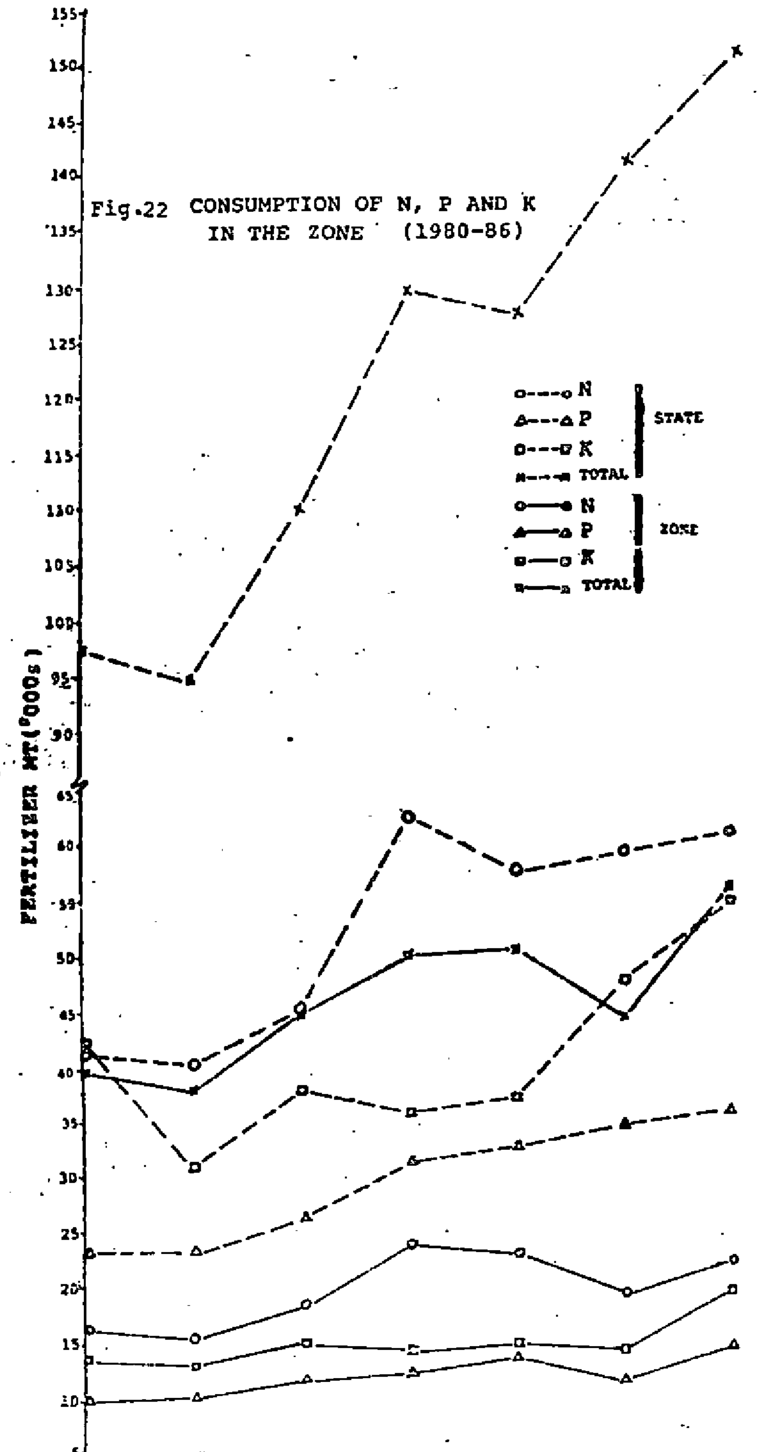


Fig.22 CONSUMPTION OF N, P AND K IN THE ZONE (1980-86)

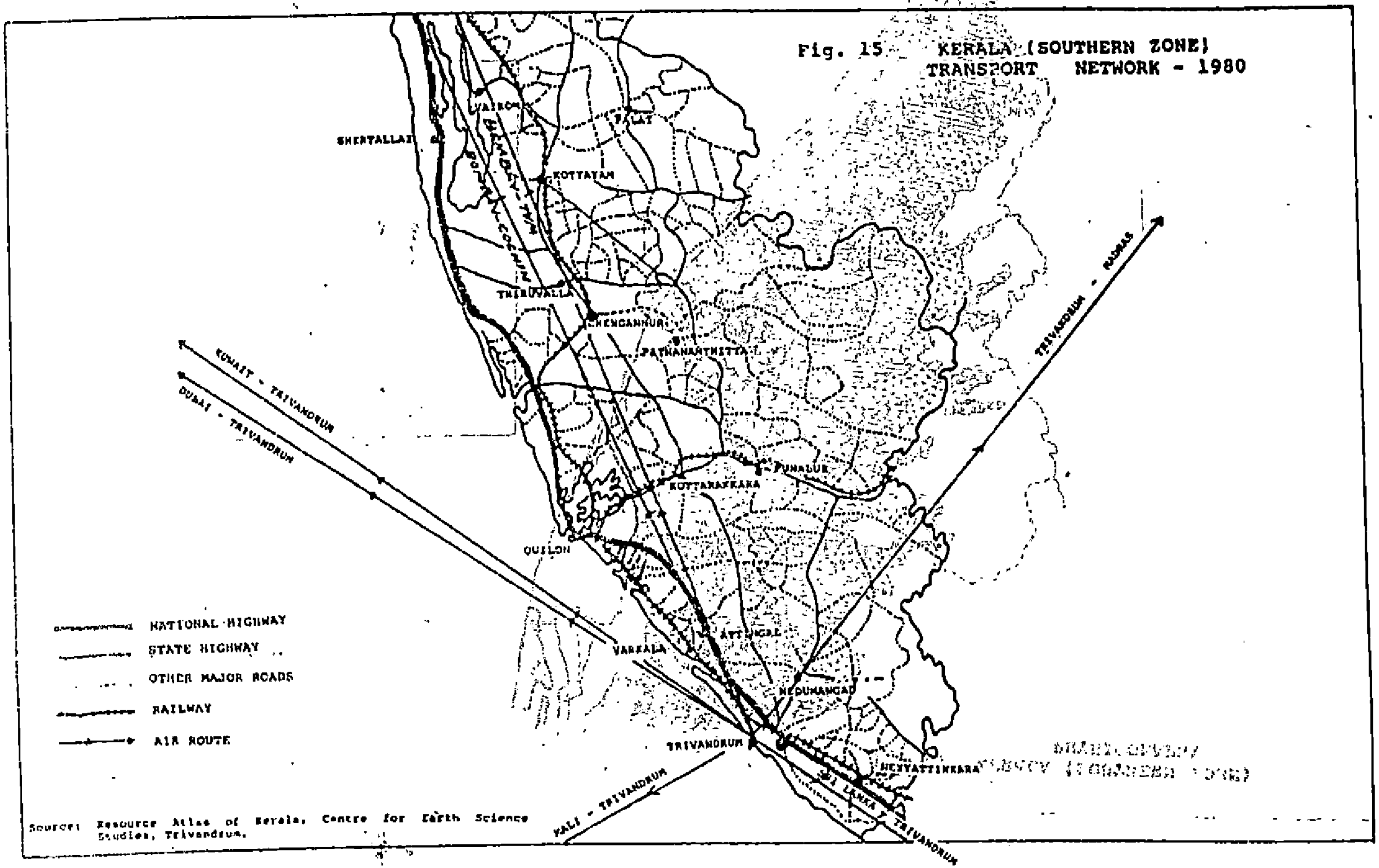


Fig. 15 KERALA (SOUTHERN ZONE) TRANSPORT NETWORK - 1980

Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum.

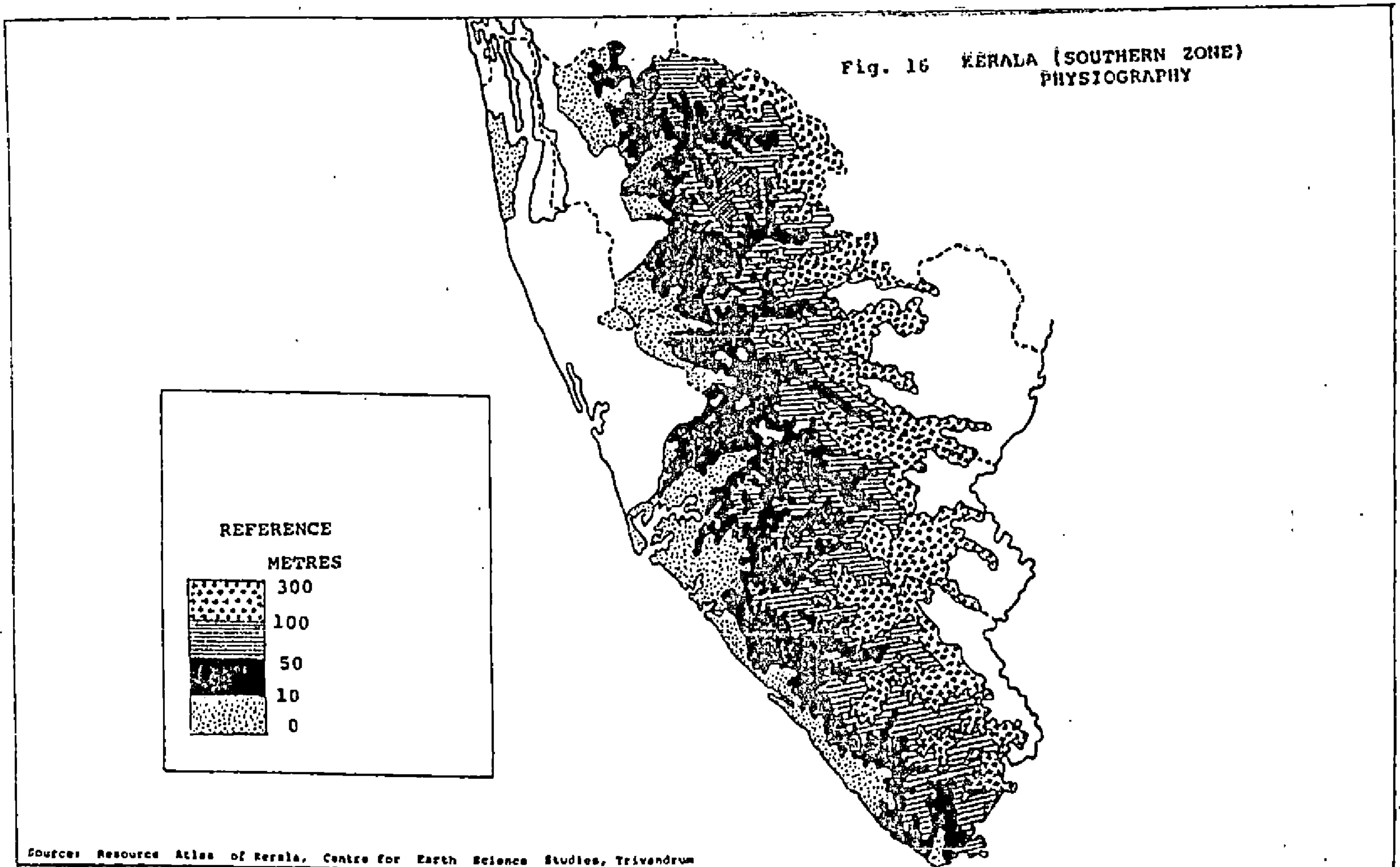


Fig. 16 KERALA (SOUTHERN ZONE) PHYSIOGRAPHY

Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum

twentytwo priority watersheds in the State have been identified and schemes formulated for implementation. In the southern zone, eight watersheds have been identified (Table 28).

Table 28. Watersheds identified in the southern zone

Watershed	District	Area(ha)
Puravimala	Trivandrum	1000
Mylamood	Trivandrum	1800
Manithotta	Trivandrum	2500
Palakuzhi	Trivandrum	1500
Ommannoor	Quilon	1000
Kakkathode	Pathanamthitta	3500
Erumappara	Kottayam	1000
Manjayilaruvi & Iramponikara watershed	Kottayam	2000

2.4 Climate

Being in tropical belt, the zone receives plenty of solar radiation. The daily average for the tropics is reported to be about 400 langleys. Seasonal variations depend largely on the rainfall distribution pattern. Seasonality in solar radiation has considerable impact on crop yields and fertiliser response. Research data on the variation in solar radiation in different parts of the zone are, however, meagre.

The data on the mean monthly values of rainfall, maximum and minimum temperatures and relative humidity in the southern zone for the last 15 years are given in Annexures LXXII to LXXV. In terms of standard climatic types, the southern zone can be considered as having a humid tropical climate with an oppressive summer and plentiful seasonal rainfall. The climate is moist and hot, drier in the interior region. The entire southern zone, except a few pockets in the eastern parts of Quilon and Pathanamthitta districts (Pathanamthitta, Konni, Adoor and Punalur), falls under wet-dry tropical climates with 4.5 to 7 humid months as per Troll's classification (1965) which considers the length of crop growing season (Fig. 23). The hot season from March to May is followed by South West monsoon from June to September, June being the rainest month. The mean date of onset of the South

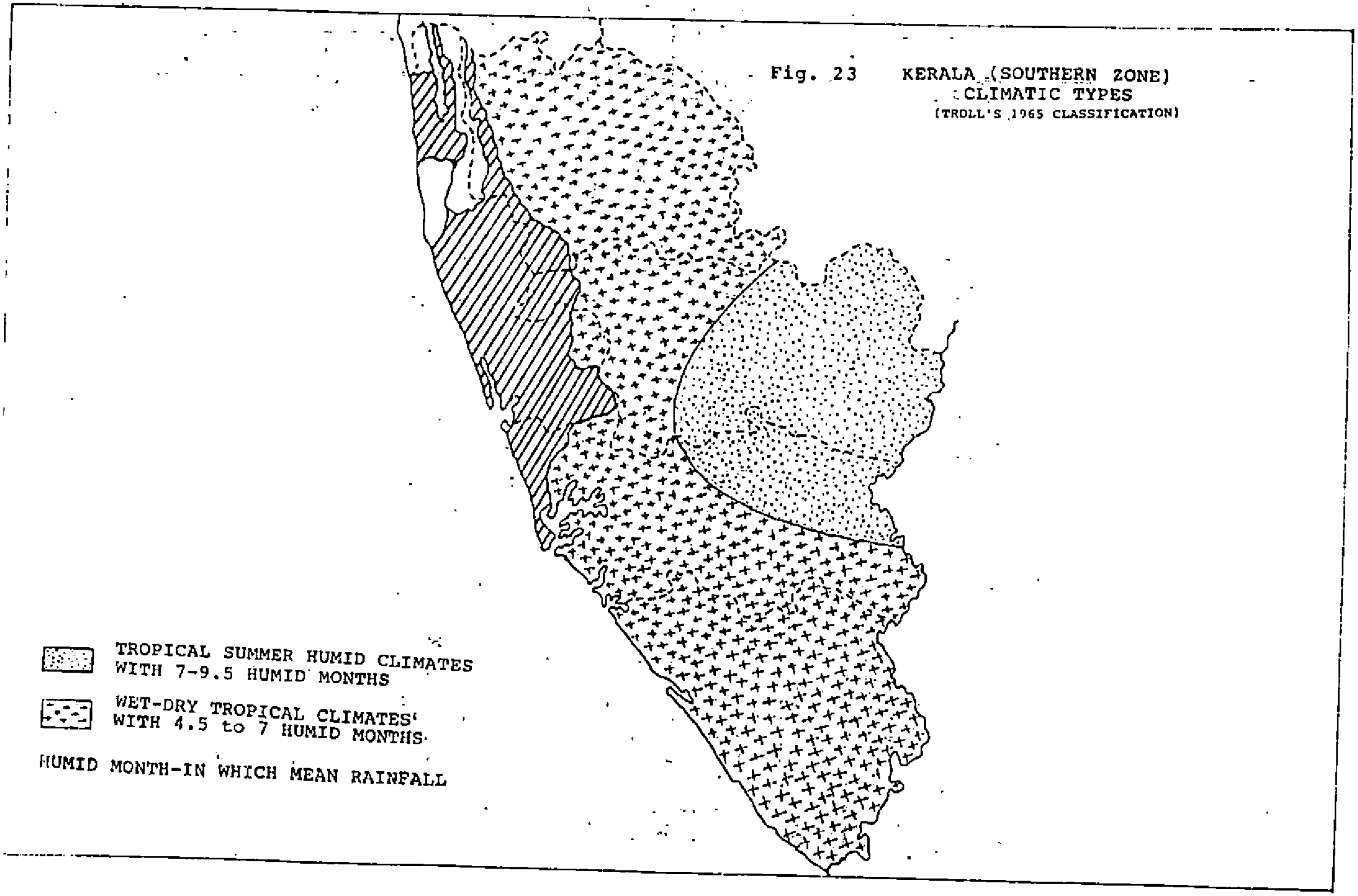


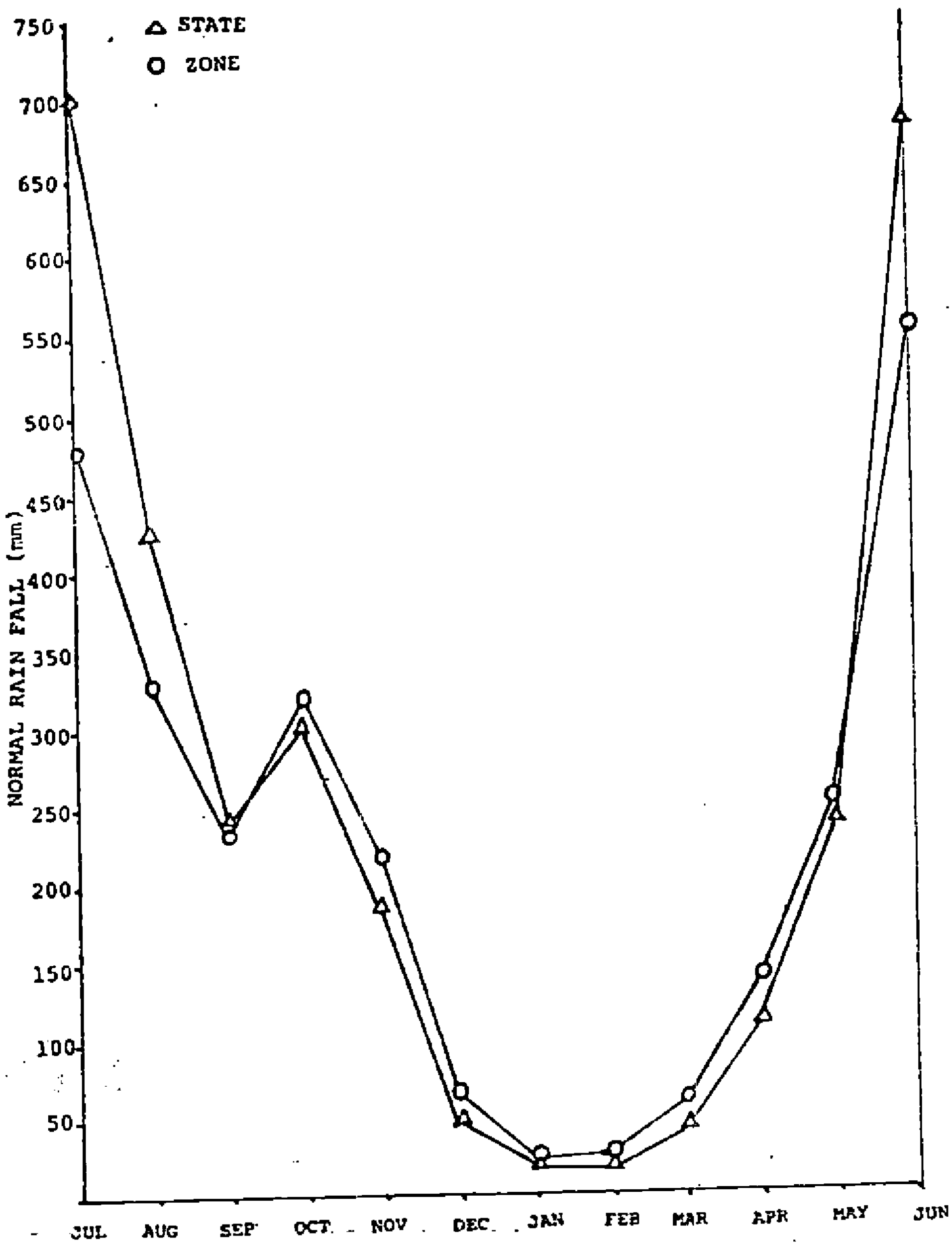
Fig. 23 KERALA (SOUTHERN ZONE)
CLIMATIC TYPES
(TROLL'S 1965 CLASSIFICATION)
TROPICAL SUMMER HUMID CLIMATES
WITH 7-9.5 HUMID MONTHS
WET-DRY TROPICAL CLIMATES
WITH 4.5 to 7 HUMID MONTHS
HUMID MONTH-IN WHICH MEAN RAINFALL

West monsoon varies from May 25th to June 1st. The North East monsoon occurs from the middle of October to November, the peak period being October (Fig. 24). The rest of the period (December to May) is generally dry with or without occasional light showers. The annual rainfall of the zone is about 2700 mm. About 57 per cent of annual rainfall is received from the South West monsoon and 21 per cent from the North East monsoon. Occasional precipitation during the off season periods contributes to the rest (Fig. 25). The rainfall distribution has two maxima (one in June and the other in October) due to the influence of the two monsoons. An increasing trend in the rainfall is noticed from South to North of the zone (2000 mm to 3000 mm), except at Mundakkayam where the annual rainfall is more than 4000 mm. The lowest rainfall of <500 mm is received in the eastern parts of Quilon district and the highest of >3000mm, in the areas East of Mundakkayam during the South West monsoon. The maximum rainfall (>800 mm) during the North East monsoon is received around Punalur and Pathanamthitta-Ranni areas and varies from 500 mm in the extreme south to 800 mm in the central part of the zone. The rainfall during the other periods is comparatively low in the entire zone, except at Kanjirapalli in Kottayam district and West of Adoor in Pathanamthitta district (Fig. 25d). The average number of rainy days per year is 124 in the zone, the highest (160 days) at Konni and the lowest (84 days) at Parassala. The comparatively low rainfall variability zones are concentrated in the southern parts where the seasonal rainfall is high. The data regarding the various weather parameters that build the climate of the zone are discussed below:

2.4.1 Rainfall

The data on the average monthly rainfall (mm) in the zone for the past fifteen years (1970-71 to 1984-85) are presented in Annexure LXXII along with the normal rainfall data (Fig 26 and Fig. 27). During 1973, 1976, 1980 and 1983, the zone received no rainfall at all during January. The February rains also were absent in 1973, 1976 and 1982. The 15-year data reveal that July rainfall in all these years was markedly below the normal rainfall in Kerala. The normal rainfall of the zone for July was 478 mm while that of the State was 703 mm. In

Fig.24 KERALA (SOUTHERN ZONE)
NORMAL RAINFALL



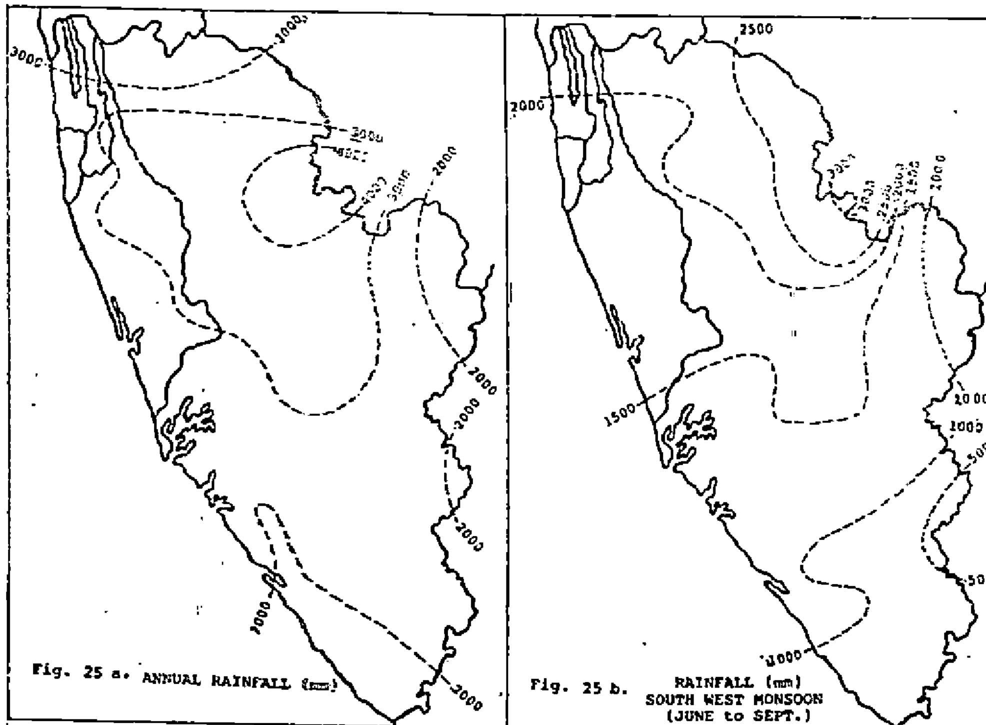
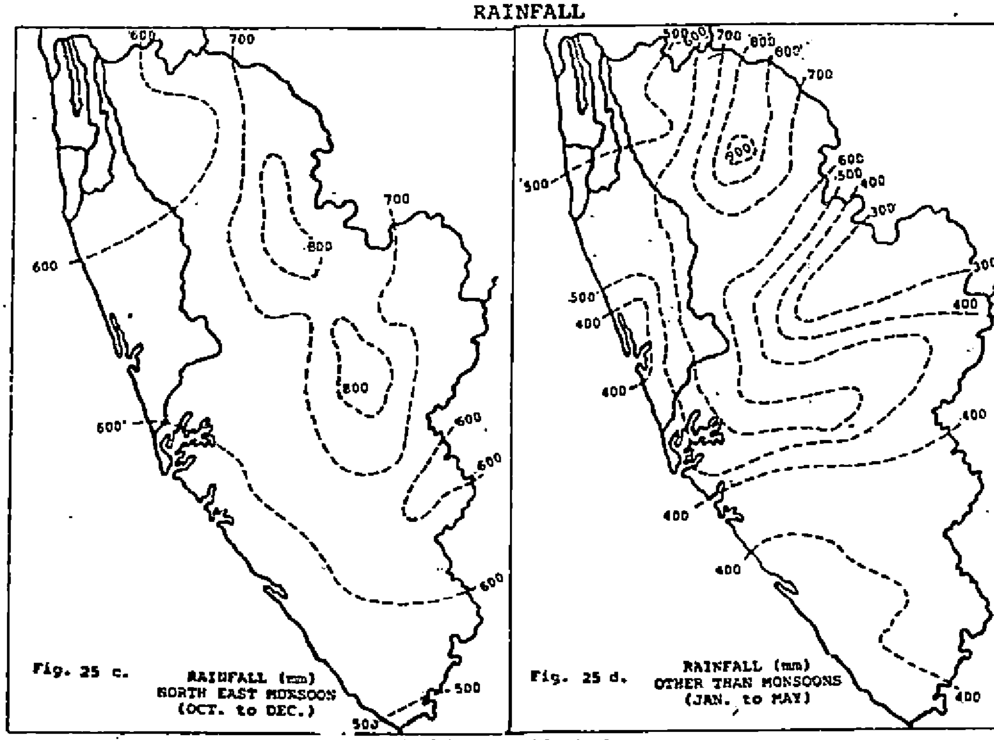
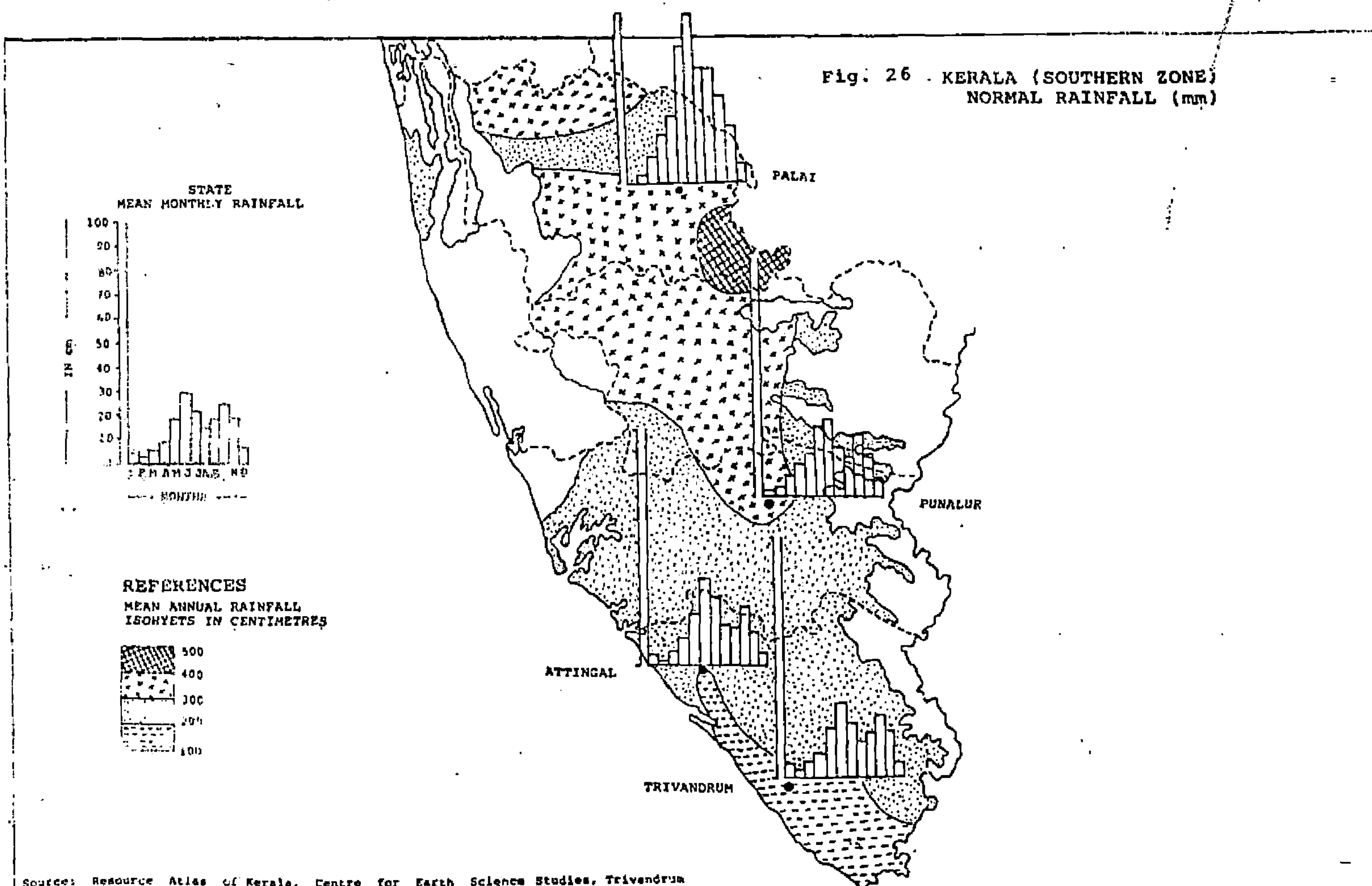


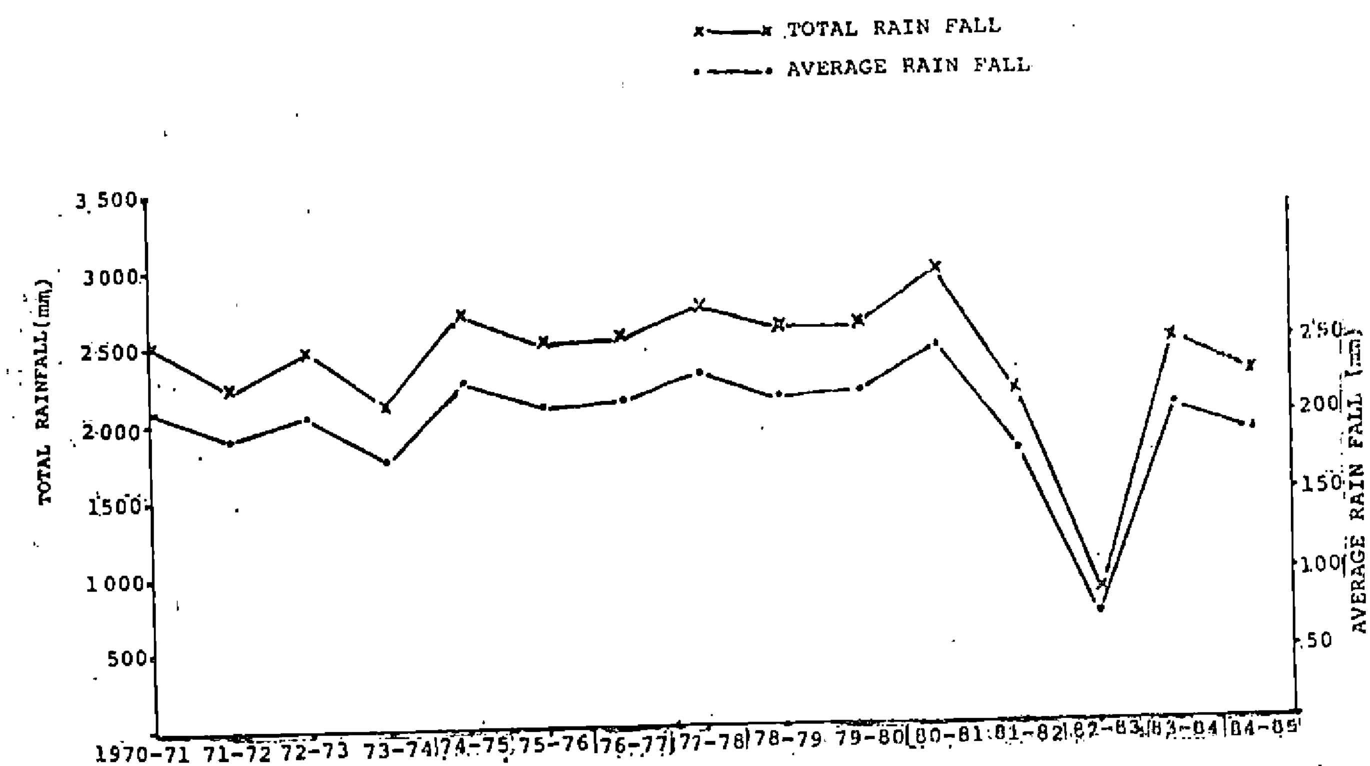
Fig. 25
KERALA (SOUTHERN ZONE)
RAINFALL





Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum

Fig.27 KERALA (SOUTHERN ZONE)
TOTAL AND AVERAGE RAINFALL
(1970-71 TO 1984-85)



1975 and 1976, the August rainfall was more than the normal rainfall of Kerala while during the other years, it was below the normal level. The normal rainfall of the zone for August is 331 mm and that of the State is 426 mm. June rainfall also shows the same trend. However, during the periods from November to April, the zone received more rainfall ranging from 26 mm to 221 mm, the corresponding figures for the State being 17 mm to 185 mm. The rainfall in the zone is more or less evenly distributed. However, during the year 1983, an intense and unprecedented drought prevailed in the zone which affected the growth and productivity of several seasonal, annual and perennial crops, particularly the plantation crops. During that year, the zone received only 886 mm rain which was the lowest recorded during the past 15 years. In 1987 also, drought situations occurred due to the weak nature of the South West monsoon, though not as intensely as it was in 1983. The effective annual rainfall in the zone is more (about 80 per cent) than that in the other zones. The data on the normal and average rainfall during 15 years (1970-1985) in the district of Trivandrum are presented in Annexure LXXII(a), of Quilon in Annexure LXXII(b), of Alleppey in Annexure LXXII(c) and of Kottayam in Annexure LXXII(d). The data on the average number of rainy days (1931-60) and the average number of rainy days with rainfall of >20 mm and >50 mm are given in Annexure LXXIII. The average number of rainy days was the lowest in February, and the highest in June. The months January and February had the lowest number of rainy days with rainfall of >20 mm while the month of June experienced the highest. The situation with regard to the number of rainy days with rainfall of >50 mm also followed the same trend.

Water balance

The water balance (Fig. 28) of the southern zone indicates that water deficit starts in December and ends by April. The overall magnitude and duration of water deficiency are less (269 mm in four months) due to the influence of both the South West and the North East monsoons which bring rains to the zone. This is probably one of the reasons for the acceptable crop productivity in the southern zone.

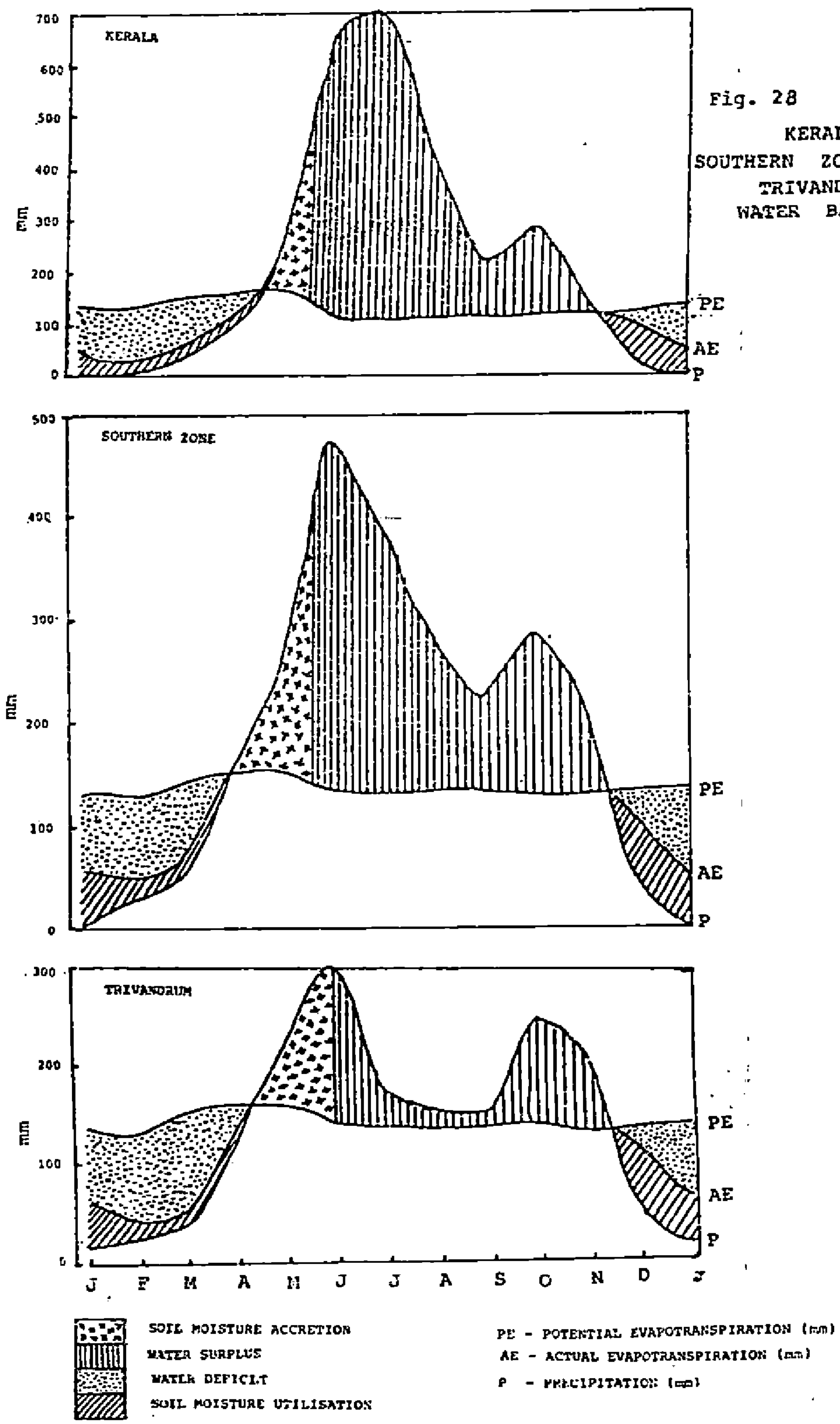


Fig. 28

KERALA,
SOUTHERN ZONE AND
TRIVANDRUM
WATER BALANCE

2.4.2 Temperature:

The data on the mean surface air temperature in the zone for the past 14 years (1972 to 1985) are presented in Annexure LXXIV. The mean annual temperature varied from 22.5°C to 32.8°C at Punalur. The lowest mean monthly minimum and the highest mean monthly maximum temperatures were also recorded at Punalur (20.4°C in January and 36.3°C in March). The months of March and April were the hottest, and the month of January, the coldest. During the kharif season (June to September), the maximum temperature varied between 29.7°C and 30.8°C. The minimum temperature remained more or less steady at 23.0-23.4°C. During the rabi season (September to December), the maximum temperature remained almost steady at 30.7°C to 31.9° C and the minimum, at 22.6-23.3°C. The temperature variations in the zone are given in Fig. 29.

2.4.3 Humidity (R.H.)

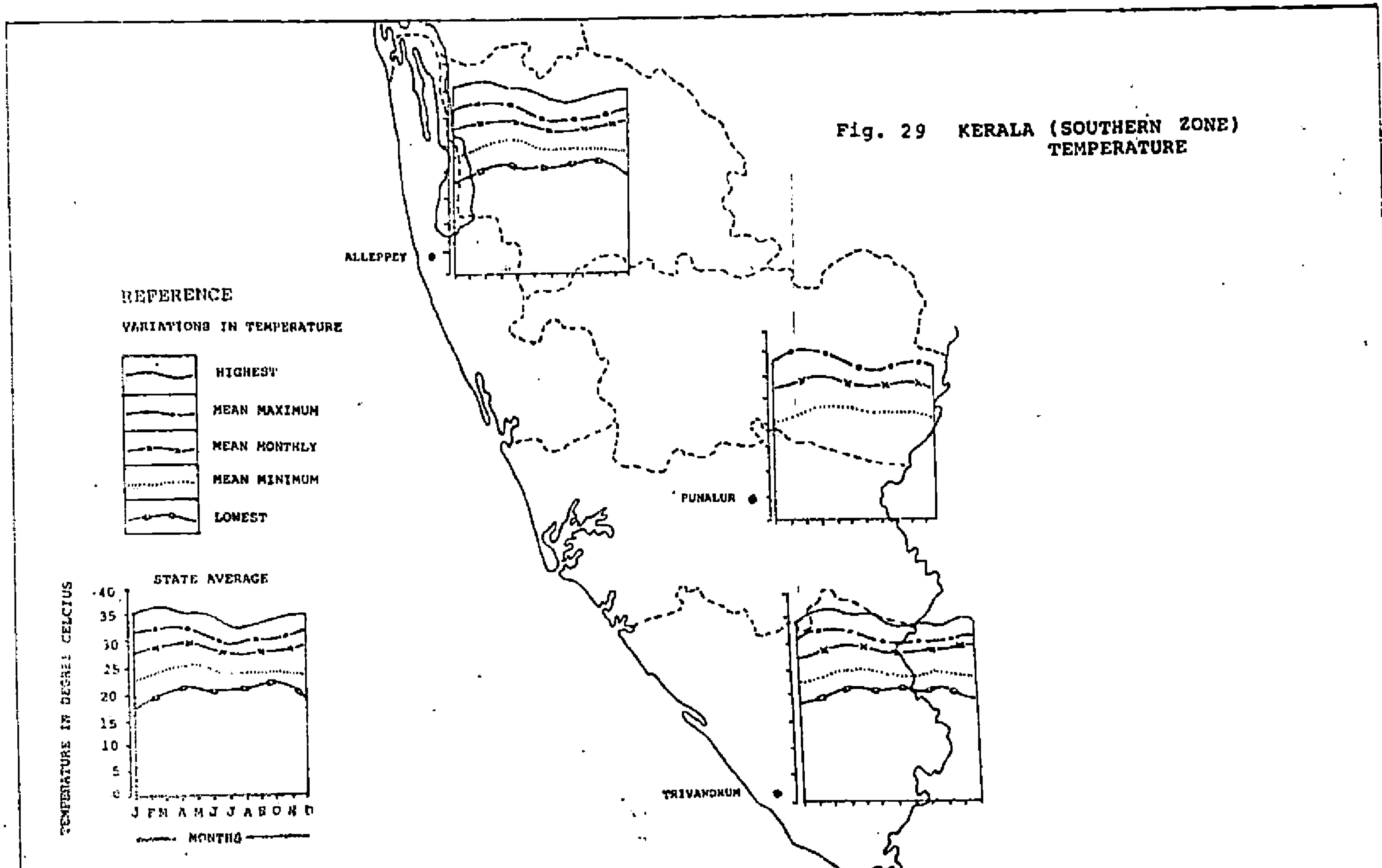
The data on the mean relative humidity (per cent) in the southern zone districts during the past 14 years (1972 to 1985) are presented in Annexure LXXV. Highest humidity is observed during June to August in all the districts of the zone, coinciding with the heavy South West monsoon season. The lowest is in the months of January and February, which are the non-monsoon hotter months. The mean relative humidity in the zone ranged from 76.8 per cent at Punalur to 80.0 per cent at Alleppey. The changes in the mean annual temperature, humidity and rainfall in the zone are presented in Fig. 30.

2.4.4 Cloudiness

The skies are generally lightly or strongly clouded during early June to November. January, February and March are the least cloudy months with three octas. The most cloudy month is July with six octas.

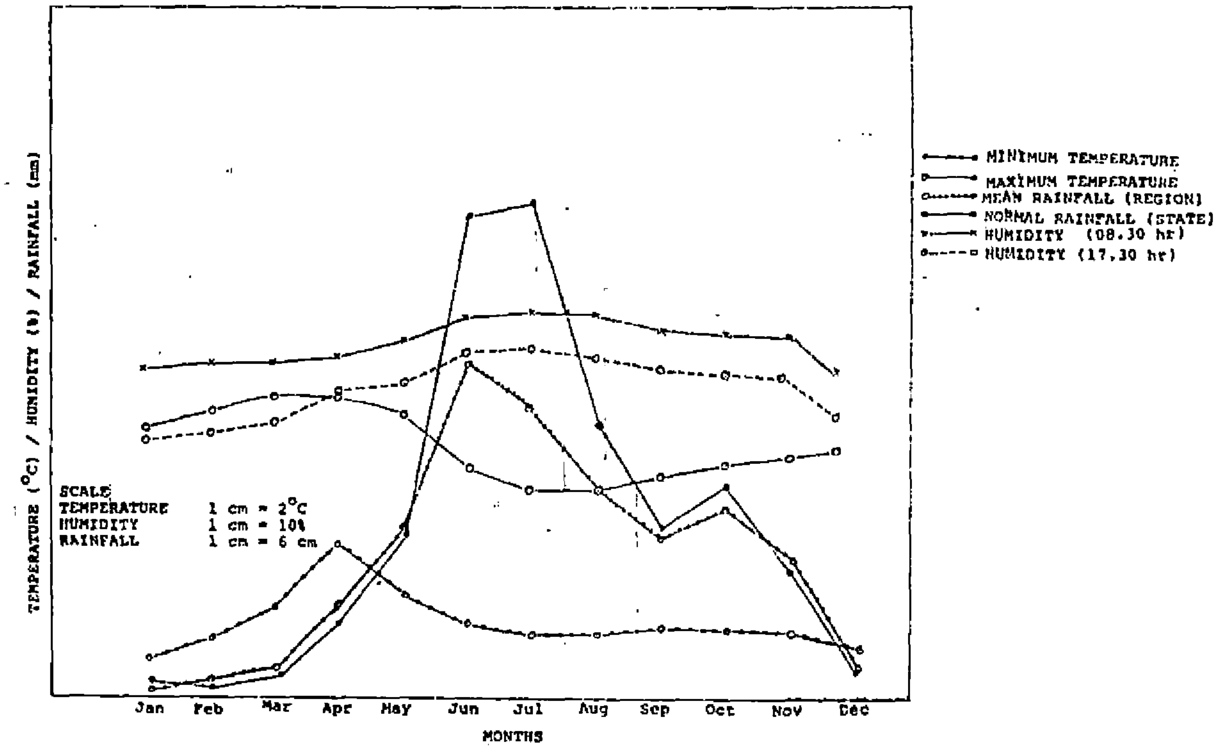
2.4.5 Wind

During May to September, the surface winds are North-westerly, whereas from January to April and from October to December, the winds are North-easterly in the



Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum

Fig. 30 MEAN ANNUAL TEMPERATURE, HUMIDITY AND RAINFALL 1970-71 to 1984-85



morning and South-westerly in the evening. The speed of North-westerlies occasionally reaches 30 km per hour level during May to September. The normal wind spee (1931-60) and the potential evapo-transpiration (1974-83) values for Trivandrum and Alleppey districts are given in Annexure LXXVI.

2.4.6 Evaporation

Due to high humidity and low$_2$wind speed, the annual evaporation is less than 175cm^2, against the annual precipitation of 2500 mm. Though the soil in the zone may have net residual moisture during the summer, extreme moisture stress during January to March is a regular feature.

2.5 Land use pattern

The data on land use pattern in the zone during the years 1970-71, 1975-76 and for the six-year period from 1980-81 are presented in Annexure LXXVII. The data cover the districts of Trivandrum, Quilon, Alleppey, Kottayam and Pathanamthitta. The data for the earlier period (1970-71) included those of the present district of Idukki which was formed in January 1972 from parts of Quilon and Kottayam districts. Idukki district, not covered under the southern zone, has large area under forests, as is reflected in the higher figures for the year 1970-71 in the Annexure. The southern zone constitutes 28 per cent of the area of the State. Forests in this zone constitute 27 per cent to the State. More than 50 per cent of the area in Pathanamthitta district is covered by forests. Alleppey district has no forest area. Fig. 31 shows the distribution of forests (closed and open degraded) in the zone.

During the past 10 years, not much change has been visible in the area under forests. However, the area under different forest classes in Kerala during 1972-1975 and 1980-1982 based on visual interpretation of Landsat data collected by the National Remote Sensing Agency (NRSA), Department of Space and given in Annexure LXXVIII reveal that the per cent of forest area in the State to the total geographical area in 1972-75 was 22.15 and that in 1980-82 was 18.98 (Fig. 32 and Fig. 33). During the interval (1972-75 to 1980-82), the forest area reduced by about 3.17 per cent of the total geographical area of the

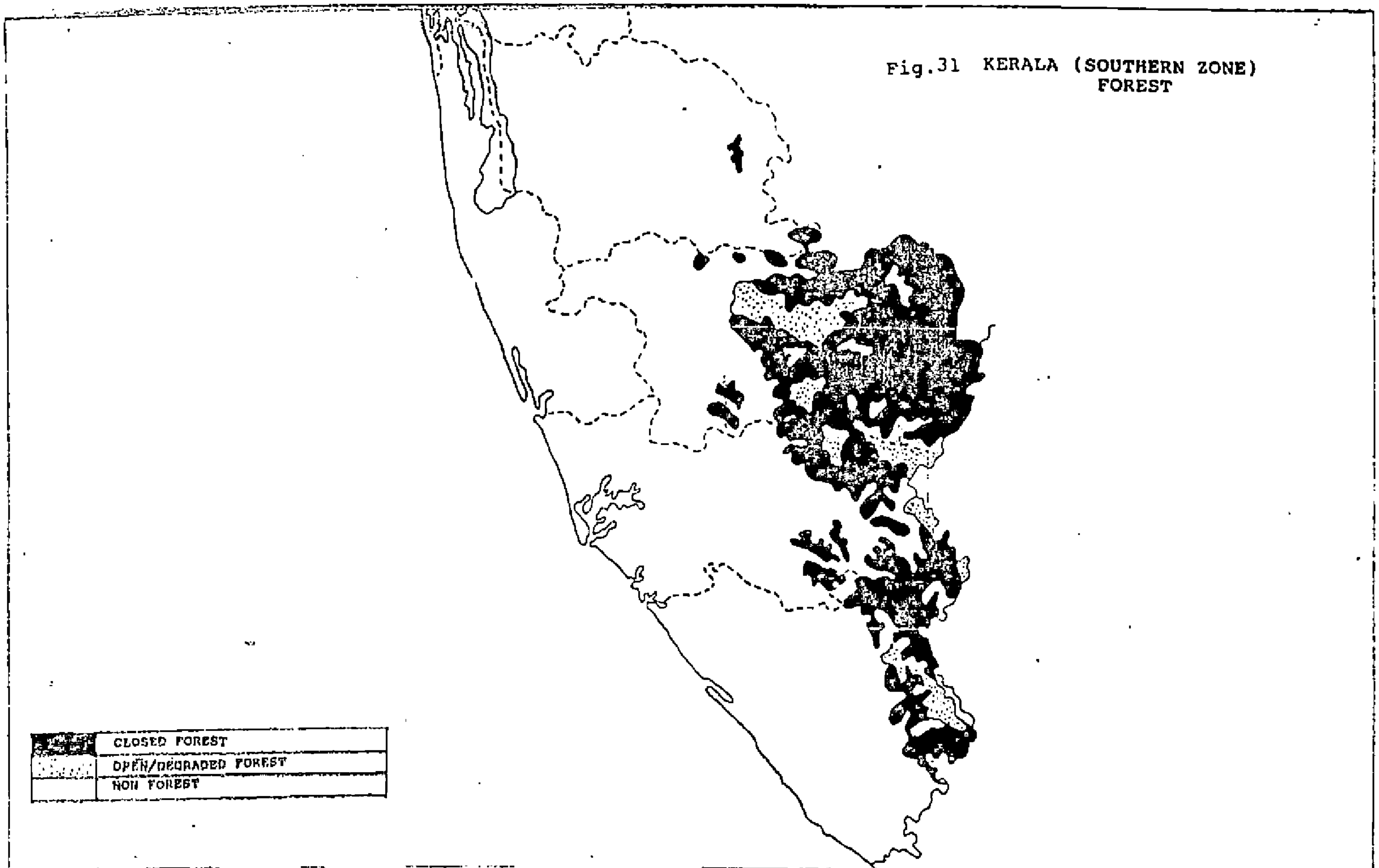


Fig.31 KERALA (SOUTHERN ZONE) FOREST

Fig. 32
KERALA - FORESTMAP
(BASED ON VISUAL INTERPRETATION OF LANDSAT IMAGERY)
FOR PERIOD 1972-1975

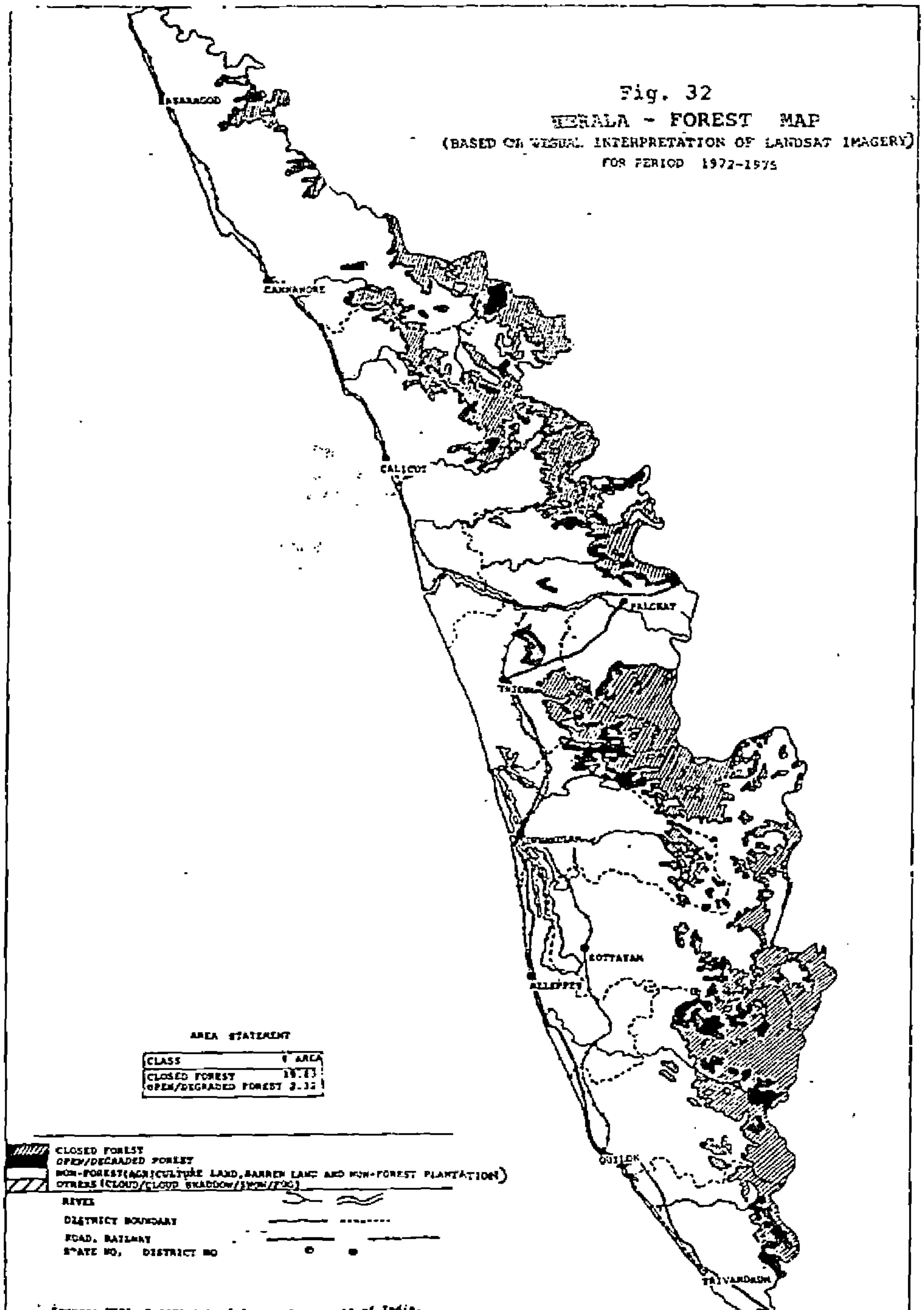
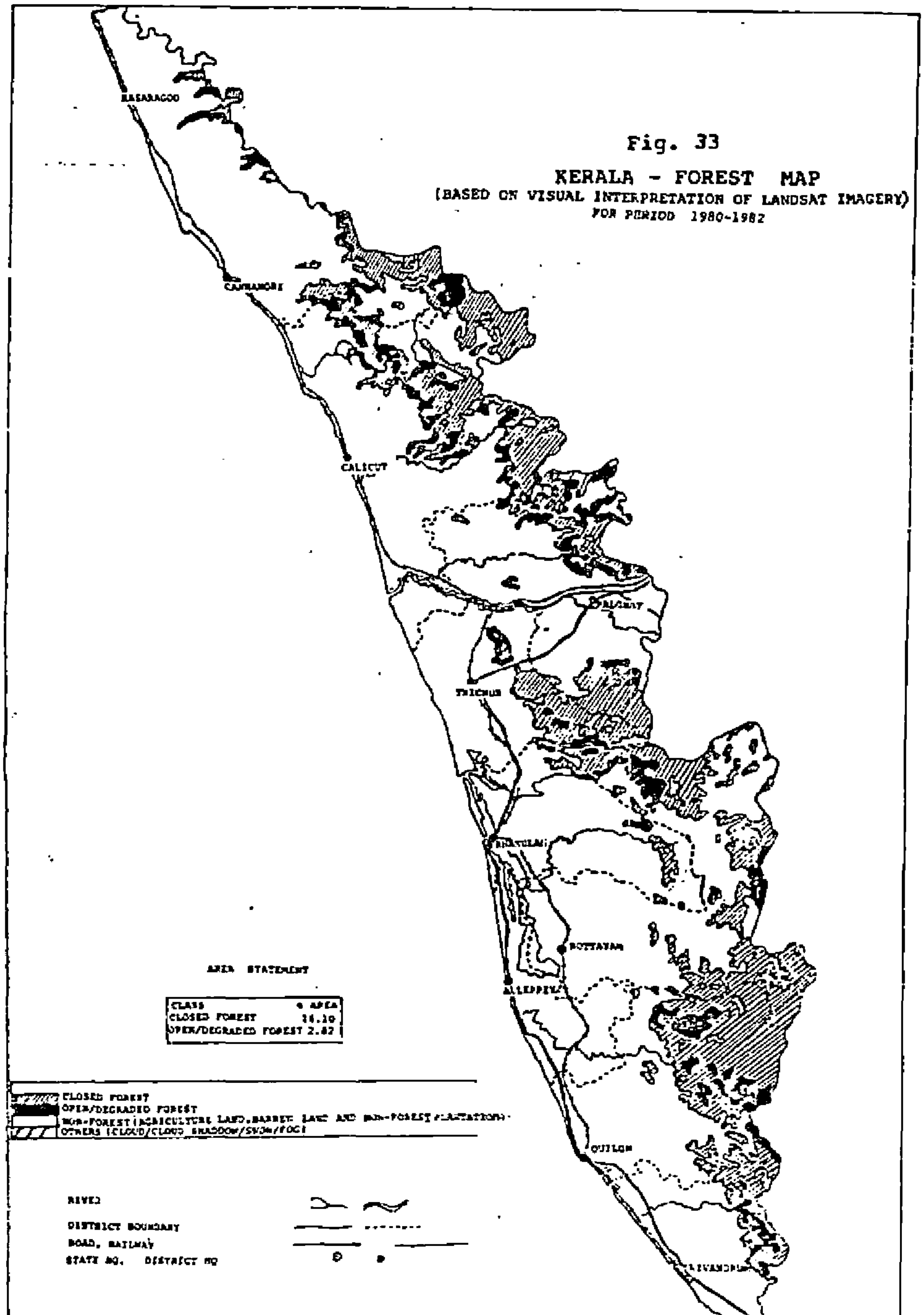


Fig. 33

KERALA - FOREST MAP
(BASED ON VISUAL INTERPRETATION OF LANDSAT IMAGERY)
FOR PERIOD 1980-1982



Source: NRSA, Department of Space, Government of India.

State. This means that the actual forest area in Kerala is significantly lower than the estimations made through conventional methods (Table 29).

Table 29. Satellite Remote Sensing data on forest cover in Kerala State

	1972-75 (%)	1980-82 (%)	Change (%)
Total area under forest cover as percentage of total geographic area	22.15	18.98	(-)3.17
Closed forests	19.84	16.15	(-)3.69
Open/degraded forests	2.32	2.82	(+)0.50

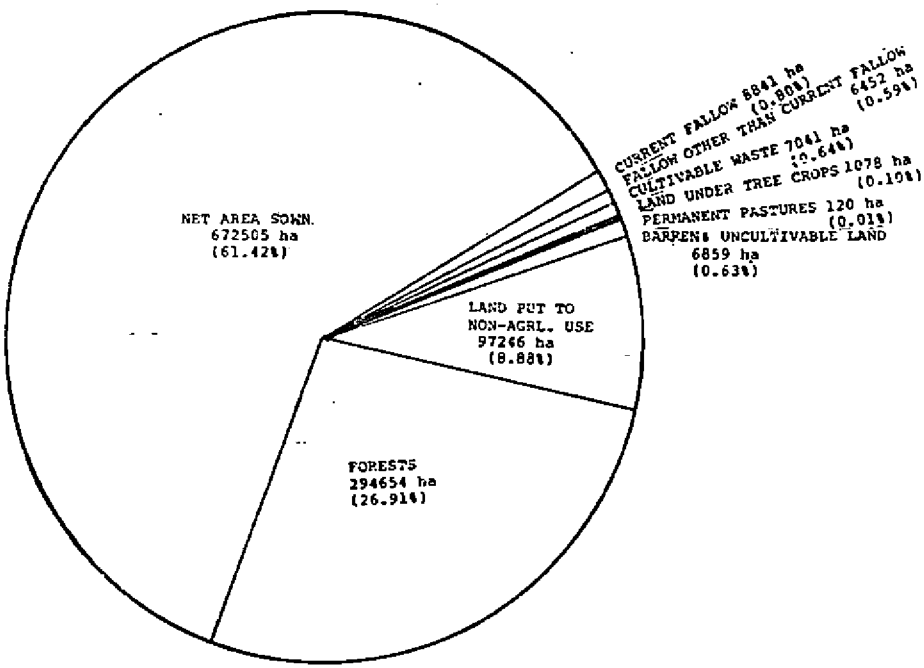
From the above, it is to be inferred that the actual tree clad area for the period 1980-82 (18.98%) is significantly lower than the figures reported earlier for this period. The possible causes of deforestation are encroachment, unauthorised felling of trees, submergence of forest areas by hydro electric dams/other projects, shifting cultivation, erosion, forest fires, forest diseases etc. The State has lost 3.17 per cent of forest area in approximately seven year's time.

Land put to non-agricultural use was 8.9 per cent in the zone and formed 34.91 per cent to the State in 1986, thus showing an increase of 3237 ha. from that of the previous year. Steady increase in the area, though not appreciable, could be seen in the zone after 1983, probably due to increased population. Barren and uncultivable land showed a decreasing trend during the past 10 years. In 1986, this class of land constituted 0.63 per cent of the geographical area of the zone and 8.25 per cent to the State. Current fallows formed 0.80 per cent of the zone and 20.44 per cent to the State. The area sown more than once in the zone was 2.51 per cent and constituted 40.69 per cent to the State. The net area sown was 6,72,505 ha which was 61.42 per cent in the zone and 30.69 per cent to the State. This remained more or less steady during the past 10 years. The net area sown in the State increased by 4068 ha in 1964-85 and further by 6562 ha in 1985-86. The area sown more than once increased by 8873 ha in 1984-85 resulting in an increase of 12941 ha in the total cropped area during 1984-85 compared to that of the previous year. However, during 1985-86, the area sown more than once in the State decreased by 14653 ha, thus bringing down the total cropped area by 8091 ha. In the zone, a decrease in the area sown more than once of 12,457 ha was noted during 1984-85 and of 10,176 ha during 1985-86. After 1983-84, a similar decreasing trend could be seen in the total cropped area which in 1986 was 9,47,383 ha constituting 86.0 per cent in the zone and 33.1 per cent to the State. The land utilisation pattern in the zone is presented in Fig. 34.

2.5.1 KERALA STATE LAND USE BOARD

The Kerala State Land Use Board, which was constituted in 1975, is responsible for keeping a continuous watch on the land management problems of the State. The main objectives include collection and codification of data on land resources using remote sensing techniques, advising the Government on policy frame work for correct decisions on the land use, monitoring / co-ordinating the implementation of the decisions of the Government relating to land use, preparation of an optimum land use plan using remote sensing techniques in collaboration with Department of Space, aerial photography (black & white and colour infra red in 1:15,000 scale) covering the entire State in collaboration with the National Remote Sensing Agency, Hyderabad; interpretation of the aerial photographs and Landsat imageries, and mapping with the aid of Photo-interpretation Laboratory and Cartographic Cell. Inventory of the forest resources of the State using multi-band photographs and delineation of forest types of Kerala utilising aerial photography, forest resource inventory, waste land delineation and mapping, using thematic mapper imageries for the National Waste Land Development Board are the other activities of the Board. A data bank has been set up to collect and collate data and maps on land resources and land use. Aerial survey maps of Kerala State, soil survey maps, grouped survey

Fig.34 KERALA (SOUTHERN ZONE)
LAND UTILISATION PATTERN
1985-86



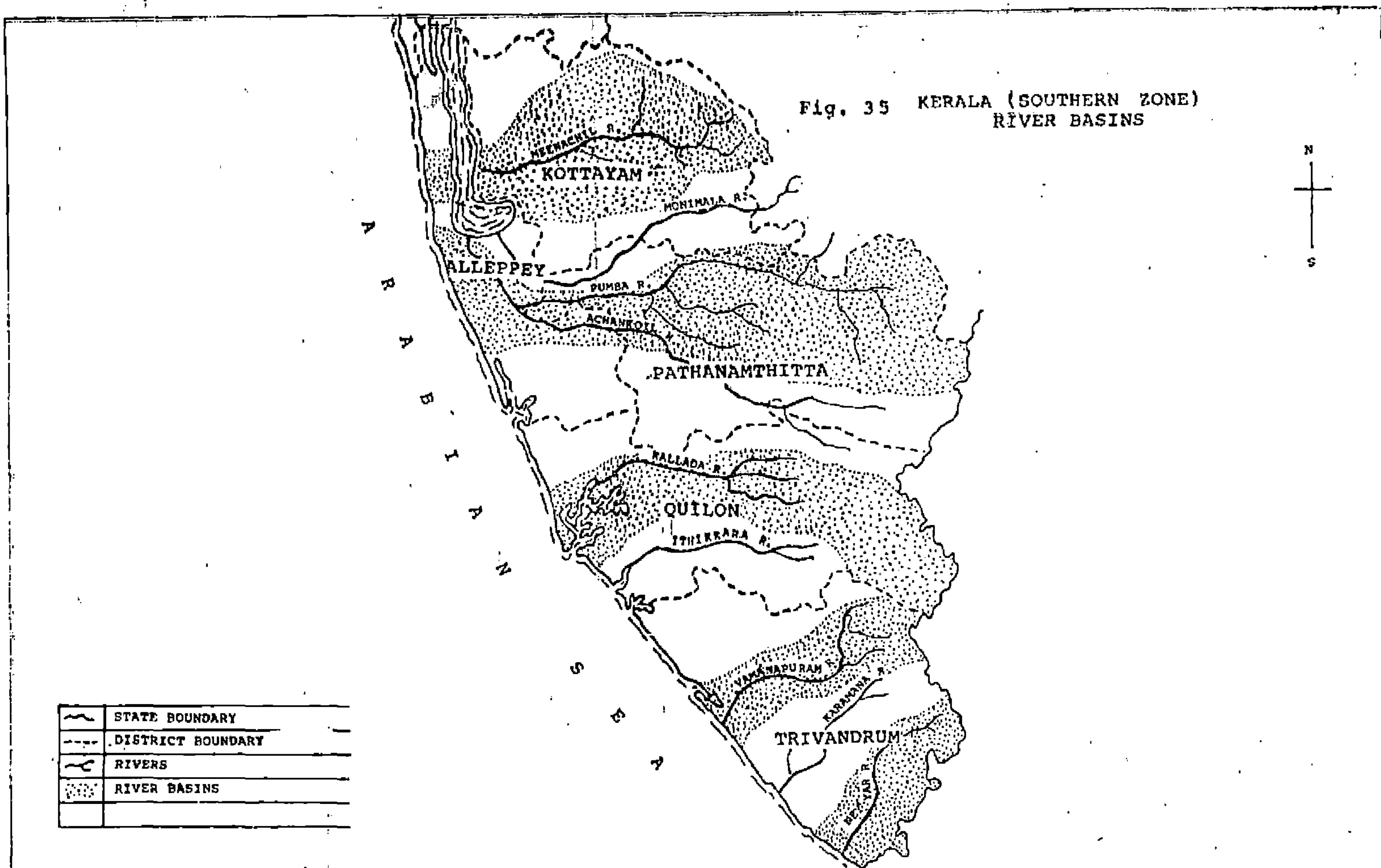


Fig. 35 KERALA (SOUTHERN ZONE) RIVER BASINS

maps, data on irrigation projects etc. have been stored in the data bank. For the proper utilisation of the remote sensing data generated by the IRS satellite, a User Cell Agency under the National Natural Resource Management System has been set up.

2.6 Irrigation

Fourteen rivers form the major water sources of the river-based irrigation system in the southern zone. The major rivers shown in Fig 35 Manimala, Pumba and Achancoil are inter-district rivers. Data on the major river water resources in the zone along with the districts benefited, are furnished in Annexure LXXIX. Brief descriptions of the rivers follow:

The Moovattupuzha River

The Moovattupuzha river is formed by the confluence of three rivers -the Thodupuzha, the Kaliyar and the Kothamangalam river. After the confluence at Moovattupuzha (Ernakulam district), the river flows South-westerly for 2 km, westerly for 13 km and turns South-West and ultimately joins the Vembanad lake through a series of channels. The length of the river is 121 km. The total drainage area of the river is 1554 sq.km. During its course, it passes through 45 villages of the Thodupuzha, Moovattupuzha, Vaikom, Kunnathunadu and Kanayannur taluks, of which only the Vaikom taluk is in the southern zone.

The Meenachil River

The river is formed by several streams originating from the Western Ghats. It has a length of 78 km and total drainage area of 1272 sq.km. The river passes through the villages of Poonjar, Erattupetta, Kondur, Bharananganam, Lalam, Kummannum, Nirikkad and finally through Ettumanoor, Kumaranallur, Kottayam, Kumarakom etc., touching the towns of Poonjar, Palai, Ettumanoor and Kottayam, and empties into the Vembanad lake.

The Manimala River

The river starting from Tatamala at 1156m above MSL passes through several estates and reaches Kootikkal where the Kokkayar joins it. Several rivulets also feed the main stream. Taking a southerly course till Mundakkayam, it follows a westerly course and taking more streams, it reaches Manimala. At Neerettupuram it confluences with Pumba river. The river has a length of 90 km and drains an area of 847 sq.km. It passes through the villages of Peruvanthanam, Mundakkayam, Erumeli, Manimala, Kallooppara, Kaviyoor and the Thiruvalla town.

The Pumba River

This is the longest river in the zone and the third longest in Kerala. It is formed by the confluence of several rivers - the Pumba, the Kakki, the Azhuthai, the Kakkad, and the Kallar. The river flows through 80 km in Quilon district and enters Alleppey district. After joining the Manimala and Achankoil rivers, it empties into Vembanad lake through several branches. The length of the river is 176 km with a drainage area 2235 sq.km. The important areas covered are Naranamuzhy, Perunad, Vadasserikkara, Ranni, Kuriyannur, Kozhencherry, Pandanad and Neerettupuram.

The Achankoil River

Several small streams join together and form the Achankoil river. Flowing through Kumbazha, Idappamon and Thazhakkara, one branch of this river joins the Pumba river at Tharaimukku. Later, it splits into several small branches and the major branch again joins the Pumba river at Veeyapuram. The length of the river is 128 km with a total drainage area of 1484 sq.km. The river covers portions of Kunnathur, Mavelikkara, Chengannur, Karthikappalay, Karunagappally and Pathanamthitta taluks, of which the first, the third and the last mentioned taluks belong to the zone.

The Pallikkal River

The river rises from the southern slopes of Kalaritarakunnu at an elevation of less than 60m above MSL North of Adoor. Passing through Adoor, the river drains into Kozhikkottukayal near Karunagappally town. The river has a length of 42 km with a drainage area of 220 sq.km.

The Kallada River

This river is formed by three rivers, the Kulathupuzha, the Shendurni and the Kalthuruthy which join together near Parappar by the side of Trivandrum-Shencottah road. Passing through Thenmala, Pathanapuram and Enathu, the river drains into Ashtamudi lake, West of Quilon district. The length of the river is 121 km with a drainage area of 1699 sq.km. The important towns served by the river are Punalur, Pathanapuram, Kottarakkara, Adoor, Kundara and Quilon.

The Ithikkara River

The river originating from the low hills situated South-West of Kulathupuzha empties its waters into Paravoor lake near Meenad. The river passes through the villages of Vayala, Pampira, Ayoor, Thiruvambhagom, Attoorkonam and Adichanallur. Kottiyam, Chathannur and Chadayamangalam are some important places served by this river. The length is 56 km and catchment area 642 sq.km.

The Ayoor River

The river rising from Navaikulam crosses the national highway (NH 47) at Navaikulam, flows towards the West and empties into Edava-Nadayara lake at Nadayara. The length of the river is 17 km and it drains an area of 66 sq.km.

The Vamanapuram River

The river originates from Chemunji Mottai at about 1860m above MSL. Flowing through Kallar and Manjappara with tributaries joining it on the way, the river continues its westward course through Palode. After cascading over a 13 metre fall known as Meenmutti, the river flows upto Vamanapuram and continuing its westward flow it falls into Anjengo lake near Chirayinkil. The length of the river is 88 km and the drainage area, 687 sq. km.

The Mamom River

Originating from Pandalakottu malai near Vembayam and crossing the NH 47 at Mamom, the river flows westward ending at Anjengo lake near Chirayinkil. The length of the river is 27 km and the drainage area, 114 sq.km.

The Karamana River

The river originates from Chemmunji Motta and Agastyamalai of the Nedumangad hills and flows southwards till it flows into the Arabian sea near Thiruvallom. Killi Aar which joins the Karamana river near Nadakara is its main tributory. The length of the river is 68 km. It has a catchment area of 702 sq.km. Trivandrum city is served by this river.

The Neyyar River

This is the southern most river in the zone. Starting from Agastya hills, it flows in South-West direction in the mountainous areas and then flows through Ottasekharamangalam and ultimately empies into Arabian sea near Poovar. The length of the river is 56 km. It has a drainage area of 497 sq.km. It passes through the villages of Ottasekharamangalam, Kulathummal, Maranalloor, Perunkadavila, Neyyatinkara municipality, Chenkal and Kulathur.

The data on the major river basins in the zone, the annual yield, annual utilisable water etc. are given in Annexure LXXIX.

2.6.1 Irrigation facilities and constraints

In Trivandrum district, about 60 per cent of the total geographical area is arable. Of this, a negligible percentage alone derives the benefit of assured irrigation throughout the year. Neyyar irrigation project is the only project commissioned in the district. Paddy is the main crop cultivated in the areas with assured water supply. Vegetables cultivated in parts of Neyyattinkara taluk and betelvine cultivated in the small holdings of Nedumangad and Neyyatinkara taluks are, however, exceptions. These are irrigated by pot watering from rivers, streams and wells. Coconut, which is the most important cash crop, is seldom irrigated due to the non-availability of water, particularly in the summer months from December to May. As such, the crop can be generally considered as rainfed. In the very small holdings in the urban areas, a few farmers irrigate coconut by pot watering. Karamana, Neyyar and Vamanapuram are the three rivers flowing in the district. The dams at Aruvikkara and Peppara serve as perennial sources of drinking water for the capital city of Trivandrum and the surrounding areas. In the suburbs of Trivandrum city, is the Veli lake which lies in close proximity to the sea. Due to the possible saline pollution, the water is seldom used for irrigation. Another lake lying in proximity to the sea in the district is Kadinamkulam, located in Kadinamkulam panchayat. Vellayani lake located about 11 km South West of Trivandrum city is a fresh water lake.

Vellayani kayal reclamation

The lake lying 1.5 to 2.0 m below the MSL is situated on the boundary of the three sides of the College of Agriculture - the Vellayani campus of the Kerala Agricultural University. The lake forms the main catchment for the run off and seepage from the neighbourhood. The Instructional Farm of the College of Agriculture has an area of 165 ha of the *kayal*(lake) area where paddy is cultivated during the *puncha* season (December to April) after dewatering. A *Padasekhara Committee* is constituted every year to arrange and supervise the dewatering operations. Cultivation in the *kayal* lands provides employment and livelihood to a sizeable section of the local people.

Every year, 25,000 to 30,000 man days are employed for the cultivation of the *kayal* lands. A portion of the *kayal* area is owned by small and marginal farmers of the locality. Paddy is the main crop grown by them. Vegetables are also grown to a limited extent. Till a few years ago, a single crop of paddy was being taken during February to May, after pumping out water into an adjacent reservoir. Excess water from the reservoir was diverted through an artificial canal to Karamana river about 3.5

km away, and from there to the sea. In spite of the annual strengthening of the mud walls of the reservoir, frequent breaches resulted from the pre-monsoon rains in May, flooding the entire kayal land causing destruction of the standing paddy crop at its critical growth stage at great concern to the cultivators. Under the Vellayani Kayal Reclamation Scheme of the State P.W.D., the reservoir has recently been strengthened with rubble. The reservoir now serves as a perennial water source enabling a single crop of paddy in the kayal land during January to May. The area benefited by the scheme is 651 ha. Three crops of paddy can now be taken at the fringes with minimum risk. A project for reclamation of kayal lands for the purpose of coconut planting and inland fishing is under implementation by the Instructional Farm. So far, 4208 coconut seedlings have been planted under this scheme.

In Quilon district also, paddy is the major crop that is irrigated at present. Some vegetables are also cultivated under irrigation, although to a negligible extent. This district has abundant water resources (rivers) for exploitation. However, they have not been harnessed fully for irrigation. There is immense scope for increasing the irrigation potential in this district by implementing major and minor irrigation schemes. The Ashtamudi lake, the Paravur lake and the Edava-Nadayara lake exist in this district. Coast line of a narrow strip of land separates these lagoons in the hinterland from the sea. The lagoons or backwaters and the rivers are connected to the sea through small openings called Azhis or Pozhis, depending on whether the opening is permanent or temporary. Occasionally, a few of these lakes get contaminated with brackish water from the tidal waves of the adjoining sea. The lakes serve the inland navigation system. The Sasthamkotta lake having an area of 3.73 sq. km. is a fresh water lake and a perennial source of drinking water for the Quilon municipal town.

In Kottayam district, the percentage of area irrigated to the net area sown is comparatively negligible (5.5). Practically no irrigation is done in the uplands, as the rivers get dried up during the summer. Only a few lift irrigation schemes have been commissioned.

The area irrigated in Alleppey district is nearly 20 per cent of the total area. In the Pumba basin, the total ayacut area of Government operated lift irrigation schemes extends to 2345 ha (net) or 2345 ha (gross).

In the zone, Government owned lift irrigation schemes are confined to river pumping schemes mainly concentrated in the bigger river basins and to the summer discharges from the hydel schemes. The schemes maily cater to the needs of paddy cultivators of the zone. The major constraints in the development of irrigation include:

- High cost of maintenance compared to the cess collected by the Government. Minor irrigation Class II schemes are to be maintained by the Panchayats. Several Class II works have become defunct due to inadequate maintenance.

- Studies on the utilisation of ayacut commissioned are meagre except the CADA programme.

- Reservoirs are to be located either in reserve forests or hilly areas already inhabited. Eviction of the inhabitants may pose problems.

- Objections from environmentalists and Scientists relating to the possible ecological imbalance and reduction in the area under forests.

2.6.2 Irrigation projects

The data on the achievements under the major and medium irrigation projects in the zone are furnished in Annexure LXXX. The major irrigation projects (completed, under execution and under investigation) are shown in Fig. 36.

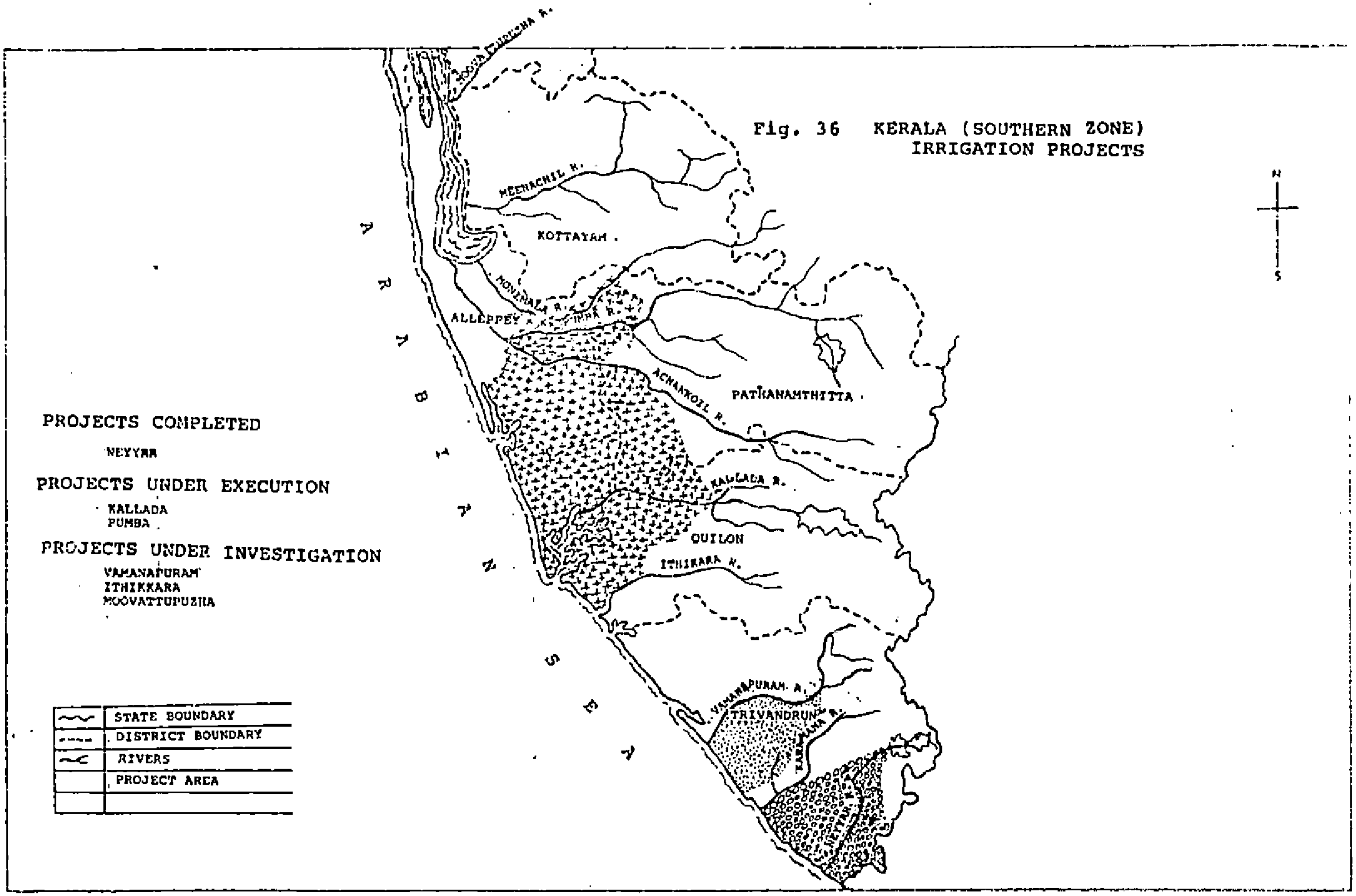


Fig. 36 KERALA (SOUTHERN ZONE) IRRIGATION PROJECTS

Completed projects:

Neyyar project

The Neyyar irrigation project, commissioned in 1964, is the only major irrigation project in the Trivandrum district. The right and left bank canal systems command 11,740 hectares of the net ayacut area in the taluks of Neyyatinkara, Trivandrum and Nedumangad. Parts of Kanyakumari district (Tamil Nadu) are also benefited from this project. The total irrigated area is 10.5 per cent of the total cropped area of the district. The Command Area Development programmes of the State Government include among others, Neyyar command area also. Village wise area benefited by the Neyyar irrigation project in the Trivandrum district is furnished in Table 30.

Table 30. Villages benefited by the Neyyar irrigation project

Taluk	Village	Area benefited (ha)
Neyyattinkara	Kulathur	2503
	Chenkal	1730
	Parassala	639
	Kollayil	654
	Perinkadavila	139
	Keezharoor	43
	Thirupuram	461
	Neyyatinkara	1397
	Athiyannur	864
	Pallichal	406
	Kottukal	711
	Karumkulam	309
	Kulathummal	37
	Maranalloor	279
	Ottasekharamangalam	106
	Kallikad	115
	Nemom	583
Trivandrum	Thiruvallom	415

The net work of canals and field channels constructed for the purpose of providing irrigation to the above villages mostly get dried up in the summer months of February to May, due to want of water in the main canals.

2.6.3 Projects under execution:

Kallada project (Quilon district)

The Kallada project, under execution at Thenmala, across the Kallada river, is expected to serve an ayacut area of 92,000 ha (gross) and 61,630 ha (net) in the districts of Pathanamthitta, Quilon and Alleppey on its completion. Construction of the net work of canals and field channels is nearing completion.

Pumba project (Quilon district)

The project is expected to serve an ayacut area of 49,456 ha (gross) and 21,135 ha (net) in Chengannoor and Thiruvalla (parts of which are under the southern zone) as well as in Karthikapally and Mavelikkara (which do not come under the southern zone).

Projects under investigation

Moovattupuzha river valley project (Kottayam district)

The project would utilize the tail water from Idukki hydroelectric project. When commissioned, it is expected to provide irrigation to Uzhavoor, Kaduthuruthy, Vaikom and Ettumanoor block areas in the Kottayam district in an area of 52,200 ha (gross) and 17,400 ha (net).

Meenachil project (Kottayam district)

The project would benefit Kottayam district and the irrigation potential is estimated to be 20,000 ha (gross) and 10,000 ha (net). Under other sources of irrigation such as minor irrigation and lift irrigation, an additional area of 8,133 ha can also be irrigated.

The lower reaches of Moovattupuzha and Kallada rivers are occasionally prone to pollution from industrial effluents discharged into these river systems. The Kallada river gets polluted by effluent discharge from the Punalur Paper Mills and the Lakshmi Starch Factory (Kundara). Several rubber industries from Kottayam and the Hindustan Newsprint Factory at Velloor pollute the Moovattupuzha river.

Vamanapuram project: (Trivandrum district)

The project envisages construction of two dams, one at Valayanki across the main river and the other at Mailammoodu across Chittar as well as a pick up veir at Pathalakayam. The irrigation potential is etimated to be 18,014 ha (gross) and 8,803 ha (net).

2.6.4 Source-wise and crop-wise irrigation

Data on the source-wise net area irrigated in the zone for the period 1980-86 are given in Annexure LXXXI and for the period 1985-86 in Fig 37. Wells, tanks, canals as well as minor and lift irrigation systems are the sources in the zone. Of the total net irrigated area of 47,429 ha which constitutes 7.3 per cent of the total geographical area of the zone (1.2 per cent to the State), Government canals constitute 19.5 per cent and private canals, 1.1 per cent. Government tanks constitute 3.2 per cent and Government wells, 0.3 per cent of the net irrigated area of the zone. Private tanks and wells contribute 29.5 and 5.4 per cent, respectively. Minor and lift irrigation facilities benefit 12.5 per cent and other sources cover 28.6 per cent of the net area irrigated.

Data on the crop-wise gross area under irrigation in the zone during 1980-86 period are furnished in Annexure LXXXII and for the period 1985-86 in Fig. 38. Of the crop-wise irrigated gross area of 60,881 ha in the zone, paddy alone is irrigated in 35,812 ha which is 58.8 per cent of the irrigated gross area in the zone and 12.7 per cent of the irrigated gross area of the State. Coconut is ranked second with 17,814 hectares gross area irrigated (29.3 per cent and 24.4 per cent of the irrigated gross area of the zone and the State respectively). Vegetables are irrigated in 3.1 per cent and banana, in 1.4 per cent.

The vast extent of inland waters in Quilon and Alleppey districts and the coastal belt, offer immense

Fig. 37 KERALA (SOUTHERN ZONE)
NET AREA IRRIGATED (SOURCE-WISE)
(1985-86)

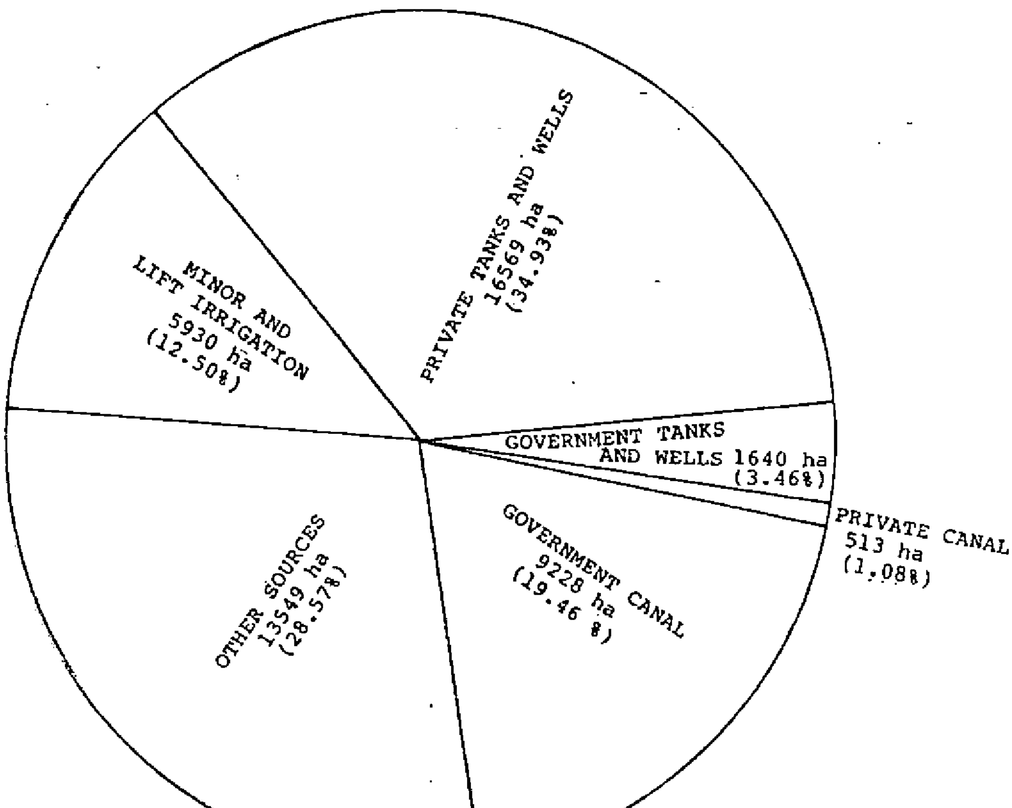
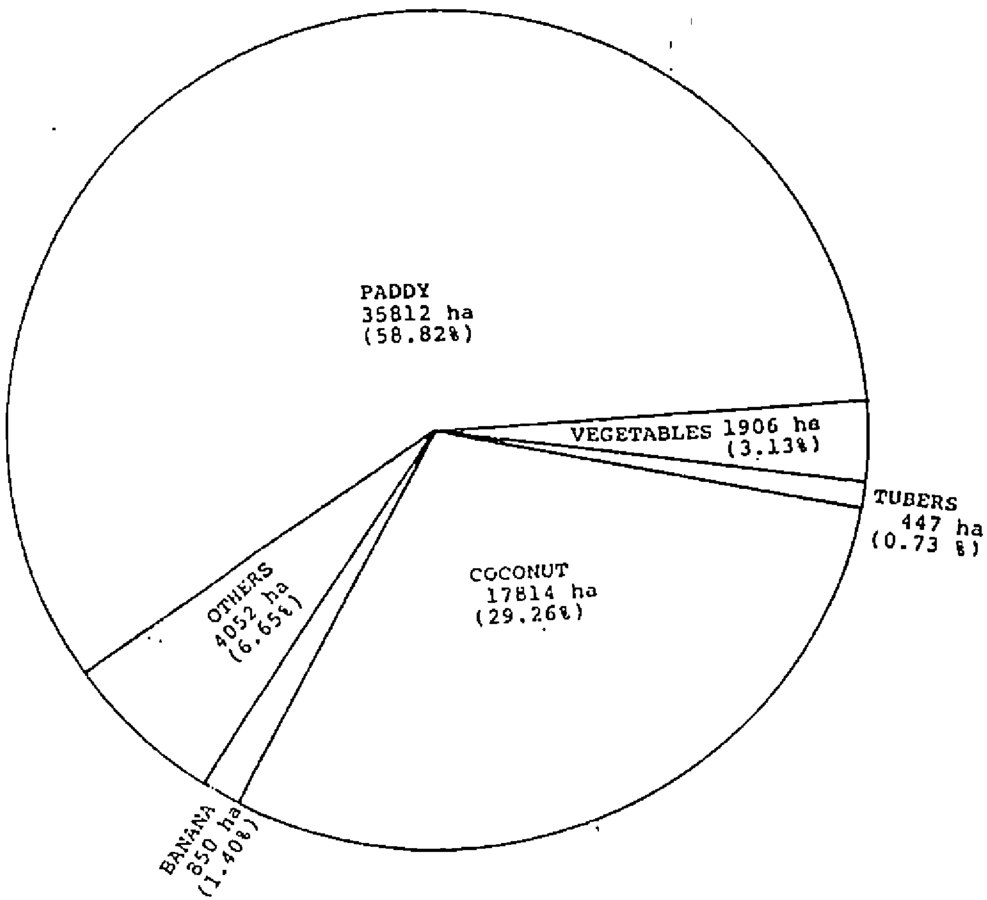


Fig.38 KERALA(SOUTHERN ZONE)
GROSS AREA UNDER IRRIGATION
(CROP-WISE) 1985-86



potential for the development of aqua culture in the zone. The sources of fishing consist of lakes (Veli, Kadinamkulam, Anjengo, Edava-Nadayara, Paravur, Ashtamudi), canals and rainfed tanks. Prawns, oil sardine, sardine, shark, tilapia, mackeral, cat fish, muliet, etroplus etc. are the important varieties. The reservoirs of irrigation projects of Pamba, Kakki, Neyyar etc. are the other sources available for the development of inland fishery. However, these water sources are yet to be properly exploited. There are several inland fishing villages in the zone. The details of the important fishing villages are furnished later in this Chapter. Lake waters, lagoons, ponds and tanks are also used for retting coconut husk which is the raw-material for the manufacture of coir and coir products such as coir fibre, coir yarn, coir mats, coir matting, coir rugs and carpets, coir rope, curled coir, rubberised coir goods etc. which are foreign exchange earners.

2.6.5 Ground water potential of the zone

The usefulness of a soil depends largely on the prevailing groundwater conditions. Being a heavy rainfall area, surface water is used for all purposes in the zone. Crops are grown generally under rainfed conditions. Domestic water requirements of the rural population is met by dug wells. Surveys conducted by the Geological Survey of India, the Department of Geology, Kerala and the Ground Water Department, Kerala have indicated ground water potential, especially in the coastal and near-coastal areas. The coastal areas have been suitable for sinking medium capacity tube wells. The gneisses in general are water bearing. The ground water in the crystalline rocky terrain can be developed through large open wells. Fluctuation in ground water table is noticed. Near the coastal belt, the ground water table is less than 5 meters. In the mid and the mid upland, it varies from 10m to 30m, depending upon topography. The activities of the State Ground Water Department includes systematic survey and investigation of the groundwater system, preparation of water table map, rendering technical guidance in matters connected to well irrigation, monitoring of qualitative and quantitative fluctuation of the system and analysis of the data from permanent observation wells. The responsibility of the department includes exploration of ground water potential and implementation of viable programmes for the development of water supply and irrigation systems. Identifying suitable location and designing various types of wells for the farmers, carrying out technical feasibility studies of the Minor Irrigation Schemes as well as drilling and construction of production tube wells and bore wells are the other important activities under the development programmes of the Ground Water Department. There is considerable gap between the irrigation potential created and utilised (Fig. 39). The prevailing cropping pattern in the State favours minor irrigation schemes. The present investment in irrigation which is largely towards the irrigation of the wet land crops like paddy has to be extended to benefit the garden lands also.

With the farmers' participation, the Department has launched a community irrigation programme. Under this programme, a number of filter point units, bore well units, tube well units and surface wells have been completed. The data on the ground water recharge, the draft and the balance as on 30.6.1985 for the zone are furnished in Annexure LXXXIII.

Remote sensing has recently been recognised as a useful tool in ground water surveys and exploration. Of the available satellite data products, Landsat band 7 manual interpretations, interpretation of standard colour composites and composites made from photo-optically stretched data could be used in identifying and selecting areas for ground water exploration. Thermography is a technique within remote sensing and thermal lines can be considered suitable for detection of inland discharge to streams and discharge to the sea. Ground water discharge in coastal areas can be detected by this technique.

2.6.6 Hydroelectric projects

Kerala's power is at present purely hydro-based. The major hydro-electric project in the zone is "Sabarigiri" consisting of Pumba and Kakki reservoirs with a power tunnel connecting the two. Sabarigiri project, previously known as the Pumba hydro-electric project with six generating units, is in the Pumba basin and is situated South of the famous Sabarigiri. This project, with an installed capacity of 300 MW, an energy

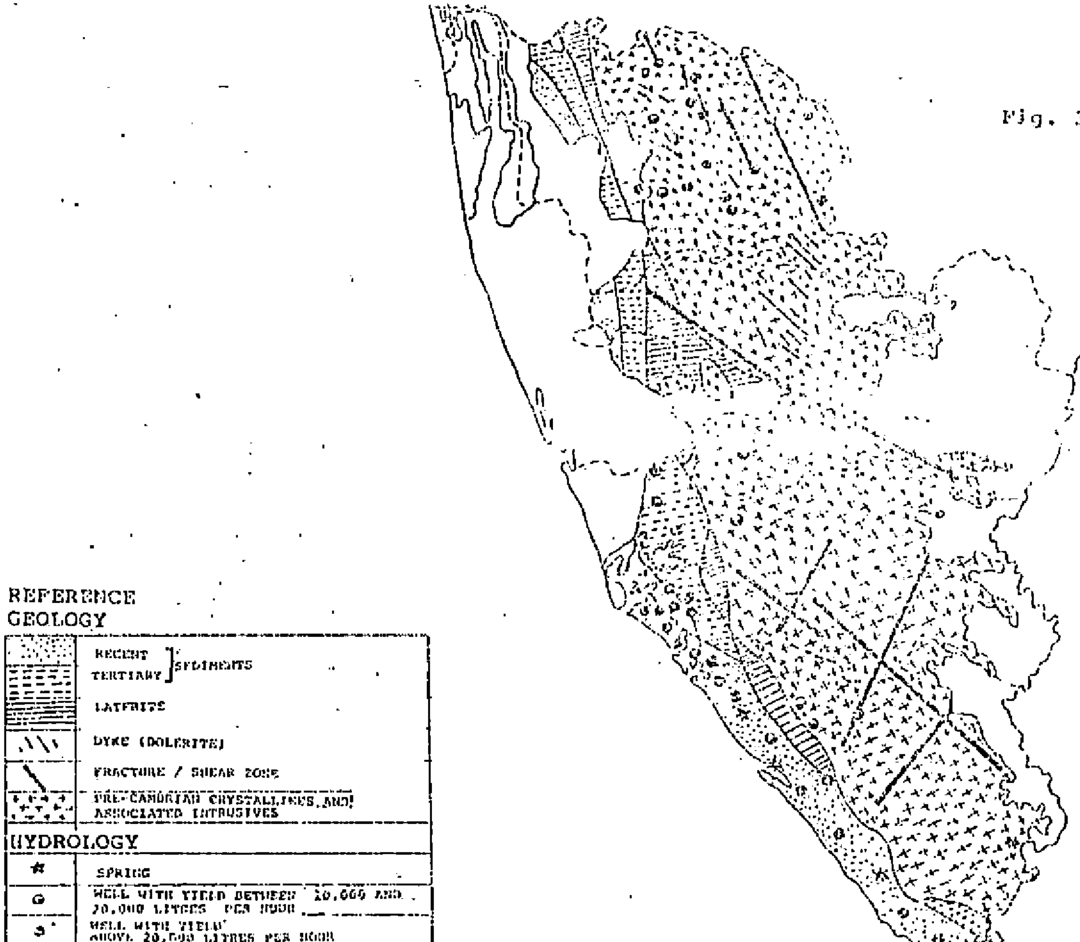


Fig. 39 KERALA (SOUTHERN ZONE)
HYDROGEOLOGY

Source: Resource Atlas of Kerala, Centre for Earth Science Studies, Trivandrum

potential of 1213 MKwh and capable of generating 1402.07 MKwh units, has already been commissioned. Sabarigiri, next to Idukki, is the biggest hydro-electric project in the State in respect of installed capacity and power generation. The power house is situated on the right bank of Moozhiyar, a tributory of Pumba river. With a gross head of 750m (2499 ft) and a firm power draft of 23 cumecs (830 cusecs), about 230 MV of power is developed at 60 per cent load factor. Augmentation of Pumba and Kakki reervoirs of the existing Sabarigiri hydro-electric, project, by diversion of the adjacent streams to generate about 125 M units of power per annum at this power station, is contemplated by the Sabarigiri Augmentation Scheme. The work on dam and tunnel for diversion of upper Moozhiyar water to the Kakki reservoir was completed in 1980 and about 40 M. units of power per annum are additionally generated at the Sabarigiri power station.

The Kakkad hydro-electric project is a tail race development of the existing Sabarigiri project, supplemented by water from the two tributories of Kakkad Aar, namely, Moozhiyar and Veloothodu. The work was started in 1978-79. Power station is located at Seethathode. The installed capacity of the project is expected to be 50 MV with two generation units of 25 MV each. The commissioning of the two units and the completion of the project are expected by the end of 1990.

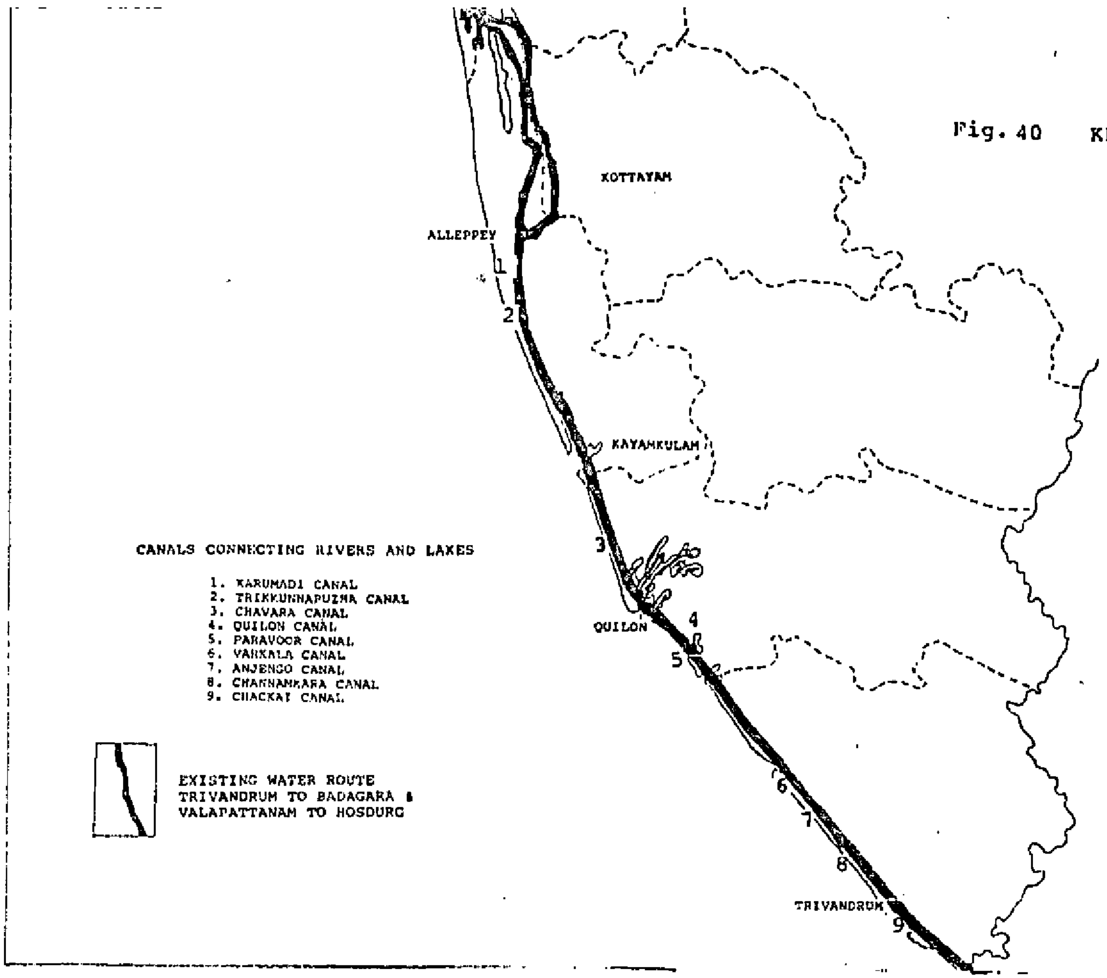
The Kallada hydro-electric project under construction, is a low head scheme with a dam toe power station in the on-going Kallada Irrigation Project for utilising the irrigation water for power generation. Preliminary and enabling works at work site are almost completed. Construction of the power house is in progress. Generation of about 12300KW of power at 60 per cent load factor is expected. The commissioning of the first unit is expected by 1989.

2.6.7 Inland water transport system in the zone

The West Coast Canal from Quilon to Cochin extending to 146km, passing through Kuttanad and the industrial town of Alleppey in the North-South direction forms the backbone of the main water ways of the southern zone. The system consists of a sequence of artificially made link canals connecting the various lagoons and backwaters lying in proximity to the coastal line. Several important points such as Kottayam, Changanassery, Chengannur, Vaikom etc. connect to this main canal system. Most of the rivers in the zone have their outlets in these backwaters and as a natural sequence, the rivers in varying lengths have also formed part of the navigation system. The reach from Alleppey to Quilon is navigable, except the very small stretches like Cheriyazhikal, Karumadi thodu and Chavara thodu which have to be deepened. In Kerala, earliest efforts for inland navigation are traceable in the Malabar area in North Kerala during 1766-1848 and later in the Cochin area during 1840-1870. The first attempts for connecting the backwaters by artificial canals to provide water route from Trivandrum was made during 1860-1880. The first canal opened was the one from Channankara at the southern tip of Anjengo lake to the landing place at Valliakkadavu. Navigation from Trivandrum upto Varkala cliff was thus made possible. Paravoor canal connecting the backwaters at Edava and Paravoor was then constructed along with the canal connecting Ashtamudi and Paravoor lakes. Then came the Chavara canal connecting Ashtamudi with Panmana backwaters. The commercial canal connecting Alleppey town with the backwaters was also attempted. The Anantha - Victoria - Marthandom (AVM canal), an extension of the T.S.Canal from Trivandrum to the South, formed the beginning of this system. The reach between Poovar in Trivandrum district and Colachel, which is now part of Kanyakumari district of Tamil Nadu was completed in 1867 leaving a gap of 8 km between Trivandrum and Poovar. Thus, the entire water route from Trivandrum to Alleppey in the zone and beyond Alleppey could be completed by 1875, leaving a gap of less than 1000 metres at Varkala, located halfway between Trivandrum and Quilon. To complete the water communication system, the Varkala Barrier Canal consisting of open cuttings and two tunnels, had to be constructed. The open cuttings were opened to traffic in 1877 and the tunnels, in 1880. These tunnels have a width of 4.5m each. The longer tunnel is about 700m long and the shorter, about 350m. The tunnels have a height of 5.0m and a draft of one metre only, which allows country crafts to pass. Work on Alleppey-Shertalai canal, though started in 1912, was later abandoned. By 1880, there was a continuous water way from Trivandrum in the South to Badagara in the North of the State, enabling through traffic, touching Alleppey and Cochin. This route came to be known as the West Coast Canal covering 558.3km in the State, of which Quilon to Cochin alone covers 146 km (Fig. 40). Details of the coastal canal system in the southern zone are furnished in Annexure LXXXIV.

In earlier days, the back waters and rivers served as the natural transportation system. Railways and later road transport gradually replaced this. The canal system, rivers and lakes are now mainly used for passenger ferry services with motorised wooden boats and for the transport of voluminous cargo items in country boats manually operated with bamboo poles. The State Water Transport Department (SWTD), the Kerala Inland Navigation Corporation (KINCO) and the Kerala State Road Transport Corporation (KSRTC) are the three agencies actively involved at present in the water transport operations in the State. The Water Transport Department provides regular passenger transport services in the backwaters between Quilon, Alleppey, Vaikom, Kottayam, Kumarakom and Changanassery inter-connecting the many water bound isolated locations of Kuttanad in between. Selected areas in the existing passenger routes in the zone, viz. Kottayam-Alleppey, Alleppey-Changanassery via Moncompu, Thakazhi-Kavalam, Alleppey-Chengannoor including Pulikeezh-Alleppey and Edathua-Alleppey, Mohamma-Kumarakom ferry, Vaikom-Pallippuram ferry, Poothotta-Panavally have to be developed. Landing facilities also need improvement. Most of these routes are along the rivers of Pumba, Manimala and Meenachil and other canals artificially built to interconnect the rivers. During certain seasons, the canals and rivers get clogged with the water weeds - salvinea and water hyacinth, making navigation strenuous. The water way between Quilon and Trivandrum has many obstructions such as bridges, banks and shoals. Many of these small navigable open canals running from North to South were originally designed for small slow moving country boats. The bunds on either side are thickly populated and have profuse vegetation. In many places, wild growth of branching trees blocks traffic in these narrow canals. The dwellers along the banks dump all wastes into the canal. In many places, even small country crafts are unable to move. The stagnant water is dirty and polluted. The canals appear to have been totally neglected.

Fig. 40 KERALA (SOUTHERN ZONE) INLAND WATERWAYS



Near Varkala, the water way crosses several towns and the system of two tunnels having a draft of hardly one metre allowing only the country boats to pass and remaining in a highly neglected condition is the major bottleneck for improving the inland navigation in the zone. Development of the canal system at this point involves high cost.

The West Coast Canal System between Quilon and Cochin is the most important section and carries about 60 per cent of the total tonnage of cargo transported through the inland water ways of the State. In between Quilon and Alleppey, two lakes Ashtamudi and Kayamkulam are in open connection with the sea. Fishermen also use the water ways with their small canoes.

Canal water transport system is the principal and cheaper means of communication enabling not only the distribution of agricultural produce from the areas around the canal but also the needs of industries such as tiles, brick, sand, timber, lime shell, fertiliser, fish, toddy, coir, clay, aluminium, cashew and other raw materials and finished products during day and night. Coconut husk, coir products, hill products of pepper, rubber etc. can thus be transported to the marketing centres at long distances. Coconuts planted in large numbers on the bunds of the water ways form the basis of coir industry which is flourishing in and around the Alleppey town. The main exit for the agricultural produce from Kuttanad is the coastal town of Alleppey. Several coir factories are situated in the urban and suburban areas of Alleppey. Central Coir Board is located at Kalavoor, about 10 km North of Alleppey town. Retted coconut husk needed for coir making is collected from the neighbouring back water areas and are carried to factories through the water ways in country crafts, which also serve to carry the finished products to the coir marketing societies and exporting centres. In and around Quilon, several cashew processing centres operate. The Kerala State Cashew Development Corporation has its headquarters at Quilon. Water transport of raw cashew nut to the factories is cheaper. Toddy tapping in coconut is an occupation of a minority of the population in the zone. Transport of tapped toddy to their destinations is invariably done in canoes. Fishing is another important occupation of the coastal community. The Indo Norwegian Fisheries Project at Neendakara, 15 km

North of Quilon town and several other small fishing industries around Quilon and Alleppey make use of inland water transport facility.

The zone's water ways are at present maintained by the irrigation wing of the State PWD. They are now rendered less serviceable due to want of proper maintenance and also due to increased availability of other modes of quicker transport through road. Side erosions and silting have reduced the draft and traffic. Maintenance of the existing landing places and jetties, side protection works of the canals and also construction of additional link canals are necessary. Many of the canals are shallow and unsuitable for bulk transport by bigger country crafts. Terminal facilities are inadequate. Country crafts are old and leaky and need replacement. In spite of all these limitations, the inland water transport has survived on account of its suitability for moving certain types of cargos over long distances and its low cost factor. Kerala being mostly rural, the inland water ways play an important role in the economic uplift of the rural areas by providing transport connections (especially in water-logged areas, islands etc.), employment for large population, development of fish culture and development of tourism. The State Government has proposed various schemes for solving the bottle-necks in the inland water transport system which have to be implemented by four agencies, the PWD, the SWTD, the KINCO and the KSRTC. The integrated development of the water ways in the zone under the West Coast Canal System is an immediate necessity. A co-ordinated approach should be followed for the development of human settlement and employment centres near and around the water way system. This can lead to better living conditions to the rural population.

2.7. Socio-economic characteristics, land holding pattern

Land reforms in Kerala, introduced in 1969, may be considered as a radical and comprehensive institutional step which changed drastically the land holding pattern of the zone and also of the State. Implementation of the provisions of the Land Reforms Act has resulted in the restriction of ceiling on land holdings. The Act also intended to take over and distribute surplus lands as a result of which the number of large holdings declined sharply. The tenancy reforms, granting ownership (Pattas) to Kudikidappukars (hutment dwellers) helped to increase the number of marginal holdings (below 1.0 ha). Eventhough several landless people have become land owners, agricultural production has not gone up satisfactorily.

Data on the distribution of operational holdings in the districts of southern zone according to the size of the holdings are furnished in Annexure LXXXV. It could be seen from the Annexure that around 93 per cent of the total operational holdings belong to the marginal (less than 1.0 ha) and five per cent, to the small farmers. The remaining two per cent holdings fall under semi-medium, medium and large categories. Percentage number of holdings and percentage of area of operational holdings in the zone compared to those of the State (1980-81) are given in Annexure LXXXVI. In the zone as well as in the State, these values are the highest for the size holdings of upto 0.5 ha. As the size of the holdings increased, the percentage number of holdings and percentage area of holdings progressively decreased. The density of population ranges from 778 persons per sq.km in Kottayam district to 1538 in Trivandrum district. Trivandrum district registers the highest urban density followed by Quilon, the least urban density being recorded by Alleppey district. Rural density is the highest in Trivandrum district followed by Alleppey, least being in Kottayam. The population of the southern zone is 74.43 lakhs. Agriculture and allied activities form the major occupation of the people, except in the municipal and city corporation areas as is clear from the Annexure LXXXVII dealing with the percentage distribution of working population in the taluks under the zone.

The highest percentage (38 per cent) of cultivators is found in Konni block. Vellanad and Vamanapuram blocks have the highest percentage of agricultural labourers (52.0 and 50.9 %, respectively). Among the municipalities in the zone, Pathanamthitta has the highest percentage of cultivators (21.8 per cent), while the maximum concentration of agricultural labourers and people engaged in agricultural activities can be seen in Nedumangad municipality, followed by Varkala. In Trivandrum city and the municipalities of Kottayam and Quilon, "other workers" constitute more than 90 per cent, since service or business form their major occupation, agriculture being only a secondary occupation for them. In the zone, in general, cultivators constitute nearly 16 per cent, agricultural labourers, 27 per cent and household industry workers, 4.7 per cent. Other workers in the zone constitute 52 per cent. These figures are not much different from the corresponding figures for the State, viz. 13, 28, 3.7 and 55, respectively.

Several coir factories, small and big, thriving in and around Alleppey town and the several cashew processing units (27 in Quilon, three in Alleppey and two in Trivandrum districts) employ skilled labourers, mostly women. However, the employment of these women workers in cashew factories is only seasonal, depending upon the availability of raw cashew nuts. Inland and marine fishing is the occupation for nearly five per cent of the population of the zone.

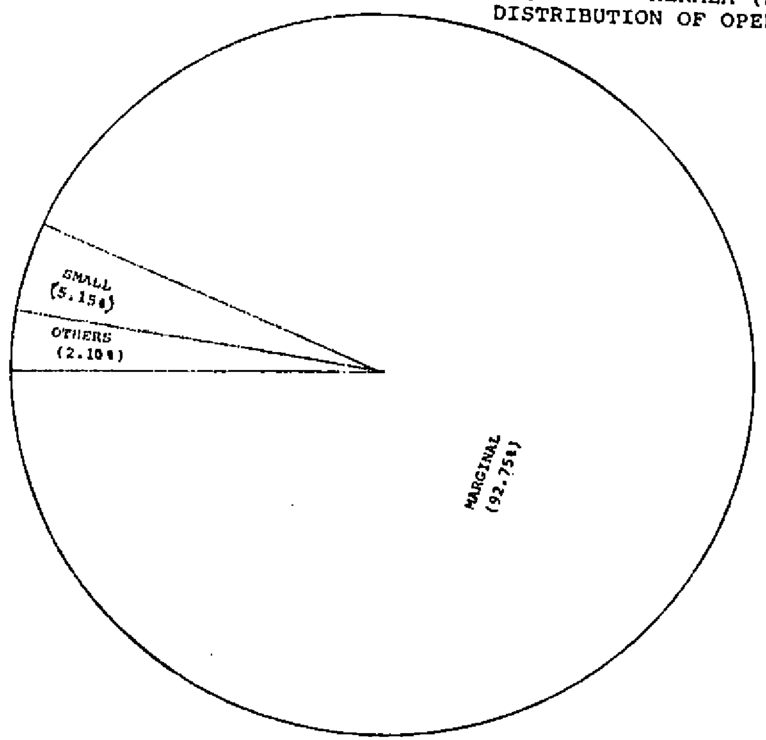
Majority of the population in the zone speak Malayalam, being their mother tongue. A small percentage in Trivandrum district speak Tamil also, since a few settlers are migrants from the adjacent Kanyakumari district of Tamil Nadu. Due to the high literacy rate and the fact that a good number work in government offices and private establishments, more than 40 per cent population of this district has a working knowledge of English also. Business minded people, those interested in small industries and the farmers try to make the best use of the facilities of grant, loans and subsidies available under the unemployment assistance, self employment schemes and other programmes under the nationalised banks, scheduled commercial banks, the regional rural banks, institutions such as NABARD, DRDA etc., co-operative institutions and the government. Various community development programmes are implemented by the blocks in the zone which include the Integrated Rural Development Project (IRDP), Training of Youth for Self Employment Programme (TRYCEM), National Rural Employment Programme (NREP), Rural Landless Employment Generation Programme (RLEGP) etc., in addition to the 20 point programme envisaged by the Government of India. This is one of the factors which has contributed towards the improvement of living standards of the people, particularly in the urban and suburban areas during the past 15 to 20 years. In urban and suburban areas, Agriculture is the secondary occupation for more than 50 per cent of the population due to their engagement in service or business. The main occupation in the rural areas is, however, Agriculture. Migration of labourers and technicians to the other states and areas including the gulf and other countries seeking job opportunities has also contributed towards the better living conditions in the rural and urban areas of the zone.

2.7.1 Holdings

As mentioned earlier, nearly 93 per cent of the holdings in the zone are marginal (less than 1.0 ha) against the State figure of 88 per cent (Fig. 41). About 15 lakhs operational holdings of different sizes exist in the zone which constitute 39 per cent to the State. Large holdings of 10 ha and above are, however, more in this zone, compared to the State figure. Small holdings (1.0 to 2.0 ha) constitute 5.2 per cent of the region which is 7.6 per cent to the State. Only 0.04 per cent of the holdings in the zone are large (above 10 ha). This constitutes 0.1 per cent to the State. The classification of operational holdings is in accordance with the classification prescribed by the District Rural Development Agency. A more detailed classification of the holding size-groups and district-wise percentage distribution of the operational holdings and of the area of operational holdings in the zone relating to the years 1970-71 and 1980-81 are furnished in Annexures LXXXVIII and LXXXIX. Nearly half of the operational holdings in the zone falls under the holding size of 0.5 ha and below, against the State figure which works out to nearly three-fourths.

The total number of operational holdings in all the southern districts has increased during the period 1971 to 1981. The number of holdings in the holding size-groups 0.04 ha to 0.5 ha. has considerably increased in the four districts during this period, while substantial decreases could be observed in the holding sizes above 0.5 ha. The area of operational holdings has increased during the ten-year period in all the districts except Trivandrum. The area pertaining to the different holding sizes from 1.0 ha upto 20.0 ha has, however, reduced except in Kottayam district where an increase could be noticed for the holding sizes between 4.0 ha and 20.0 ha.

Fig. 41 KERALA (SOUTHERN ZONE)
DISTRIBUTION OF OPERATIONAL HOLDINGS (1983-84)



2.7.2 Workers and non-workers

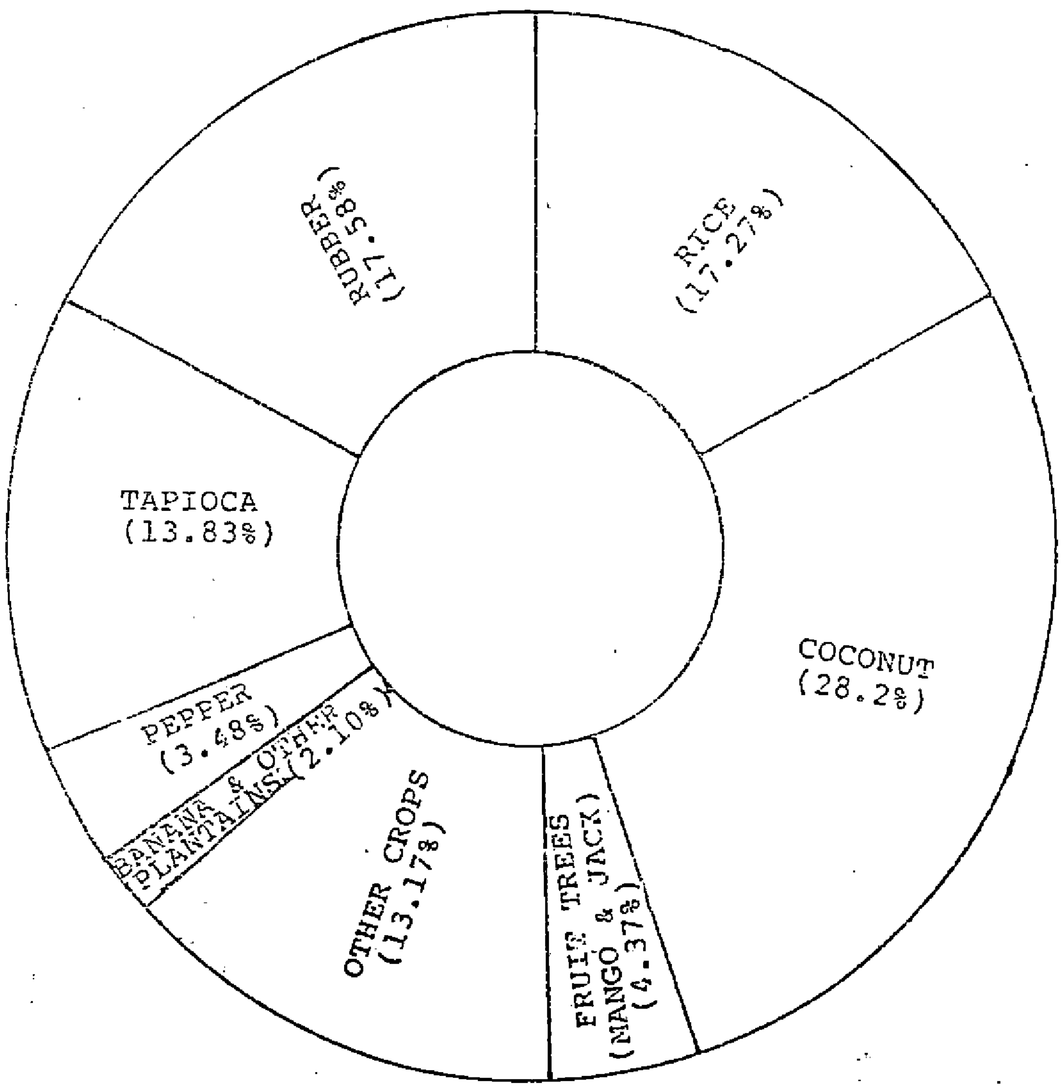
From the data on the block-wise and district-wise percentage distribution of the main workers furnished in Annexure LXXXVII, it is seen that the percentage of the cultivators in the zone constitutes 15.7, which is above the State figure of 13.1. Agricultural labourers and persons engaged in household industries form 27.4 per cent and 4.7 per cent, against the respective State figures of 28.2 per cent and 3.7 per cent.

2.8 Cropping pattern, major crops and crop sequences

In the zone, the total area under different crops is 9,47,383 ha which constitutes 33.05 per cent of the cropped area in the State. The climate, soil type and the physical formation of the zone favour the growth of a large number of cash crops which include plantation crops like coconut, arecanut, cashew, pepper, coffee, tea, rubber; seasonal crops such as rice, tapioca, pulses, sesamum, sugarcane, groundnut and horticultural and spice crops like mango, pineapple, banana, jack, ginger, turmeric, nutmeg, clove and cardamom. However, the major crops are rice, coconut, tapioca, banana and pepper. In higher elevations, rubber is also grown. The details of area under principal crops in the zone are presented in Fig. 42. The cropping seasons for the major crops of the zone are presented in Fig. 43. The main crops cultivated and the percentage to total cropped area in the zone are:

Coconut (267119 ha) (28.2%)	Rice (163573 ha) (17.27%)	Rubber (166509 ha) (17.58%)
Tapioca (131033 ha) (13.83%)	Pepper (32979 ha) (3.48%)	Banana & Plantains (19919 ha) (2.10%)
Cashew (21136 ha) (2.23%)	Arecanut (11759 ha) (1.24%)	Pulses (7561 ha) (0.8%)
Cocoa (9717 ha) (1.03%)	Sesamum (6922 ha) (0.73%)	Ginger (4580 ha) (0.48%)

Fig. 42 KERALA (SOUTHERN ZONE)
AREA UNDER PRINCIPAL CROPS



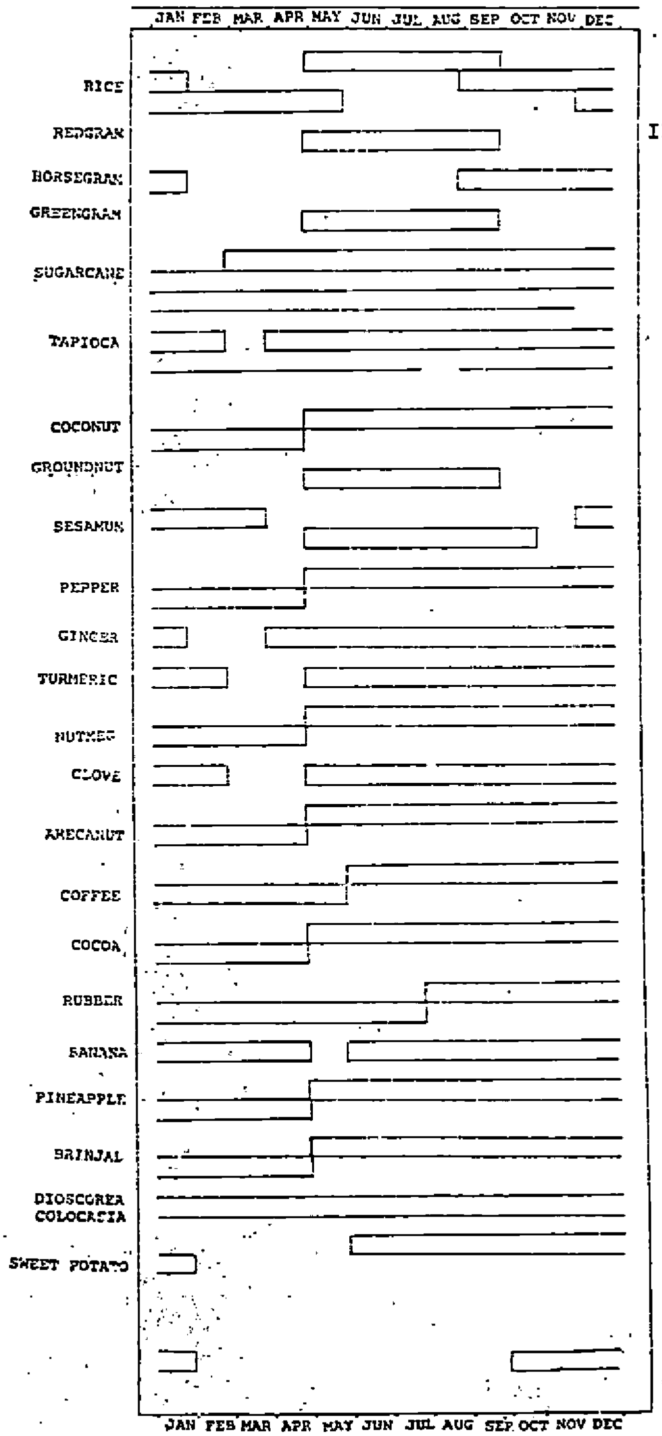


Fig.43
CROPPING SEASONS
IN THE SOUTHERN ZONE)

2.8.1 Cropping pattern

There is a high degree of poly-cropping in the zone, particularly in the midlands and highlands. Paddy is the main food crop in the low lands. The crop combinations and the crop sequences in the highland, midland and lowland presently followed by the farmers of the zone are given below:

Highland

Perennial	-	Rubber, Coconut, Arecanut, Pepper, Cashew etc.
Annual	-	Tapioca, Banana, Yams, Ginger, turmeric etc.
Seasonal	-	Paddy, Pulses, etc.

Midland

Perennial	-	Coconut, Rubber
Annual	-	Tapioca, Banana, Fodder grass, etc.
Seasonal	-	Paddy, Pulses, Vegetables etc.

In the dry land area of the midland and highland sub-zones, mixed cropping pattern is generally followed. Coconut and tapioca are the major crops in these sub-zones. Tapioca is grown on the slopes of small hills also. Annuals like sugarcane, pineapple, fodder grass etc., seasonals like tubers, pulses, vegetables, sesamum and a wide variety of perennials like cashew, jack, pepper, cocoa, clove etc. are invariably seen in the midlands and highlands.

In the wetlands, where rice-based cropping system is followed, the major crop sequences in the three seasons in the order of 1st crop (Autumn) season (Virippu) from May to August, 2nd crop (Winter) season (Mundakan) from September to December and 3rd crop

(Summer) season (Punja) from January to April-May are as follows:

Paddy	-	Paddy	-	Paddy
Paddy	-	Paddy	-	Pulses/Sweet potato
Paddy	-	Paddy	-	Vegetables/Oil seeds
Paddy	-	Banana		
Paddy	-	Tapioca		
Paddy	-	Paddy	-	Fallow

These cropping sequences are followed based on the availability of water. In places where canal irrigation facility is not assured and no other type of irrigation is within the reach of the farmer, the field is kept fallow during the 3rd crop season which falls during summer.

Eventhough a poly-cropping pattern with a mixed stand of various crops with annuals and seasonals is observed in the midlands and the miduplands (highlands) throughout the zone, four major farming systems can be identified as follows:

2.8.2 Rice-based farming system

The rice-based farming system is dominant in the low lands, where sufficient water is available for irrigation. A single crop, two crops or even three crops in a year are raised during the Virippu, Mundakan and Punja seasons, respectivey depending on the availability of water. In kayal (backwater) lands, paddy is raised after draining out the impounded water. During the third crop season, if sufficient water is not available for irrigating paddy, seasonal crops like vegetables such as cucumber, bhindi or amaranthus, pulses or oil seeds are attempted in the rice fallows. If no water is available, the field will be kept fallow till the South-West monsoon appears, ie. till May end. Under rainfed conditions of paddy cultivation, dry sowing is practiced by some farmers. Seeds will be dry sown during April-May expecting the South-West monsoon by early June. Direct sowing and transplanting are popular in the zone. However, farmers prefer direct sowing during the first crop season and transplanting, during the second and third crop seasons. Line planting is seldom done by the farmers as it involves more labour. Under the rice-based cropping system, crop rotation is followed in some locations. Here, the rice fields are utilised for raising banana or even tapioca, as according to some farmers continuous cultivation of paddy might result in the attack by pest and diseases, heavy weed infestation and loss of soil fertility. Hence, some farmers grow banana in lowlands after the harvest of the first crop paddy. After banana is harvested, tapioca is raised or banana is repeated in the crop sequence, after which rice is again grown during the third year. This cropping system is followed by some farmers in Neyyattinkara, Kottarakkara etc. The following cropping sequence is thus:

Rice-Rice-Pulses	- I Year,	Banana	- II Year
Rice-Rice-Rice	- I Year,	Tapioca	- II Year

With regard to paddy, the farmers in the southern districts of the zone prefer to cultivate red kernelled varieties with more straw. Cheradi, a local long duration variety (also known as Kutti Cheradi or Japan Cheradi) apperas to have the above preferential qualities. It is, therefore, popular in the southern districts of the zone particularly during the second crop season although the yield of this variety is not high. However, both high yielding and local varieties are cultivated.

Data on the season-wise coverage by high yielding and local varieties of paddy in the five districts of the zone are furnished in Annexures XC(a) and XC(b). It has to be borne in mind that about 90 per cent of the area in Alleppey district as well as 15 per cent each in Quilon and Kottayam districts do not fall under the southern zone. Of the total 6.78 lakh ha under paddy in the State (1985-86 data), the zone has a share of 24.1 per cent. In the zone, HYVs of rice are cultivated annually in 42.4 per cent of the total rice area. The remaining 57.6 per cent is under local varieties. During the winter season, the HYV coverage in the zone is 27 per cent as against 13 per cent in the State while in autumn and summer, the coverage is 44.9 per cent and 68.4 per cent, respectively against 30.0 per cent and 45.6 per cent in the State. Data on the area and productivity of HYVs furnished in the Annexures XCI and XCII relate to the entire district area, since panchayat-war information are not available at present. In Trivandrum district, HYV coverage during the autumn and winter seasons could be seen following a decreasing trend during the period upto 1982-83. Thereafter, the coverage gradually increased. The data relating to Quilon district for the periods upto 1983-84 are the combined data for the two districts of Quilon and Pathanamthitta, while the data for 1984-85 relate to the two districts separately. Thus, by considering the data for 1984-85 for these two districts together, it can be concluded that HYV coverage during the recent years, in general, followed an encouraging trend in these districts also. Area under HYV in the winter (second crop) season did not increase during the past 10 years in Trivandrum, Quilon and Alleppey districts, while in Kottayam, an increasing tendency was exhibited after 1982-83. Alleppey district recorded a slightly increasing trend over the previous years with regard to HYV during the autumn season of 1984-85, though fluctuations were noticeable in the preceding years. Pathanamthitta district had the largest area (90 per cent) under HYV. Area under local varieties in this district during these two seasons was less when compared to the State average. The HYV coverage during the summer season recorded a downward trend uniformly in all the districts of the southern zone towards 1984-85. The data reveal that the farmers in the southern zone were becoming increasingly aware of the benefit of cultivating HYVs of paddy. An evaluation conducted by the State Planning Board showed that the total area covered by HYVs of paddy in the zone and in the State had increased steadily over the years, more so in the <u>virippu</u> season. The study also indicated that the cost of cultivation of HYVs of paddy was nearly 30 per cent higher than that of the local varieties. Average yield of HYVs was nearly 42 per cent higher than that of the local varieties. The benefit:cost ratio for HYVs is 1.67 as against 1.49 for the local varieties, indicating only a marginal advantage for the HYVs. Net area increase under rice in future is a remote possibility, since large scale conversion of rice fields for cash crops of higher net return has already taken place and continues in spite of the Land Utilisation Order in force which prevents such conversion.

The level of adoption of HYV paddy was more among those whose main occupation was Agriculture and least among wage earners and non-agricultural land holders. Both the number of persons as well as the percentage of area covered under HYVs were relatively more among the larger size holdings. Majority of the rice farmers have small or marginal holdings. Lack of adequate credit at appropriate time, high cost of inputs such as fertilisers, pesticides, weedicides etc., lack of irrigation water during the 2nd and 3rd crop seasons, high cost of field preparation, labour intensive nature of paddy cultivation and increasing cost of labour are the other major constraints in HYV paddy production. As against the 36 per cent share of the total production of rice in 1984-85, the contribution by HYVs of rice in 1985-86 in the State had declined to 29 per cent. This is mainly due to the decline (25.96 per cent) in the total area covered under HYVs during the three seasons. Largest fall (36.17%) in area coverage under HYVs was during the winter seasons followed by autumn (25.46%) and summer (12.61%), compared to the levels in the previous year. Floods in the autumn season and drought in the winter season are the likely constraints in increasing the HYV area in the State during 1985-86. Development of technology for the efficient use of the limited water resources available for irrigation and development of suitable drainage practices for the different situations and agricultural sub-zones in the zone, need attention.

Data pertaining to irrigated and unirrigated area under high yielding and other varieties of paddy in the districts of the zone during the three cropping seasons of 1984-85 are given in Annexure XCIII. Irrigated area under paddy (all varieties) in the zone during the autumn season constituted 5.0 per cent of the total paddy area in the zone and 1.4 per cent of that of the State. Trivandrum and Pathanamthitta districts had larger paddy areas under irrigation during autumn. Unirrigated paddy area dominated in the entire zone during this season, which constituted 95 per cent of the paddy area of the zone and 25 per cent of that of the State. During autumn season, irrigated area under HYV paddy was very low compared to the other paddy varieties irrigated in the zone and also in the State. In fact, HYVs of paddy in the zone were mostly grown in larger areas under rainfed condition. During autumn, South-West monsoon provides sufficient water for the paddy crop and hence, the paddy areas during this season are mostly rainfed. Very often, some of these paddy areas even get flooded thereby creating problems of drainage. Irrigated area under HYVs in the zone during autumn was 0.5 per cent while 99.5 per cent of the area under HYVs was rainfed. Irrigated area under other paddy varieties during autumn constituted 11.1 per cent in the zone while rainfed area constituted 88.9 per cent. During winter season, irrigated paddy area (all varieties) constituted 31 per cent of the total paddy area in the zone and 6.5 per cent of that of the State. Irrigated area under HYVs paddy in the zone constituted 48 per cent to the zone and 15 per cent of that of the State. More than 50 per cent of the total area under HYVs in the zone is rainfed during winter as against 94 per cent in autumn. Sizeable areas under HYVs and local paddy varieties in all the districts of the zone remained irrigated during winter. Irrigated area under other paddy varieties during winter season constituted 24 per cent in the zone as against 11 per cent in the autumn season, while rainfed area constituted 76 per cent. In summer, paddy was grown only in areas of assured irrigation. In Quilon district, in the absence of an irrigation system, no area is cropped to HYVs of paddy in summer. Maximum irrigated area under HYVs in summer was in Pathanamthitta district. In summer, the irrigated paddy area constituted 26 per cent in the zone and 10.5 per cent in the State.

Data on the percentage distribution of season-wise area under paddy-irrigated/unirrigated in the zone during the past five years (1981 to 1986) are given in Annexure XCIV and for the year 1984-85 in Fig.44. Unirrigated paddy area during autumn and winter in all the five districts of the zone remained without much alteration during the past four years and ranged between 70 per cent and 100 per cent, while in summer, the irrigated area under paddy dominated, except in Alleppey and Kottayam districts. In Trivandrum district, irrigated area during autumn remained unchanged during the period 1981 to 1985 while irrigated area under winter and summer seasons increased. Summer area under irrigation increased from 77 per cent in 1982 to 94 per cent in 1985. In Quilon district, irrigated area during autumn decreased from 5.0 per cent in 1982 to zero in 1985. Winter irrigated area increased, while summer irrigated area decreased. In Pathanamthitta district, summer irrigated area in 1985 was 99.5 per cent, while irrigated area in autumn and winter were much less compared to unirrigated areas in that year. In Alleppey district, 99.7 per cent of the area was rainfed during 1985 autumn. Irrigated area during winter increased during 1981 to 1984 with a drop in 1985. Irrigated area in summer was less in this

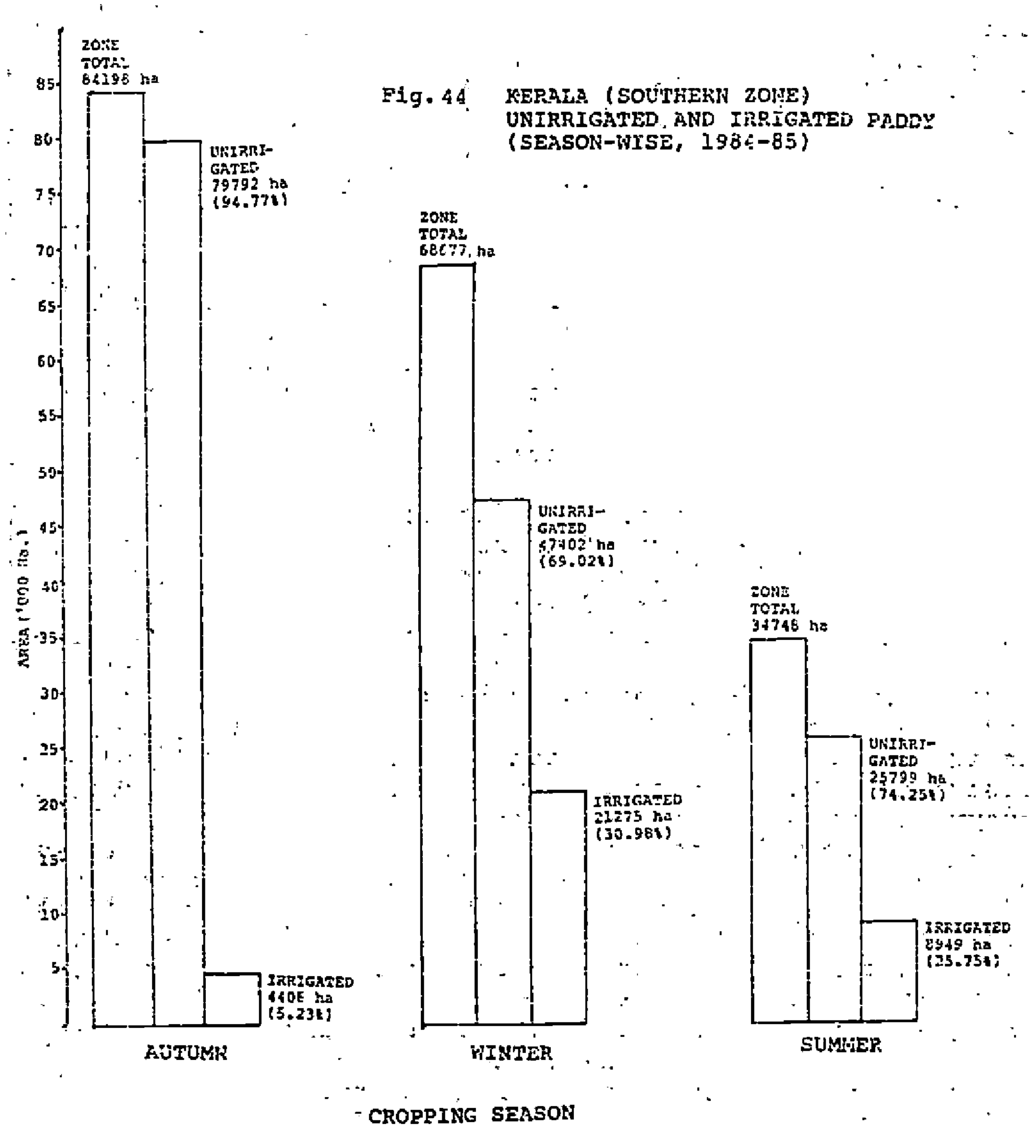


Fig. 44 KERALA (SOUTHERN ZONE)
UNIRRIGATED AND IRRIGATED PADDY
(SEASON-WISE, 1984-85)

district and showed a declining trend (13.5 per cent in 1985). In Kottayam district, irrigated area in autumn was neglegible while in winter, irrigated area increased from 33 per cent in 1981 to 62 per cent in 1985. Summer irrigated area in Kottayam district increased from 1981 to 1985. In the State, irrigated paddy area in autumn though improved during the past four years, was very low (14 per cent). In winter, increasing trends were shown reaching 65 per cent. Irrigated area in the State during summer showed decreasing trend during the years 1982 to 1985 and constituted only 67 per cent during 1985.

2.8.3 Coconut-based farming system

In coconut based farming system, coconut will be the pivotal crop. The system is in vogue in highlands and hill slopes as well as in the level areas in the midlands. This cropping system includes a number of inter-crops like pepper, arecanut, tapioca, cocoa, banana, clove, ginger, turmeric, fodder grass etc. and in some areas, upland rice, pulses and oil seeds. The selection of annual or seasonal crops is made depending on the age of the coconut plants so as to make the best use of the sunshine infiltrating to the plantations for maximum out turn from unit area. HYVs of coconut such as T x D and D x T are also cultivated. However, West Coast Tall which starts yielding in five to six years under good management, is the most popular.

2.8.4 Tapioca-based farming system

The midland and midupland (highland) sub-zones of the southern zone account for about 65 per cent of the tapioca produced in the State. Out of the total area under tapioca, about 40 to 50 per cent is in the form of pure planting and about 30-40 per cent, as intercrop in coconut gardens. In both the situations, the main planting season is April-May which often extends to June, depending upon the distribution of the South-West monsoon. Planting in September-October, synchronising with the onset of North-East monsoon, is also being practised. The crop is grown in a variety of soil conditions. Though M4 is the most popular and most preferred variety under cultivation, a number of local varieties such as Kalikalan, Pannivella, Kayyalachadi etc. are also cultivated. Hybrids such as H-165, H-97, H-226, H-2304, H-1687 (Sree Vaishakhom), H-2304 (Sree Sahya) etc. developed by the Central Tuber Crops Research Institute, Trivandrum have not attained sufficient popularity due to the unawareness of the farmers about these varieties and due to the farmers' preference towards M4 and local varieties. The unstable market conditions result in certain degree of risk in its production as a pure crop. Intercropping with suitable seasonal crops of short duration such as pulses or oilseeds during the early stages of growth of tapioca, when the crop canopy is less, is also practised in some areas.

Increased productivity through cultivation of improved varieties of cassava, adoption of intercropping with groundnut or pulses and introduction of a marketing system through Co-operative Marketing Societies or a regulated market to avoid distress sales by the farmers and exploitation by the middle men can make tapioca cultivation more remunerative. The activities of the CTCRI, Sreekariyam, Trivandrum set up in July 1963, are centered round:

1) Evolving high yielding disease-resistant tuber crop varieties through a global collection of germplasm and hybridisation.

The Institute maintains a total of 1320 germplasm collection of tapioca. High yielding cassava cultivars evolved at this Institute include

H-97 (Mean yield 28 t/ha)
H-165 (Mean yield 30 t/ha)
H-226 (Mean yield 29 t/ha)
H-1687 (Sree Visakhom, mean yield 40t/ha)
H-2304 (Sree Sahya, mean yield 32t/ha)

2) Working out optimum cultural and fertiliser management practices for the different tuber crops and cropping systems.

3) Monitoring and evolving control measures for the pests and diseases.

4) Extension of the benefits of the newly evolved HYVs and their production technology to the farming community engaged in tuber crops cultivation.

5) Research on industrial utilisation and post-harvest technology.

The Institute has adopted 200 farm families under the Lab to Land Programme which showed positive impact of such programmes. A standardised process of preparing ethyl alcohol to the tune of 400 to 420 bulk litres from one ton cassava flour has also been developed. A Tissue culture unit has been set up to take up meristem culture, for developing virus-free plants.

2.8.5 Homestead Farming System

Homestead is an operational farm unit or farming environment in which crop (coconut, tapioca, banana, tree-spices, pepper, vegetables, etc.), livestock, poultry and/or fish production is carried out mainly for the purpose of satisfying the farmer's needs. A complex interaction exists among soil, plants, animals, other inputs and environmental factors in the farmer's plot where he lives and manages.

This type of farming is unique to Kerala, and particularly to the southern zone where farmers utilise the available backyards of their houses for growing a variety of annual and seasonal crops of their own choice. Farmers choose their crops and crop combinations without any scientific basis, the only criterion being their home requirement. Cattle rearing is alo undertaken in many homesteads, particularly in the suburban and rural areas as a complementary enterprise. "Crop + livestock" is almost the general rule in homestead farming. More than 50 per cent of the cultivated area in the zone is under homestead cultivation, where marginal and small farmers have coconut or tapioca as the main crop which is intercropped with a variety of perennials, annuals and or seasonals. The area may vary from 0.02 ha to 1.0 ha. Homesteads raised in areas exceeding 1.0 ha are not uncommon. The different perennials include jack, mango, cocoa, pepper, nutmeg, clove, etc. and the annuals include different cultivars of banana, pineapple etc. Different vegetables, minor tubers, pulses etc. are the seasonal crops seen in this multi-tier system. This system is in vogue in the zone as the agro-climatic conditions favour the raising of a wide variety of crops. In some homesteads, mixed farming (crop-livestock or crop-livestock-fish) is practised by farmers, where the waste from one can be recycled to serve as food for the other. The increased productivity of homestead garden needs more attention, particularly for the small holdings of the marginal and small farmers, since these constitute more than 50 per cent of the cultivated area in this zone.

2.8.5.1 <u>Bee keeping</u>

The role of bees in improving the income from homesteads through increased yields of agricultural and horticultural crops apart from the value of honey and bee-wax needs consideration. Honey bees help the farmers in increasing the yield of crops by helping in pollination. They provide honey and bee-wax which are much valued. The income derived by way of increased crop yield by assisted pollination by bees is much higher than the value of honey harvested. Bee keeping provides part time employment to the farmers maintaining colonies. The approved agency for the distribution of bee boxes and for the popularisation of apiculture in the zone is the Khadi and Village Industries Commission which supplies mostly the ISI-A type 8 frame bee box. The price fixed for the bee box is Rs.250/-, under 50 per cent subsidy. Private agencies also handle the distribution of bee boxes.

The hive bee, <u>Apis cerana indica</u> is the domesticated honey bee in the zone. Data on the honey and wax production in the zone during 1985-86 and 1986-87 are given in Annexures XCV(a) and XCV(b). There were 1,28,532 colonies during 1986-87 with an annual yield of 11,70,381 kg of honey valued at Rs.1,87,26,096/- and 5791 kg wax valued at Rs.1,73,730/- in the zone. Honey production in the zone was 44 per cent to the State and bee-wax production, 54 per cent. Apart from the domesticated honey bees, the rock bees (<u>Apis dorsata</u>) in the forests and nearby areas in the zone also yield honey. Crops like pumpkin, cucumber, snakegourd, bittergourd, melon, guava, pomegranate, coffee, etc. require agents like honey bees for fruit and seed set. Introduction of short term crops in the cropping patterns in the homesteads can provide adequate food to the bees throughout the year. Bees are affected badly by the extremes of weather conditions. Pests, predators and diseases are serious problems to the bee keepers. Irrational use of pesticides is deleterious to the honey bees and aggravate the situation which in turn affects the farmers.

2.8.5.2 Gobar gas plant

The State Department of Agriculture and the Khadi and Village Industries Commission (K & VIC) are the two main agencies in the State actively involved in assisting in the erection of bio-gas plants of different sizes in the homesteads, providing the benefit of central subsidy prescribed by NPBD. About 80 per cent of the gas plants commissioned by the State Department of Agriculture are of 3.0 cu m capacity, while the average capacity of gas plants commissioned through the K & VIC is 4.0 cu m. About 95 per cent of the gas plants commissioned by the State Department of Agriculture are of "fixed dome" type also known as the Janatha plants, while K & VIC erect the "floating type". The data on the distribution of bio-gas plants in the zone during 1983-1987 are furnished in Annexure XCVI.

2.8.6 Other farming systems

In certain isolated parts of the zone, farming systems with banana, arecanut or pepper as the main crop, also exist.

Though Kerala grows a variety of perennial, annual and seasonal crops, only eight perennial crops are very important. They are coconut, arecanut, rubber, pepper, cashew, cardamom, tea and cocoa. Among the annual crops, tapioca, yam, colocasia, sugarcane ginger, turmeric, banana and other plantains are important. Among the seasonal crops, paddy, pulses and vegetables are important. In growing the seasonal and annual crops, the farmers are adopting cultivation of crop varieties depending upon their preference to them. A sizeable portion of the cultivated area is under mixed crops. About 80 per cent of the cultivated area is occupied by seasonal and annual crops in the zone, the main constituent being tapioca. A base line survey conducted by the Nutrition wing of the Health Services Department in 1978-79, revealed that the average daily consumption of roots and tubers per adult was 167.8 g.

2.9 Area, production and productivity of the major crops

2.9.1 Rice

Separate taluk-wise/block-wise data on the area and production of agricultural crops grown in the zone are not available for compilation in this report, except in the case of paddy for which taluk-wise data (1975-76 and 1985-86) are given in Annexure XCVII. In Alleppey district, about 90 per cent of the cropped area and in Quilon and Kottayam taluks, about 15 per cent in each, do not belong to the zone. The data relating to area, production and productivity furnished in the Annexure, however, pertain to the entire area of the five districts of the zone including the portions in these districts which do not belong to the zone.

Area under paddy in the zone during 1971 was 2,26,575 ha and rice production, 3,66,785 tonnes. In 1976 the area increased by three per cent and production, by five per cent; but in 1981, a reduction in area by 15 per cent and in production by 14 per cent could be noted. In 1982, there was a marginal increase in area by 3.5 per cent and production, by 10.4 per cent. The area under paddy in 1982 which was 2,04,215 ha. decreased in 1985 to 1,87,622 registering a decrease of 18 per cent. In 1986, a further decrease of 13 per cent in area was noted. Compared to the 1971 figures, the area under paddy in 1986 decreased by 28 per cent and rice production showed a decrease of 16.6 per cent. When compared to the just previous year, the area decreased by 13 per cent and production by 12 per cent in 1986. Inspite of the reduction in the area under paddy, the per hectare production of rice increased during these years. The productivity of paddy was 1605 kg per hectare in 1971 which progressively increased to 1743 kg per ha. in 1984 to 1851 kg in 1985 and to 1869 kg in 1986, against the

State average yield of 1632 kg in 1974, 1720 kg in 1985 and 1729 kg in 1986, showing better performance in the zone over the State. The area under paddy in the zone in 1971 which was 25.9 per cent to the State and rice production which was 28.3 per cent to the State remained almost steady, ranging between 24 per cent and 28 per cent during the past 15 years. Production of rice has been stagnant while population has been growing, resulting in a widening gap between the internal production and requirement. The present level of production in the zone and also in the State is less than 50 per cent of the internal requirement which necessitates dependence on supply from outside the State.

The taluk-wise and season-wise break up of the area under paddy, rice production and productivity of paddy during 1976 and 1980 to 1986, given in the Annexure XCVII indicate the following:

The area under paddy during the three seasons in all the taluks in Trivandrum district, except the autumn crop in Chirayinkil taluk, decreased appreciably during the 10 years from 1975 to 1985. In Chirayinkil taluk, the area under paddy during the summer season which was 651 ha in 1976 came down to just 14 ha in 1985. In the districts also, the area under paddy in the three seasons recorded appreciable decrease. In Quilon district (erstwhile) which also includes the major portions of the present Pathanamthitta district, the autumn season paddy alone showed increase in area during the years 1975 to 1980. Thereafter, the area progressively reduced in all the taluks in this district till 1985. In Alleppey district which has only two taluks under the zone, paddy area decreased in both the taluks, Chengannur and Shertalai. In Chengannur, increase was seen till 1983; and decrease later on. Summer paddy area rapidly declined right from 1976 onwards. Shertalai taluk had no area under summer paddy. In Kottayam district, the paddy area during autumn decreased after 1982. Decrease in winter paddy area was noted even from 1976. Summer paddy area which was 17,482 ha in 1976 reached 5,816 ha in 1985, ie., reduced to one-third during 10 years, with more than 50 per cent reduction during 1976 to 1981. In this district, Kanjirappally taluk had the least area under paddy during autumn and winter and no area during summer. In Kottayam and Vaikom taluks, winter paddy area decreased; but autumn paddy area had increased. Summer paddy grown in 2,069 ha in 1976 in Vaikom taluk progressively decreased to 411 ha in 1981 and to 16 ha in 1985. In Meenachil taluk also, the summer paddy area which was 440 ha in 1976 came down to 21 ha in 1985. In general, in the zone, the area under paddy reduced during the past 10 years ending 1985. In the State also, area has decreased.

In Neyyattinkara taluk, autumn paddy productivity increased from 2,312 to 2,887 kg per ha during the years 1982 to 1985. Winter paddy productivity also increased; but could not reach the 1976 figure of 2,759 kg/ha. Though paddy area during summer reduced in this taluk, producitivity followed an encouraging trend in the years 1984 and 1985. In Trivandrum taluk, while autumn and winter paddy productivity increased to 3,084 and 2,300 kg/ha respectively in 1985, the productivity during summer declined. In Nedumangad taluk also, summer productivity of paddy reduced while the productivity increased during the autumn. In Chirayinkil taluk, the productivity figures during the years 1976 and 1985 remained without much change, though fluctuations were seen in between these years. Summer productivity, however, declined from 1,225 kg/ha in 1976 to 870 kg/ha in 1985.. In the Trivandrum district, in general, paddy productivity during the autumn season progressively increased to 2,761 kg/ha in the year 1985 which is above the State figure of 2623 for that year. Winter paddy productivity, though was better (2,368 kg/ha) compared to previous years, was less than the State figure and failed to reach the productivity for the year 1976 which was 2,595 kg/ha. Summer paddy productivity, though increased during 1981 to 1983, declined progressively reaching 1,419 kg/ha in the year 1985 as against the State productivity of 2,993 kg/ha for that year.

Kunnathur taluk under Quilon district recorded the maximum productivity of 2,743 kg/ha in 1982 which rapidly decreased to 1,681 kg/ha in 1984 with slight improvement during 1985. Winter producitivity had also the same trend of changes. Summer productivity during 1985 was satisfactory though fluctuations were seen in the preceding years. In Pathanapuram taluk, autumn productivity increased during 1976 to 1983 touching

3,525 kg/ha; but decreased during 1984 and 1985. Summer productivity of 3,338 kg/ha in 1983 also showed decreasing trend. In Quilon district, in general, autumn productivity showed increases till 1983, after which it declined, while winter productivity was found more or less steady during the past 10 years. Summer paddy productivity, however, decreased. For the taluks under the present Pathanamthitta district, data for the year 1985 alone are available. Adoor and Thiruvalla taluks (portions only belong to the zone) recorded uniformly higher productivity during the three seasons in 1985. Summer paddy productivity in Adoor was 4,505 kg/ha while Thiruvalla recorded 4,487 kg/ha. These high figures indicated that these taluks had potentially productivve paddy areas. In Alleppey district, the autumn paddy productivity in Chengannur taluk increased upto 1984 and dropped during 1985. Winter season productivity was high till 1982; but decreased in later years with 2,638 kg/ha in 1985. Productivity of summer paddy, however, was encouraging. In Shertalai taluk, winter productivity showed gradual decreases after 1981, while that during the autumn season showed improvements over the past 10 years. The taluk had no paddy cultivation during summer seasons. In portions of Alleppey district falling within the zone, in general, the productivity improved except the winter paddy in Shertalai taluk. In Kottayam district, the productivity improved in all the four taluks falling within the zone, except in Vaikom taluk where the productivity during the summer decreased appreciably after 1983, and in Kottayam taluk where the productivity of the autumn crop decreased during 1985. Kanjirappally taluk had very limited paddy area. The taluks in the zone with paddy productivity more than 3000 kg/ha were Adoor, Thiruvalla and Kottayam. In the State, in general, increased paddy productivity during the three seasons could be observed during the part 10 years.

2.9.2 Other crops

Annexure XCVIII and Figs. 45 to 48 give the data pertaining to area, production and productivity of major crops grown in the zone. The area under most of the crops, except rubber declined in the zone although productivity of many crops were maintained without appreciable drop.

Fig. 45 KERALA (SOUTHERN ZONE)
AREA, PRODUCTION AND PRODUCTIVITY
OF PRINCIPAL CROPS 1971-1985
RICE, COCONUT, TAPIOCA, BANANA

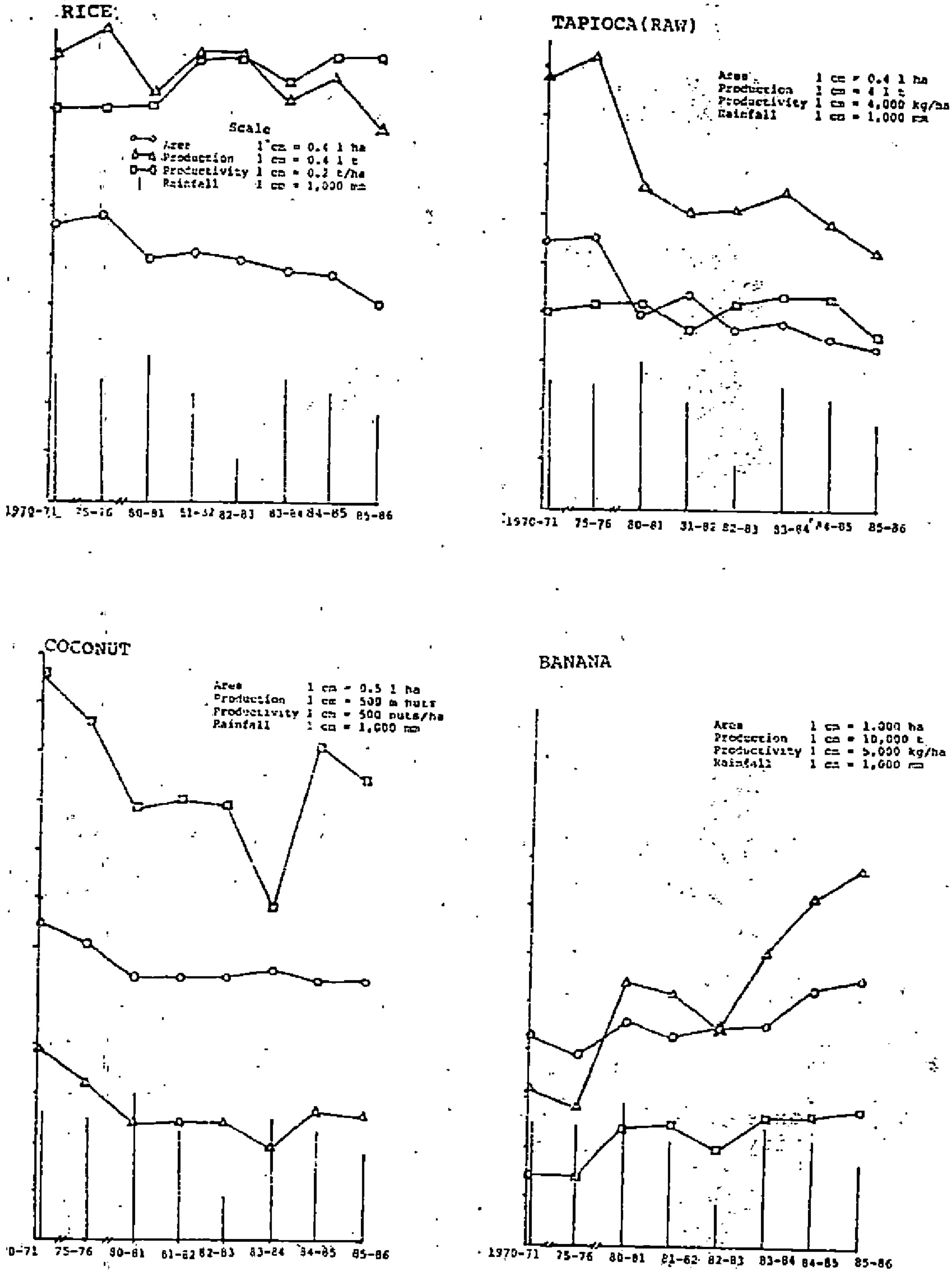
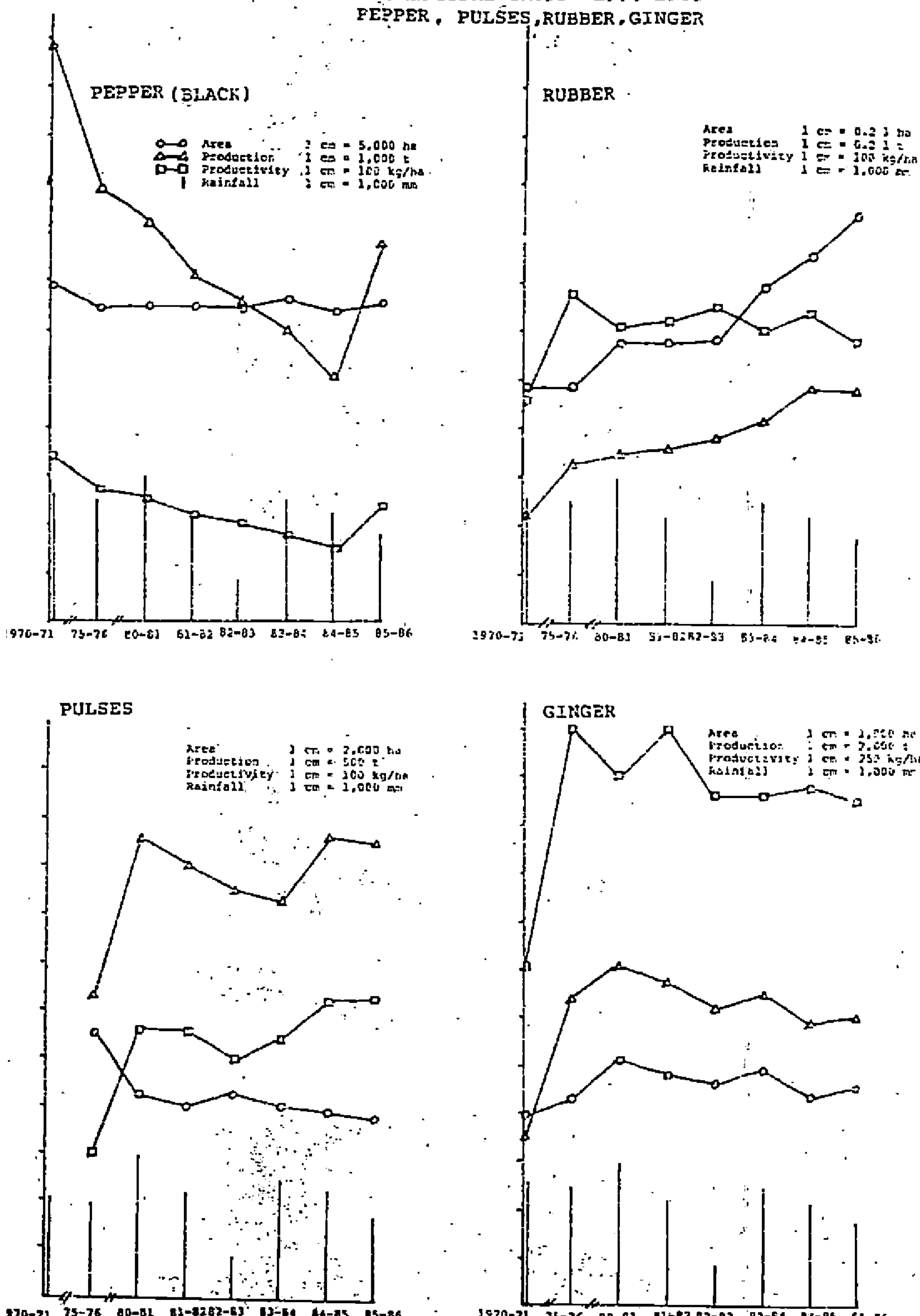


Fig. 46 KERALA (SOUTHERN ZONE)
AREA, PRODUCTION AND PRODUCTIVITY
OF PRINCIPAL CROPS 1971-1985
PEPPER, PULSES, RUBBER, GINGER



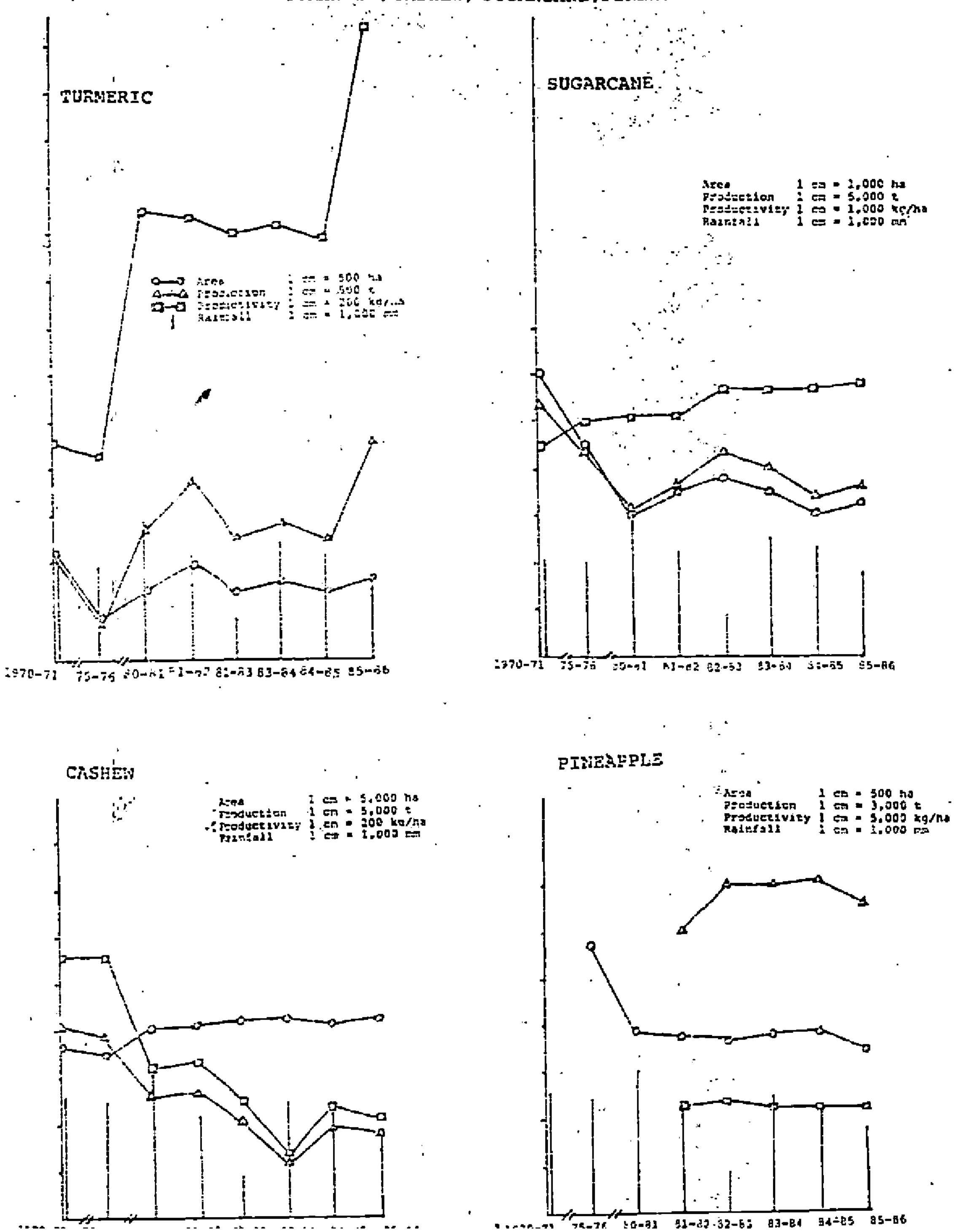
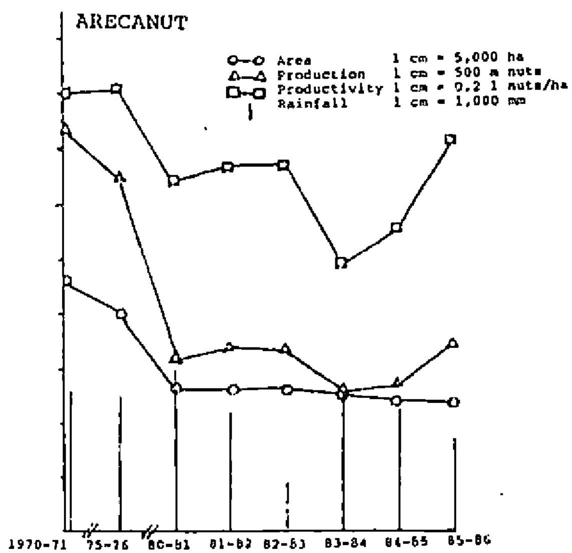
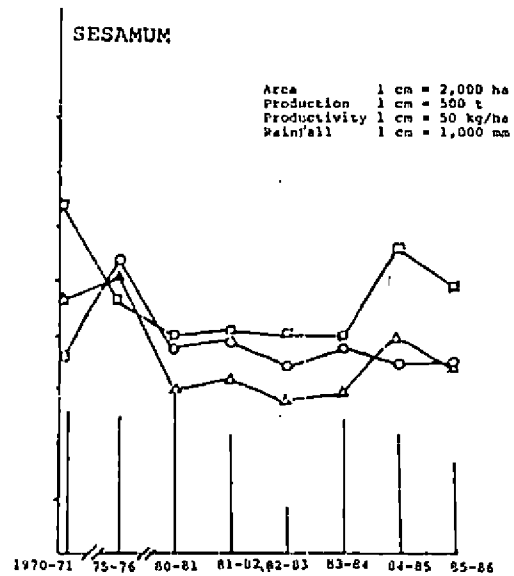


Fig. 47 KERALA (SOUTHERN ZONE)
AREA, PRODUCTION AND PRODUCTIVITY
OF PRINCIPAL CROPS 1971-1985
TURMERIC, CASHEW, SUGARCANE, PINEAPPLE

Fig.48 KERALA (SOUTHERN ZONE)
AREA, PRODUCTION AND PRODUCTIVITY
OF PRINCIPAL CROPS 1971-1985
ARECANUT, SESAMUM





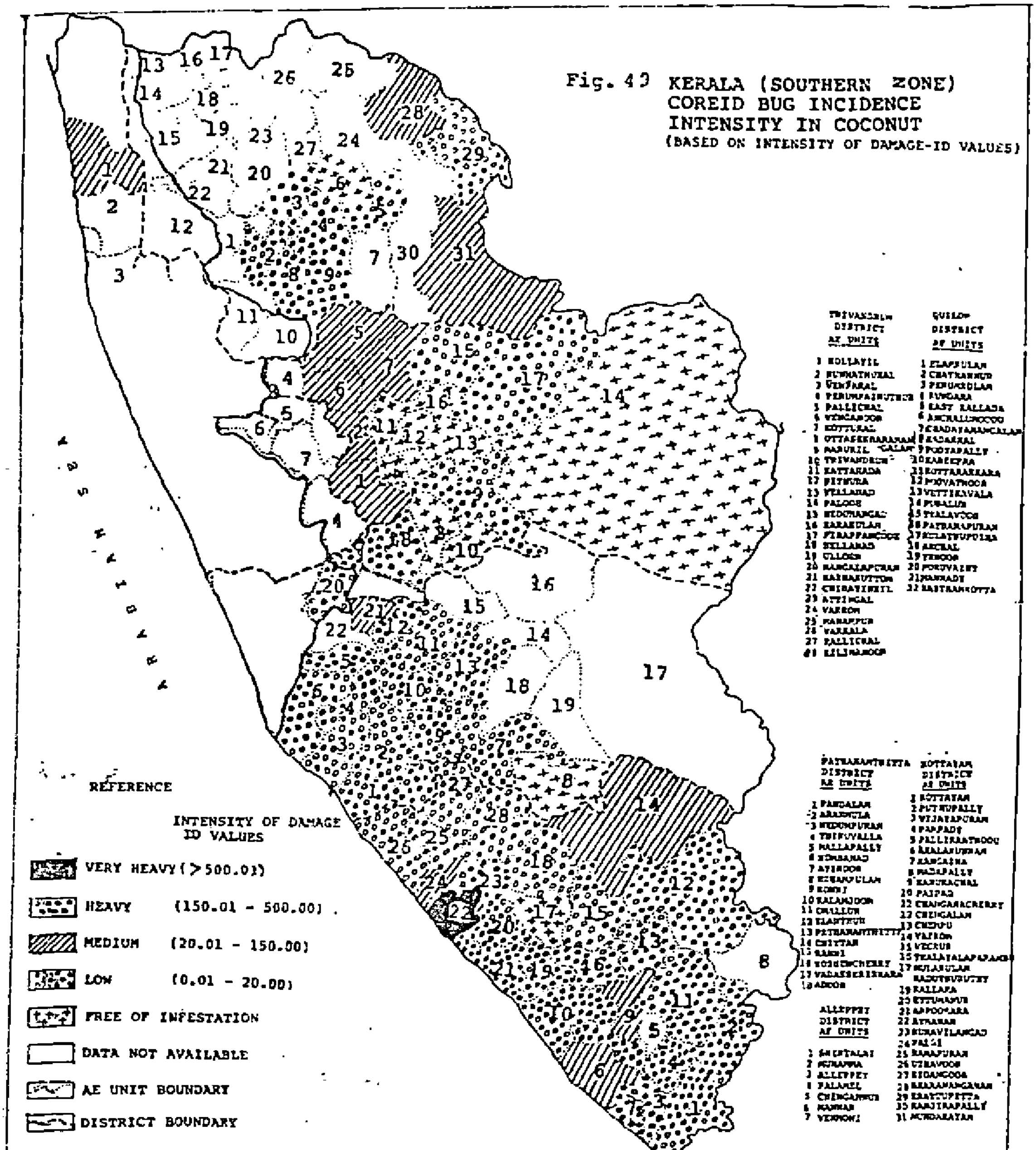


Fig. 49 KERALA (SOUTHERN ZONE) COREID BUG INCIDENCE INTENSITY IN COCONUT (BASED ON INTENSITY OF DAMAGE-ID VALUES)

Source: Dept. of Agrl. Entomology, College of Agriculture, Vellayani

The area under coconut which was 3.26 lakh ha in 1971 in the zone reduced to 2.67 lakh ha in 1986, recording a reduction of 18 per cent, while in the State the reduction was only 2.0 per cent. Sharp decline in the production and productivity were noted in 1985-86 in the zone and in the State. The root (wilt) disease affecting coconut palms in some parts of the zone and the acute drought which occurred during 1983 might have affected the area and productivity of this remunerative crop. In the zone, the decline in the production of coconut can also be ascribed to the attack by coreid bug at flowering and during the early stages of development of the nuts. The attack leads to severe button shedding and poor development of the nuts. The intensity of incidence of coreid bug on coconut, based on ID values arrived at after a detailed survey, is given in Fig. 49. Very heavy incidence is reported at Chirayinkil (Trivandrum district) and heavy in Vijayapuram (Kottayam district). The area under coconut in the zone which was 45 per cent to the State and production of nuts which was 48 per cent to the State in 1971 reduced to 38 per cent to the State in 1986.

Tapioca:

The area under tapioca as well as production of the crop decreased during the past 15 years. The area and production in the zone which were 74 per cent and 76 per cent to the State, respectively in 1971, decreased to 65 per cent of each to the State during 1986. The productivity of tapioca which was 16,181 kg/ha in 1971 increased by 477 kg/ha in 1976 and further increased by 804 kg/ha in 1984 with maximum productivity level of 17,462 kg/ha during 1984. However, in 1985, the productivity declined by 467 kg/ha from the preceding year and in 1986, further declined by 709 kg/ha.

Sweet potato:

This crop also followed more or less the same trend with regard to area and production. The area under sweet potato in the zone constituted 5.0 per cent to the State in 1986. The area under sweet potato which was 416 ha in the zone in 1976, reduced to 241 ha in 1986, recording a drop of 42 per cent in 10 years. Production and productivity declined after 1983, attaining a low productivity level of 5,581 kg/ha, in 1986 which was 34 per cent less than the State productivity of 8,444 kg/ha.

Banana:

Area cropped to banana and its production increased in the zone (20 per cent and 42.5 per cent, respectively) and in the State (15 per cent and 22 per cent, respectively) during the past five years. The productivity in the zone in 1985 increased by 15 per cent to the State and in 1986, by 8.0 per cent to the State.

Other plantains:

The area cropped to other plantains and their productivity in the zone had gone down during the past five years by 9.0 per cent and 6.5 per cent, respectively. The productivity level of 4,188 kg/ha in 1986 in the zone was 5.0 per cent higher than that in the State. The productivity, in general, showed a slightly decreasing trend after 1984.

Pepper:

Area and production of pepper decreased in the zone during the past 15 years. Area was 34,478 ha in 1971 constituting 29 per cent to the State. In 1986, the area decreased to 32,979 ha (4.0 % decrease) while the area in the State increased by 3.0 per cent during the past 15 years. Production of black pepper in the zone which was 11,857 tonnes in 1971 constituting 47 per cent to the State, decreased to 8,893 tonnes in 1976 constituting 36 per cent to the State and further decreased to 7,792 tonnes in 1986 constituting to 23 per cent to the State. The decrease in production in the zone during 1971-76 was 25 per cent, during 1976-81 was 7.0 per cent and during 1981-86 was a further 6.0 per cent, while in the State, the production increased from 25,029 tonnes in 1971 to 33,121 tonnes in 1986 registering a rise of 32 per cent over a period of 15 years.

The productivity of pepper in the zone was low r when compared to that of the State during the past five years.

Rubber:

Area and production of rubber considerably increased during the past 15 years in the zone and in the State. The area in the zone constituted 50 per cent and the production, 52 per cent to the State in 1986. The productivity of rubber in the zone was always higher than that in the State. When compared to the previous years, the productivity showed slight decrease in 1986, both in the zone and in the State.

Cashew:

Area under cashew remained without much change in the zone. The productivity level of 1122 kg/ha in the year 1971 was maintained by the zone and the State till 1976. Thereafter, the productivity dropped to 632 kg/ha in 1981, 464 kg/ha in 1985 and 414 kg/ha in 1986. Area under cashew and production of raw nuts in the zone which were each 18 per cent to the State, also decreased to 15 per cent and 11 per cent, respectively to the State in 1986.

Sugarcane:

Area under sugarcane in the zone which was 79 per cent to the State in 1971 came down to 41 per cent in 1986. Area under sugarcane in the State increased marginally during the past 15 years while area in the zone suffered considerable drop. However, the productivity in the zone as well as in the State increased during these years, maintaining nearly steady figures during 1984, 1985 and 1986. The zone recorded higher productivity compared to the State.

Cocoa

The percentage of area under cocoa in the zone to the State which was 51 during 1981 rose to 58 in 1986 at 59. Area under cocoa decreased; but the productivity went up from 150 kg/ha in 1981 to 371 kg/ha in 1986 in the zone. The productivity in the State also increased from 128 kg/ha in 1981 to 361 kg/ha in 1986.

Ginger:

Area under ginger in the zone which was 32 per cent to the State in 1971 increased to 41 per cent in 1981; but dropped to 29 per cent in 1986. Area in the State, however, increased by 29 per cent during the last 15 years. Productivity of ginger in the zone increased from 1,780 kg/ha in 1971 to 2,992 kg/ha in 1976; but thereafter showed slightly decreasing trend and maintained steady at 2,627 kg/ha in 1986. The State productivity of ginger, however, increased progressively during 1971 to 1986 touching 2,837 kg/ha in 1986. The higher productivity in the zone over the State seen in earlier years reversed after 1984.

Turmeric:

The area under turmeric decreased during the past 15 years from 1,130 ha in 1971 to 708 ha in 1985 with slight improvement in 1986. Substantial increase in turmeric production was noticed in 1986, resulting in an increased productivity in the zone by 37 per cent over that of the State during that year. Productivity of turmeric in the zone and in the State during 1980 to 1985 remained the same. In 1986, however, productivity in the zone exceeded the State productivity. During that year, 37 per cent of the total production in the State was from the zone.

Pulses:

Area under pulses in the zone which accounted for 31 per cent to that of the State in 1976 decreased to 25 per cent in 1981 with marginal increase in 1986 in the zone, reduced during the last 10 years with the least area 7,561 ha recorded in 1986. Productivity of pulses in the zone, however, progressively increased during the past 10 years and reached maximum of 625 kg/ha in 1986 as against the maximum of 721 kg/ha in the State. State productivity was higher than the productivity in the zone during these years. Production of pulses in 1986 in the zone was 4,723 tonnes as against 20,475 tonnes in the State constituting 23 per cent to the State. Production in the zone in 1976 was 3,154 tonnes which increased to 4,856 tonnes in 1981 with not of much change till 1986. Pulse production in the zone is low and practically the entire requirement in the zone is at present met from other States. The extension of area under pulses cultivation in the zone therefore needs active consideration.

Arecanut:

Area under arecanut in the zone which was 27 per cent to the State remained unchanged in 1976 but reduced to 21 per cent in 1981; but later increased to 27 per cent during the year 1983 to 1986. Production level in the zone which was 29 per cent to the State in 1971 reduced and steadied at 15 per cent to the State in 1981 which continued till 1986 at the same level. Productivity of arecanut in the zone and in the State decreased during the years 1976 to 1982 but thereafter, appreciably increased, reaching highest productivity of 1,43,975 nuts in the zone and 1,81,697 nuts in the State in 1986.

Pineapple:

Productivity figures for pineapple in the zone are available from 1981 only. Area and production of pineapple in the zone were not much altered during 1982-1985. In 1986, however, both the area and production dropped whereas the State figures remained steady. Area under pineapple in the zone in 1986 was 36 per cent to the State and production of pineapple, 33 per cent to the State.

Betel vine:

Details of area cropped to betel vine from 1976 are available; but not the production details. The area under the crop in the zone was 45 per cent to the State in 1976 and increased upto 49 per cent in the later years; but dropped to 45 per cent in 1985 and to 40 per cent in 1986. Area in the zone cropped to betel vine progressively reduced during the past five years and reached the lowest level of 444 hectares in 1986.

Sesamum:

Sesamum cultivation is restricted to Onattukara area falling under the Alleppey and Quilon districts, during rabi. The Onattukara sandy areas are, however, not covered by this zone. Area under sesamum which was 64 per cent to the State in 1976, reduced to 51 per cent in 1981 and further reduced to 48 per cent during the past five years. Productivity also decreased; but the years 1985 and 1986 showed improvement. The productivity in the zone was lower than that of the State during the last five years. Of the total sesamum production in the State, the zone accounted for 46 per cent in 1986. Area under sesamum in the zone constituted 48 per cent to the State.

Fodder grasses:

Area under fodder cultivation in the zone in 1971 was 197 ha which increased in 1976 to 341 ha, rose to 1401 ha in 1981 and dropped to 1126 ha in 1986. In the State also, the area under fodder followed the same trend. Production details are not available for discussion in this report.

Coffee:

Area under coffee in the zone reduced from 2,361 ha (7.5 per cent to the State) in 1971 to 1,391 ha in 1981 (2.4 per cent to the State) which continued till 1986. In 1986, however, marginal increase in area in the zone was noted. In the State, however, the area under coffee progressively increased from 31,564 ha in 1971 to 41,778 ha in 1976, to 57,949 ha in 1981 and to 65,641 ha in 1986. Productivity in the zone was 392 kg/ha in 1986, which was low. Productivity figures for the zone were higher than the State figures during all these years. However, coffee production in the zone during 1986 constituted only 3.0 per cent of the State's total production.

Tea:

The major tea producing area in the Idukki forest region which was part of the Kottayam district, was separated into Idukki district in January 1972 and hence, the area under tea in the zone as given in the Annexure is seen abruptly reduced to 5,032 ha after 1970-71. Though the area marginally increased to 5,344 ha in 1981, it later decreased to 4,455 ha in 1986. In the State, the area under tea progressively decreased during the past 10 years. The productivity of tea reduced from 493 kg/ha in 1976 to 400 kg/ha in 1981 with not much of change thereafter. However, only 3.0 per cent of the State's total production of tea was accounted by the zone.

Lemongrass:

The area under lemongrass in the zone remained without much decrease during the past five years. Productivity of lemongrass oil in the zone was much higher when compared to that of the State during those years. In 1986, the productivity of oil was 70 kg/ha in the zone as against 49 kg/ha in the State. Production of lemongrass oil in the zone in 1986 was only 3.0 per cent to that of the State indicating that this is not a major crop in the zone.

Cardamom:

As in the case of tea, cardamom is mainly grown in Idukki forest areas (parts of Kottayam district, now in Idukki district) which are not included in this zone. The southern zone had no area under cardamom in 1976, when the total area under cardamom in the State was 54,004 ha. In 1981, the zone had 275 ha under cardamom with a production of 16 tonnes of processed cardamom. The area increased to 335 ha. in 1982 which remained unchanged till 1986, while the production gradually decreased to 9.0 tonnes. Productivity also decreased. The zone was seen less productive with regard to cardamom when compared to the State during the past five years with productivity reduced to 27 kg per ha as against the State figure of 55 kg/ha in 1986. Cardamom area in the zone constitutes only 0.5 per cent to that of the State and the production 0.27 per cent to the State, showing that cardamom is not a major crop in the zone.

The cropping density of rice, coconut, tapioca and banana are depicted in Figs. 50(a) to 50(d). Such maps have been presented also for pepper, rubber, cashew and sugarcane [Figs. 51(a) to 51(d)].

Others:

In 1986, tamarind, mango and jack were cultivated in the zone in 3,326 ha, 20,903 ha and 20,508 ha, respectively. Area under tamarind constituted 30 per cent of that of the State while mango and jack each constituted 35 per cent. Production of tamarind and mango in the zone during 1986 constituted 29 per cent and 20 per cent, respectively to the State, while jack fruit production was 53 per cent to the State. The area and production of mango decreased progressively during the past five years while those of tamarind were not much altered. Though jack fruit production indicated a decreasing trend, the area under jack remained more or less steady. The productivity of tamarind remained steady while that of mango and jack declined during the past five years. The productivity of tamarind and mango in the zone were low when compared to those of the State, while that of jack was high. These crops are grown in several homesteads in the zone.

2.9.3 Social forestry

Under this programme, the residual capacity of the nutrient rich soil is utilised for achieving the objectives of eco-restoration and production of small wood, fuel, fodder and green manure. Farm forestry is a major component of social forestry representing 81 per cent of the total tree planting programme and envisages planting of forest trees which are adaptable to the phyto-environment in homesteads and crop lands, barren lands, interspaces in agricultural crops, bunds, canal banks, road sides, school compounds, rail lines, etc., without detriment to the yield from agricultural crops grown. Production and distribution of various plant seedlings to the public through voluntary agencies such as Sastra Sahitya Parishad, Mahila Samajams, Social Forestry Clubs, Fine Arts Societies etc., raising of school forestry parks, demonstration plots and tribal welfare activities are also included in the programme. Trivandrum, Quilon, Pathanamthitta, Alleppey and Kottayam are the five Social Forestry divisions in the southern zone under the Kerala Forest Department, with 11 Ranges as noted in Table 31.

Table 31. Social Forestry Divisions and Forest Ranges in the zone

Division	Ranges
Trivandrum	Neyyattinkara Trivandrum Attingal
Quilon	Quilon Punalur
Pathanamthitta	Pathanamthitta Ranni
Alleppey	Alleppey Chengannur
Kottayam	Kottayam Ponkunnam

Each division is under the charge of an Assistant Conservator of Forest and each range is under a Range Officer. The main schemes under which the activities are undertaken are:

1. World Bank Scheme
2. National Rural Employment Programme (NREP)
3. Small and Marginal Farmers' Scheme
4. Rural Fuel Wood Scheme
5. Rural Landless Employment Generation Project (RLEGP)
6. Tribal Medicinal Pilot Scheme
7. Flood relief

Though there are common activities in all the schemes, each has specific objectives as governed by the guidelines issued under the new 20 point programme.

Production and distribution of seedlings to the public, planting in government lands and institutional compounds, raising of avenue and strip plantations, maintenance of older plantations and raising fuel plantations for the tribals are the activities of the World Bank Scheme.

NREP is a centrally aided scheme, wherein food grain is given as part of wages. The scheme intended primarily for giving employment to the rural poor with special attention to Scheduled Caste/Scheduled Tribes. Raising of nurseries for the production of various seedlings for distribution to the public, raising plantations in government lands, and avenue plantation/strip plantation along roadsides, railway lines etc., raising social forestry parks to induce awareness of tree planting among the public, raising of medicinal plants etc. are the activities.

The centrally sponsored Small and Marginal farmers assistance scheme intents to assist small farmers by supplying the seedlings (at least 25% shall be those of fruit trees) free of cost so that trees can be grown without altering the land use pattern and help in meeting the fodder and fuel wood needs.

Under the Rural Fuel Wood Scheme which is also centrally sponsored, raising of fuel wood species to meet the demand of the public, raising of such plantations in government lands and institutional compounds, raising of nurseries, production and distribution of seedlings to the public, raising belt plantations, strip plantations, avenue plantations etc. are the activities undertaken. In the various locations, the species are selected with due regard to the local conditions and preferences. The plant species distributed / planted are listed in Table 32.

Tribal Medicinal Pilot Scheme envisages cultivation of medicinal plants in the forest land.

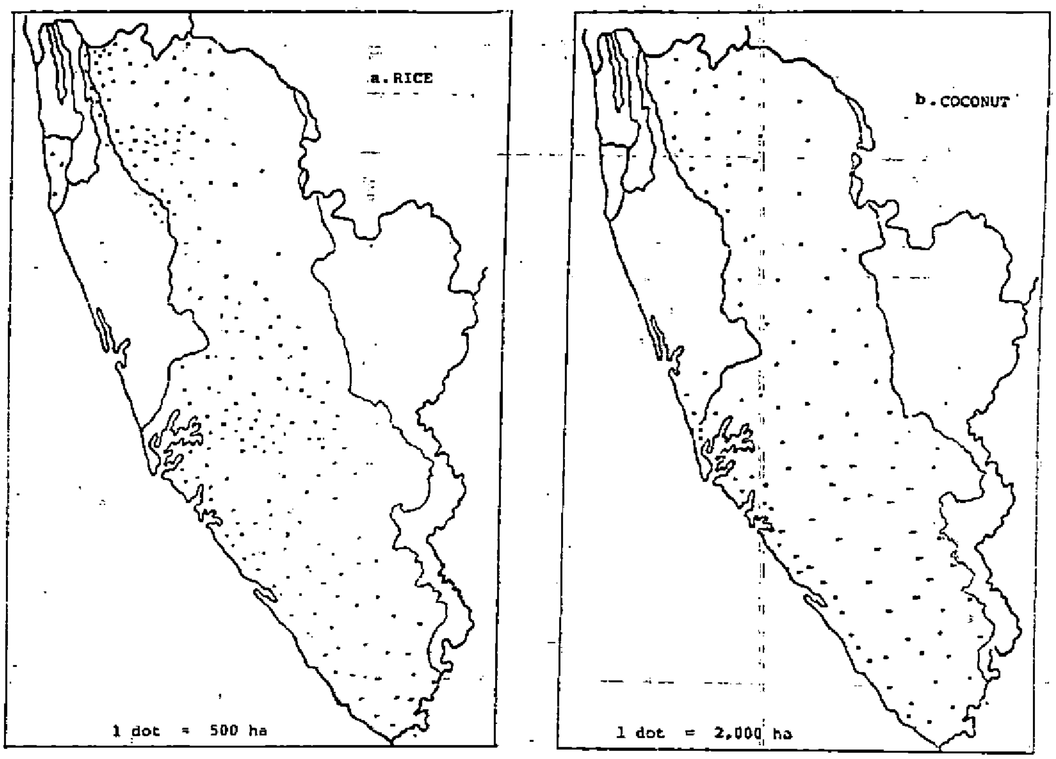
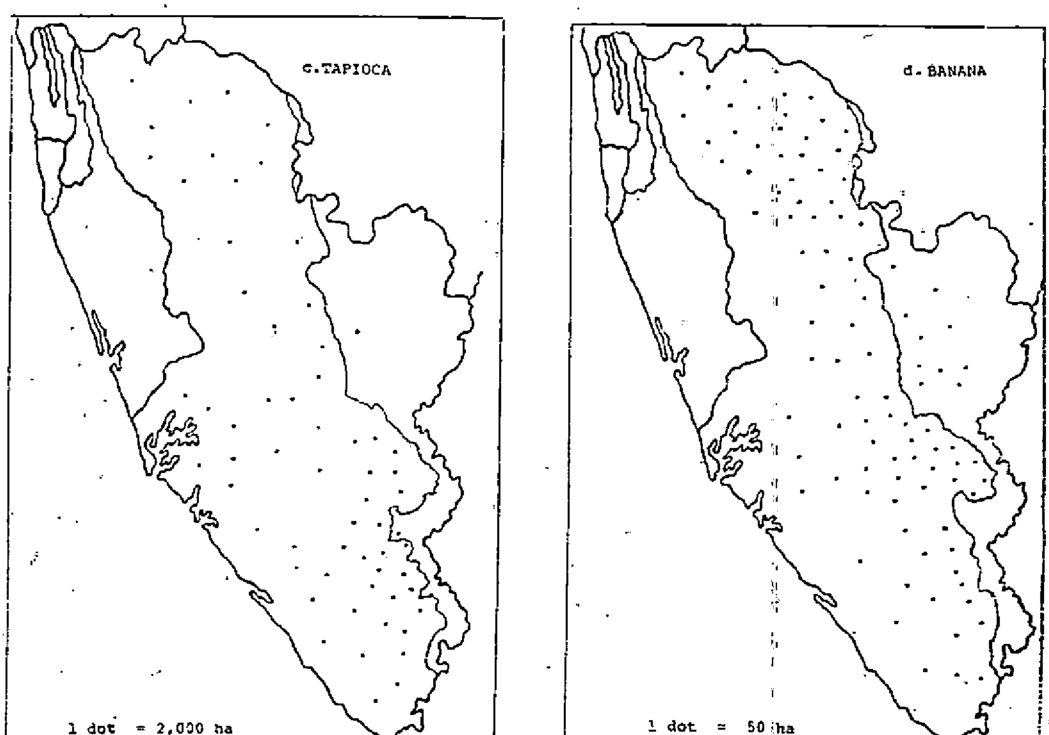


Fig. 50 CROPPING DENSITY



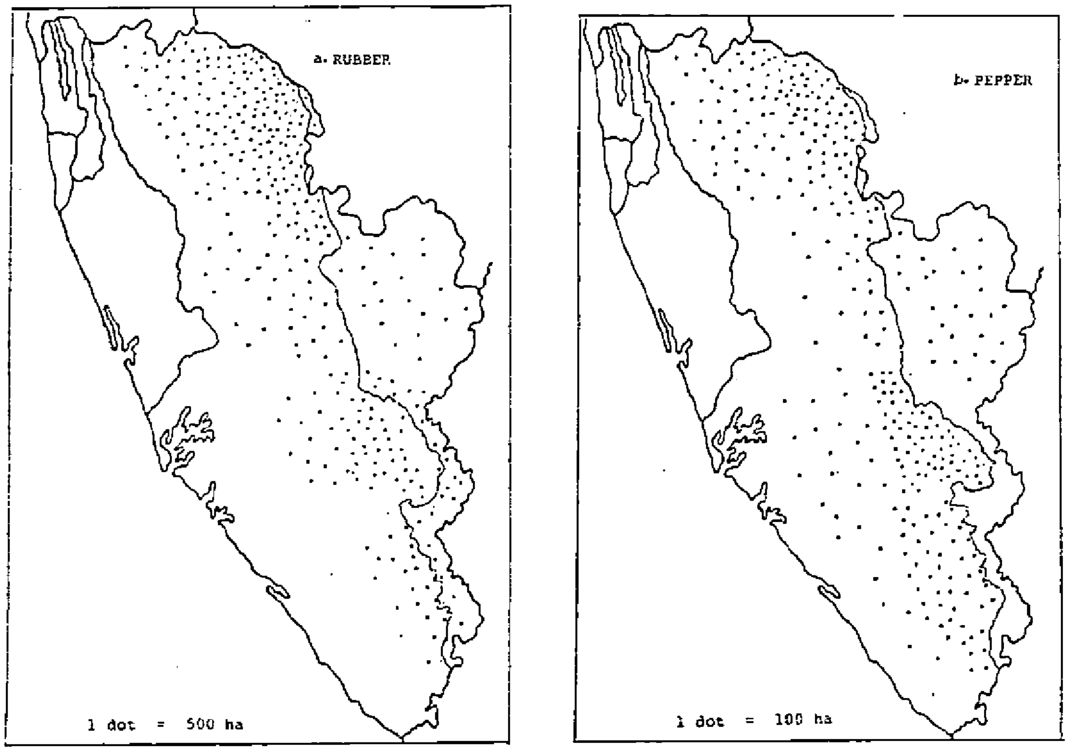


Fig. 51 CROPPING DENSITY

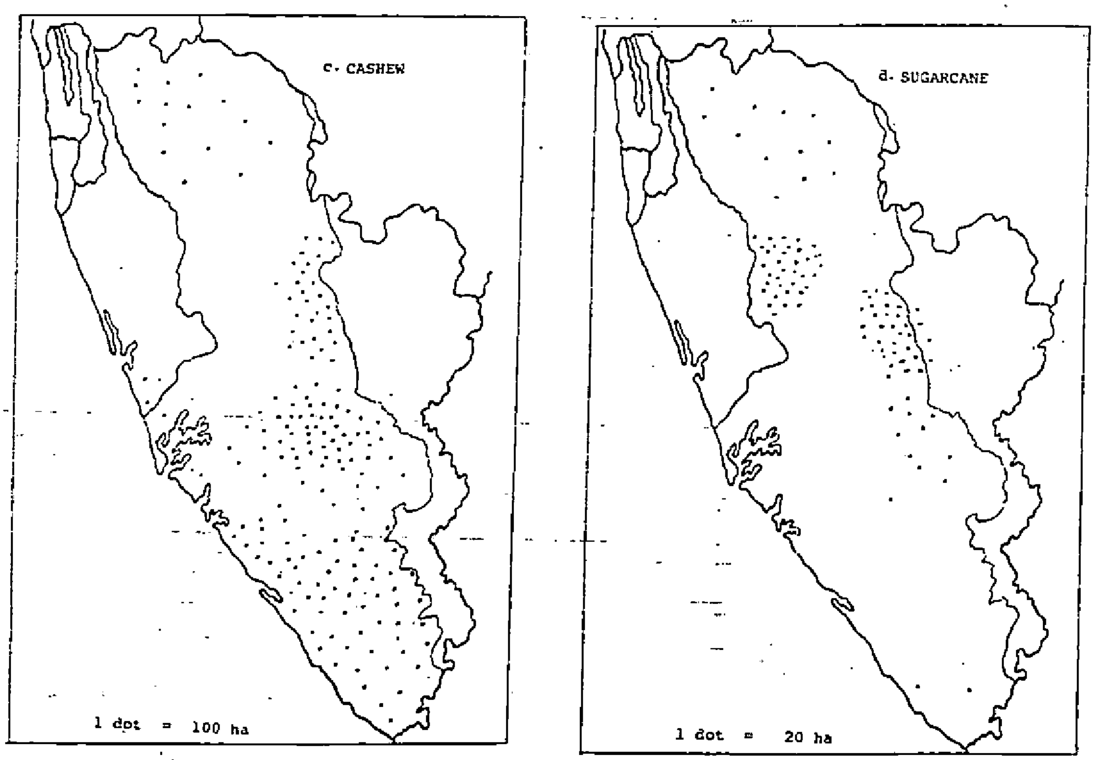


Table 32. Plant species distributed / planted under the State Social Forestry Programme

Botanical name	Local name
Ailanthus triphysa	Matty
Casurina equisetifolia	Kattaadi
Albizia falcataria	Peelivaka
Leucaena leucocephala	Subabul
Tectonia grandis	Teak
Eucalyptus tereticornis	Eucalyptus
Eucalyptus citriodora	Eucalyptus
Grevillia robusta	Silver oak
Acacia auriculiformis	Karnapatri
Swietenia macrophylla	Mohogany
Azadirachta indica	Vepu
Cassia fistula	Kanikkonna

Data on the physical targets and achievement during 1984-87 under the different schemes on Social Forestry in the southern zone under the Department of Forests are furnished in Annexures XCIX(a) to XCIX(c).

2.10 Horticultural status

The agro-climatic situation in the zone is favourable for the cultivation of several horticultural and plantation crops of economic importance. Species like clove, nutmeg, cinnamon etc. are cultivated in many homesteads in the midland and highland sub-zones. Cardamom is, however, restricted to the colder zones in the eastern parts of the zone adjoining the Western Ghats. Fruit trees such as mango, jack, citrus, guava sapota etc. are invariably found distributed throughout the zone. These crops find places as intercrop along with coconut in many homesteads. Cocoa, ginger, and turmeric are the inter-crops grown in many homesteads. Pepper is a dollar earning crop and different local varieties are grown by farmers in larger areas and also in homesteads. High yielding pepper variety Panniyur-1, is yet to gain sufficient popularity in the zone. Pineapple is seldom cultivated as pure crop on a large scale, eventhough the climatic conditions are favourable. This crop is seen rarely scattered in some homesteads. Betelvine cultivation is attempted with some success in parts of Neyyattinkara taluk and Nedumangad taluk. Cultivation of sugarcane is restricted to Mavelikkara, Thiruvalla and Pandalam taluks, where M/s. Travancore Sugars & Chemicals Ltd. and M/s. Mannam Sugar Mills consume major portions of the produce. Sugarcane Research Station under the Kerala Agricultural University is functioning at Thiruvalla. Cultivation of sugarcane is also attempted at Kalanjoor and nearby Panchayats in Pathanamthitta district. Red Banana is a rare variety cultivated exclusively in the southern parts of the zone, as a pure crop and this variety fetches high value in the market. Nendran banana has also high market value and is cultivated on large scale. Other varieties grown include Palayankodan, Poovan, Monthan, Robusta, Njalipoovan, Padatti etc. However, bunchy top disease is a major constraint in increasing the production. Vegetable cultivation including pulses is practiced in the uplands and in summer rice fallows of assured irrigation in the taluks of Neyyattinkara and Nedumangad. The present production of vegetables is insufficient to meet the full demand in the zone and sizeable quantities are procured from the neighbouring state of Tamil Nadu. There is great scope for vegetable production in the zone. Cashew is a promising crop of the coastal tract and midland zone. Large scale cultivation of cashew and better management of the existing cashew plantation have to be attempted since raw cashew nuts are of great attraction in view of the several cashew processing units situated in the Quilon district. In these factories, the job available to the several women workers employed in the processing work, depends solely on the availability of raw nuts. Even after import of raw nuts in addition to indigenous collection, these skilled women in large numbers get only seasonal work. Technology has to be developed for the proper utilisation of the ripe cashew fruits now going as waste. However, feny and alcohol are made on a small scale and with success, though potentiality exists in its utilisation for making jams and jellies also. The Department of Agriculture, Kerala has cashew plantation at Kottarakkara. Another material of vast potentialities is the coconut water. Considerable amounts are being wasted. Research work on the processing of coconut water for various uses will be helpful to the large scale coconut cultivators.

increased cultivation. Ornamental plants suitable for the humid, tropical climate need popularisation along with orchids, foliage plants and flowering plants.

Tropical Botanical Garden and Research Institute, Palode

The Institute was started under the Government of Kerala with the objective of establishing a botanical garden-cum-arboretum and for promoting research and developmental studies relating to medicinal plants and other plants of economic importance. The garden and the attached research institute are located at Palode, 40 kms. North-East of Trivandrum city, at the foot hills of the Western Ghats. The Institute has the following research and developmental activities.

Plant Bio-technology Laboratory

The Laboratory is intended for advanced research in cell genetics and plant genetic engineering. Micropropagation of rare species and superior hybrids of orchids, production of desirable hybrids and mass multiplication of rare and important medicinal plants, ornamental plants etc. are the other activities. The Institute has a collection of medicinal plants with about 600 different species.

Herbarium

The Institute has a collection of more than 5000 mounted specimens and over 9000 duplicates of vascular plants and other century old specimens.

Herbal garden

A collection of 1600 plants belonging to 600 species, grouped according to their therapeutic properties, is maintained by the Institute.

Orchidarium

The Institute has a collection of more than 1200 plants including rare endemics and important hybdrids.

Ornamental plants

The Institute has a collection of over 1000 roses, several varieties of flowering and foliage plants and their wild relatives.

Arboretum

More than 1000 specimens have been introduced and planted in an area of 15,000 sq. m.

Germplasm centre and seed bank

Germplasm collection and preservation are being attended to.

Plantation Corporation of Kerala Limited, Kottayam

The Corporation has been functioning since 1963 as the largest Public Sector Undertaking, cultivating rubber and cashew. There are seven rubber estates and four cashew estates under it. The total area under rubber is 7,300 ha and under cashew is 6,020 ha spread throughout the State. The Corporation runs on profit. The Corporation is proposing to expand its activities to industrial sector such as setting up of a furniture manufacturing unit, a chain of rubber based small scale units and a feny distillery to make use of the ripe cashew fruit.

Oil Palm (India) Limited, Yeroor

This was started as a subsidiary of the Plantation Corporation of Kerala Ltd. in 1969 to serve as import substitution of edible oil, particularly in view of the consumer acceptability of imported palm oil. This became an independent company in 1977 with share participation by the Governments of Kerala and India at 51:49. After clear felling of trees in the forests of Yeroor, Kulathupuzha and Chithara panchayats, oil palm planting has been completed in 3,820 ha, consisting of 2,044 ha. in Yeroor estate, 776 ha. in Kulathupuzha estate and 1,000 ha. in Chithara estate. The crude red palm oil produced in the local factory is marketed to soap, vanaspathy and lubricant manufacturers. During the past three years the annual production of crude palm oil from pulp alone was as follows:

1984-85	1985-86	1986-87
540 t	975 t	1275 t

Intercropping with oil palm has been found to be not feasible because of possible soil erosion, grazing cattle and harvesting of oil palm affecting the intercrops.

2.11 Agricultural Engineering Status and Constraints

Mechanisation in Agriculture in the State has been rather slow compared to other parts of India. The indigenous agricultural implements so far being used by farmers are being replaced slowly by improved implements such as, bose ploughs, mould board ploughs, disc ploughs, threshers, bund formers, puddlers, seed drills, harvestors, winnowers, plant protection equipment, irrigation implements etc. A Research Testing and Training Centre, functioning at Vellayani, Trivandrum district under the State Department of Agriculture is engaged in the design and development of improved implements. The Centre has also modified the traditional implements and developed newer ones. The implements developed by private firms and local mechanics are also tested in the Centre and approval issued for standard items. The Department of Agriculture, the Kerala Agro-Industries Corporation and the Kerala Agro-Machinery Corporation are handling the distribution of improved implements and equipment to farmers on subsidised rates. Data on the distribution of pumpsets (oil and electric), ploughs (wooden and iron) and power tillers and tractors distributed for agricultural purposes in the zone are furnished in Annexure C. The total number of diesel and electric pumpsets in the zone during 1982 was 10,410 (10.5 per cent to the State) as against 5,375 (9.8 per cent to the State) in 1977 and 3427 (12.5 per cent to the State) in 1972, recording appreciable progressive increase in consumption in the zone during the ten year period ending 1982. Though the increase in pumpsets is noted in the zone, the percentage to State with regard to the number of pumpsets in 1972 which was 12.5 has come down to 10.5 in 1982 indicating lesser consumption compared to the other zones of the State. The Annexure giving details of ploughs in the zone would indicate that the number of iron ploughs and wooden ploughs was the highest in Quilon district in 1977 and 1982 and the least in Kottayam district. Wooden ploughs and iron ploughs in the zone constitute 12.5 per cent and 49 per cent, respectively to the State. There is considerable reduction in the number of wooden ploughs during the years from 1972 to 1982 in the districts as well as in the zone. The number of iron ploughs registered an increase during 1972 to 1977 and a decrease during the next five years, probably due to the decrease in the rice area. Details of distribution of tractors and power tillers in the zone according to 1982 census furnished in the Annexure indicated highest number (285) of power tillers distributed in Kottayam district while in the case of tractors, Alleppey district with 71 tractors ranked foremost. In general, nearly 12 per cent each of the tractors and power tillers distributed in the State is available in the southern zone. The availability of tractors and tillers is high in the rural areas.

Data on the distribution of plant protection equipment in the zone are furnished in Annexure CI. Nearly 12 per cent of the power operated sprayer-cum-dusters in the State exists in the zone. More than 50 per cent of the total power sprayers in the zone is in Alleppey district. Quilon district has the least number of power sprayer-cum-dusters. The percentage of hand operated sprayers and dusters in the zone worked out to around 25 and 27, respectively of the State.

The Kerala Agro Industries Corporation Ltd. is a State Government enterprise dealing with the sale of tractors and power tillers, procurement and distribution of spare parts for tractors and power tillers, procurement and distribution of paddy seeds, repair and maintenance of agricultural machinery, sale of agricultural machinery under hire purchase scheme etc. The Kerala Agro-Machinery Corporation Ltd. (KAMCO) formed in 1973, is a subsidiary unit of Kerala Agro-Industries Corporation Ltd. This public sector undertaking is engaged in the indigenous manufacture and distribution of Kubota Power Tiller with Japanese collaboration. This is specially designed for the small farmer to perform almost all his farming operations. The tiller can economically operate pumps upto 10 H.P. for irrigation purposes.

2.12 Animal Husbandry and Livestock status

2.12.1 Livestock pattern

The livestock and poultry generate employment and additional income to vast majority of weaker section of the farming community. The marginal farmers, small farmers and landless agricultural labourers and the working class of the small and cottage industries have limited scope for obtaining gainful employment. Under this situation, the income of the weaker sections of the farming community can be raised only by providing subsidiary occupation, through cattle rearing, goat rearing, poultry farming etc. However, poultry farming and dairying as full time occupations have only limited scope. The development of this sector is all the more important from the point of view of nutritional aspect also. Apart from the supply of milk, eggs and meat required for domestic use, many of the farm operations like ploughing, transport etc. depend on animal power. The animals also provide the requirement of farm yard manure, besides the extra income through the sale of surplus milk, eggs and other products. Thus, in the rural areas, dairying and poultry can become part of an integrated farming system. At present, there are only a few organised poultry farms in the zone. The major share of eggs produced is from backyard farming. Farmers take keen interest in broiler industry around the suburban areas. Rural areas offer milk and milk products for urban need. The per capita requirement of milk is estimated at 201 g per day. The per capita availability of milk (1981-82) in the State was 106 g per day, which works out to 118 g per adult. The per adult consumption in 1977-78 based on the Base Line Diet Survey conducted by the Department of Health Services was only about 64 g. The gap between the availability and consumption can be bridged only by raising the milk production. The survey also indicated a level of consumption of fish , meat and eggs of about 80 g per adult per day as against the recommended intake of 60 g of fish, meat and eggs. The present level of consumption appears satisfactory. Average yield of milk from cattle is low in the zone.

The yield of cross-bred cow is 3.82 kg per day and that of desi cow is 1.7 kg per day. The average milk production of buffalo is estimated as 3.15 kg per day. Inadequacy in the quality of stocks, insufficient feed and fodder, and high mortality rate in female calves are the major constraints in milk production. Milk production from cows can be increased by increasing the number of cross-bred cows and gradually reducing the low yielding desi cows and by reducing the intercalving period through scientific feeding and management. Cultivation of fodder varieties with protein content also deserves consideration. Coconut gardens can be brought under fodder as intercrop and more paddy lands during 3rd crop season can be brought under legumes such as cowpea. Possibility of large scale planting of fodder trees such as subabul as part of the social forestry programme in the vacant lands has to be examined. The possibility of utilising the sugarcane tops and pineapple wastes, after proper processing, could serve as economic sources of feed.

2.12.2 Livestock population

The thirteenth quinquennial livestock census (1982) report revealed that the total livestock in the State showed an increasing trend since 1966. The population which was 46.41 lakhs in 1966 in the State, progressively increased to 49.36 lakhs in 1972, to 53.19 lakhs in 1977 and to 56.45 lakhs in 1982. The 1982 population was 6.12 per cent over that of the previous census year. The total poultry population of 99 lakhs in 1966 in the State was 15.46 lakhs in 1972, which rose to 134.89 lakhs in 1977 and further to 150.83 lakhs in 1982. Comparing with 1977 census, the increase in poultry in 1982 was 12.66 per cent. The category-wise data of the livestock population in the southern zone for the years 1977 and 1982 are summarised in Annexure CII. Total livestock population during 1977 and 1982 in the State and in the zone are compared in Fig. 52 and those of poultry (fowls and ducks), in Fig. 53. The population of livestock (21 lakhs) and poultry (57 lakhs) in the zone in 1982 constituted 36.6 and 38.0 per cent, respectively to the State. Of the total livestock in the zone, 59 per cent was cattle while the State figure was 55 per cent. Buffaloes formed 3.5 per cent of the total livestock in the zone constituting 1.3 per cent to the State's

Fig. 52 KERALA (SOUTHERN ZONE)
TOTAL LIVESTOCK POPULATION
(1977 AND 1982)

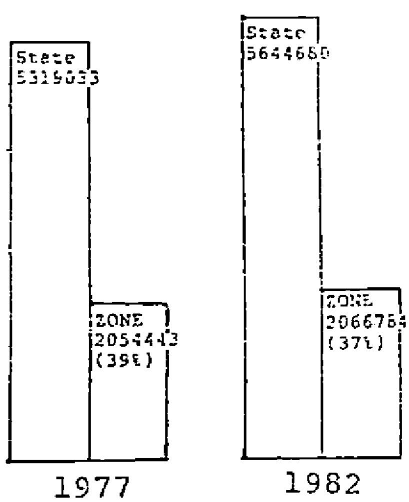
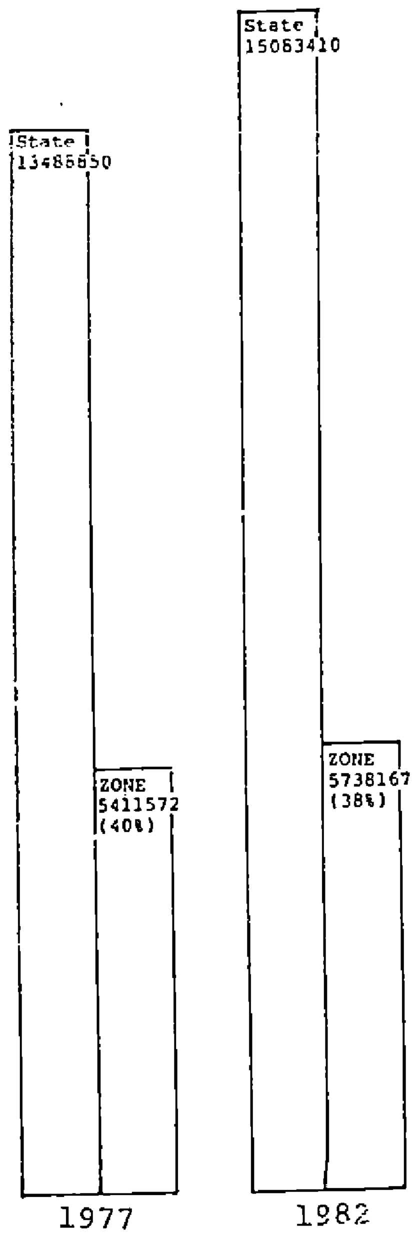


Fig. 53 KERALA (SOUTHERN ZONE)
TOTAL POULTRY (FOWLS & DUCKS)
(1977 AND 1982)



livestock. In the case of goat, sheep, and pigs, however, much difference was not seen between the figures for the zone and the State. Though the total livestock in the zone as well as in the State progressively increased during the period till 1982, the proportions of cattle and buffaloes contributing towards the total livestock in the zone were less. The percentage of rural-urban split distribution of cattle population as per the 1982 census is given in Annexure CIII. The percentage of rural population of cattle was highest in all the districts and ranged between 87.8 and 96.32 while the urban population ranged between 3.68 and 7.13, except in Trivandrum urban with 12.2 per cent of that district total. Better breeds of cattle were comparatively more in the southern districts. Of the total cattle, 56 per cent are cross-breds in the zone as against 47 per cent in the State. The improvement in the genetic make up of cattle has contributed towards increased milk production. Buffaloes were also found concentrated in rural areas (88-92 per cent), the State figure for the rural distribution being 95.4 per cent. Among the districts, Quilon ranked first in the total livestock population, while Alleppey had the maximum population of poultry. Trivandrum district had the maximum number of buffaloes, while Kottayam was very much on the top as regards pigs. Cattle population in 1982 registered a decrease of 2.5 per cent in the zone over the 1977 figures. Population of buffaloes showed a declining trend. From 90,120 in 1977 in the zone it came down to 73,133 in 1982 (18.8 per cent reduction). The population of goats and sheep moved up while that of pigs in the zone came down by 25 per cent during the period between 1977 to 1982. Regarding poultry, the population increased by six per cent in the zone during the five years from 1977 to 1982, while in the State the increase was 12 per cent. Poultry population in the zone in 1982 was 57,38,167 which constituted 38 per cent to the State. Poultry, particularly the improved and hybrids, are reared on intensive system like cage and deep litter whereas the farmers having limited country fowls rear breeds on back-yard system. The density of poultry per sq.km in the zone worked out to 526 as against the State figure of 388. The population of fowls in the zone constituted 37 per cent and that of ducks, 60 per cent to the State. Data on the population and percentage distribution of poultry (fowls and ducks) in the zone as per the 1982 census are furnished in Annexure CIV(a).

The institutions in the zone where poultry layers and broilers, poultry products and feed are sold, are listed in Annexure CIV(b).

Details of the veterinary institutions in the zone under the State Department of Animal Husbandry are provided in Annexure CV. The field level staff of the dairy department provides extension service to dairy farmers on various aspects of dairying and conduct of anti-sterility camps, calf rallys, cattle shows, training camps etc. In addition, the department also maintain a number of institutions to attend to the various aspects of animal husbandry.

2.12.3 Institutions under the Dept. of Animal Husbandry

Institution	Function
Regional Poultry Farm, Kodappanakunnu, Trivandrum	Mixing of poultry feed, hatching of eggs and supply of chicks etc.
District Livestock Farm, Kodappanakunnu	Milch animals are kept for milk purpose and milk supplied to Central Dairy. Production of fodder and supply. Rearing of rabbits.
Livestock Management Training Centre	Training on broiler farming layer management, sexing of chicks, dairy farming, rabbit rearing etc.
Broiler Farm, Pettah, Trivandrum	Supply of broiler chicks and hatching eggs.
Intensive Poultry Development Block, Pettah, Trivandrum	Giving incentives for poultry development, advancing loans etc., providing inputs and marketing facilities avoiding middle men.
Jersey Farm Extension Unit, Chethackal, Palode, Trivandrum dist.	Maintenance of Jersey bull mothers.

Institution	Function
Veterinary Biological Institute, Palode	Production of vaccines and other biological products needed for the prevention and treatment of diseases. Conducting infertility camps relating to problems in cross-bred cows.
Jersey Farm, Vithura, Trivandrum dist.	Improvement of the breed.
Regional Poultry Farm, Kureepuzha, Quilon	Breeding of poultry.
Turkey Farm, Quilon	Supply of turkey hatching eggs and poults.
Central Hatchery, Chengannur	Breeding and development of poultry.
Livestock Farm, Kulathupuzha	Bull Station and Frozen Semen Production Centre.
Feed Compounding Factory, Chengannur	Production of adult mash and chick mash.
Duck Farm, Niranam, Pathanamthitta dist.	Production of strains of duck breeds suitable for the agroclimatic conditions of Kerala.
District Poultry Farm, Mannarcaud, Kottayam district	Supply of eggs and birds.
Progeny testing of cross-breds of Jersey, Kanjirappally	Testing of cross-bred Jersey progeny.

2.12.4 **Kerala Livestock Development and Milk Marketing Board Ltd. (KLD & MM)**

The Kerala Livestock Development and Milk Marketing Board Ltd. is the agent of the State Government in handling matters relating to the breeding and nutritional aspects of livestock in the State. Production, processing and distribution of bull semen needed for the breeding and improvement of livestock, particularly in the Trivandrum and Quilon districts is the major activity of the Bull Station and Semen Bank at Kulathupuzha which is controlled by the Board. Apart from the fodder development activities in the southern districts, the Board undertakes operational research on fodder varieties suited to the condition of the zone. The Board is also making available to the farmers reasonably priced, nutritive, cattle, poultry and pig feed in addition to providing facilities for inoculation and vaccination against common contageous diseases in cattle and for deworming of calves.

2.12.5 Kerala Co-operative Milk Marketing Federation Ltd., Trivandrum

The Federation functioning since 1983, handles the procurement, processing and marketing of milk and milk products. The Federation has implemented the National Programme of Operation Flood II, in Kerala under the technical guidance from National Dairy Development Board (NDDB), and financed by the Indian Dairy Corporation (IDC). The Federation has taken the major steps in the formation of the three-tier co-operative system envisaged, namely, the Federation as apex body at the State level, the Co-operative Milk Producers' Unions at the Regional level and the Anand Pattern Primary Dairy Cooperative Milk Producers' Union at the village level affiliated to the Milk Unions.

The Trivandrum Regional Cooperative Milk Producers' Union has the area of operation of the Trivandrum, Quilon, Pathanamthitta and Alleppey district. Supply of facilities to the milk producer-members of the Co-operative Societies, provision of Veterinary and Health Service to the milk Co-operative Societies at subsidised rates and guidance and control of the Primary Milk Co-operative Societies (365) and the Milk Unions, are some of the other responsibilities of the Federation. The Federation assures steady market for the marketable surplus of milk procured from rural producers through APCO. The milk and the dairy products are marketed under the brand name 'MILMA'.

Of the seven dairies and milk chilling plants operated by the Federation, four each are in the southern zone as given in Table 33.

Table 33. Dairies and Chilling plants in the zone

Location	Installed capacity (1 /day)
Dairies	
Trivandrum	40,000
Quilon	60,000
Alleppey	4,000
Kottayam	6,000
Chilling plants	
Maranalloor	10,000
Yeroor	2,000
Kumbazha	4,000
Mannar	10,000

The performance of the dairies during 1985 and 1986 are furnished in Annexure CVI.

2.13. Fisheries

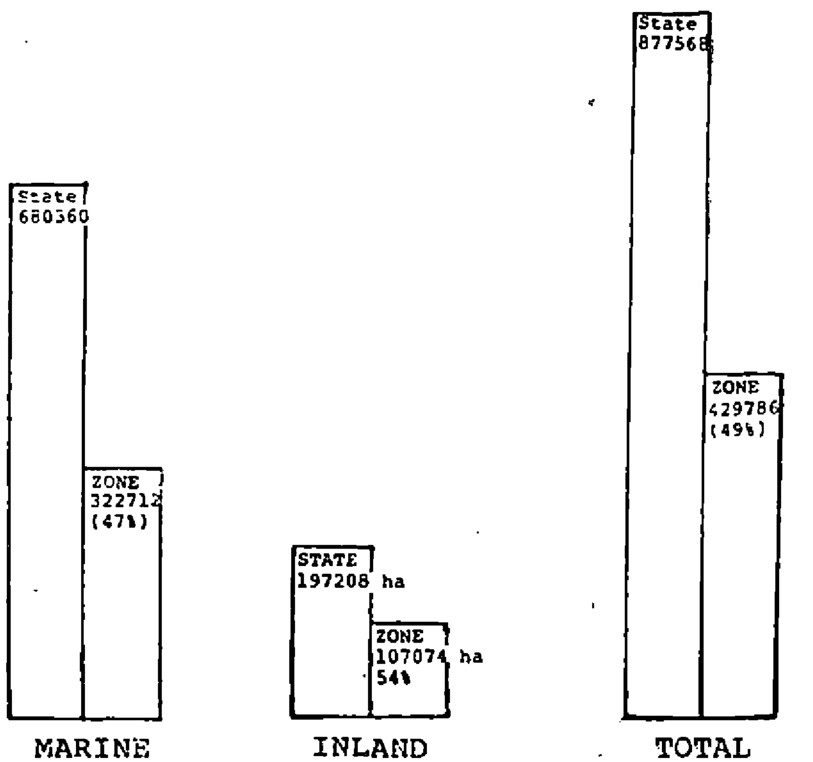
The southern zone has a coastal line of 197 km as against 590 km of the State which works out to one-third. Fishing industry occupies a unique place in the economy of the zone. As declared by the Kerala Fishermen Welfare Societies Act, 1980 there are 99 marine fishing villages in the zone, distributed between Trivandrum (42 nos.), Quilon (27 nos.) and Alleppey (30 nos.) districts.

The names of the fishing villages in the zone are furnished in Annexure CVII. Kottayam and Pathanamthitta districts in the zone are not coastal districts and hence no scope exists in these districts for sea fishing. In addition to the marine fishing villages, inland fishing villages also exist in the zone. Fishermen in the zone live mostly in the form of compact colonies. Annexure CVIII shows the district-wise distribution of fishermen population in the zone. The fishermen population in Kerala in 1985-86 is estimated as 8.776 lakhs which forms nearly 3.2 per cent of the State's total population. An increase of 1.57 per cent in the fishermen population from that of the previous year was noted during 1985-86. Fishermen in the southern zone (4.3 lakhs) constitute 49 per cent of the State's fishermen population. Marine fishermen population in the zone as percentage to State worked out to 47.4 and inland fishermen population to 54.3 (Fig. 54).

The fishing season is throughout the year, except the heavy monsoon months of June-July. Information on the species-wise, district-wise split up of marine fish landings in the zone for the years 1980, 1981, 1982, 1984 and 1985 is given in Annexure CIX. Separate information on taluk-wise basis is not available and hence the data furnished therein covered the entire coastal area of these districts, though some coastal taluks of Alleppey and Quilon do not belong to the zone. The total marine fish landings in the districts of the zone in 1982 was 1.81 lakh tonnes which constituted 55.5 per cent to the State. Marine landing of fish during 1985 was 1.65 lakh tonnes constituting 49.7 per cent to the State. In 1985 the highest landing was at Quilon district (91,202 t) followed by Alleppey district (44,012 t) and was the least, at Trivandrum district (29,939 t). The marine fish landings in the zone during 1980 which constituted 64.2 per cent to the State showed a downward trend to 41.5 per cent to the State in 1981, to 55.5 per cent in 1982, to 46.2 per cent in 1984 and to 49.7 per cent in 1985. There was decline in fish production in the zone during 1980 to 1985. Of the different species, Oil Sardine, Other Sardines, Prawns, Mackerel, Tunnies, Red mullets, Soles, Perches and Cat fish formed the major marine landings.

Top most among the marine products exported was the frozen shrimp which alone constituted 82 per cent of the total export. Export was mainly through the port of Cochin. A natural fishing harbour exists at Vizhinjam,

Fig. 54 KERALA (SOUTHERN ZONE)
FISHERMEN POPULATION
(MARINE AND INLAND)
(1985-86)



15 km South-West of Trivandrum city. A sub-station of the Central Marine Fisheries Research Institute (ICAR), Cochin is also functioning at Vizhinjam. The Indo Norwegian Fisheries Project set up in 1952 at Neendakara, Quilon district is another fishing harbour in the zone with the object of development of fishing industry in the zone and improvement of the living conditions of the local fishing community through mechanisation of fishing boat, provision of repair facilities, introduction of new types of fishing gears, improvement of processing and curing methods, construction of ice plant, supply of insulated vans and motor crafts for transporting fresh fish, improvement of environmental sanitation and establishment of a health centre.

The vast extent of the inland water in the zone offers immense potential for the development of inland fisheries. The source of fishing area consists of lakes, lagoons, rivers, channels and rainfed tanks and also the reservoirs of the irrigation projects. The fish fauna in these water sources are, however, not properly exploited.

Data on the species-wise, district-wise break up of the inland fish landings in the zone for five years from 1980 to 1985 are given in Annexure CX. The total inland fish landings in the zone was estimated as 11955 t in 1984-85 which constituted 43.3 per cent to the State. The percentage of inland fish landings in the zone to the State remained almost steady during the five year period ending 1985 and ranged between 41.9 and 44.5. Prawns, etroplus, murrels, cat fish, mullets and tilapea were the largest landings. The estimated production of inland fishes in the State during 1986 was 28,578 t as against 27,617 t in 1985 with a marginal increase of 961 t (3.5 per cent). The main constraint in the development of fisheries in the zone is that middle men continue to control the marketing of the lions share of the landings. Fishermen get only very low share of the consumer price. There is no post harvest technology available to the fishermen who try to dispose off the produce as early as possible. Occasionally the produce is dried and marketed. Cold storage facilities are not within their reach. As per the 1982 population estimate, the per capita production and consumption of fish works out to 13.5 kg and 11.7 kg per annum, respectively.

Other constraints in fish production are:

- Continued economic plight of the traditional fishermen who are still operating with unimproved, traditional crafts

- Want of sufficient number of fishing harbours and landing centres

- Lack of regulated marketing system

- Brackishwater prawn culture is yet to be developed fully

- Deep sea fishing is yet to pick up

<u>Mud</u> <u>banks</u>:

The formation of mud banks (<u>Chakara</u>) is a phenomenon unique to the Kerala sea coast, which often occurs a few days after the onset of South West monsoon. The climate exerts a calming effect on sea that the area is extremely still without waves and a small country craft can ply over the water without risk. Mud banks often occur at specific locations in coastal Alleppey.

The fishes gather in large numbers in localised shallow areas of the sea, not very far away from the sea coast during this period. The duration may vary between a few days to even one month. Fishermen in large numbers gather and make use of this occasion for boosting their harvest.

The occurrence is sporadic, varying from year to year in extent and in duration. The mud banks existing centuries ago have a wide range of effects on the cultural and economic aspects of the people of the coastal belt and merit detailed study.

The main fishery research stations in the zone under the State Department of Fisheries are listed in Table 34.

Table 34. Major Fishery Research Stations in the zone

Station	Work attending to
Marine Survey Station, Vizhinjam	Biological studies on species, Gear-wise landings trend of fisheries, pollution of sea by effluents
Fisheries Research Station, Edathua	Artificial preparation of fresh water prawns, hydrobiological studies of fish farms.
Fisheries Complex, Pannivelichira, Kozhencherry	Production of quality fish seeds and experimental frog culture

2.13.1 Matsyafed

Mechanised fishing boats became popular in the field of marine fishing in Kerala after 1975. As per the 1982 census, 5161 mechanised fishing boats were available in the State which included among others, Gill netters, trawlers and liners also, two thirds of which existed in the zone. Non-mechanised boats such as Beach scine boats, plank built boars, dugs out canoes, catamarans etc. are estimated as 26,720 in the State, 61 per cent of which existed in the zone in 1982. The increase in the yield of marine products on account of these boats which was 43 per cent in 1975, rose to 48 per cent in 1980. In 1986, Kerala exported 34,212 tonnes of fish, earning foreign exchange to the tune of Rs.164 crores. About 82 per cent of the exported marine products was frozen shrimp. The Kerala Fisheries Corporation, the Kerala Fihermen Welfare Corporation and the Kerala Inland Fisheries Development Corporation were formed for the increased fishing activities in the State. The activities of the Kerala Fisheries Corporation which was formed in 1966, were centred around deep sea fishing and distribution and marketing, including export of frozen marine products. The Kerala Fishermen Welfare Corporation formed in 1978 had been looking after the social and economic uplift of the traditional fishermen, particularly the housing, relief operations, women's bus services and the distribution of fishing equipment. In 1982 the Kerala Inland Fisheries Development Corporation came into existence. Fish culture, seed production etc. were the activities of the Corporation. In 1984 all the defunct and defective fisheries cooperatives then in existance were coordinated under the district level cooperative societies and these in turn were brought under the Kerala State Cooperative Federation for Fisheries Development, popularly known as "MATSYAFED". With the inception of Matsyafed, the responsibilities of the three Corporations which were previously in existence were taken over by the Federation. The Kerala Fishermen Welfare Board came into existence in 1986 to implement the various welfare programmes for the fishermen community.

2.14 Agricultural Marketing status and constraints

The important crops in the southern zone having marketable surplus are tapioca, coconut, pepper, banana, rubber and paddy. The agricultural commodities undergo various types of transactions viz. Farm, Wholesale (Primary, Secondary and Terminal) and Retail, before they reach the ultimate consumer. The farmer receives a low price for his produce, while the consumers have to pay a high price. The markets in the zone can be classified under two categories viz. Wholesale and Retail. In the State, there are 1,363 markets of which 348 are Wholesale markets and the rest, Retail markets which conduct daily, biweekly or weekly sales and purchases. These markets are controlled by municipalities, panchayats, market committees or private individuals. Maximum number of markets are in Quilon and Trivandrum districts, the number being 273 and 222, respectively. The block-wise distribution of Wholesale and Retail markets and their periodicity of functioning are given in Annexure CXI. In the southern zone, there are 152 Wholesale markets and 500 Retail markets dealing with agricultural commodities as against 348 and 1,015, respectively in the State. Wholesale markets in the zone constitute 44 per cent of that of the State and Retail markets, 49 per cent. There are daily markets, biweekly, triweekly and weekly markets. A few markets function four days a week. Fortnightly markets and monthly markets are also available. In the zone, three weekly Wholesale markets, five thrice a week markets, 110 biweekly markets and 34 daily markets are operated. Retail markets of weekly nature or fortnightly, monthly, bimonthly and of longer durations together make up to 29, while the number of thrice a week markets, biweekly markets and daily markets constitute 10, 139 and 323, respectively. In Elanthoor block, a retail market functions only once an year while in Parakkode Block, a livestock exhibition-cum-retail market is of occasional occurrence.

Coconut forms the most important remunerative crop in this zone, cultivated in an area of 7,04,682 ha. giving a total production of 3,377 million nuts per year. The major percentage of the coconut harvested are marketed. Generally, two channels of marketing are available for coconut. The cultivator sells the coconut to the local copra merchants, who in turn, convert the coconut into copra, dry it and sell it at the terminal market at Alleppey or Cochin. Secondly, the copra merchants may give the copra to the local oil millers, who crush the copra into oil and the oil is marketed at the terminal markets. Only 50 per cent of the milling copra in the State is crushed in to oil and the remaining quantity is diverted for milling in Bombay, Calcutta or Madras. Most of the crushing units in the State are obsolete and the recovery of oil is lower than that at Bombay and other places, where large expellers and solvent extraction units are employed. The Bombay millers therefore decide the price of coconut oil in the country which in turn decides the price of copra and coconut in Kerala. Though the price of the coconut oil and copra in the terminal markets are fairly attractive, the cultivators are not getting a proportionate price for their produce. They are offered a low price and are being exploited by the village merchants and middle men. Wide fluctuations in the price of coconuts and coconut products have occurred from time to time, causing considerable hardship to the cultivators. Against this background, stability in price was aimed at by the Government through the operation of a public sector undertaking viz. The Kerala State Coconut Development Corporation Ltd. The Corporation has under it, one of its two Integrated Coconut Processing Complexes in the zone, located at Attingal, 35 km North of Trivandrum, equipped with machinery for the extraction of coconut oil from dried coconut kernel (copra). The coconut is procured either raw or in the form of copra, through

Service Cooperative Societies representing their member farmers, at reasonable prices based on quality. The factory started commercial production in 1980 and has at present a crushing capacity of 40 to 45 m tonnes copra per day. The oil is marketed under the brand name KERAGEM. With the integration of processing and marketing, better processing efficiency and market competition could be achieved and small farmers are benefited in the form of higher farm prices for their produce. Starting of a solvent extraction unit under the Corporation is under consideration.

Tapioca is grown in an area of 1.31 lakhs ha. in the zone yielding a production of 2.13 million tonnes. Here also a better percentage of the produce is marketed. The produce is generally sold to a village merchant or a contractor or sold piece-meal at the spot itself, at the prevailing local price which is normally low. The village merchant finds out his way to sell it in distant markets at comparatively better prices. Sometimes, the tubers may be further used for starch manufacturing. In either case, the producers who are at the bottom most level are exploited. Due to lack of awareness on post harvest technology, the cultivators are forced to sell the produce immediately after harvest. Rodent attack of the standing crop and market fluctuations for the produce are the constraints in the production of the crop.

In the case of pepper, the cultivation is mainly in the midland and highland sub-zones. The total area under pepper is 32,979 ha in the zone giving production of 7,792 tonnes of black pepper. Here also, the presence of village merchants, petty dealers and other middle men spoil the marketing system. Pepper, being a dollar earning crop fetching a very high price, sufficient benefit is not reaching the hands of the poor cultivator. Similarly the vegetable producers are also not assured of marketing facialities in the zone.

With regard to banana, it is cultivated on massive scale only in some pockets in the zone. However, this is an essential crop in every homestead. The marketing of banana and other plantains takes place in two ways. The cultivator may take the produce directly to the distant market and sell it or distress sales may be effected through the village merchants.

With regard to paddy, the marketed surplus is very negligible. As is the case with the State, the southern zone is not a surplus area with regard to rice production. Rice is the staple cereal food for the entire population in the State. Considerable quantities of rice are being procured by Government from other states to meet the daily demand. The major percentage of paddy production in the zone is used for home consumption and for seed purpose. Recently there is a tendency among the cultivators to convert paddy lands to grow coconut and other plantations. This is mainly due to the increase in labour cost, risks of climatic fluctuations and the low price obtainable for paddy which is not commensurate with the cost of cultivation according to several farmers.

Another major crop of importance to the farmers is rubber, which is cultivated in the midland and midupland (highland) sub-zones in larger areas. Eventhough the investment cost for the first few years is higher, the crop, once established, continues to give remunerative returns for a long period. Marketing of rubber is mainly done through rubber marketing societies and the farmers are seldom cheated with non-remunerative prices.

In general, it is noticed that the cultivators, inspite of obtaining a better production of the crop, are not able to get a remunerative price for their produce. The sale of the commodities mostly takes place in the village premises itself and the village merchants who form the main functionary in the marketing system take the maximum advantage. This forms the main constraint of the marketing system in the zone. To overcome this or to provide better price to the cultivators for their produce, co-operative marketing may have to be encouraged or regulated markets introduced. The marketing aspects become important since many of the cash crops and other agricultural commodities such as rubber, pepper, cashewnut, cardamom, coir products, fish etc. attract national or international markets. Marketing problems include, absence or lack of grading at the primary level, lack of storage and transport facilities, lack of proper market intelligence, unauthorised deduction in cash and kind, faulty weighment, adulteration, exploitation by middle men etc. A comprehensive marketing legislation for improving the agricultural marketing practices in the State is yet to be enacted by the Government.

The Kerala State Co-operative Marketing Federation (MARKETFED) is an apex institution of Primary Marketing Co-operative Societies, with a major share capital from the State Government. The Federation entered the field of procurement and marketing of agricultural inputs as early as in 1972. Distribution of reputed brands of fertilizers to farmers at fair price and on easy terms of payment through Agricultural Co-operative Societies and their sales/procurement depots, distribution of pesticides, monopoly procurement of copra, cashew, pepper, ginger and spices through the Primary Co-operative Societies to the extent possible and their export are some of the major activities of MARKETFED. The procurement and distribution of essential commodities are done by Government through the Public Distribution System (PDS) which plays a vital role in meeting the demand of the people for these commodities. The number of wholesale and retail shops under the PDS showed increases every year. The Kerala State Civil Supplies Corporation distributes commodities such as food grains, sugar, kerosene, edible oils, grocery items, vegetables, etc. through depots popularly known as "Maveli Stores", located in all the taluks of the zone. Mobile Maveli Stores, under the brand name "Supply Co", are also functioning satisfactorily. The Corporation also offers special assistance to the public, during Onam, Christmas, Bakrid etc. by conducting festival markets. Quality control of agricultural commodities through AGMARK grading is looked after by the Marketing Wing of the State Department of Agriculture. Coconut oil, gingely oil, honey, spices etc. are thus graded. Several other approved co-operative marketing agencies function in the zone.

MILMA and MATSYAFED are the co-operative organisations under the State Government, involved in the activities relating to the procurement and distribution of milk including milk products and fish, respectively.

The Central Arecanut and Cocoa Marketing and Processing Co-operative Ltd., Mangalore (CAMPCO), a joint venture of the Governments of Kerala and Karnataka, has a centre at Nedumangad in the zone for procuring arecanut and cocoa from the growers at an economical price and supply the same to the consumers at fair price, minimising middle men and their margins. The Kerala State Coconut Development Corporation has its own programmes of procurement of raw coconut and copra from the Primary Co-operative Societies, conversion into coconut oil at its factory at Attingal, Trivandrum district and distribution under the brand name KERAGEM. The Kerala State Co-operative Coir Marketing Federation (COIRFED) is concerned with the procurement and sale of coir and coir products. The Kerala State Coir Corporation functioned primarily as a marketing agency for nearly 3,000 primary coir units. Coir industry during the recent years is, however, facing the situation of being eclipsed by competition from the neighbouring States of Tamil Nadu, Karnataka and Andhra Pradesh, where the manufacture of coir and coir products had gained momentum through mechanisation. About 60 to 65 per cent of the total cost of coir production in Kerala accounted for wages to labour. Mechanisation would bring down not only the production cost but also save the labour from the traditional method of extraction of the fibre after retting the husks for some months and then manually beating it to produce pith, which will not be as concentrated as in mechanised units, suitable for upholstery mats, mattresses etc. Product diversification and mechanisation of the industry at the end products stage are helpful in obtaining better markets. A worker will only be able to extract fibre from about 100 husks a day. However, to assure enough supply of retted husks to the traditional workers, Government do not encourage the operation of defibering machines for extraction of fibre from coconut husk.

The Kerala State Bamboo Corporation, Angamali (Ernakulam district) has its activities relating to promotion of bamboo industry in the State. The Corporation collects reeds from the forests and distributes them to traditional workers, registered small scale units, Scheduled Caste Co-operative Societies and other actual users in the entire State. The marketing of finished goods is also arranged by the Corporation so that the workers could get reasonable price for their products.

The Kerala State Cashew Development Corporation Ltd. (KSCDC), Quilon formed in 1970, is a fully owned company of the State Government and has a net work of activities connected with the procurement of raw cashew nuts and marketing of the processed cashew kernels, avoiding middle men. It has under its control 34 cashew factories in the State of which 29 are located in the southern zone as given in Table 35.

Table 35. Cashewnut processing units in the zone

District	Location		
Trivandrum	Kallambalam Kilimanoor		
Quilon	Kottiyam Kilikollur Nedavathur Mynagappally Ayathil Puthoor Edamalakkal Chathannur	Kannanalloor Maikone Ezhukone Elampalloor Palkulangara Nedumpaikulam Mukhathala Chittumala	Thellikuzhi Eravipuram Parippally Paruthumpara Kunnathur Kallumthazhom Kanjankadu Changamanadu
Alleppey	Kayamkulam Nooranad Karimulakkal		

Quilon district alone has 24 cashew factories. These factories together employ on an average, 30,000 skilled labourers, mostly women, for the nut processing work such as shelling, peeling, grading and filling in tins. The Corporation is also running one factory at Kottiyam to manufacture Tannin from cashew testa. The annual indigenous procurement of raw nuts is around 1.25 lakh tonnes, the peak season being April to August. In addition, 28 to 30,000 tonnes of raw nuts are imported. Around 22,000 tonnes of processed cashew kernels are annually exported, fetching foreign exchange to the tune of nearly Rs.200 crores. Cashew shell oil is also marketed. Domestic consumption of nuts in the zone is less than 3.0 to 5.0 per cent of the annual production. The skilled women labourers get work in the factories only seasonally since the industry has been facing constraints primarily for want of raw nuts which have to be imported. Many of the exporting countries have now developed their own technology for processing nuts, which has affected the import. Adding to the constraints in cashew industry, when the minimum wages for workers in the cashew industry in Kerala was revised, there was a tendency for the unauthorised removal of raw nuts to neighbouring States where labour was cheaper. The activities connected with the quality control of cashew nut are handled by Cashew Export Promotion Council. Cashew Workers' Cooperative Society (CAPEX) is also in the field of cashew industry, for taking up the closed cashew fatories by organising them into primary societies. CAPEX is also handling the procurement and marketing of cashew nuts.

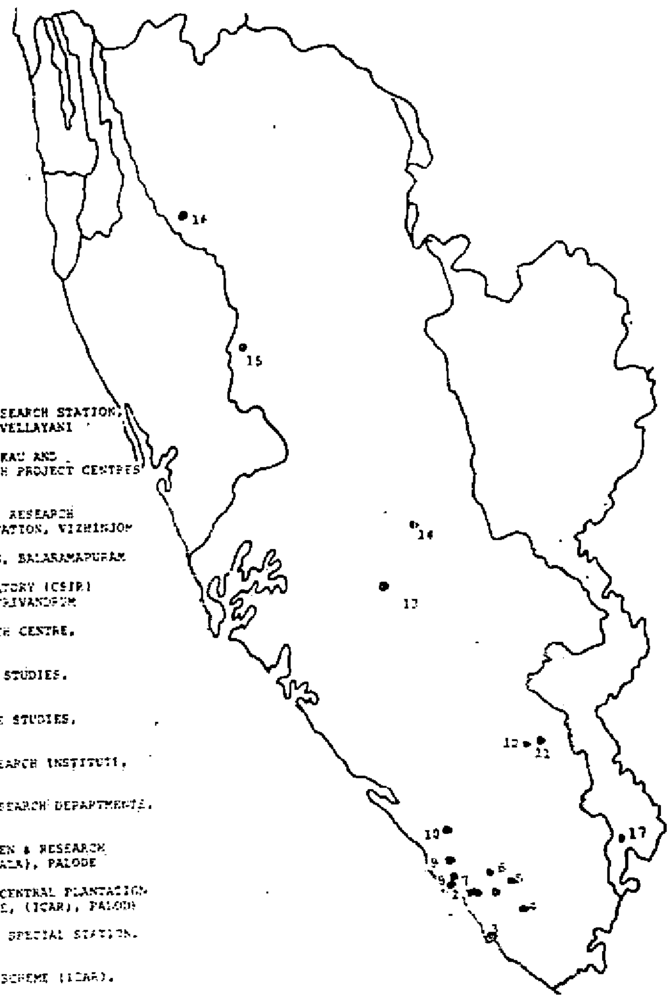
Credit facilities

Short, medium and long term agricultural credits are available to the intending farmers of the zone through Commercial Banks such as State Co-operative Bank, District Co-operative Bank etc., Regional Rural Banks, Nationalised Banks etc. The Kerala State Co-operative Agricultural Development Bank Ltd (KSCADB), Trivandrum is organised on a federal basis as an apex body, with 10 Regional Offices and 35 Primary Co-operative Agricultural Development Banks in the State affiliated to it, for advancing long term loans to farmers. Four Regional Offices and 12 Primary Co-operative Banks exist in the southern zone. The Regional Offices located at the district headquarters at Trivandrum, Quilon, Alleppey and Kottayam in the zone, sanction and disburse the loans to the Primary Banks in their area of operation. The Primary Banks directly extend the long term loans of seven years and above, to the agriculturists for the various developmental activities. Medium term loans for five years are also occasionally extended for specific agricultural purposes. Under the farm-sector, the bank is undertaking mainly two types of lending, viz. Ordinary and Schematic. Ordinary loans are issued for meeting the sporadic agricultural development requirements and necessary funds are mobilised by issue of ordinary debuntures subscribed to by Life Insurance Corporation, Government, State Bank of India and Commercial Banks. Under the schematic lending, the Bank formulates specific schemes for specified compact areas and implement the schemes with the funds procured by the issue of Scheme debentures subscribed to, mainly by NABARD and assistance from State and Central Governments. Ordinary loans to farmers are advanced for sinking new wells and tanks, repairs to wells / tanks, for pumpsets, contour bunding, cattle sheds, farm houses, barbed wire or stone fencing, plantations, levelling, bunding, land reclamation, terracing for soil conservation, construction of drainage channels, repayment of old debts etc., while schematic lending covers minor irrigation, farm mechanisation, plantation, land development including soil conservation measures, land reclamation, cultivation of horticultural/ plantation crops such as coconut, rubber, cashew, coffee, pepper, cardamom, pineapple, betelvine, arecanut etc., inter-space filling, drought schemes etc. The Bank also lends for other purposes like dairy, fish culture, poultry / broiler, gobar gas, goat rearing, bullock and bullock carts, country boat, sericulture, integrated farm development etc. Loans under non-farm sector are also sanctioned for tiny and small scale industrial activities allied to Agriculture such as processing of copra and other agricultural produce, coir products, mat making, repair of pumpsets, bee keeping, silk production, bakery etc. up to a limit of Rs.30,000 per individual. Commercial Banks such as State Co-operative Bank or District Co-operative Bank, Regional Rural Banks and Scheduled Banks are the other agencies in the zone operating the funds provided under NABARD, to extend medium term and short term loans to farmers. Farmers who are members of the local Farming Co-operative Societies, also obtain the benefit of loan from these societies, on easy terms of repayment.

Details on the working of the Primary Co-operative Agricultural Development Banks in the southern zone for the years 1985, 1986 and 1987 are furnished in Annexure CXII.

In addition, the Scheduled/Nationalised Banks and Co-operative Institutions such as State Co-operative Bank, District Co-operative Banks, Primary Co-operative Societies, Regional Rural Banks etc. also, advance to farmers, various types of loans for agricultural and allied purposes. Details of the extent of district-wise advances extended for agricultural purposes in the zone and the number of beneficiaries under the banking system including KSCADB, during the calendar year 1985 are furnished in Annexure CXIII. During 1985, the zone had 3.29 lakh beneficiaries which constituted 34 per cent of those of the State. An amount of Rs.14.27 lakhs was advanced which constituted 37 per cent to the State. During 1986, the amount advanced increased to Rs.17 lakhs, maintaining the same percentage (37) of share to the State.

Fig. 55 KERALA (SOUTHERN ZONE)
RESEARCH INSTITUTIONS



1. REGIONAL AGRICULTURAL RESEARCH STATION, NARP (SOUTHERN REGION), VELLAYANI
2. COLLEGE OF AGRICULTURE, KAU AND ICAR COORDINATED RESEARCH PROJECT CENTRES VELLAYANI
3. CENTRAL MARINE FISHERIES RESEARCH INSTITUTE (ICAR), SUB-STATION, VIZHINJOM
4. COCONUT RESEARCH STATION, BALARAMAPURAM
5. REGIONAL RESEARCH LABORATORY (CSIR) COMPLEX, PAPPANAMCODE, TRIVANDRUM
6. CROPPING SYSTEMS RESEARCH CENTRE, KARAMANA, TRIVANDRUM
7. CENTRE FOR DEVELOPEMENT STUDIES, AKULAM, TRIVANDRUM
8. CENTRE FOR EARTH SCIENCE STUDIES, AKULAM, TRIVANDRUM
9. CENTRAL TUBER CROPS RESEARCH INSTITUTE, (ICAR), SREEKARIYAM
10. UNIVERSITY OF KERALA RESEARCH DEPARTMENTS, KARIAVATTOM CAMPUS
11. TROPICAL BOTANICAL GARDEN & RESEARCH INSTITUTE (GOVT. OF KERALA), PALODE
12. RESEARCH STATION UNDER CENTRAL PLANTATION CROPS RESEARCH INSTITUTE, (ICAR), PALODE
13. NARP (SOUTHERN REGION), SPECIAL STATION, SADANANDAPURAM
14. NATIONAL DEMONSTRATION SCHEME (ICAR), [illegible]
15. SUGARCANE RESEARCH STATION, THIRUVALLA
16. RUBBER RESEARCH INSTITUTE OF INDIA, PUTHUPPALLY, KOTTAYAM
17. AICP ON TRIBAL AREA RESEARCH, AMBOORI

2.15 Research Stations/Schemes/Organisations in the zone under the Kerala Agricultural University

Major research institutions functioning in the zone under the Kerala Agricultural University, University of Kerala and the Central and State Governments are located in Fig. 55. Major research centres in the zone under the Agricultural University and their functions are listed in Table 36.

Table 36. Research Stations / Schemes functioning in the zone under the Kerala Agricultural University.

Research Centre	Functions
College of Agriculture, Vellayani	Teaching and Research
Regional Research Station, National Agricultural Research Project (Southern zone), Vellayani	Lead function on tapioca, ver.function for rice, homestead farming & other crops
All India Co-ordinated Project for Research on Forage Crops, Vellayani	Intensive research on Agronomic aspects of promising forage crops suitable for Kerala State
All India Co-ordinated Project for Research on Pesticide Residue, Vellayani	Estimn. of residues of pesticides in different crops in Kerala
All India Co-ordinated Project for Research on Oil Seeds, Vellayani	Standardisation and management practices in sesamum and groundnut
All India Co-ordinated Project for Research on Nematodes, Vellayani	Nematode diseases of crop plants and their control
ICAR *ad hoc* scheme on Rice Cyst Nematode, Vellayani	Survey, biology, host-plant relationship & assessment of crop loss

Research Centre	Functions
Science and Technology project on Mycorrhizae and Forest Eco-systems in Kerala, Vellayani	Studies on Ecto-mycorrhizae of the forest ecosystems of Kerala w.s.r. to Idukki
Science and Technology Project on Mushroom Flora of Kerala, Vellayani	Survey of edible mushroom flora of Kerala
Kerala State Committee on Science and Technology-Scheme on <u>Pleurotus</u>, Vellayani	Standardisation of techniques for large scale cultivation of <u>Pleurotus</u>
All India Co-ordinated Project on Tribal Area Research, Amboori	Development of viable technology in agrl. and related fields w.s.r.t. tribal area
College of Rural Home Science, Vellayani	Teaching and Research
Coconut Research Station, Balaramapuram	Manurial and Agron. trials on coconut
Cropping Systems Research Centre, Karamana	Manurial and agron. trials on rice and rice-based cropping systems
Special Station, National Agricultural Research Project (Southern Zone), Kottarakkara	Lead function: Homestead farming Ver. function: tapioca and other tubers
National Demonstration Scheme, Kottarakkara	Experiments in cultivators' fields

2.16 Operational institutions under the Department of Agriculture

State Seed Farms, Agricultural Farms, Coconut Nurseries and other Nurseries and Testing Laboratories are the major operational institutions under the Department of Agriculture (Table 37).

Institutions in the zone under the Department of Agriculture, where seeds and planting materials are produced, are given in Annexure CXIV.

Table 37. Operational Institutions under the Department of Agriculture, Kerala

District	State Seed Farms	Agricultural Farms	Coconut Nurseries	Testing Laboratories	Others
Trivandrum	. Ulloor . Chirayinkil	. Peringamala	. Kazhakuttom . Valiathura	. Pesticide Testing Laboratory, Tvm. . Fertiliser Testing Laboratory, Tvm. . Soil Testing Laboratory, Trivandrum (Stationary and Mobile) . Central Soil Testing Laboratory Trivandrum.	. Banana Nursery, Peringamala
Quilon (*)	. Karunagapally . Kottarakkara . Kadackal . Adoor	. Anchal	. Karunagapally . Kadackal	. Soil Testing Laboratory, Quilon (Stationary and Mobile) . Oil grading Laboratory, Quilon.	. Cashew Station, Kottarakkara . Extension Training Centre, Kottarakkara (under Development Department)
Pathanamthitta				. Soil Conservation Research Station, Konni. . Soil Analytical Lab (Soil Survey), Konni.	
Alleppey (*)	. Arunoottymangalam . Pullad . Veeyapuram	. Mavelikkara	. Mavelikkara	. Soil Testing Lab., Alleppey (Stationary and Mobile)	. State Sugarcane Seed Farm, Pandalam. . Kayamkulam Kayal Reclamation Scheme . Central Hatchery, Chengannoor.
Kottayam (*)	. Vallachira . Kozha	. Kozha	. Kozha	. Soil Testing Laboratory, Ettumanoor (Stationary)	

(*) includes problem areas also

CHAPTER III

AGRO-ECOLOGICAL SITUATIONS IN THE ZONE

3.1. Criteria followed in identifying agro-ecological situations

In the southern zone, the agro-climatic conditions and cropping patterns show local variations based on soil and physiographic divisions, topography, irrigation and social factors. The zone has different topographical situations based on which a broad classification has been made into:

1) Lowlands bordering the coastal belt (0 to 7.5 m from MSL)

2) Midlands of the central & interior parts of zone (7.5 to 75.0 m) and

3) The mid-uplands or the highlands (75.0 - 750.0m) consisting of the undulating terrains and gentle to steeper slopes forming the foot hills of the high ranges.

Paddy is cultivated in the lowland patches of the entire zone wherever irrigation facility exists, right from the coastal sandy tract on the West to the loamy highland tract on the East. The categorisation of the physiographic position of the land in the zone such as lowland, midland, highland etc. is taken into consideration with or without slight modification in identifying the agro-ecological situations in the zone.

Rainfall cannot be considered as a criterion in identifying the different farming situations in the zone, except probably the situation existing in the highland zone.

Another criterion considered to distinguish between the farming situations identified in the zone is the soil type. Though much diversity is not seen in the chemical features of the soil, its textural status differs in some of the agro-ecological situations. For instance, the coastal soils of the zone has a dominance of sandy loam classified under coastal alluvium, while the midland and the highland situations contain laterite soil. The low land paddy soils are invariably hydromorphic. Red loam soil has been identified in parts of Neyyattinkara and Trivandrum taluks which is loam in texture. The banks of the rivers and lakes and also the backwater areas and lagoons have alluvial soil. Basically, all these are laterite soils found extensively as residual formations in the midland sub-zone and form low flat-topped ridges and small hills between the Western Ghats and the Arabian Sea. Laterites and lateritic soils with low CEC and low fertility status exist in the midlands and highlands.

Irrigation facility in the zone is not sufficient enough to benefit all the cultivated crops. Under most of the farming situations identified, rice is grown as the principal crop in the low lying areas or areas near rivers and canals or valleys in the foot hills where irrigation facilities exist. In the irrigated areas, rivers, tanks, lakes, wells or a net work of canals serve as water sources. Crops and crop mixes other than wet land paddy are cultivated in the drier regions irrespective of whether irrigation facility exists or not. Several crops are thus cultivated under purely rainfed conditions. Hence, irrigation applied to cultivated crops in the zone is also considered in identifying the farming situations.

Physiographic situation

The land situations such as coastal land, midland, highland, reclaimed soil situation (back-water area) etc. are considered for identifying the farming situations in the zone. In all these farming situations, paddy is also grown in the lowlying patches and to distinguish between the wetland and the dryland in these farming situations, a sub-classification is also made as follows:

Land situation

Situation	Location	Crops grown
Lowland coastal zone		
1. Coastal wetland (CWL)	Wetlands of the coastal tract	Paddy
2. Coastal dryland (CDL)	Drylands of the coastal tract	Mainly coconut and rarely tapioca and banana
3. Reclaimed backwater areas (RB)	Marshy land patches adjoining the coastal belt	Mainly coconut
Midland zone		
4. Midland wet situation (MLW)	Low lying wetland (Soil: brown hydromorphic)	Rice and rice-based farming system
5. Midland dry situation(MLD)	Drylands and garden lands of the midland belt (Soil: laterite)	Coconut, rubber and perennials, annuals and seasonals
6. Midland dry situation, Red loam soil (RLS)	Drylands and garden lands of the midland belt in the southern tip of the zone (Soil: red loam)	Coconut and perennials, annuals and seasonals
Highland zone		
7. Highland wet situation (HLW)	Low lying wetland patches of the highland zone (Soil: brown hydromorphic)	Rice and rice-based farming system

8. Highland dry situation (HLD)	Drylands and garden lands of the highland zone (Soil: laterite)	Rubber, coconut and other perennials, annuals and seasonals

All zones

9. Homestead farming situation (HF)	Homesteads throughout the zone	Poly-cropping

Altitude:

Based on the altitude from MSL ranging from 0 to 750 metres, the area has been categorised under the following three elevation groups:

	Location	Altitude
1. Low elevation (LE)	Coastal sandy tract and reclaimed backwater areas	Upto 7.5m from MSL
2. Medium elevation (ME)	Midland situation	Between 7.5m and 75m above MSL
3. Higher elevation (HE)	Highland situation	Between 75m and 750m above MSL

Soil

Sandy loam is dominant in the coastal dryland and backwater areas in the zone. Hydromorphic soil invariably exists in most of the wet lands. Laterite soil is most dominant in the dry lands and garden lands of the midland and highland sub-zones while red loam soil exists in small patches at the southern tip of the midland sub-zone. For the identification of the farming situations, the following soil types are considered.

Soil type	Location	Texture
Hydromorphic soil (HS)	Wet lands in the zone	Clay, clay loam, sandy clay loam, coastal & riverine alluvium
Sandy loam soil (SlS)	Coastal areas	Sandy, sandy loam, sandy clay loam
Sandy alluvium (SaS)	Backwater areas	Alluvium
Laterite soil (LS)	Midland belt and highland areas	Laterite loam, laterite clay loam, gravelly laterite
Red loam soil (RlS)	Southern parts of the midland belt	Red loamy soil

Irrigation:

The crops which are grown under the different farming situations are described as rainfed and irrigated. Thus, irrigated crop (IC) and rainfed crop (RC) are the two situations. Both conditions exist in the different agro-ecological situations, depending on the irrigation facility.

3.2. Summary of the agro-ecological situations

Considering the different factors such as land situation, altitude, soil texture and irrigation, nine specific agro-ecological situations have been identified in the zone for which appropriate farming systems, cropping patterns and management practices are to be developed. Table 38 provides the summary of the nine situations thus identified in the zone. Fig. 56 shows the locations where the different farming situations occur. Some of the farming situations occur interspersed. For instance, paddy is grown in patches by the farmers in the lowlying tracts through out the zone. Such farming situations are not separately indicated in the figure. They are, however, indicated in the map combined with the adjacent farming situation. "Homestead Farming System" exists in all the land situations, elevation levels and soil conditions throughout the zone.

Fig. 56 KERALA (SOUTHERN ZONE)
AGRO-ECOLOGICAL SITUATIONS

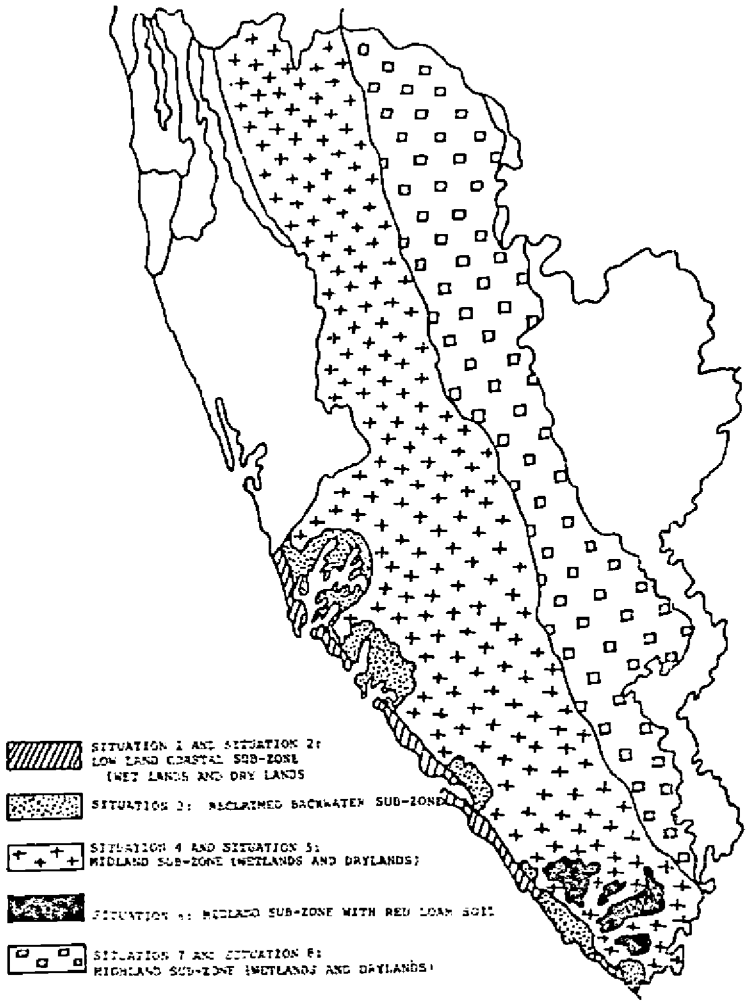


Table 38. Agro-ecological situations in the southern zone

Sl. No.	Agro-ecological situation (Symbol)	Apr. area (sq.km)	Altitude (m)	Rain fall (mm)	Soil texture	Land situation	Rainfed/ irrigated	Major crops	Special features	Location
1.	Coastal wetland, low elevation, hydromorphic soil, rainfed crop (CWL-LE-HS-RC)	15	0 to 7	1750 to 3000	Sandy loam Sandy clay loam, sandy alluvium (Hydromorphic)	Lowland, level	Rainfed and irrigated	Paddy	Dry sowing of paddy during April, later rainfed. Second crop rarely attempted. Fallow in summer. Transplanted rice during the first and second crop seasons under irrigation	Wetland patches in the coastal tracts of Tvm district and parts of Quilon and Allepey districts
2.	Coastal dry land, low elevation, sandy loam soil, rainfed crop (CDL-LE-SlS-RC)	60	0 to 7	1750 to 3000	Sandy, sandy loam, rarely loam	Lowland, level	Rainfed	Coconut tapioca cashew	As intercrop in coconut gardens, tapioca and banana are grown	Dry lands of the coastal tract in the district of Trivandrum and parts of Quilon and Alleppey
3.	Reclaimed backwater situation, low elevation, sandy alluvium, rainfed crop (RB-LE-SaS-RC)	60	0 to 5	1750 to 3000	Loam, sandy loam, coastal alluvium	Lowland, level to gently sloping	Mainly rainfed. Irrigation in homesteads only	Coconut	Coconut is grown on bunds and in level land with intercrop such as tapioca and/or vegetables. These are the backwater areas reclaimed from the adjoining lakes and lagoons in proximity to the seacoast Paddy seldom grown. Retting of coconut husk and coir making popular.	Backwater areas adjoining the sea coast lying in the Panchayats of Kulathoor, Poovar, Kottukal, Thiruvallam, Attipra, Kadinamkulam, Chirayinkil, Chavara, Anjengo, Azhoor, Shertalai etc.
4.	Midland wet, medium elevaton, hydromorphic soil, irrigated crop (MLW-ME-HS-IC)	610	7 to 75	1880 to 3500	Riverine alluvium, loam, sandy clay loam, clay loam, clay (Hydromorphic)	Midland, Level/ terraces	Irrigated	Two crops of paddy. Third if irrigation is available	Paddy is the main crop cultivated. In summer fallows, vegetables, sweet potato, pulses and rarely groundnut, gingely etc. are grown. Other sequences: Rice - banana or rice - tapioca	Low lying areas distributed throughout the central portions of the zone in the districts of Trivandrum; Quilon, Pathanamthitta and Kottayam

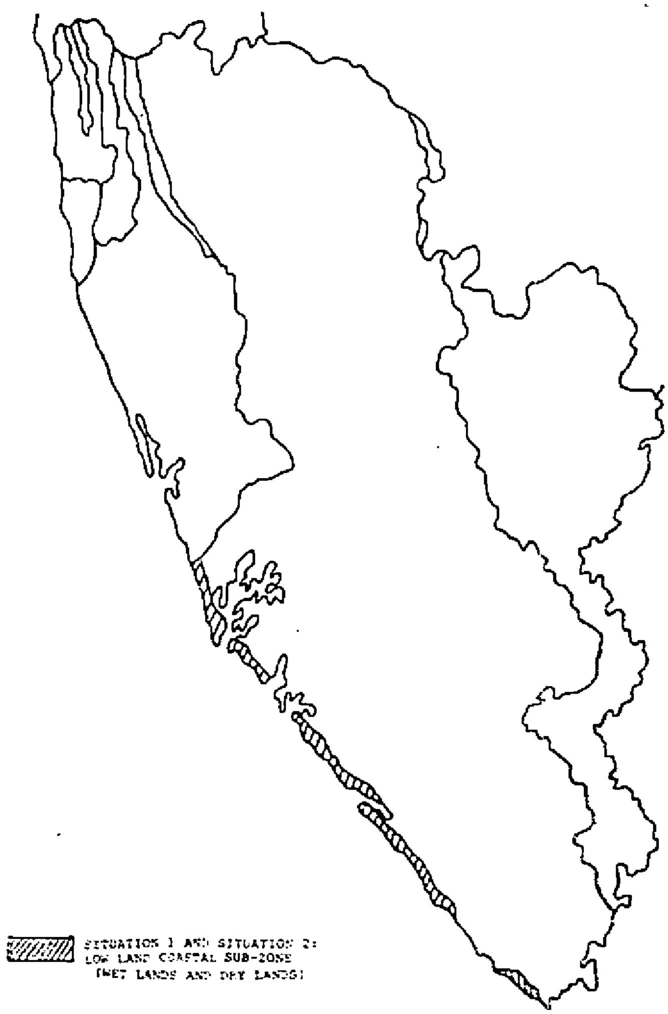
Table 38 contd.

Sl. No.	Agro-ecological situation (Symbol)	Apr. area (sq.km)	Alti-tude (m)	Rain fall (mm)	Soil texture	Land situa-tion	Rainfed/ irriga-ted	Major crops	Special features	Location
5.	Midland dry, medium elevation, laterite soil rainfed crop (MLD-ME-LS-RC)	3510	7 to 75	1880 to 3500	Gravelly laterite loam or clay loam (Laterite)	Mid-land, level, gently slop-ing	Mostly rainfed. Occasio-nal irriga-tion	Coconut Tapioca Banana Pepper Upland rice Vegeta-bles Cashew Fruit trees	Coconut-based and tapioca-based farming systems. Intercrops of banana, pepper, vegetables, tubers, fodder etc in the homesteads. Arecanut, cocoa, cloves, nutmeg, cashew, rubber, furit trees, sugarcane, pineapple etc. are the other crops grown	Entire central and interior portions of the zone, less the lowlying areas (wet paddy lands)
6.	Midland, medium elevation, red loam soil, rain-fed crop (ML-ME-RlS-RC)	317	7 to 75	1750 to 2500	Lateritic loam (red loamy soil)	Mid-land	Rain-fed	Coconut Tapioca Banana Vegeta-bles Pulses	Coconut based farming system with inter-crops like tapioca, banana, pepper, ground nut	Parts of Neyyattinkara and Trivandrum taluks (Nemom block, Neyyattinkara Municipal area and Athiyannoor block)
7.	Highland wet, higher elevation, hydromorphic soil, irrigated crop (HLW-HE-HS-IC)	100	75 to 750	2000 to 3500	Laterite loam, clay, clay loam, sandy clay loam (Hydro-morphic)	Vallios between undula-ting or steep slopes	Rainfed and irriga-ted	Paddy (One or two crops depen-ding on water)	Paddy is the main crop. Fallow in summer if water not available. Vegetables, pulses, sweet potato, crop sequences of rice-tapioca or rice-banana, if water available	Depressions and low lying areas found in the higher elevation on the eastern portions and foot hills ad-joining High Ranges
8.	Highland dry, higher elevation, laterite soil, rainfed crop (HLD-HE-LS-RC)	1845	75 to 750	2000 to 3500	Gravelly loam (laterite) Organic matter con-tent high in some areas	High-land	Rain-fed	Coconut Rubber Pepper Tapioca Banana, Fodder, Fruit crops, Spices	Soil erosion likely. Coconut-based farming system. Intercrops are banana, tapioca, spices, pepper, arecanut, pineapple	Higher eleva-tions of the eastern parts of the zone and foot hills of the uplands adjoining the High Ranges, excluding the paddy lands

Table 38 contd.

Sl. No.	Agro-ecological situation (Symbol)	Apr. area (sq.km)	Alti-tude (m)	Rain fall (mm)	Soil texture	Land situa-tion	Rainfed/ irriga-ted	Major crops	Special features	Location
9.	Homestead farming (HF)		0 to 750	1750 to	Laterite, red loam, sandy loam, and assorted textures	Low-land, Mid-land, High-land	Irri-gated and rain-fed	Polycropping of coconut, banana and other plantains, tapioca and other tubers, vegetables, pepper, pine-apple, fruit trees, fodder, clove, nutmeg, etc. Crop-livestock, crop-livestock-fish systems	Coconut-based farming system with intercrops cultivated in unscientific manner. Polycropping to suit farmers' needs is followed in most of the homesteads	Throughout the zone

Fig. 57 AGRO-ECOLOGICAL SITUATION UNDER LOWLAND COASTAL SUB-ZONE (SITUATION 1 AND SITUATION 2)



Homestead Farming System is not separately marked in the figure. Similarly, irrigated cropping and rainfed cropping, both exist under the same farming situation and hence, not separately shown in the figure.

3.3 Agricultural characteristics of agro-ecological situations

3.3.1. Agro-ecological situation under the lowland coastal zone covering Situations 1 and 2

Both Situation 1 and Situation 2 occur in the lowland coastal zone and hence, the features such as delineation of the area, physiography, climate, land utilization pattern, irrigation and the land holding pattern including the socio-economic characteristics are common to the two situations. These are, therefore, not separately discussed. Area under the Farming Situation 1 is about 10 to 15 sq. km. and that under the Situation 2, about 60 sq. km. Situations 1 and 2 are shown in Fig. 57.

1. Delineation of the area of the lowland coastal zone

The lowland coastal zone occurs on the western side of the zone, in areas adjoining the entire sea coast in the North-South direction and extending to a width of 1.0 to 1.5 km. from the sea shore, covering a total area of nearly 75 sq. km. In fact, the Situations 1 and 2 together occur in the lowland zone. The area constitutes 17 per cent of the coastal length of the State(590 km.) and 1.5 per cent of the total area of the zone. The coastal belt from Varkala extending to Paravur, constituting an area of nearly 10 sq. km. is, however, interrupted occasionally by laterite projections from the adjoining midland zone and hence, excluded from the lowland coastal zone. This sub-zone has river deltas, portions of backwaters and coastal sandy areas of the Arabian Sea. The isolated wet land patches, cropped exclusively to paddy under Situation 1 are not localised; but are distributed uniformly throughout the coastal vicinity. The area of individual paddy fields varies from 0.02 ha to 0.50 ha. The data on gross cropped area, net area under crops, area under dry land and area under wetland contained in the situations are furnished in Table 39.

Table 39. Drylands and wetlands under the situations 1 and 2

District	Taluk	Block	Panchayat	*Net cropped area(ha)	*Area dry land (ha)	*Area wetland (ha)	*Total area under crops (ha)
Trivandrum	Neyyattinkara	Parassala	Poovar) Kulathur)	2402	2386	384	2770
	Neyyattinkara	Athiyannur	Karumkulam) Vizhinjam) Kottukal)	5735	5958	697	6655
	Trivandrum	Kazhakkuttom	Attipra) Kadinamkulam)	3206	3447	650	4097
	Trivandrum	Trivandrum (Rural)	Kadakampally)	718	799	180	979
	Chirayinkil	Chirayinkil	Anjengo) Azhur) Chirayinkil	3415	3589	707	4296
	Chirayinkil	Varkala	Vettoor) Edava)	2287	2531	393	2924
Quilon	Quilon	Ithikkara	Paravoor	1794	2058	408	2466
		Mukhathala	Eravipuram	1246	1368	362	1730
		Anchalumood	Sakthikulangara	655	996	115	1111
Alleppey	Ambalapuzha	Ariyad	Mararikulam (S)	2055	2874	787	3661
	Kanjikuzhy	Kanjikuzhy	Mararikulam (N)) Shertalai) (S)	3278	4063	972	5035
	Shertalai	Pattanacaud	Aroor	1022	755	595	1350
			Total	27813	30824	6250	37074
			Zone	672505	783810	163573	947383
			State	2190985	2188271	678281	2866552
			% to zone	4.14	3.93	3.82	3.91

* Net cropped area, area under dry land, area under wet land and total cropped area as given in the Table relate to the entire coastal Panchayats eventhough only the portions of these Panchayats grazing the coastal boundary can be considered under this agro-ecological situation, for which data are not available.

The net cropped area in the Situations 1 and 2 together is 27,813 ha, which is 4.1 per cent to the zone (Fig. 58). The total cropped area under the two situations is 37,074 ha, which constitutes 3.9 per cent to the zone (Fig. 59). Situation 1 has 6,250 ha under wetland paddy, which is 3.8 per cent to the zone (Fig. 60). Situation 2 has 30,824 ha dryland constituting 3.9 per cent to the zone (Fig. 61).

The dryland coconut gardens with or without intercrops of tapioca and rarely banana and other plantains constitute Situation 2, occupying 80 per cent of its total cropped area in the lowland sub-zone, the rest being cropped to wet land paddy constituting Situation 1. Both occur throughout the coastal sub-zone. Valuable mineral deposits such as Ilmenite, Rutile, Zircon, Sillimenite and Monazite are seen in plenty in the beach sands occurring in some of the panchayats under the zone. These sands are separated and put to industrial use. Rich concentrations of Monazite and Ilmenite occur at Chavara and Neendakara in Quilon district.

2. Physiography:

The zone borders the West coast and has an almost level or very gently sloping topography, with lowlying areas, normally ranging in elevation between 0 to 3 m from MSL. Rivers and streams of various sizes flowing from the eastern parts of the zone cut across this area in the East-West direction at different locations and empty their water into the sea and form deltas. Major rivers traversing this area are the Karamana river, the Neyyar and the Vamanapuram river in Trivandrum district which fall straight into the sea. Parts of Veli lake, Kadinamkulam lake, Anjengo lake, Edava-Nadayara lake, Paravur lake and the Ashtamudi lake have access to sea coast.

3. Climate:

This agro-ecological situation enjoys a warm humid, tropical climate with annual rainfall of 1750 mm to 3000 mm. Alternate wet and dry periods form part of the climate. During the wet season extending from the end of

Fig. 58 SITUATION 1 AND SITUATION 2
NET CROPPED AREA (ha)

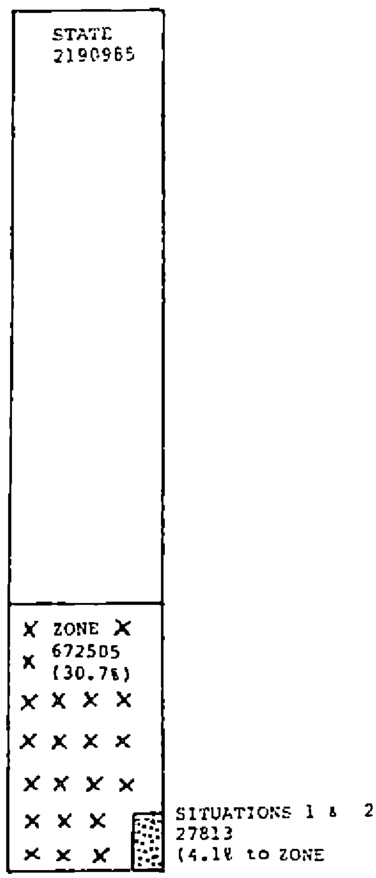


Fig. 59 SITUATION 1 AND SITUATION 2
TOTAL AREA UNDER CROPS (ha)

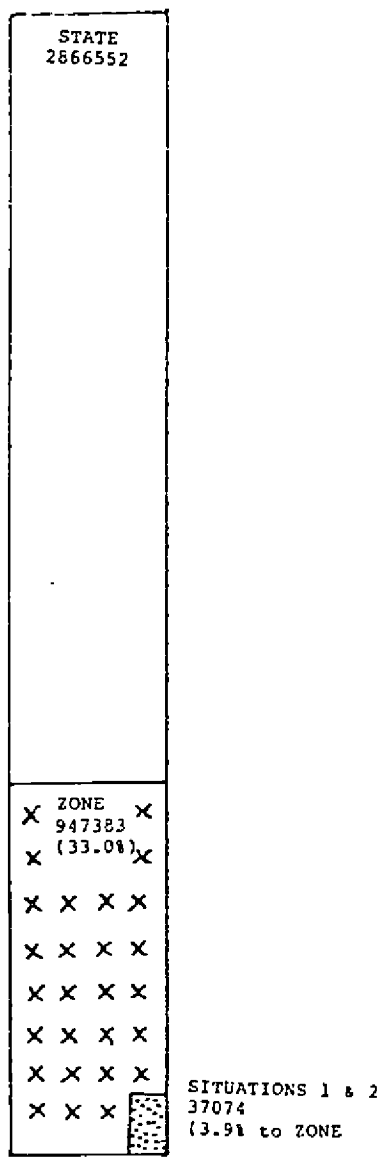


Fig. 60 SITUATION 1
TOTAL AREA UNDER
WETLAND RICE (ha)

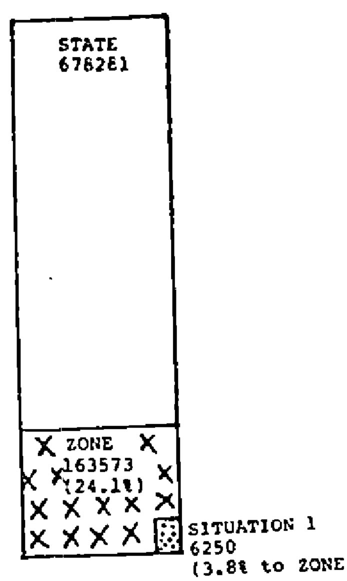
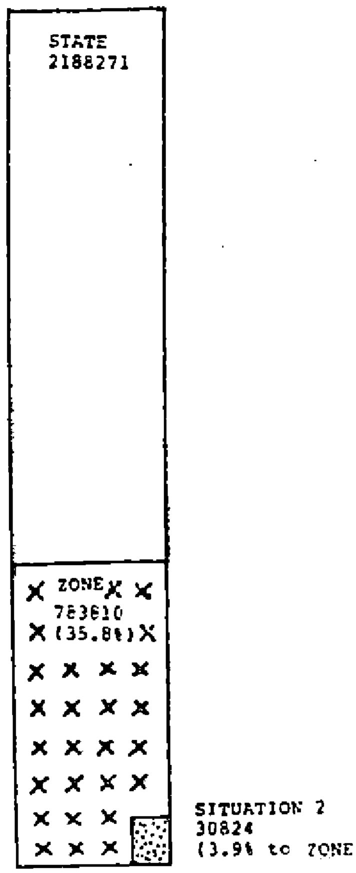


Fig. 61 SITUATION 2
TOTAL AREA UNDER DRYLAND CROPS (ha)



May to the middle of November, rains are received from both the South-West and North-East monsoons. About 60 per cent of the total annual precipitation is contributed by the South-West monsoon, 30 per cent by the North-East monsoon and the rest by off-season rains. Maximum intensity of rainfall is during June and July and the least during the summer months of February to April. The mean daily maximum and minimum temperature varies from 23°C to 33°C. The temperature variations through the seasons are not large. March and April are the hottest months, with temperature occasionally touching 36 to 37°C. Temperature is not a limiting factor for the cultivation of crops. The relative humidity values are in the range of 85-90 per cent and are higher when compared to that in the other agro-ecological situations in the zone. In brief, heavy annual rainfall, high humidity of atmosphere and a more or less uniform temperature throughout the year are the climatic features of this sub-zone.

4. Soils:

Under Situation 1, hydromorphic soil and riverine alluvium are found in patches with sandy loam, sandy clay loam and rarely clay loam texture, where paddy is cultivated. In Situation 2, two major soil types have been identified, the coastal alluvium on the sea coast and the riverine alluvium in the vicinity of rivers and lakes. The texture of the soil under this situation ranges from sandy to sandy loam. The lakes contained in this zone often carry salt due to intrusion of sea water under tidal influences and on such occasions may not be suitable for irrigation of salt sensitive crops, particularly rice. In view of the coarser texture of the soil, low water holding capacity and low fertility status resulting from the leaching away of the nutrients result. The CEC is also very low due to low content of organic matter and clay. Hence, crops grown under this agro-ecological situation often suffer from water stress conditions. Clay content of the soil is very low except near the rivers and lakes. The soil is acidic with pH ranging from 4.5 to 6.0 due to low base saturation. In spite of the nearness to the sea the electrical conductivity seldom records high value, and such temporarily saline situations even if arise, do not normally affect the crops other than rice.

The soil series are Kazhakkuttom series, Poovar series, Chirayinkil series, Karamana series, Vembayam series, Perinkulam series, Umayanallor series, Koduvila series, Mannar series and Neendakara series. Kazhakkuttom series and Poovar series "form the nearly level to very gently sloping coastal plain bordering the sea in the West and tongues of lands extending towards river beds and have recent marine deposits, running as parallel strip between the West coast and the midland laterites. These are very deep sandy coastal soils, in flat to very gently sloping sand beaches, deltas and lagoons". The coastal alluvium of the Quilon district is derived from sandy coastal alluvium stretching as a narrow belt along the coastal region. Soils are fine sandy to coarse sandy in texture and are greyish brown to reddish brown in colour, having uniform textural grade down the profile with single grain to weak structural development and ill-defined horizons. Mannar soils are more sandy and extends to the centre of Karunagapally and are grouped under psamments. Neendakara soils are loamy mixed isohyperthermic, Typics tropofluvents. Kazhakkuttom soils are also classified under psamments. Characteristics of the soil series occurring in this situation are discussed in detail in Chapter II. In view of the several constraints and also due to the increased population density, the small strips of the presently available wet land paddy areas are being slowly reclaimed for more profitable coconut plantation or for building purposes. It is likely, therefore, that during the years to come, the wet land patches existing under this agro-ecological situation may become extinct.

5. Land utilisation pattern

Information on the land utilisation pattern exclusively for the zone is not available for discussion. Total cropped area in the 20 panchayats bordering the sea coast is 37,074 ha which constitutes nearly 4.0 per cent of that of the zone. Area under non-agricultural uses in these panchayats is 6,694 ha constituting 0.7 per cent of the zone. "Area cultivable but not cultivated" constitutes 1,208 ha which forms 0.17 per cent of the zone. Net area cultivated is 27,813 ha constituting 4.0 per cent of that of the zone. Dry land area is 30,824 ha, wet land area is 6,250 ha each constituting nearly 4.0 per cent of that of the zone.

6. Irrigation

Only 40 per cent of the cultivated area is irrigated. Well is the major source of irrigation for paddy under this agro-ecological situation accounting for 60 per cent of the total irrigated area under paddy. Rivers and lakes constitute 30 per cent and canals contribute to 10 per cent. However, the river or lake water will be helpful only if the cultivated area lies close to these sources and at lower levels. Otherwise the crop is grown rainfed. Lakes often get polluted with salt water from sea and hence may not always be suitable for irrigation. Pot watering by some farmers is practiced and for this, the farmers have to depend on surface wells, tanks and small ponds. In the northern parts of the zone, viz; in Shertalai taluk, small surface ponds are available which are used to irrigate crops. Although the ground water table is high and is within 5 m depth, filter point wells and tube wells are not installed in sufficient number, with the result that irrigation facility in this situation is meagre. Except near the rivers and lakes, irrigation is a real constraint for the farmers in the situation. Attempts have to be made therefore to exploit the immense ground water potentialities available in this situation by digging more wells. Most of the crops grown are under strictly rainfed conditions. Coconut is the main agricultural crop.

7. Land holding pattern - Population - Socio economic condition

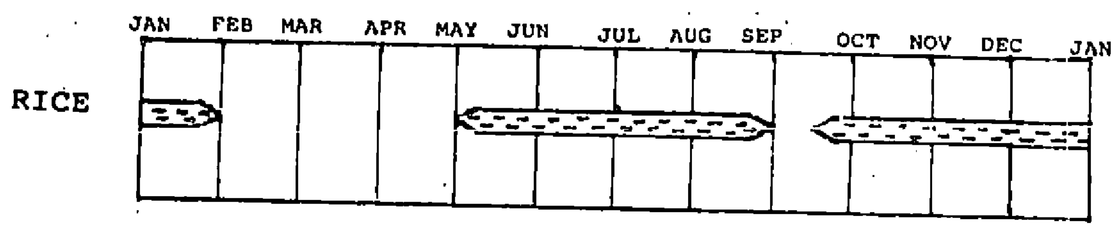
About 95 per cent of the holdings belong to marginal farmers. Bigger holdings are rare and constitute only 5.0 per cent. The wetlands under Situation 1 owned by individual farmers seldom measure beyond one acre. The paddy fields lie within one km away from the sea coast. Most of these farmers have other activities such as business, service or fishing or agricultural labour so that paddy cultivation is only a secondary occupation for them. Fishing is the primary occupation of about five to eight per cent of the population of the zone. Marine fishing villages in the zone are listed in Annexure CVII. One fishing harbour exists in the Vizhinjam port, 15 km South-West of Trivandrum. A marine research centre under the C.M.F.R.I. Cochin and the Indo Norwegian Fisheries Project are functioning at Vizhinjam and Neendakara, respectively. Fishermen community totals to 3.23 lakhs, constituting 47.4 per cent of the fishermen population in the State. Their main occupation is fishing and the women members are engaged in activities, such as repair and fabrication of fishing nets or coconut husk retting for coir making or plaiting of coconut leaves for thatching purposes. The 20 panchayats covering the coastal lowland situation have 1,51,611 main workers which constitutes 21 per cent to the zone, the rest being marginal workers and non-workers. Among the main workers, six per cent are cultivators, 23 per cent agricultural labourers, 10 per cent household industry workers and 61 per cent "others". The total population under this zone is 3.0 lakhs, which constitutes four per cent of the zone and nearly 1.2 per cent to the State. Of the towns existing in this zone, Quilon has the maximum density of population. Absentee landlordship prevails in this zone which constitutes about 10 per cent. The number of households in these Panchayats is 53,897 which constitutes 4.0 per cent to the zone. Since according to farmers, paddy cultivation is not a remunerative occupation, due to the risks and expenses involved, such small patches of paddy lands are being slowly converted into cocount gardens. The agricultural economy of this agro-ecological situation is controlled mainly by the coconut crop which thrives fairly well under the coastal condition, even without irrigation and proper manuring.

Situation 1 Coastal wet land - low elevation - hydromorphic soil - rainfed crop (CWL-LE-HS-RC)

8. Major crops/cropping pattern/cropping systems

Cultivation of paddy as a wet land crop is practiced by farmers in this agro-ecological situation. The size of the paddy fields individually owned by farmers seldom goes beyond one hectare. Strips of paddy lands of size 0.02 to 0.50 ha are most common and these are distributed in scattered areas located within one km distance from the coastal boundary. Due to irrigation limitations, only one crop of paddy is usually taken. Dry sowing is practiced in nearly 25 per cent of the wet lands, the rest is wet sown. Seeds are dry sown during April with the arrival of pre-monsoon showers and further growth of

Fig. 62 SITUATION 1 CROPPING SEASON



the crop is looked after by South-West monsoon expected by the end of May. More than 60 per cent of the rice farming is done under rainfed conditions. Near the lake beds and river banks, however, paddy is wet sown or transplanted from nursery and grown as irrigated crop. High yielding, improved and local varieties are popular. Adoption of HYV is nearly 30 per cent. Yields from paddy fields in the vicinity of rivers and deltas is satisfactory. In such locations, a second crop paddy is also successfully taken by several farmers. In locations other than lake beds and river banks, second crop paddy is raised by limited number of farmers who generally prefer improved or local varieties, because the crop has to occasionally withstand stress conditions. In view of this constraint and due to the possibility of saline intrusion from sea in some locations, rice production is not very encouraging. During the third crop season (January to April), more than 50 per cent of the paddy fields are kept fallow. Summer crops like vegetables, sweet potato, pulses and oil seeds are rarely grown due to water shortage.

Single crop system (rainfed)

Paddy seeds are dry sown by the middle of April or the seedlings transplanted from end of May with the onset of South-West monsoon and harvested in September. The monsoon provides the necessary moisture. However, flooding and occasional saline intrusion are the major production constraints, in some locations under this situation.

Double crop system (irrigated)

Two crops of paddy are taken, one during May to September as mentioned earlier and the other during October to January (Fig. 62). The system is followed by farmers only if irrigation is assured. Direct sowing or transplanting is done by farmers at their own choice, convenience and available facilities. Due to the possible water stress during the second crop season, local or improved varieties are preferred to HYVs by more than 65 per cent of the farmers.

The area under wet land paddy has considerably decreased during the recent years due to the high cost of labour and the strain and risk involved in its cultivation. More remunerative coconut palms, the cultivation of which involves less cost and risk, are grown in such reclaimed paddy fields.

9. Adoption pattern and production constraints

The percentage of adoption of the recommended practices for rice cultivation is very low among the farmers of this situation, for which the farmers present their own justification. Application of fertilisers is not possible without irrigation facilities. For the same reason, a second crop becomes difficult. Moreover, several farmers are not aware of the new technologies in the field of rice cultivation. In view of the above, and also due to the poor economic condition of many farmers, the percentage of adoption of several of the components of the production technology is very low. High yielding varieties of paddy are tried in limited locations, because of the higher cost of cultivation, the risk of saline intrusion into the paddy fields (in a few locations), the difficulty in irrigation and the need for constant and special care to be taken against pests and diseases. The major constraints in crop production are the following:

Low water holding capacity, low CEC and low fertility status of the soil. In view of the coarser texture of the soil, transplantation of the rice crop, if not done immediately after ploughing and levelling the field, becomes difficult, because the soil surface becomes harder and the finger cannot penetrate two inches depth to plant the seedling. The roots of crops will be devoid of moisture unless frequent irrigation is given. Improvement of water holding capacity of the soil by application of organic matter and improvement of the efficiency of the added fertilisers by split application and improvement of the texture of the soil by adding clay are being attempted by a few farmers. However, the addition of clay to improve the textural condition of the soil is not a feasible proposition because of the high costs involved.

Hazards due to saltish lake water from the sea and its inundation into paddy fields of the coastal areas of Poovar, Andoorkonam, Azhoor, Pazhanchira (Kadakkavoor), Paravur, Ithikkara, Adichanallur, Shertalai and Vaikom affect the paddy crop. Screening rice variety for salt tolerance and reclamation of lands unsuitable for paddy are the suggested remedies.

Non-availability of water, particularly during the second and third crop seasons (October to January and January to April). Erratic and uncertain nature of the monsoon, high labour cost and the poor economic condition of the farmers discourage them to take risks in raising second and third crops. However, farmers have to depend on wells and small ponds for pot watering which is the only method of irrigation possible. A good number of these wells and ponds get dried up in summer. Developing an efficient irrigation system through exploitation of ground water system by installing filter point wells and tube wells and evolving drip irrigation system wherever feasible and conservation of moisture by better agro-techniques are the immediate needs. Summer crop varieties of vegetables, pulses etc. suitable for this situation have to be identified and popularised.

In view of these constraints, which are mostly of a general nature, this farming situation is slowly vanishing and the areas earlier used for paddy are being converted for high value upland crops like coconut.

General production constraints

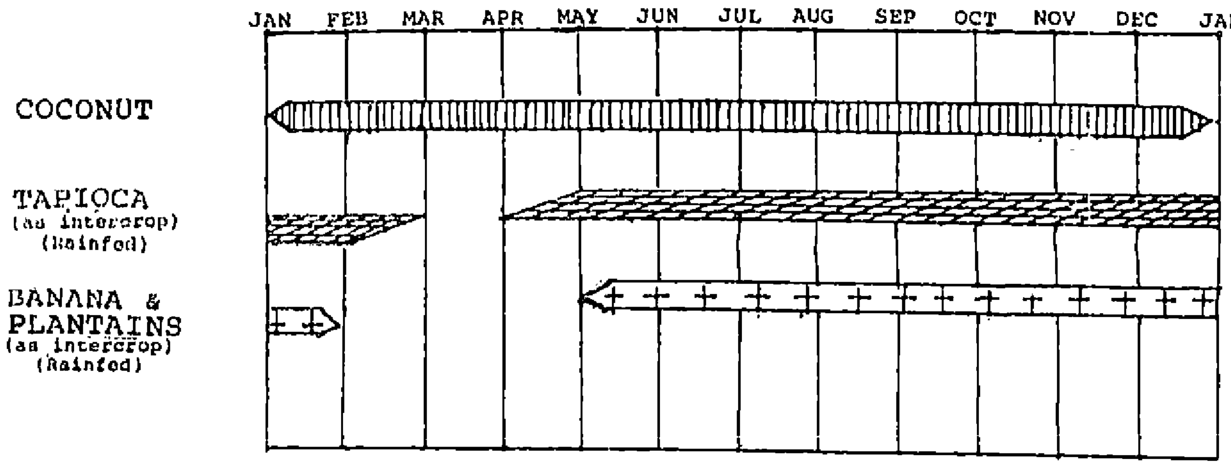
Loose texture of the soil leading to poor water and nutrient retaining capacity of the soil, deficiency of organic matter and want of irrigation facility are the general production constraints in this situation which hinder improved crop production.

3.3.2 Situation 2 Coastal dry land - low elevation - sandy loam soil - rainfed crop (CDL-LE-SlS-RC)

8. Major crops/cropping patterns/farming systems

Coconut is the most important crop grown under fully rainfed conditions. The intensity of cropping is 133 per cent. Tall, semi-tall and dwarf varieties are cultivated in garden lands and along the bunds. High yielding

Fig. 63 SITUATION 2 CROPPING PATTERN



varieties of coconut palms are seldom cultivated and therefore, constitute only 3.0 to 10.0 per cent. The West Coast Tall (WCT) is the prominant variety grown. The crop thrives particularly under the conditions of proximity to the sea. Tapioca is also grown; but rarely as a pure crop. It is grown intercropped in coconut gardens. The performance does not appear to be very encouraging. Apart from the yield considerations, growing of tapioca as intercrop in coconut gardens helps in preventing unauthorised encroachment of grazing cattle into the coconut gardens. The yield from coconut gardens is of the order of 100 to 120 nuts per annum while that of tapioca is rather low (8 to 9 tonnes/ha). As against the State average yield of 16.15 tonnes/ ha, tapioca yields better in the zone (17 to 18 tonnes/ha). Banana is also grown as intercrop in between coconut palms in the homesteads, irrigated by pot watering. The varieties grown are Palayankodan, Nendran, Njalipoovan, Poovan and Robusta. The cropping patterns in the Situation is given in Fig. 63. In sandy soils, clay is incorporated during the "digging of the basins" to improve the texture, by affordable farmers. Burial of coconut husks in the basins of the palms is a practice recommended for conservation of moisture. About five per cent of the farmers in this situation adopt this practice. The extent of adoption of this practice in the zone is slighly better (5.0 to 8.0 per cent). Green manure crops such as Crotalaria juncea (sunn hemp), Tephrosia purpurea (Koliji) and cover crops such as Calapagonium sp. which are recommended for enriching the soil and preventing the erosion, are grown only to a limited extent. The number of such farmers is less than one per cent. However, glyricidia and sesbania are grown by many farmers around the boundaries of coconut gardens and homesteads. The leaves are collected and ploughed into the paddy fields during land preparation or applied to the coconut basins during the digging operation done in April-May. Chemical fertilisers are seldom applied to coconuts and very rarely to tapioca, mostly due to the want of irrigation facilities and also due to the belief among some of the farmers that chemical fertilisers once applied should be continued every year without a break; other wise, there would be serious set back in the condition of the palms and heavy reduction in the yield. About 30 per cent of the farmers, however, apply cow dung annually to the coconut basins, during the digging just before the South-West monsoon.

9. Adoption pattern and production constraints

The adoption pattern and production constraints relating to coconut are explained in Volume 2. Intercropping and mixed farming can be adopted in coconut gardens and accordingly, rice, maize, legumes and pulses, tubers such as tapioca, sweet potato, yams, colacasia etc., fruit plants such as banana and other plantains, pine apple, beverage crops such as cocoa and fodder grasses such as Hybrid Napier, Guinea grass etc. are recommended. However, only very few farmers grow these inter-crops except in homesteads if sufficient area is available. The cropping pattern followed by the farmers is coconut grown alone or coconut intercropped with tapioca or with miscellaneous fruit trees such as mango, jack etc. and annuals like banana and various tubers in the available land in their homesteads. Upland rice is sown in coconut gardens just prior to the South-West monsoon showers in May, in some parts of the Quilon district. The adoption with regard to irrigation to coconut palms is only one per cent in this Farming Situation and with regard to fertilizer application also, the adoption percentage is very low. If the ground water potentials are properly tapped, better irrigation to coconuts and other intercrops such as tapioca can be expected. Other constraints in crop production under this Situation are listed below:

- Lack of standardised cheap techniques for post harvest handling and storage of farm produce. "Copra" which is the dried kernel of coconut, is an item of great market demand. Climatic conditions during post harvest handling of the kernel very often cause infestation of the copra by *Aspergillus*, leading to hazards due to aflatoxin.

- Lack of a cropping pattern to meet the requirements of home consumption as well as seasonal market demands..

- Unscientific spacing, non-manuring, under-manuring and imbalanced manuring for coconut palms followed by some farmers in view of the high cost of labour involved in manuring, both being not within the reach of many marginal and below-average farmers.

There are some areas where coconuts are planted very close and not receiving nourishment. Closer spacing of the palms is reflected in the decreased yield of nuts.

Lack of a scientific proposition for an ideal poly-crop combination in coconut gardens including miscellaneous fruit trees such as mango, jack etc. Lack of a scientific proposal for a a crop-livestock-fisheries mixed farming suitable to coconut based farming system, incorporating the recycling techniques.

Lack of a suitable technology for a multi-tier system of cultivation in coconut gardens.

Toxic hazards of salinity due to sea water inundation in some locations. For the coconut palms, however, this is not a serious problem as the crop thrives well even in saline situations. Such saline prone areas have already been reclaimed for coconut cultivation.

Pollution to coastal area and the coconut palms in the vicinity of M/s Travancore Titanium Products Ltd., Veli, Trivandrum due to effluent discharge containing sulphuric acid and ferrous sulphate. The leaves of coconut palms standing on either side of the open drain leading the effluent to sea, are seen wilted and the palms present an unhealthy and barren look. The local fishermen population are at a disadvantage since no fish landing occurs in this location.

Insect attack viz. Coreid bug, Rhinocerous beetle, Red palm weevil and Nephantis cerenopa on coconut.

Root (wilt), bud root and leaf rot diseases of coconut. Though involvement of mycoplasma like organisms (MLO) in the root (wilt) diseased palms has been established, a lot of further research is in progress for finding out a solution to this problem. Regulation of private nursery activities and imposing internal quarantine on coconut seedling movement can help in checking the spread of disease in coconut.

Lack of suitable shade-tolerant varieties of pulses, groudnut and other seasonals/annuals which can be intercropped in coconut plantations under shaded or partially shaded conditions. Under the NARP (southern zone), the available improved varieties of different pulses, groundnut and other seasonals have been screened for shade tolerance. Screening of cowpea, black gram, horse gram, green gram and groundnut varieties for shade tolerance is in progress.

Lack of suitable varieties of companion crops such as groundnut and other seasonals during the early growth phase of tapioca (upto 3 to 4 months) when sunlight will be available in the interspaces. In the southern zone, the available improved varieties of different pulses, groundnut and other seasonal crops have been screened for companion cropping with tapioca.

General production constraints

Loose texture of the soil and poor water and nutrient retaining capacity of the soil, deficiency of organic matter and want of irrigation facility are the general production constraints in this situation which hinter improved crop production.

The poor physico-chemical properties should be improved by addition of organic matter. Soils are reclaimed by adding clay wherever economical. Nitrogenous fertilizers in four or five split doses should be applied to rice crop. Measures for the conservation of moisture should be adopted. Potentialities of exploiting the groundwater resources for bringing about improved irrigation facilities under this farming situation have to be explored by digging tube wells and filter point wells.

Acidity and low water holding capacity of the soil are also constraints. Due to the nearness to the sea coast, the soil has coarse texture and leaching loss is likely. The soil has a pH ranging from 4.5 to 5.5 due to low base saturation. Corrective measures such as lime application for soil acidity and addition of clay to improve the water holding capacity of these porous soils, application of organic matter to improve the soil structure and growing of cover crops and adoption of other moisture conservation techniques are followed by affordable sections of the farming community which constitutes only 10 per cent.

Low content of organic matter and plant nutrients in the soil.

Lack of scientific crop-livestock combination in the homesteads.

Situation 3 Reclaimed backwater situation - low elevation - sandy alluvium - rainfed crop (RB-LE-SaS-RC)

1. Delineation of the area

These are rural backwater situations of land areas extending to nearly 60 km^2 area, constituting about one per cent of the zone (0.2 per cent to the State), located mostly near the coastal belt of the zone in isolated patches, where sea water can get entry either direct or through lakes and lagoons (Fig. 64). Back water areas of the coastal sub zone are found in Trivandrum, Quilon and Alleppey district covering the western parts of the taluks, blocks and panchayats contained in Table 40.

Seven blocks and 15 panchayats are contained in this sub-zone. Only portions of these panchayats fall under this agro-ecological situation. Area, population and number of homesteads are thus worked out based on the assumption that roughly one third of the panchayat area belongs to the situation. Also, since the data pertaining to dryland area, wet land area, net area cultivated and other components of the land utilisation pattern are not available for the individual panchayats, the available data for those blocks covered under the situation are fractionated roughly based on the presumed extent of the agro-ecological situation covared under each of the relevant blocks and presented for purposes of

Fig. 64
SITUATION 3

discussion in this report. The data may not be very accurate; but the reader can get an idea about the characteristics of the sub-zone.

Table 40. Delineation of the area under Situation 3

Taluk	Block*	Panchayat*	Net Area cultivated (ha)	Area of dry land (ha)	Area of wet land (ha)	Total area under crops (ha)
Trivandrum						
Neyyattinkara	Parassala	Poovar, Kulathur	480	477	77	554
,,	Athiyannur	Vizhinjam, Kottukal, Thiruvallam	360	894	105	999
Trivandrum	Tvm. (Rural)	Kadakampally	72	80	18	98
Chirayinkil	Chirayinkil	Chirayinkil, Azhoor, Kadakkavoor, Vakkom, Anjengo	1423	1495	295	1790
,,	Varkala	Edava	286	316	49	365
Quilon						
Quilon	Ithikkara	Paravur	448	514	102	615
Alleppey						
Shertalai	Kanjikuzhy	Mohama, Thanneermukkom	820	1015	243	1259
	TOTAL		4389	4791	889	5680

* Portions only.

The zone is charaterised by accumulations of water in a net work of small canals and cross canals with high ground water table and cultivated almost exclusively to coconut. Retting of coconut husk for making coir rope and other coir products is a regular feature seen in this agro-ecological situation. The retting of coconut husk for a few months under saline water leads to unpleasant odour pollutiong the atmosphere and the entire area is nearly marshy. The situation represents the low lying marshy areas reclaimed for coconut cultivation.

2. Physiography

The topography of the land under this situation is level with elevations ranging from 0 to 5 metres above or below MSL. The situation is classified under low land.

3. Climate

Humid tropical climate prevails in this tract with maximum temperature 32°C and minimum 18°C. As the coconut palms are found in large numbers, the canopy of the palms provides shade on the ground and hence high day atemperature are not always experienced on the land surface. The rainfall ranges from 1750 to 3000 mm per annum. The mean annual rainfall recorded is around 2000 mm of which about 60-65 per cent is received from South-West monsoon during June-July months. North-East monsoon and summer rains together constitute the rest. Due to the proximity to sea coast, the relative humidity is higher (80-85 per cent).

4. Soils

Red loam, lateritic, sandy and coastal alluvium are the soil types found under this agro-ecological situation. The physico-chemical properties of these soil types are discussed in Chapter II along with their morphological features. The soils under this situation are acidic (pH 4.5 to 5.0). Electrical conductivity often reaches 3 to 4 mmhos/cm^2 in some seasons which can restrict rice growth. The main soil series identified are Kazhakkuttom series, Chirayinkil series and Poova series. The main crop is coconut. The soils of this low lying situation are alluvial in nature with admixture of sand fractions of looser texture and have dark colour. Sandy and sandy loam soils are also very common. In some locations, a slight spongy feeling will be felt on treading through the soil surface, resulting from the use of coir waste along with soil for reclamation of the land. Coir waste is the rejected powdery portions of the retted coconut husk after making coir, known locally as "Chakirichoru".

5. Land utilisation pattern

Total geographical area of the Situation is around 60 sq.km. This Situation has 925 ha of land area under non-agricultural uses, which constitutes 1.0 per cent of that of the zone and 0.3 per cent to the State. Area cultivable but not cultivated constitutes 163 ha, which is 2.0 per cent of that of the zone and 0.1 per cent to the State. Net area cultivated is 4390 ha which constitutes 0.7 per cent of that of the zone and 0.2 per cent to the State. The Situation has 4791 ha dryland (0.6 per cent of that of the zone and 0.2 per cent to the State) and 889 ha wet land (0.5 per cent of that of the zone and 0.1 per cent to the State) together contributing to 5680 ha of total area under crops. This constitutes 0.6 per cent of the total cropped area in the zone and 0.2 per cent to the State.

6. Irrigation

Irrigation is seldom given to the crops. The ground water table is normally fairly high in this sub-zone which itself is sufficient to keep the coconut palms in healthy condition. Since a net work of canals and sub canals exists in this situation, the accumulated water in these canals has occasionally saline contamination and toxic concentrations of organic acids, and hence not considered as highly suitable for irrigation, except for the coconut palms which prefer a saline atmosphere. Rivers such as Karamana, Neyyar and Vamanapuram flow through this sub-zone and empty their water in the vicinity and the water in these rivers is available for irrigation.

7. Land holding pattern - population and socio-economic characteristics

The 15 Panchayats have a total population of 1.28 lakhs with 23,400 households, each constituting 1.7 per cent of the zone and 0.5 per cent to the State. These Panchayats, together contain 1,07,029 main workers constituting 4.0 per cent of the zone . Marginal farmers are 16,022 in number, constituting 3.8 per cent in the zone. Non workers in the zone constitute 3.8 per cent. Of the main workers, cultivators form 6.0 per cent, agricultural labourers 25 per cent, house-hold industry workers 11 per cent and "others" 58 per cent. In the zone these constitute 2.0, 4.0, 9.5 and 4.7 per cent, respectively. Majority of the land (about 70 per cent) under this situation belongs to average and marginal farmers who own farms of upto 1.0 ha or even more. These farmers may invariably have, besides Agriculture, other occupations. As such, Agriculture is to be considered as the secondary occupation in this agro-ecological situation. However, about 10 to 15 per cent of the farmers may be from the affluent sections of the farming community living in urban areas, who own coconut gardens which are either managed by themselves by frequent visits to the sub-zone or through paid managers who reside in the sub-zone itself and look after the cultivation. However, more owner cultivation than absentee landlordship cultivation exists in this situation. Women folk in this sub-zone who belong to the poorer sections of the farming community have the occupation of plaiting coconut leaves used for thatching purposes. Many of these skilled women have coconut husk retting and coir making as the major occupation and they earn their livelihood from the meagre wages paid by contractors. engaged in this thriving business. The daily wage they get does not normally exceed Rs.15/- per day, except that the skilled women may get a little more. Men are also engaged in this type of activity. The retting of coconut husks along the saline back waters and other stagnant ponds to produce coir fibre causes serious water pollution problems. Large quantity of organics including pectins, pentosans, tannins etc. are liberated. The polyphenols are continuously leached out. A highly turbid greenish coloured water with foul smell develop in the retting yards in the backwaters. The eco-hydrology of the retting yards have to be properly studied to reduce pollution hazard in the current practice and to suggest alternate retting technology to ward off unhygeinic environment. Tapping of sweet toddy from coconut palms is another occupation by a negligibly small percentage of the male population. Inland fishing is practiced by the fishermen community which constitutes about 3.0 per cent.

The situation has a density of population ranging between 700 and 800 per sq.km. Most populated (37,298) is in Vizhinjam coastal panchayat while the least populated (15,632) is Anjengo panchayat. Of the total population in the sub-zone, 35 per cent are cultivators, 40 per cent, agricultural labourers, 10 per cent, landlords and the rest have occupations relating to small scale industry or business. Coconut is the main crop controlling the agricultural economy. The incidence of root wilt and other diseases of coconut, gradually spreading to alarming proportions, therefore, cause great concern.

8. Major crops and cropping patterns / systems

Coconut is the main crop and is grown mostly rainfed. It occupies 3,391 ha, which constitutes 60 per cent of the gross cropped area in this Situation and 1.3 per cent in the zone. The intensity of cropping is 129. The crop is raised in garden land, dry land, bunds and paddy lands converted to dry land, mostly as pure crop. In such situations, arecanut or cocoa is also intercropped (Fig. 65). Seedlings of coconut are planted in June during the onset of South-West monsoon. West Coast Tall is the variety grown throughout. However, along the bunds of reclaimed low lands, palms of shorter stature are also grown. The ground water table is high and as such, irrigation is seldom given to coconuts. Organic manures in the form of FYM or green leaf are applied once during the annual digging of the coconut basins in April-May. Chemical fertilizers are not normally applied. The harvest of coconut is done once in 45 days or 60 days. The cropping pattern is: coconut alone as a pure crop in the open or coconut with anuuals such as tapioca, banana or with perennials such as cocoa and fruit trees in the homesteads. Block-wise coverage under the major crops is given in Table 41. Only the portions of the blocks falling within the situation are considered therein.

Fig. 65 SITUATION 3
CROPPING PATTERN

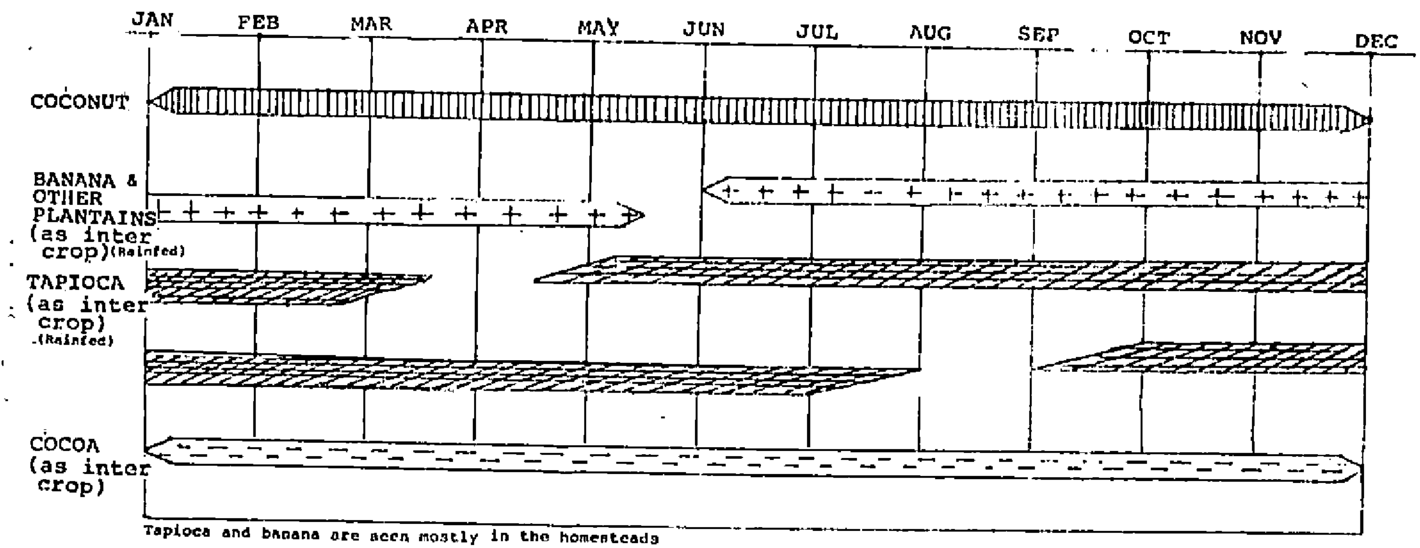


Table 41. Bock-wise coverage (ha) under the major crops grown in Situation 3

*Block	Coconut	Tapioca	Paddy	Areca-nut	Cashew	Pepper
Parassala	302	160	77	3	6	8
Athiyannur	816	338	105	5	10	18
Trivandrum (Rural)	56	18	18	1	1	2
Chirayinkil	1027	265	295	24	61	42
Varkala	150	56	49	3	15	5
Ithikkara	330	157	102	6	23	18
Kanjikuzhy	710	-	243	10	56	-
Total	3391	994	889	52	172	93
% (1)	1.27	0.76	0.54	0.44	0.81	0.28
% (2)	59.70	17.50	15.65	0.91	3.03	1.64
% (3)	0.36	0.10	0.09	0.005	0.02	0.01

*Portions only

(1) Percentage of the crop to total area of the crop in the zone
(2) Percentage of the crop to total area under different crops in the situation
(3) Percentage of the crop to the gross cropped area in the zone

Insect attack on coconut palms, particularly that of coreid bug, red palm weevil, Nephantis cerenopa and rhinozeros beetle is common and also diseases such as bud rot, leaf rot and root wilt. The area under tapioca is 994 ha. Coverage of tapioca as pure crop is 17.5 per cent of the gross cropped area in the situation, 0.76 per cent of the total cassava area in the zone and 0.1 per cent of the gross cropped area in the zone. Improved M4 and local cassava varieties form the component crop of the poly-cropping system in many homesteads. In the low lying areas where hydromorphic soil occurs, paddy is grown in 889 ha which, however, forms only 0.5 per cent of the total paddy area and 0.09 per cent of the gross cropped area of the zone. In fact, paddy is presently cultivated in negligible areas only. Reclaimed paddy fields are used for growing coconut. Other crops are rare. In the homesteads, however, polycropping with banana and other plantain varieties, tapioca and minor tubers, pepper, legumes etc. is practiced in the coconut-based farming system, some of which are irrigated by pot watering from wells. However, the average yield of these intercrops are much lower than their production potential. The gross cropped area in the Situation is 5,680 ha.

9. Adoption pattern and production constraints

Details of the adoption pattern and the production constraints relating to the crops cultivated in this agro-ecological situation are furnished in Volume 2. The general production constraints are summarised below:

General production constraints

Soil salinity due to tidal sea water inundation through lakes and backwaters.

Pollution of water resulting from the retting of coconut husk for coir making in backwater areas in Quilon and Alleppey districts. Moreover, the retting of the husks needs five to six months. Suitable micro-biological techniques for hastening the retting of the husk in a shorter period, confining the retting to restricted areas to avoid large scale pollution and minimising the undesirable odour polluting the atmosphere due to retting, thereby maintaining better hygeine, will be helpful in making coir industry more thriving with least pollution hazards. Suitable methods for the utilisation of coconut husk waste after coir making have to be evolved. At present, the coir waste is used along with soil for the reclamation of backwater areas.

Lack of economically viable mixed farming system. A suitable and economically viable crop-livestock-fish or crop-fish farming system for the backwater areas has to be developed.

Root wilt, bud rot and leaf rot are the diseases of coconut slowly progressing to serious conditions. Detailed study on the etiology of root wilt disease in coconut palms are in progress at CPCRI Regional Station at Kayamkulam and at the Kerala Agricultural University. Coreid bug incidence in coconut leading to button shedding has also been reported.

Agro-ecological situation under the midland sub-zone covering Situation 4 and Situation 5

Both Situation 4 and Situation 5 occur in the midland sub-zone, hence the features such as delineation of the area, physiography, climate, soils, land utilisation pattern, irrigation and the land holding pattern including the socio-economic characteristics are common to both the Situations with minor variations and are therefore not separately discussed.

1. Delineation of the area of the midland sub-zone

This agro-ecological situation (Fig. 66) which is the largest situation and the most thickly populated of the entire zone, occupies an area of nearly 4,225 sq.km, constituting 65 per cent of the total area of the zone and distriruted among all the five districts of the southern zone. Intensity of cropping is 139 per cent. The dry lands of the midland subzone in Trivandrum, Quilon, Pathanamthitta, Kottayam and Alleppey districts covering the eastern parts of Neyyattinkara, Trivandrum, Chiravinkil, Quilon, Thiruvalla, Chengannur, Changanassery and Vaikom taluks, western parts of Nedumangad, Pathanamthitta, Meenachil and Kanjirappally taluks, majority of the Kottarakkara, Kozhencherry, Kunnathur and Kottayam taluks are included under the midland sub-zone. Parts of Trivandrum and Neyyattinkara taluks with red loam soil, for which separate situation (Situation 6) has been identified are, however, not included in this situation. Block-wise data on the net cropped area, area under dryland, area under wetland and total area under crops are furnished in Table 42.

Fig. 66
SITUATION 4 AND SITUATION 5

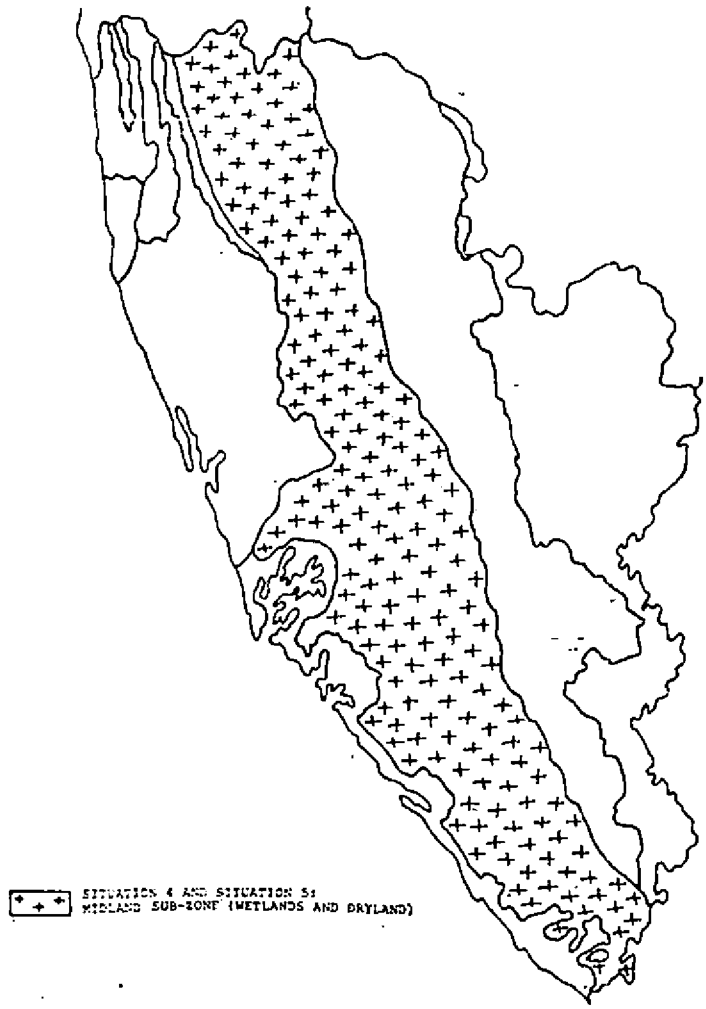


Table 42. Delineation of the area (in ha) under Situations 4 and 5

*Block	Net cropped area	Area dryland	Area wetland	Totalarea under crops
Chirayinkil	7969	8374	1649	10023
Kilimanoor	17075	15686	2551	18297
Varkala	8005	8858	1377	10235
Vamanapuram	21274	22717	1997	24714
Kazhakkuttom	11221	12064	2276	14340
Nemom	11388	9857	1981	11838
Trivandrum Rural	2872	3197	720	3917
Parassala	7205	7159	1153	8312
Anchalumood	2621	3983	461	4444
Chittumala	4277	6825	944	7769
Kottarakkara	10083	11404	1755	13159
Mukhathala	6229	6841	1809	8650
Pathanapuram	19921	22891	1926	24817
Sasthamkotta	13834	15155	3605	18760
Ithikkara	10762	12346	2450	14796
Koipram	107	11155	1587	12742
Kulanada	3542	3434	686	4120
Mallappally(Half)	5746	6136	487	6623
Pandalam	4777	4703	1158	5861
Parakode (Half)	8932	10372	1130	11502
Pulikeezh	40	1721	3165	4886
Aryad	6164	8623	2361	10984
Chengannur	8520	5544	4512	10056
Kanjikuzhy	8194	10157	2430	12587
Thycattussery	4269	6711	1927	8638
Ettumanur	11104	7718	6273	13991
Kaduthuruthy	16684	13298	5620	18918
Madappally	11894	8458	4582	13040
Pallom	13490	11351	8096	19447
Pampady	15495	16161	456	16617
Uzhavur	15482	14013	1742	15755
Vaikom	8808	7304	5854	13158
Total	282614	314216	78720	392936

* Data relate to the entire block area, eventhough portions of a few of these blocks do not fall under the Situation. Panchayat/ village-wise data are not available for discussion.

Net area under crops constitutes 42.0 per cent to the zone (Fig. 67). The total area under crops in the two situations together accounts for 41.5 per cent to the zone, of which drylands constitute 33.2 per cent and wetlands, 8.3 per cent (Fig. 68).

2. Physiography:

The topography of the situation is characterised by level to gently sloping, to moderately steep areas. The elevation from MSL ranges between 7.5 m to 75.0 m, consisting of the undulating area of low hills, steep side slopes enclosing narrow valleys and undulating plains bisected by numerous drainage channels lying on the East of lowland zone. The elevation of the land slowly increases from the West towards the East. Paddy is cultivated in the low lying areas and depressions in valleys and in undulating areas made into terraces.

3. Climate:

The zone enjoys a warm humid tropical climate with mean annual rainfall of 1875 mm and a mean temperature of 26.1°C. The mean maximum and minimum temperatures recorded are 35 and 21°C, respectively. Mean annual rainfall ranges between 2000 to 3400 mm. The seasons are controlled by the South-West and North-East monsoons. The South-West monsoon starts by the end of May or early June and continues up to the middle of August. The maximum precipitation is received from the South-West monsoon with intense downpour during the months of June and July. The North-East monsoon begins by the end of September and lasts till November. A secondary maximum rainfall, thus, occurs in October, but more than 55 to 60 per cent of the annual rainfall is derived from South-West monsoon. The temperature variation through the seasons is not large. March, April and May are the hottest months. Generally, drought and hot spells are not intense. However in 1983, the drought which occurred was very intense and affected the growth and productivity of many crops, particularly coconut, arecanut and banana. After the cessation of the North-East monsoon, the day temperature gradually increases after September, but cooler nights are often experienced owing to fall in temperature during the nights. Temperature is not a

Fig. 67 SITUATION 4 AND SITUATION 5
NET AREA UNDER CROPS (ha)

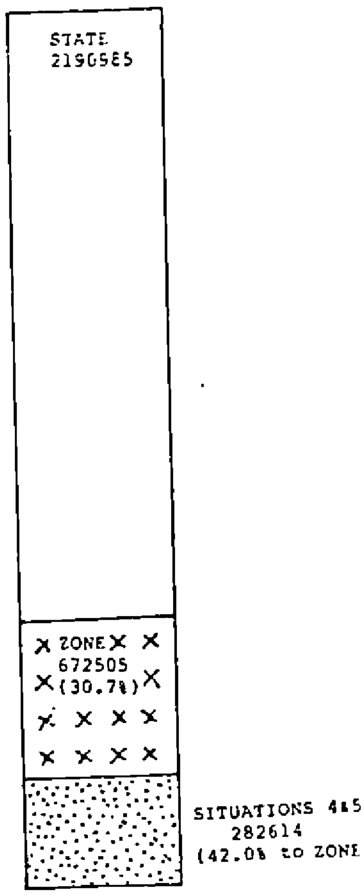
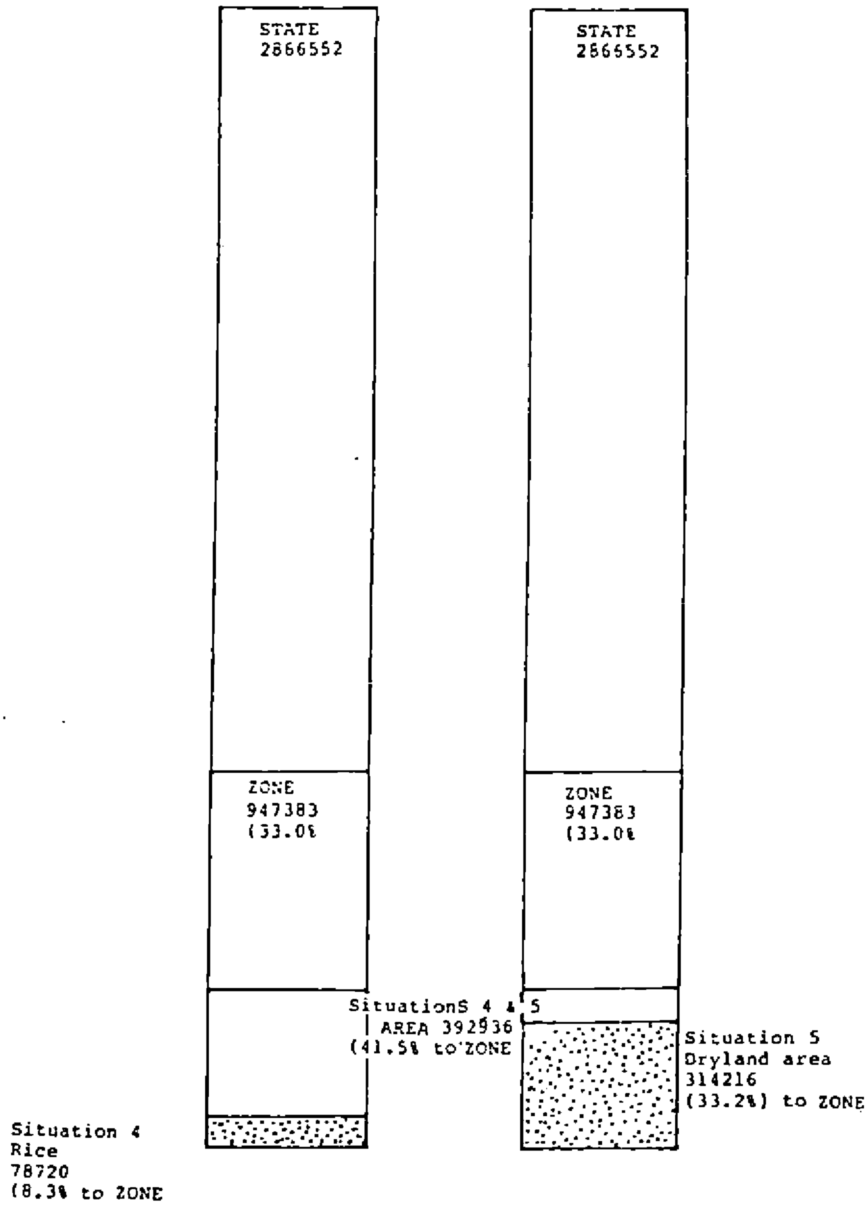


Fig. 68 SITUATIONS 4 & 5
TOTAL AREA UNDER CROPS (ha)



limiting factor for most of the cultivated crops in this agro-ecological situation. Fluctuation in ground water table is noticed from location to location; but normally it varies from 10 metres to 30 metres.

4. Soils:

Three soil types exist in the midland zone, laterite, riverine alluvium and brown hydromorphic. The characteristics of these soils including the description of soil profiles are given in detail in Chapter II. Laterite soil is the most dominant soil type in the zone. Riverine alluvium occurs on the banks of the major rivers which cut across the midland sub-zone in the East-West direction. Brown hydromorphic soils are found in the low lying areas where paddy is the important crop. In general, the soils are derived mainly from gneissic rock. They are generally well drained, very deep, dark reddish brown with a thick layer of Plinthite of laterite. Dominant clay mineral is kaolinite. High amount of gravel is noticed throughout the profile. The prominent soil type under the Situation 4 is the brown hydromorphic while that under Situation 5 is laterite which covers more than 60 per cent of the area in the sub-zone, with soil texture ranging from sandy loam to sandy clay loam to clay loam. The soil is acidic with pH ranging between 4.5 to 6.0. Electrical conductivity is negligible and this permits the growth of a variety of crops, except in a few isolated locations. The soil is very poor in all major plant nutrients; but respond well to management practices. The following soil series have been established:

Thonnackal series and Varkala series

"Deep to very deep, yellowish brown, medium textured grvelly laterite soils of tertiary origin on low laterite plateaus".

Thonnackal series:

Thonnackal series has a deposit of clay loam to clay in surface and sub soils - overlying the laterite and occurs on the lower slopes of laterite plateaus.

Varkala series:

Varkala soils are very gravelly with textural grades ranging from gravelly loam to gravelly clay and generally occur on plateau tops. No rock is traceable even in very deep profiles. Coconut, tapioca and cashew are the major crops.

Mudakkal series and Paravoor series:

Described in Volume III.

Trivandrum series and Vilappil series

Soils of this association occur in the central part of the Trivandrum district. They are very deep, reddish brown, with a fair distribution of iron and lateritic gravels in the profile. Trivandrum soils possess a thick yellowish red gravelly clay "B" horizon merging with the soft laterite below. The "A" horizon is comparatively thin and has gravelly loam to gravelly clay texture. They usually occur on summit, side slopes and foot slopes of low laterite hills and mounds. Vilappil soils are less gravelly and have gneissic boulders in the profile and occurs mostly in ridges. A variety of crops like coconut, tapioca, pepper, rubber, cashew etc. are grown.

Vizhinjam series, Pangappara series and Vamanapuram series

"Deep to very deep, medium textured, reddish brown gravelly laterite soils, with thick "A" horizon, on strongly to steeply sloping laterite hills, mounds and ridges".

Kallada series and Chiravinkil series

These are developed essentially from fine fluventile sedimentation, occuring as a narrow belt along river banks and are subject to frequent flooding during monsoon. Soils are very deep and have ill defined horizons and are riverine alluvium.

Vazhamuttom series and Pamba series

These are riverine alluvium and are young soils grouped under Entisols falling under fine loamy to clayey family and classed under typic tropofluvents.

The following soil associations have also been established in the situation. Trivandrum - Varkala - Thonnackal Association; Varkala - Sivagiri Association; Pattazhi - Karavalloor Association; Adoor - Omalloor Association; Vizhinjam - Trivandrum Association; Puthenpeedika - Konnithazham Association; Kottarakkara - Omannoor Association. The soils of these associations are grouped into two orders viz. Inceptisol and Alfisol. Alfisols fall into loamy skeletal to clayey skeletal mixed isohyperthermic family. The characteristics of the other soil series such as Anikad series, Pampady series, Kottappuram series, Kooroppada series and Arpookara series are described in Volume III. Kuttichal series, Kunnathukal series, Koduvila series' Perinkulam series, Umayanallur series, Karamana series, Vembayam series, Cherunniyoor series, Udayamperur series, Parapuzha series, Changanassery series, Manjoor series, and Vechur series occur in the hydromorphic soils under Situation 4. These series are also described in Volume III.

5. Land utilisation pattern

The midland sub-zone is the chief agricultural tract of the southern zone with maximum density of population and area under a variety of crops. The data relating to the land utilisation pattern described under Chapter II are more or less applicable for this Situation as well.

6. Irrigation

A major irrigation project, the Neyyar dam in Trivandrum district irrigates 11,740 ha paddy in this district. Two other irrigation projects, Kallada and Pamba in Quilon / Pathanamthitta districts are under execution. Moovattupuzha and Meenachil projects in Kottayam district and Vamanapuram project in Trivandrum district are under investigation. The extent of land including lowland paddy fields (in ha) likely to be benefited from these ongoing projects is furnished in Chapter 2 under the sub title Irrigation. The rivers Neyyar, Karamana, Vamanapuram, Kallada, Pamba, Achankoil, Manimala and Meenachil are flowing across this agro-ecological situation and these help in the irrigation. Tube wells, filter point wells, minor irrigation and lift irrigation schemes constructed in the sub-zone are also helpful. Small ponds are also available, in addition to the lakes (kayals) such as Vellayani kayal, Veli kayal, Edava-Nadayara kayal, Paravur kayal, Kadinamkulam kayal and Sasthamkotta kayal which can be used for irrigation. However, all the above mentioned lakes except the fresh water lakes of Vellayani and Sasthamkotta occasionally get contaminated with salt water brought from the sea. The upland crops are very rarely irrigated and mostly grown as rainfed. Lowland paddy fields, however, receive irrigation. In certain tracts irrigation from wells, canals etc. is followed. In the homesteads, however, few crops are irrigated by pot watering from wells.

7. Land holding pattern - population - Socio-economic characteristics

This situation, existing in an area of 4225 sq. km., constitutes 65 per cent of the zone. Of the nine situations identified in the zone, this agro-ecological situation has the highest density of population, highest literacy rate and maximum area put to agricultural use. Under this agro-ecological situation, Mukhathala block in Quilon district has the highest population. Maximum number of holdings constituting nearly 64 per cent is within the range of 0.04 ha to 0.25 ha. Small holdings (one to two ha) constitute six to seven per cent and the marginal holdings (below one ha) constitute 91 per cent. There is a predominance of marginal and small farmers in this sub-zone. Of the total working population, 15 to 16 per cent are cultivators, 27 to 28 per cent, agricultural labourers, four to five per cent are engaged in household industry and the rest are classed under "other workers". Coconut husk retting and coir making, cashew shell processing, inland fishing, cane and rattan work and bamboo reed weaving, hand loom etc. are some of the traditional occupations of the womenfolk from the poorer sections of the farming community under this sub-zone. Coir industry is a cottage industry concentrated mainly in the coastal belt, particularly near backwater area. On a small scale, this industry attracts labour in the midland zone also. Availability of plenty of coconut husks from the low lands and on either sides of the lakes and even from the hinderland of the coastal strip, retting facilities in the brackish lakes and lagoons and abundant women labour force are the main factors conducive to the development of coir industry. This industry is highly export oriented. Cashew processing units in Quilon and Allepey districts absorb a large number of skilled women labourers on seasonal basis and this industry flourishes for a few months annually, depending upon the availability of raw cashewnuts. Inland fishing is the occupation of five per cent of the population. There is immense potentiality for inland fisheries in the zone, since lakes, lagoons, rivers and reservoirs exist.

Situation 4

Midland wet - medium elevation - hydromorphic soil - irrigated crop (MLW-ME-HS-IC)

1. Major crops, cropping patterns/cropping systems

Rice-based farming system is exclusively followed in the lowlands and valleys between slopes under irrigation. Uneven terrains in the sub-zone are made into terraces and cropped to irrigated paddy. The area of paddy under this Situation cannot be separately estimated, since many crops under upland conditions as described under Situation 5 are also grown through out the zone. However, the lowland paddy occupies about 610 sq. km in the midland sub-zone, constituting about 20 per cent of the cropped area. These wet lands are distributed in small patches in all the Panchayats under the midland zone. Upland paddy also is cultivated under rainfed conditions in some of the taluks of Quilon district, wherein the local variety of paddy suited to the upland conditions is dry sown during the pre-monsoon showers in April-May prior to South-West monsoon. The area under upland paddy is, however, very limited and not discussed here. Wet land rice is cultivated mostly under irrigation, at different land levels resembling terraced lands. Individual fields are level but the different fields are on different terraces. Vast areas on a single plain extending to several hectares (locally known as Padasekharams) are also cropped to paddy. Both HY and local varieties of paddy are either sown, dibbled or transplanted. Here again, the exact area under direct sown (dry and wet), dibbled and transplanted conditions cannot be separately estimated since all the farmers do not use the same variety and not constantly follow the same method of planting every year. High yielding varieties are popular in the sub-zone, which constitute 50 per cent and the extent of area under HYV paddy has shown an increasing trend during these years. Low coverage of HYV paddy during the second crop season is found in Neyyatinkara, Quilon, Kottarakkara, Adoor, Pathanamthitta etc. probably due to non-availability of a HYV suitable to the location and capable of yielding red rice and more straw, acceptable to the farmers. However, local varieties are preferred by some farmers, since the floods during the first crop season and drought during the second crop season pose problems. Farmers, particularly in the southern districts of the zone, are interested in straw also, in addition to grain. During the recent days straw has become dear since the grassland areas and pastures have reduced considerably and fodder grass is not available to many farmers in sufficient quantities, necessitating dependance on factory made costlier cattle feeds which appear in the market under different brand names with or without the prescribed quality. Want of sufficient straw ~~is~~, among others, one reason for the low adoption of HYV by farmers. Sowing is normally done during Autumn, while transplantation is the system of planting normally followed during Winter. However, for each season, the farmers use their own choice in deciding the method of planting. Since transplantation involves more expenditure and more labour, many farmers prefer wet-sowing of sprouted seeds. The area under paddy has decreased in the sub-zone, though productivity is more or less maintained. Want of adequate supply of quality seeds in time, moisture stress during critical growth stages, inadequate plant population, application of NPK fertilisers in doses much below the Package recommendation, micronutrient deficiencies in intensively cropped areas etc. are some of the major constraints. The risks involved in the paddy cultivation, the high cost of labour, the low market price for the produce not commensurating with the cost of cultivation, fragmentation of the paddy areas and the pressure of population are the likely reasons for the reduction in the area under paddy. In violation of the land utilisation rules, large areas of wet lands are being reclaimed for the more remunerative, less labour intensive crops like coconut, which involves less risk, attention and susceptibility to vagaries of weather and gives fairly steady income. Large scale mining of clay from paddy fields for brick manufacture is also done, affecting the fertility status of the soil.

High acidity leads to problems of iron and aluminium toxicity,especially under conditions of waterlogging and restricted draingage, limiting crop production. Iron toxicity - a nutritional disorder of wet land rice associated with excess soluble iron, occurs in strongly acidic soils and acid sulphate soils of low base status and results from the solubilisation of iron leading to high ferrous iron concentration in the soil solution, often exceeding the toxic limit of 300 ppm. Plants absorbing ferrous iron, under such conditions may sometimes exhibit toxicity symptoms (such as burning of leaf tip, reddish brown or yellow discolouration of older leaves which later dry up) resulting in stunted growth and decreased grain yield. The situation is seen in the low lands of Alleppey and Kottayam districts and parts of Quilon and Trivandrum districts.

In the rice based farming system, however, the following cropping systems exist in the sub-zone (Fig. 69):

1. Upland paddy - Rainfed - rare.

2. Single crop paddy in wet lands. This is rare and constitutes only 5 per cent. Only one crop of paddy is taken during the autumn season.

3. Double and triple crop paddy.

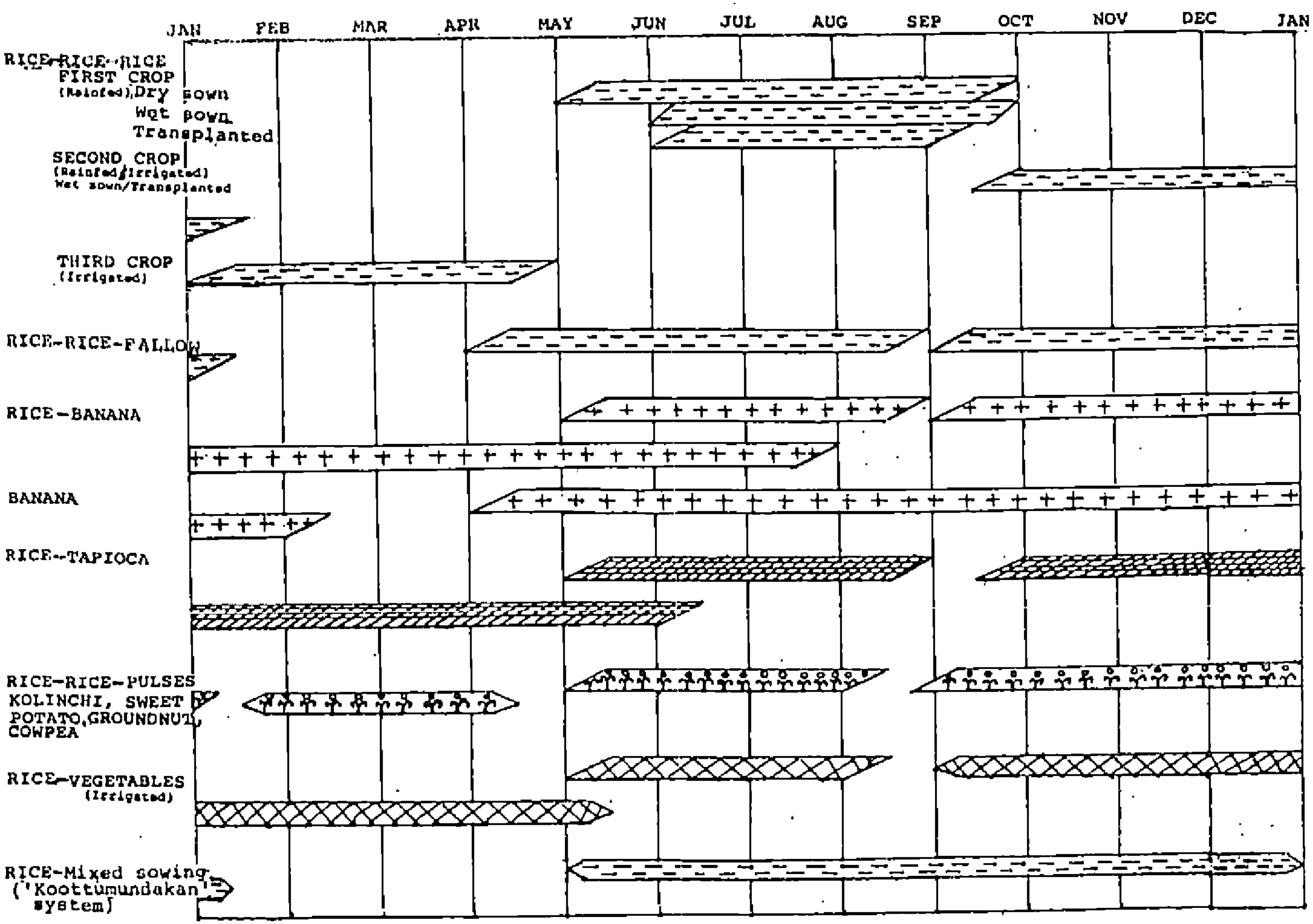
   Paddy - Paddy - Paddy

   Paddy - Paddy - Pulses

   Paddy - Paddy - Seasamum
   or Groundnut (Oil seeds)

   Paddy - Paddy - Sweet potato

Fig. 69 SITUATION 4 CROPPING PATTERN



Paddy - Paddy - Vegetables

Paddy - Paddy - Fallow

Paddy - banana

Paddy - tapioca

Paddy - Sugarcane

The cropping systems are followed depending on the availability of inputs including irrigation and based on farmers' preferences for home requirement of crops and market demand. The third season crop grown in the paddy fields may or may not change every year and hence a precise estimation of the area under these crops during the 3rd crop season is difficult.

A special farming situation under wet land paddy in the midland zone which has long been in existence and gradually becoming obsolete is the Koottumundakan cultivation, wherein mixed sowing of two paddy varieties of different durations- one of short duration, photo-insensitive variety and the other of long duration, photo-sensitive variety, is done during the first crop season. Harvest of the two varieties is done separately. This type of rice farming is done in places where the land preparation for the second crop may be difficult due to reasons such as flooding etc. and is in existence in Attingal, Kottarakkara, Adoor areas in small patches. The mixing of the varieties is done in different ratios by the farmers without scientific basis and without much optimism about high returns. The optimum ratio of mixing, if scientifically worked out, will be helpful for more economic returns. Suitable technology has to be developed for furthering the Koottumundakan cultivation which is becoming obsolete. However, this type of farming is more of a subsistence agriculture and cannot be elevated to the status of sofisticated agriculture.

2. Extent of adoption and production constraints

The extent of adoption of improved technology by farmers is summarised in volume 2. Major constraints in the production of paddy in the zone are:

Endemic occurrence of sheath blight and sheath rot in paddy, leading to poor filling of the rice grain in the sub-zone particularly in Adoor, Kottarakkara, Quilon and Neyattinkara. Also rice bug attack at the seed setting stage.

Low coverage of high yielding varieties of paddy during the second crop season, probably due to the non-availability of a HYV with red rice and more straw acceptable to the farmers of the southern districts.

High acidity leading to problems of iron and aluminium toxicity, especially under conditions of water-logging and restricted draingage, thereby limiting crop production.

Fallowing of the rice fields in the third crop season (January to April) due to lack of irrigation facilities and lack of suitable drought resistant crop varieties.

The low efficiency of "petti and para" - the Pumping units, used in some of the flooded paddy padasekharams for dewatering, which can be fabricated with cheap indigenous materials. This needs improvement.

Lack of suitable recommendation for the crop combinations and crop rotations in the rice based farming system, which are acceptable to the farmers.

Lack of high yielding varieties of rice with resistance to major pests such as brown plant hopper.

Soil erosion and silting in the ribbon valleys, particularly during monsoon seasons from adjoining slopes.

Lack of red rice variety with high grain and straw yield for the second crop season to replace the popular local variety 'Cheradi' in the southern districts of the sub-zone.

Pollution hazards due to the effluents from several rubber factories in Kottayam district and from Velloor News Print Factory discharged into Moovatupuzha river and effluents from Paper Mills at Punalur and Laxmi Starch Factory at Kundara discharged into kallada river. At

Mangalam, Kamalloor and Ambattuchira areas near Adoor, problems in crop production investigated, were in relation to the pollution of agricultural land consequent to the effluent disharged from Kodumon Rubber Factory of the Plantation Corporation of Kerala. The concentration of several natural rubber processing industries (crepe rubber, latex concentrate, crumb rubber etc.), particularly in Kottayam district is seriously polluting the water sources in the district. The effluents consisted of process water, small quantities of uncoagulated latex, inorganic and organic salts. The effluents were found to be acidic with pH values ranging from 4.5 to 6.5 due to use of formic acid and sulphuric acid for the coagulation of field latex and skim respectively. The levels of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and total dissolved solids were also of significant levels. A study on pollution control by State Planning Board on the basis of figures provided by the industries themselves and the Rubber Board showed that several industries had either no facility for effluent treatment or had only primary treatment facilities which involved physical methods of removal of impurities such as, rubber traps and sedimentation tanks, thereby failing to achieve the desired level of quality. A detailed study of the characterisation of waste streams, effects of pollutants and receiving systems, pollution control measures depending upon techno-economic feasibility, effluent recovery process etc. is necessary.

High cost of cultivation and the risks involved, making rice cultivation less remunerative.

Problems arising out of uncertain rainfall distribution in spite of good annual rainfall. First crop of dry sown paddy (Autumn) suffers from droughts in early stages and floods in the middle stages, while second crop (Winter) is affected by drought in its later stages.

Lack of suitable varieties of rice which can withstand temporary floods in the lowlands and also for areas where dry sowing is practiced.

Lack of short duration, high yielding varieties of rice suited to kayal lands (saline and non-saline), as well as the lowland areas in the zone, where presently cultivated varieties are unsuitable.

Lack of information on the causes of low yields of paddy during second crop seasons, physiological disorders of HYV, moisture stress physiology etc.

Lack of suitable variety mixes of rice for areas where the Koottumundakan system of cultivation exists.

Lack of irrigation facilities in the lower reaches of the highlands merging with the upper reaches of the valleys, where the moderately slopey lands with some terracing is cropped to Modan (upland) rice, vegetables, banana etc. either as monocrop or as crop mix along with coconut.

Lack of information on the location specific water management problems to increase rice yields, including the water requirements of rice varieties suitable for the third crop season (summer), groundwater fluctuations and the effect on puncha crop.

Want of effective utilisation of the irrigation potential created in the command area and want of sufficient stored water in irrigation project reservoir.

General constraints

Lack of timely and adequate availability of various inputs such as seeds, fertilisers, plant protection chemicals, equipment etc.

Want of irrigation facility during the late second crop season and during 3rd crop season, leading to fallowing of paddy lands.

Flooding during the first crop season and drought during the second and third crop seasons.

Uncertain and erraneous monsoon and the risk involved in paddy cultivation.

Situation-5

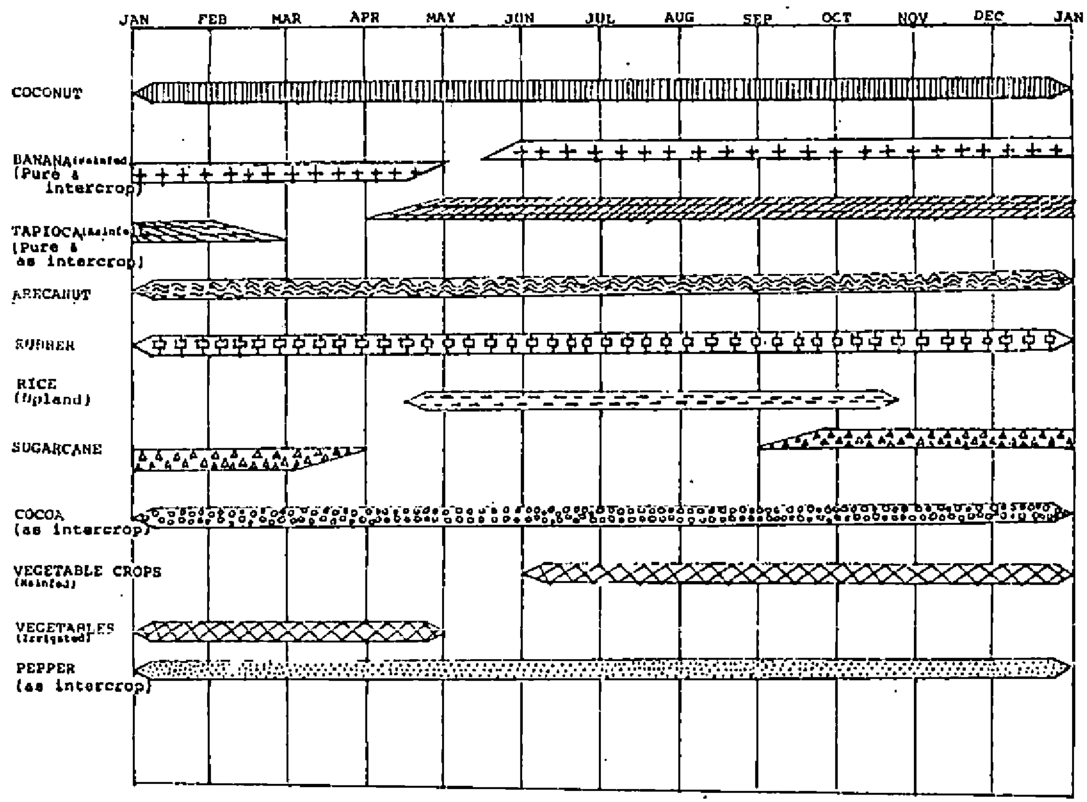
Midland dry - medium elevation - laterite soil - Rainfed crop
(MLD-ME-LS-RC)

1. Major crops and cropping patterns/cropping systems

The situation is contained in more than 60 per cent of the gross cropped area in the zone. Coconut is the major crop grown in this farming situation and this remunerative crop is extensively cultivated in every nook and corner in the sub-zone. It is grown as pure crop or inter-cropped with a variety of crops which include tapioca, banana, pepper, cocoa, clove etc. This situation covers an area of 2950 sq.km. in the midland sub-zone and forms the largest situation. The cropping patterns followed in this situation are given in Fig. 70.

Homestead cultivation involving a polycrop combination is a characteristic feature of the entire households in the zone and as such, a separate farming situation on Homestead has been identified, wherein coconut based farming system is dominant. Details of this polycropping system is discussed under Farming Situation No. 9. Banana, tapioca and other tubers, cocoa, fodder, horsegram, cowpea and other pulses and vegetables, pepper, ginger, turmeric, yam etc. are intercropped in between the available spaces in coconut, depending on the farmers' preference, in addition to miscellaneous fruit trees like mango, jack, guava, tamarind, clove, nutmeg etc. In isolated pockets, cashew orchards are also seen, as in Kottarakkara. Rubber is profitably cultivated as plantations on the eastern part of this subzone. Arecanut is grown as the main crop in Nedumangad and Palode. Broadly, four types of farming systems can be identified, namely, coconut-based farming system, tapioca-based farming system, rice-based farming system and the homestead farming system. The main crop is used in naming and describing the farming system. Thus, the coconut based farming system means that the main crop is coconut with other minor crops intercropped

Fig.7.0 SITUATION 5 CROPPING PATTERN



in the available space. The follcwing cropping patterns are seen in the garden lands under the Situation:

Coconut
Coconut - Tapioca
Coconut - Tuber crops
Coconut - Cccoa
Coconut - Arecanut
Coconut - Pepper

Except the rice-based farming system discussed under Situation 4, all others exist in the homesteads of the midland, lowland and the highland zones.

In the coconut-based farming system, coconut will be the pivotal crop. The system is in vogue in the level areas of the midlands. Recommendations with reference to spacing, irrigation, fertilizer application etc. are not followed by most of the cultivators. This cropping system includes a number of inter-crops such as pepper, arecanut, tapioca, cocoa, banana, clove, ginger, turmeric, fodder grass etc., and in some areas, upland rice, pulses and oil seeds are grown. The selection of the annual or seasonal crops is made depending on the age of the coconut palms so as to make the best use of the sunshine infiltrating to the plantations for maximum out turn from unit area. Identification of varieties of pulses and oil seeds suited for growing in the partially shaded conditions in coconut gardens was a long felt need of the farmers in this zone. Investigations hane been carried out on these lines in the southern zone. Next to coconut and paddy, tapioca occupies the major area under the Situation. Tapioca-based farming system, with tapioca as the pivotal crop, has also been identified under this agro-ecological situation, in addition to the pure cropping with tapioca. Tapioca is cultivated in terraced areas in hill slopes of the midland zone. Under monoculture or as intercrop, tapioca occupies sizeable part of the cropped area. Several local varieties of tapioca are grown by farmers viz. Pannivella, Kalikalan, Kayyalachadi, Kulambuvella, Aanakkomban, Karinjhetta etc. M4 variety which is high-yielding has become very dear and popular in the zone in the recent years. Several high yielding tapioca varieties have been evolved by C.T.C.R.I., Trivandrum but these are yet to become popular, mainly because of the farmer's unawareness. Short duration seasonal crops such as pulses and oil seeds are successfully grown as intercrops. Area under different intercrops in the zone will change every year since the farmer does not grow in his field the same intercrop every year. The main seasons for tapioca are April-May planting (prior to the onset of South-West monsoon) and September-October planting (coinciding with the North-East monsoon). Some farmers follow other seasons also. Both the pit method and mound method are popular, but farmers in Trivandrum and Quilon districts adopt chiefly the mound method for planting tapioca cuttings, while in Kottayam district the pit method is also practiced with success. In the highlands, particularly in Meenachil taluk and Kanjirappally taluk in Kottayam district, the tapioca yield is much higher than that obtained in the districts of Trivandrum and Quilon; the reason being the higher fertility status of these soils adjoining the upland high ranges. However, in these taluks rubber, which is more remunerative, has almost monopolished the area. Tapioca stems are planted at a spacing of 90 x 90 cm and it takes about three to four months to have enough canopy to cover the land. It is, therefore, possible to utilise the interspace between the rows of tapioca mounds for the intercrop like groundnut or pulses during the early stages.In all the districts under the zone where the benefits of South-West and North-East monsoons are available, growing banana as a rainfed crop, both Nendran and culinary varieties, is a common practice. In the wet paddy fields also, this crop is grown immediately after the harvest of the first crop paddy. Recommendations suited to this farming system in rice fields are not available. This is an area which will bring in results in terms of increased crop production. The Red Banana, exclusively grown and consumed with a preference in the southern districts of the midland subzone, is an exported commodity in recent days. No research results are available on the different aspects of its cultivation, post harvest storage etc., eventhough work on these lines has been initiated recently. There are areas on the banks of Ashtamudi lake and Paravur lake in Quilon district and also at Neyyar dam reservoir at Puravimala and Amboori (tribal areas) where scope exists for implementing mixed farming practices involving crop-livestock-fish, where the waste from one will be recycled as a nutrient for the other, thus making the proposition economically viable. Pepper is a dollar earning crop widely cultivated in this subzone.

2. Adoption pattern and constraints in agricultural production

The pattern of adoption of the recommended practices on crops by the farmers in this subzone has been discussed in Volume 2.

Constraints

Lack of a scientific polycrop combination in coconut gardens including misc. fruit trees such as mango, jack etc. grown in the midland subzone. A scientific polycrop combination with proper evidences on its effects on soil fertility, moisture conservation, weed suppression, pest and disease minimisation etc. has to be developed.

High acidity of the soil, coupled with low content of organic matter and available plant nutrients. Crop sequences involving legumes, which improve soil fertility and soil structure, have to be identified.

Prolonged dry spell from December to May (Summer months) seriously affects crops of perennials and annuals in the uplands and lowlands.

Unscientific spacing, non-manuring, under-manuring and imbalanced manuring of coconut followed by some farmers (in view of the high cost of manures, fertilisers and labour involved in manuring). There are areas where coconuts are planted very close and not receiving adequate nutrients.

Abnormal button shedding in coconut.

Non-utilisation of space and energy in cashew and rubber plantations. Suitable intercrops for cashew and rubber plantations have to be identified and the management practices for crop combinations with cashew and rubber as the main crops have to be standardised.

Low water holding capacity of the soil, particularly in coarse textured soils and undulating topography leading to high leaching loss and surface run off of water and nutrients during rainy seasons.

Unremunerative nature of tapioca cultivation on account of severe attack by rodents.

Lack of standardised cheap techniques for post harvest handling and storage of various produces. Climatic conditions during post harvest handling of "copra", dried kernel of coconut, very often infected by Aspergillus leading to hazards due to aflatoxin.

Use of uncertified, diseased planting material and absence of plant protection practices in tapioca cultivation.

Uncertain market and fluctuation in tapioca tuber prices. A common practice is to dispose off the standing crop on lumpsum payment to middlemen, which causes greater gaps between the consumer's price and producer's receipt. Avoidance of middlemen and help to unorganised tapioca growers are possible through organised or institutional marketing infrastructure.

Short shelf life of the tapioca tuber. Although treatment of sun dried tapioca chips with 0.5 per cent of sodium hypochlorite could prolong its shelf life upto 90 days and preservation of fresh tapioca tubers in moist (40-45 per cent) saw dust or sand upto 3 to 4 weeks without much deterioration is possible, the technologies are yet to receive response from the farmers of the zone. Refined technology is needed for the preservation of fresh tubers.

Area under tapioca cultivation is dwindling and there is little scope for further expansion of area. With improvement in the living standards of the poorer sections of the community, the material is losing the importance as a staple food for working class during the recent days. Dried tapioca chips however, forms a component of cattle, poultry and pig feeds.

Tapioca-based industries in Kerala face acute competition from the neighbouring States due to high overhead and establishment charges including wages for labourers. Considerable quantities of harvested tapioca find exit to Tamil Nadu State where more than 600 small sago and starch manufacturing units are already in operation.

Lack of proper agronomic techniques for slopy lands.

Want of package recommendation for betelvine cultivation prevalent in Neyyattinkara and Nedumangad taluks.

Want of package recommendation for Red Banana variety, preferred for cultivation by farmers in the southern districts.

Pollution to the environment (water resources and agricultural crops) in the vicinity of factories, namely, M/s K.D.P. Ltd., Alleppey; Rubber processing factory, Kodumon and other rubber processing units in Kottayam district; Paper Mills, Punalur; Starch factory, Kundara; Newsprint factory, Velloor; Coconut husk retting and coir making in Quilon and Alleppey districts etc.

Want of suitable crop-livestock-fish culture system for enhancing the net return from unit area of the marginal farmers in areas where pisciculture is possible, such as the Paravur, Ashtamudi, Akathumuri, Vellayani kayals and Neyyar dam.

Lower coverage under HYVs coconut, tapioca and pepper in the zone due to the farmers not convinced about the benefits / non-awareness / non-availability of the seedlings / cuttings / vines in sufficient quantities.

Pest attack and disease incidence in coconut and banana crops are the problems faced by farmers. Root (wilt) and bud rot diseases and coreid bug attack of coconut palms and bunchy top disease of banana. No viable technology has been evolved to control the disease of coconut root (wilt) and bunchy top of banana.

High cost of labour.

Lack of marketing facilities in the rural areas for the harvested produce particularly jack, mango, tapioca, etc.

Lack of post harvest technology for the preservation of banana, pineapple, jack, mango etc.

Mosaic virus disease in tapioca.

Non-acceptance of the high yielding tapioca varieties other than M4 by the farmers. Some of these varieties are bitter to taste and are industrial varieties, not preferred for home consumption.

Lack of standardised agro-techniques for tuber crops as a pure crop and as intercrop in coconut garden.

Shedding of spikes in pepper.

General constraints

Though rivers are flowing through this sub-zone, irrigation for the dryland crops is seldom given, except for those existing in the homesteads where pot-watering is done. Neyyar Dam in Trivandrum district is the only water source available in canals and sub-canals for irrigation of crops. However, major benefit from this source goes to wetland paddy areas only. Moverover, many sub-canals remain dry due to water scarcity in summer months. Want of irrigation facilities particularly during the summer months is, therefore, a constraint. Some minor irrigation and lift irrigation schemes operate in the sub-zone. Here again, these sources are helpful in irrigating wet land paddy only. Other general constraints in crop production are:

Lack of stability in demand and supply of various agricultural produce and lack of proper marketing system.

Pests and diseases infestation at different growth stages of various crops.

High cost of labour.

Lack of availability of sufficient planting material of the high yielding varieties of coconut, tapioca and pepper to farmers.

Situation 6

<u>Midland - medium elevation - red loam soil - rainfed crop</u> (ML-ME-R1S-RC)

1. Delineation of the area

The Situation occurs mainly in the southern end of the zone in an area of 31,699 ha, distributed among the Community Blocks of Nemom (13,323 ha.), Athiyannoor (9,118 ha) and Parassala (8,288 ha) and in Neyyattinkara Municipality (970 ha) and their border areas. The Situation is very dominant in the Panchayats of Thiruvallam, Kalliyoor, Venganoor, Balaramapuram, Chenkal, Karumkulam, Karode, Thirupuram, Athiyannoor, Pallichal and Perumpazhuthur. The Situation is shown in Fig. 71. Block-wise data on net area under crops, area under dryland, area under wetland and gross cropped area are furnished in Table 43.

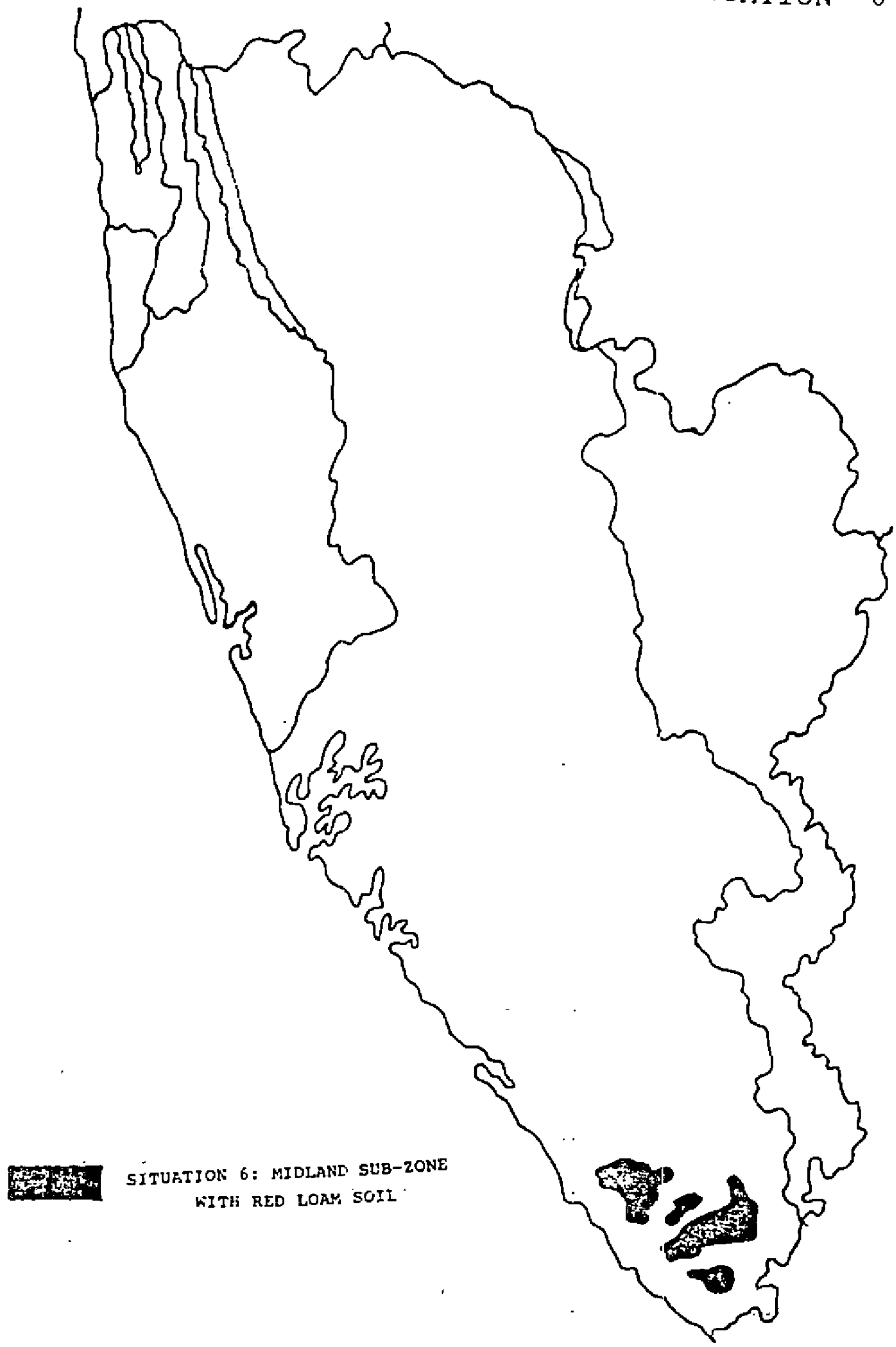
Table 43. Delineation of the area (ha) under Situation 6

Block*	Net cropped area	Area of dryland	Area of wetland@	Total area undercrops
Athiyannur	10037	10427	1219	11646
Nemom	11388	9857	1981	11838
Parassala	7205	7159	1153	8312
Neyyattinkara (Municipality)	NA	NA	NA	NA
	28630	27443	4353	31796

* Data relate to the entire block, eventhough portions of these blocks do not fall under the situation. Panchayat / Village wise data are not avilable for discussion.

@ Brown hydromorphic soil.

Fig. 71
SITUATION 6



Net cropped area in this situation constitutes 4.3 per cent and the total area under crops, 3.4 per cent of the zone (Fig. 72).

2. Physiography

The topographical features more or less resemble the midland situations (Situations 4 and 5), with level to undulating terrain having slight slopes and flat hills with elevation ranging between 7m and 100m above MSL. Rice is grown in the low lying level lands and also in slopes made into terraces where the soil is brown hydromorphic. The major area under this Situation supports a variety of perennial, annual and seasonal crops.

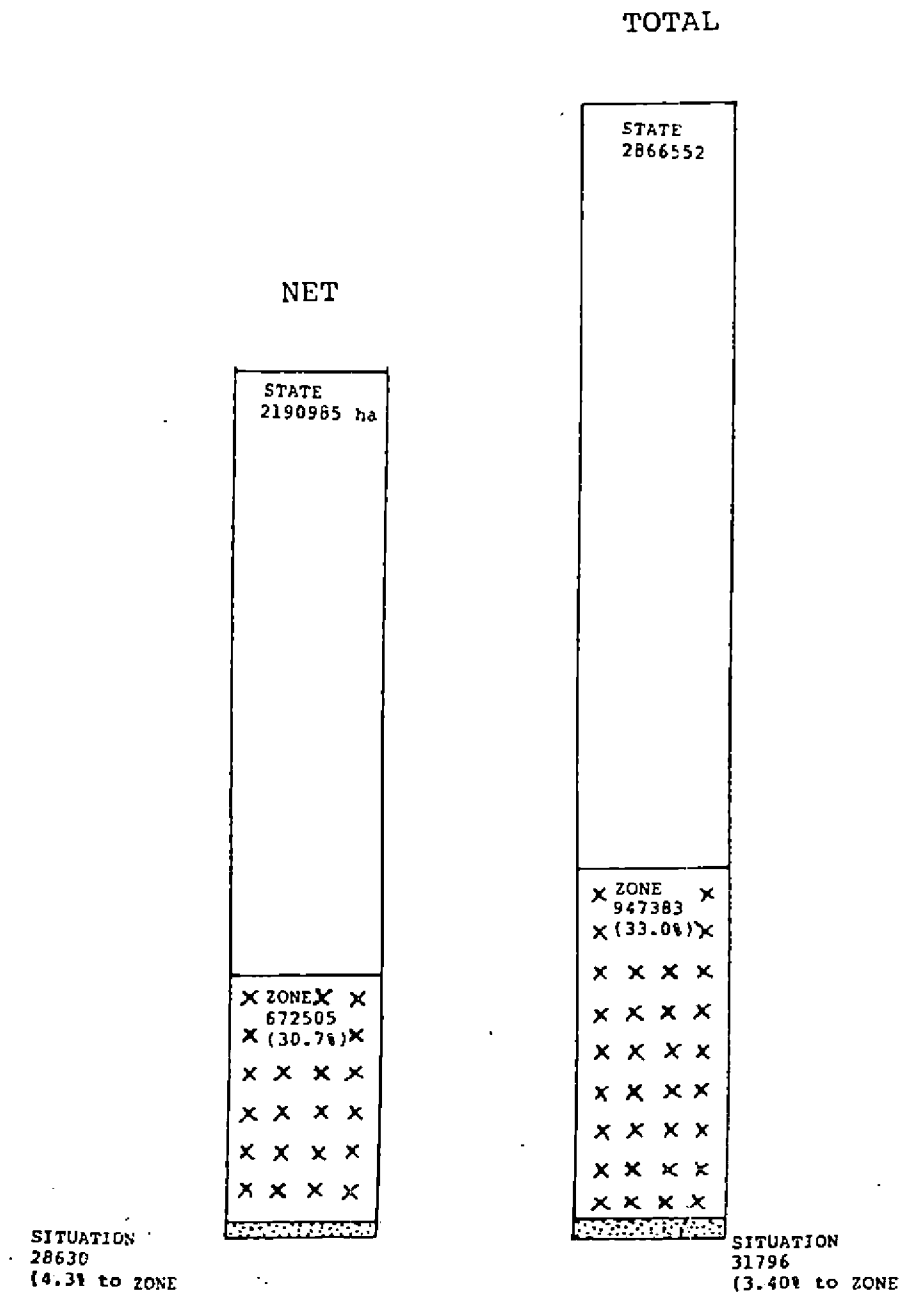
3. Climate

Climatic conditions described under Situations 4 and 5 are applicable for this Situation as well.

4. Soils

The morphological features suggest that the red loam soil has developed on some transported material, possibly aeolian deposits, and has undergone a process of imperfect laterisation. The soil has rapid permeability. These soils are very deep and horizon differentiation on the basis of colour is not easy. They are light in texture, acidic (pH 4.5 to 5.5) and fairly well drained but lie in an undulating topography. Though deficient in organic matter and low in all the major plant food elements and lime, the soil responds well to management practices. Coconut and tapioca are the major crops grown. The red colour of the soil is due to haematite and the yellow mottlings due to limonite, and their combinations result in different shades. The surface gravel content is much less. Soils similar to red soils of the Trivandrum and Neyyattinkara taluks but with higher gravel content occur in some parts of Quilon district, namely, Sasthamkotta, Varkala, Cherunniyoor, Mayyanad etc. The dominant clay mineral is kaolinite with low CEC (6-12 me/100g). Silica-sesquioxide ratio varies from 2.0 to 2.5.

Fig. 72
SITUATION 6
AREA UNDER CROPS (ha)



Neyyattinkara - Vellayani Soil Association has been established under this Situation and is described as "very deep, red loams on level to strongly sloping foot slopes and gently undulating plains".

Vellayani series represents the red loam soil of the southern and northern parts of Trivandrum district. They are "very deep, sandy loam to clay loam soils, free of gravels, with slight increase in clay content down the profile, occuring on a transitional belt in between the laterite hill slopes and coastal soils".

Neyyattinkara series has "deep to very deep soil with gravelly sandy clay loam to clay loam textural grade overlying the laterite".

In the wet land paddy fields under this Situation, however, hydromorphic soil with clay loam texture is dominant. Laterite alluvium admixed with organic matter exists as brown hydromorphic soils.

Amaravila series and Kuttichal series are identified under the hydromorphic soil situation in this subzone, formed as a result of transportation and sedimentation of material from adjoining hill slopes and also through deposition by rivers. The characteristics of this soil are explained in Chapter 2.

5. Land utilisation pattern

Separate data for this subzone in relation to land utilisation are not available. The pattern explained in Chapter 2 is more or less applicable for this Situation.

6. Irrigation

River Neyyar flows through the vicinity of this Situation. Neyyar Irrigation Project has many of its sub-canals constructed in this subzone which help in the irrigation of the wet lands. Upland crops including coconut gardens are, however, mostly rainfed. Ground water table fluctuates between 5m and 25m depth.

7. Land holding pattern/socio-economic characteristics

The total area of the subzone forming 31,700 ha constitutes nearly 5 per cent of the zone. Population under the agro-ecological situation works out to 5.7 lakhs constituting 7.7 per cent to the zone. Total households is 1.11 lakhs constituting 8 per cent of the zone. Small farmers and marginal farmers dominate. Since the Situation lies in proximity to Trivandrum Corporation and Neyyattinkara Municipalaity, at least 20 per cent of the area under this Situation is to be considered as sub-urban and the rest rural. Nearly 53 per cent of the small industries workers, service and business people who are confined to the sub-urban areas, have Agriculture as the secondary occupation and the rest depend on Agriculture; 8.0 per cent are cultivators and 39 per cent are agricultural labourers. However, in rural areas the primary occupation is Agriculture and allied activities for majority of the farmers. The socio-economic characteristics explained under Chapterr 2 is more or less applicable to this situation as well.

8. Crops and cropping patterns / systems

Data relating to the area under wetland and dry land specific to this Situation are not available. However, considering the data relating to the three major blocks as a whole, majority of which fall under this Situation, it is estimated that gross cropped area is 31,796 ha. Net area under crops is 28,630 ha. Dry land extents to 27,443 ha which constitutes 86 per cent of the gross area under crops in the subzone. Wetland area with hydromorphic soil forms 4,353 ha which constitutes 14 per cent of the gross area under crops in the subzone. Cropping intensity in this situation is 111 per cent.

1. Wetland

In the wetland areas improved, high yielding and local paddy varieties are cultivated during one, two or three cropping seasons viz., Virippu, Mundakan and Puncha.

Varieties

Virippu season

HYV: Bharathi, Jyothi, Jaya, Annapoorna, Mashoorie, H4.

Potential yield: 4 t/ha
Average yield : 3.6 t/ha
Improved : PTB2, PTB22, PTB9, PTB10
Potential yield: 3.5 t/ha
Average yield : 3.1 t/ha

Local: Japan Cheradi / Kutticheradi, Kochuwithu

Potential yield: 3.0 t/ha
Average yield : 2.8 t/ha

Mundakan season

HYV: Bharathi, Jothi, Jaya, Mashoorie, H4

Average yield : 3.0 t/ha
Improved : PTB2, PTB9, PTB22
Potential yield: 3.3 t/ha
Average yield : 2.8 t/ha

Local: Aluvella, Thattaravella, Kochuwithu, Japan Cheradi Kutticheradi, Dena, Panamkuruva, Thavalakannan

Potential yield: 3.0 t/ha
Average yield : 2.4 t/ha

Puncha season

The sub-canals of the Neyyar Irrigation Project constructed in the zone remain dry during Summer. Hence Puncha crop is seldom raised, except in the Vellayani kayal and Pallichal, Venganoor AE units, where kayal land is available for cultivation.

Improved and HYV:	PTB10, PTB20, Jothi, Triveni, Jaya
Potential yield	: 4.0 t/ha
Average yield	: 2.5 t/ha

Local varieties	: Dena, Cheera
Potential yield	: 2.5 t/ha
Average yield	: 1.8 t/ha

Cropping pattern

Rice (single crop during puncha season)
Rice-Rice-Fallow
Rice-Rice-Pulses/Sweet Potato
Rice-Rice-Oil Seeds
Rice-Rice-Vegetables
Rice-Vegetables
Rice-Banana

Rice-Rice-Fallow

Two crops are taken in succession in nearly 50 per cent of the total paddy area in the sub-zone. Kharif crop is usually direct sown in May, just prior to South West monsoon. Seeds are dry sown by early May or wet sown by the end of May. Transplanting is done by less than 30 per cent of the farmers. Short duration varieties are preferred by cualtivators during Kharif, while medium or longer duration is preferred during Rabi. The adoption of high yielding variety is more (coverage is around 50 per cent) during Kharif. For the Rabi season sufficient irrigation facilities may not exist in many locations which discouraged the farmers from growing HYV. More than 60 per cent farmers use longer duration local varieties such as Japan Cheradi/Kutticheradi etc. which are photosensitive and yields more straw eventhough grain yield may not be as attractive as for HYV. H4 and Masoorie are also grown by 15 to 20 per cent farmers. Others use improved varieties such as PTB 29, PTB 20, PTB 22 etc. Generally, paddy yield during the second crop is reported as less than that of the first crop.

Rice-Rice-Pulses

Summer rice fallows are utilised for growing pulses, vegetables or ground nut in locations where residual soil moisture is available or irrigation is possible. Else crop is raised in rice fallows by 25 to 30 per cent of the rice farmers, immediately after the harvest of the second season rice crop in December-January. The variety grown is Kolinchi or grain cowpea (C-152), the latter being supplied by the DOA through AE units. Vegetable cowpea (local) is also grown. Seed inoculation by rhizobium culture, though recommended, is not done by any of the farmers, due to non-awareness of the technology. For the cowpea crop, a light basal dose of FYM is applied by about 25 per cent of the farmers. For Kolinchi, however, no manuring is done. Chemical fertilizers are not applied to any of these crops due to want of irrigation facilities which affects the yield.

Cowpea variety	:	C-152
Average yield	:	0.6 t/ha

Rice-Rice-Oil Seeds

Ground nut and sesamum are attempted in less than 10 per cent of the rice fallows in the sub-zone during summer.

Variety	:	Ground nut TMV 1, TMV 2
		Sesamum Thilothama, Local

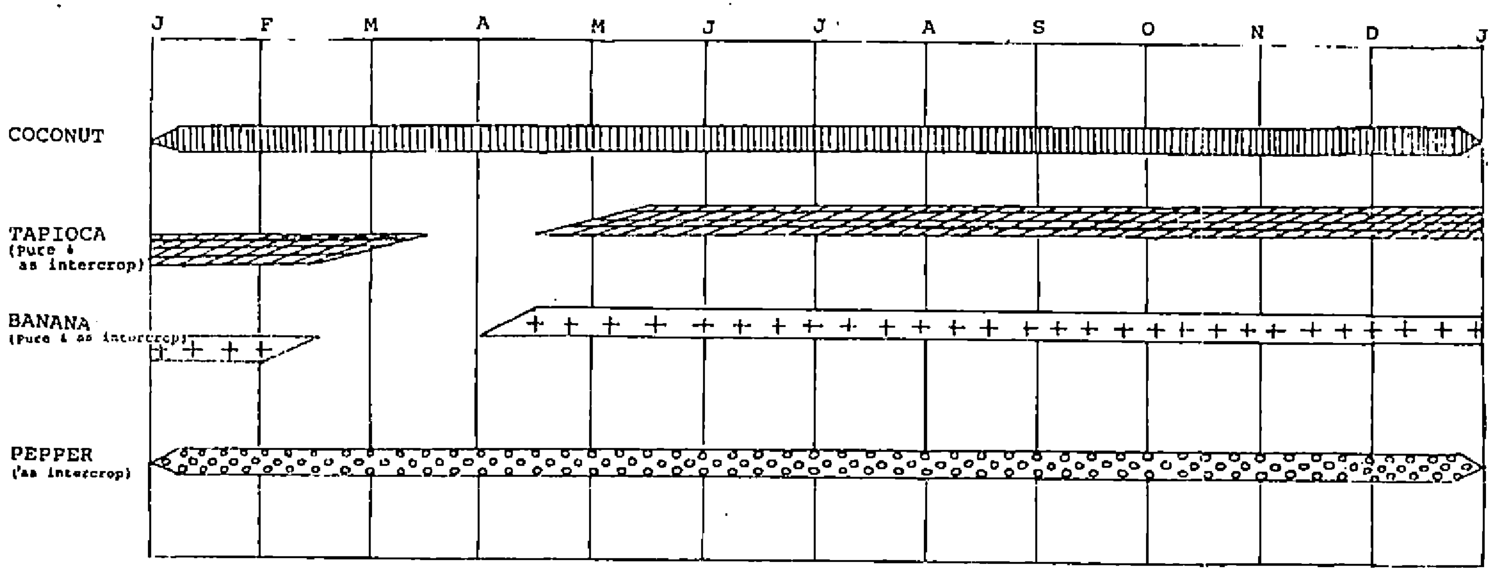
Ground nut is also attempted as an intercrop in coconut plantations but is rare.

Rice-Rice-Vegetables

After first crop paddy or after the second crop paddy, about 10 per cent of the fallow is utilised for vegetable cultivation under pot water irrigation, particularly in Kalliyoor, Venganoor and Thiruvallam Panchayats. Items of vegetable crops include cucumber, snake gourd, pumpkin, ash gourd, vegetable cowpea, bhindi, red amaranthus, brinjal, bitter gourd etc. The crops are not only manured well but also kept free of pests using PP chemicals.

Variety	:	Local
Production potential	:	25 t/ha

Fig. 73 SITUATION 6
CROPPING PATTERN



RICE AND RICE-BASED CROPPING PATTERN IS SHOWN IN Fig. 69 UNDER SITUATION 4

Other cropping systems/sequences

In less than 10 per cent of the paddy fields in the sub-zone, tapioca or banana is grown after the harvest of the first crop of paddy. In Kalliyoor Panchayat, the banana variety is invariably Nendran and tapioca variety is improved M4, though in a few locations local varieties are not uncommon.

Banana	Variety:	Nendran
Tapioca	Variety:	M4

2. Dryland/gardenland

Coconut is the main crop is this situation grown either as pure crop or inter cropped with tapioca, fodder grass, banana etc. in the open or as an essential component in homesteads (Fig. 73). The crop is grown rainfed. Variety is WCT. More than 60 per cent of the farmers apply glyricidia or other green leaf or FYM or ash or ash mixed with common salt, at least once in a year during April-May. Chemical fertilizer application is done to coconut by nearly 50 per cent of the farmers. Either single application in June every year or split application in June and September is done deriving the benefit of South West and North East monsoons. Irrigation is seldom given except for the limited coconut palms grown in a few homesteads. In most of the homesteads, coconut-based farming system exists, where the main crop coconut is intercropped with tapioca, banana, pepper, yam, colocacia diascorea, vegetables, cocoa, cloves, improved fodder grass etc. For these crops, kitchen wastes and farm wastes, including FYM are the only sources of manuring. In a few homesteads, HYV coconuts such as T x D are grown in limited number, in addition to the most dominant WCT.

Variety	:	WCT
Production potential:		80-100 nuts/tree/year
Average production:		40 nuts/tree/year

Attack by coreid bug, rhinoceros beetle red palm weevil, premature nut fall and insufficient irrigation and manuring appear to be the reasons for low yield.

Tapioca

Improved M4 is most popular in the sub-zone. Local varieties such as Pannivella, Kayalachadi, etc. are also grown. Of the different methods of planting, mound method is preferred by farmers. Tapioca is grown as pure crop in the open or as an intercrop in coconut gardens under rainfed conditions or as a constituent crop in homestead. Main planting seasons are April-May and September-October. HYV such as Sree Visakh, Sree Sahya, Sree Prakash etc. have not gained sufficient popularity in the zone, probably due to non-availability of sufficient planting material or due to lack of knowledge about the superiority of these varieties. Except the basal manuring with dry cowdung and ash done by nearly 50 per cent of the farmers, initial irrigation at the time of planting and shallow digging followed by light earthing up at the third month after planting, no other management is given to the crop by most farmers. However, nearly 20 per cent farmers apply NPK fertilizers as single dose or in split dose.

Variety:	M4
Average yield:	19.6 t/ha

Rodent attack, want of irrigation and other management practices appear to be the reasons for lower yield.

Tapioca-Cowpea

Dryland cropped to tapioca are sometimes intercropped with grain cowpea or vegetable cowpea during the early growth phases of tapioca. This is done by nearly 25 per cent of the tapioca growers.

Banana

Red Banana, Nendran, Palayankodan, Rasthali, Poovan, Robusta etc. are grown as pure crop on upland, as crop sequence in paddy fields, as intercrop in coconut gardens or as a component of the homestead farming system. In many homesteads in the zone, intercropping with coconut with Nendran, Red Banana, and culinary varieties of other plantains, tapioca and other root crops including sweet potato, ginger etc., fodder grass, pepper, pineapple, cocoa, clove and fruit trees is practiced with success.

More than 50 per cent of the farmers apply NPK fertilizers in split doses to banana upto 5th month in addition to the basal application of FYM. Reduced yield may be due to use of suckers of inferior quality, poor management given by some farmers and incidence of bunchy top disease.

Vegetables

In the sub-zone, vegetables are cultivated as pure crop mostly in the Kalliyoor, Venganoor and Thiruvallam Panchayat areas in the uplands and in the rice fields in an area of 578 ha. Vegetables also form a component of homestead farming system. The cultivated items include vegetable cowpea, grain cowpea, cucumber, snake gourd, bitter gourd, ash gourd, water melon, bhindi, red and green amaranthus, sweet potato, yams etc. Major share of these vegetables find fairly good outlets in the neighbouring Trivandrum city and Neyyattinkara town markets in addition to export to Gulf countries. Intensive plant protection operation, including the indiscriminative use of even systemic insecticides in vegetable cultivation are practiced by some farmers, to fetch high market price. Varieties of vegetables used are mostly local. Ginger is grown in 350 ha in the Neyyattinkara Agricultural Sub Division, of which the Situation forms a part. Other crops are pepper, arecanut and cashew. Betelvine is cultivated in some patches of land in the Neyyattinkara taluk. Pineapple, though a component in some homesteads, is not an important crop. Glyricidia is the green manure crop grown along the fences forming boundaries in homesteads. Other green manuring crops are rare, except Kolinchi grown in summer rice fallow. Several homesteads under this sub-zone have crop-livestock-poultry management. Improved breeds of livestock and poultry are gaining awareness among the farmers. Vellayani lake lies in close proximity to the red loam soil situatioan existing in Kalliyoor and Thiruvallam panchayats where potentiality exists for aqua culture.

9. Adoption pattern and production constraints

The pattern of adoption of the recommended practice by the farmers in this Situation has been discussed in

Volume 2. of the Status Report.

Constraints

Non-availability of water during the summer months (December to May) for irrigation. Even the canals from the Neyyar Irrigation Project remain dry during this period.

Non-availability of HYV vegetable and oil seeds suited for the open and partial shade and for the summer rice fallow.

Unawareness among the farmers about the post harvest storage and processing of the perishable items of crops.

Lack of information on the viable models of coconut based multi-tier cropping system suited for the Situation.

Lack of scientific information on the standardisation of agro-techniques for Red Banana (rainfed and irrigated) and Nendran in wet lands and banana and miscellaneous plantain varieties in partial shade.

The intensive plant protection operations including the indiscriminate use of even systemic insecticides such as carbofuran in vegetable cultivation, with the only aim of fetching high market price, would leave the produce with pesticide contamination.

Bunchy top disease in banana.

Coreid bug attack of coconut and consequent button shedding.

High cost of labour.

General constraints

Scarcity of water for irrigation to crops grown during the off-monsoon months, often leading to drought.

Agro-ecological situation under the mid upland (high land) zone, covering situation 7 and situation 8

Situations 7 and 8 occur in the highland zone (Fig. 74). The features such as delineation of the area, physiography, climate, soils, land utilisation pattern, irrigation and land holding pattern including the socio-economic characteristics, are common to both the Situations with minor variations and therefore, these characteristics are not separately discussed under each of these situations.

1. Delineation of the area under the highland sub-zone:

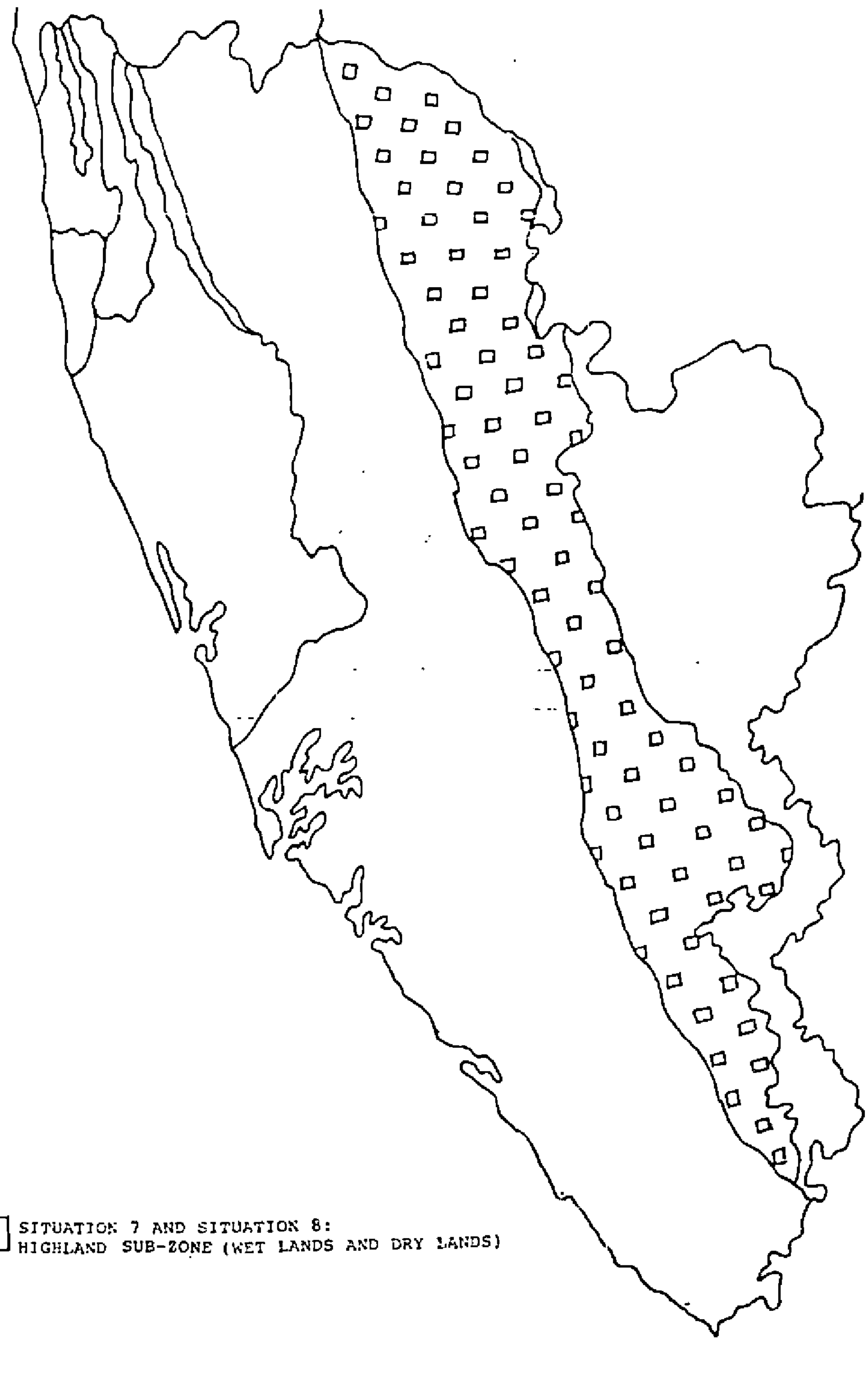
The highland sub-zone occupies an area of 2000 sq.km constituting 28 per cent of the zone, on the eastern parts of the zone, lying sandwiched between the midland zone on the western side and High Ranges on the eastern boundary of the zone. The comparatively much smaller wet land patches located in the valleys between foot hills and low lying areas (Situation 7) and the larger areas of garden lands including the rubber plantations (Situation 8), together constitute the highland sub-zone.

Fig. 75 indicates the net cropped area and the total area under rice and dryland crops. Net cropped area constitutes 37.2 per cent to the zone. Total cropped area under rice constitutes 1.9 per cent and under dryland crops, 36.0 per cent to the zone.

Unlike the midland sub-zone, paddy is not the major crop in this sub-zone. Situation 7 occupies an area of 18,391 ha (5 per cent of the sub-zone), while Situation 8 occupies an area of 3,41,403 ha, which constitutes 95 per cent of the total cropped area of the sub-zone. The cropping intensity is 144 per cent. The agro-ecological situation consisting of Situations 7 and 8 are contained on the eastern parts of the blocks listed in Table 44.

Fig. 74

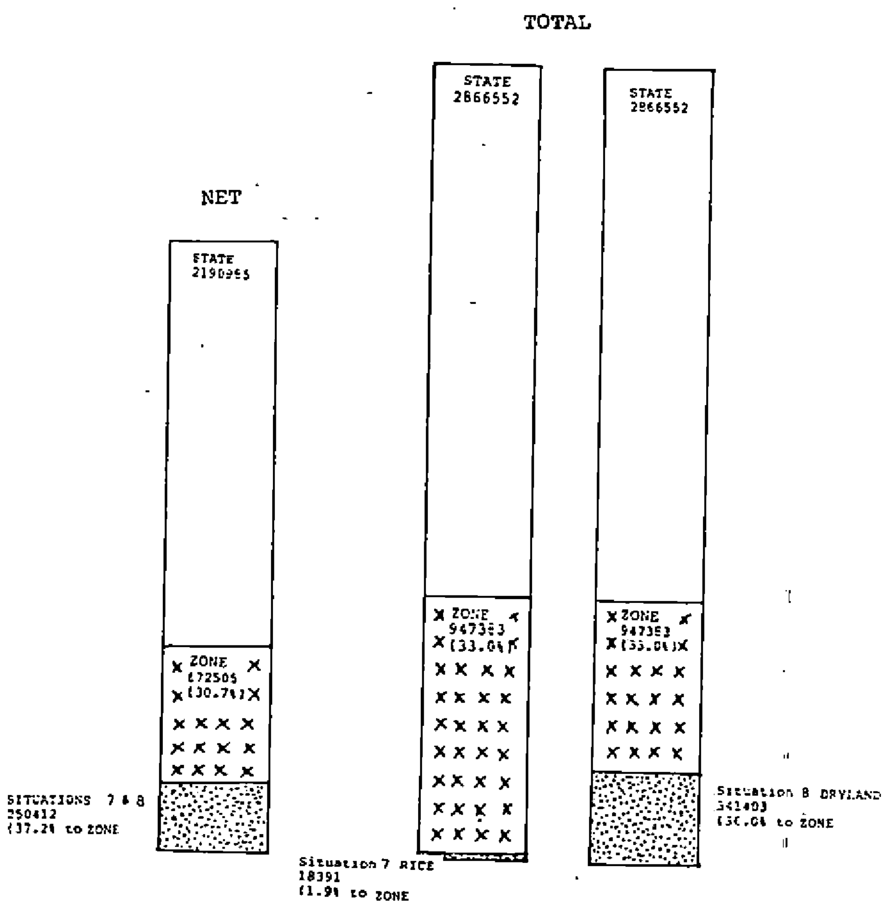
SITUATION 7 AND SITUATION 8



SITUATION 7 AND SITUATION 8:
HIGHLAND SUB-ZONE (WET LANDS AND DRY LANDS)

Fig. 75

SITUATION 7 AND SITUATION 8
AREA UNDER CROPS(ha)



The Table also contains data on the net cropped area, area under dryland, area under wet land and gross cropped area.

Table 44. Delineation of the area (in ha) under the highland sub-zone

Block*	Net Area sown	Area dry land	Area wet land	Total area under crop
Nedumangad	12517	11479	1481	12960
Vellanad	16247	16463	2021	18484
Perinkadavila	16698	26819	1993	28812
Anchal	45210	92773	2091	94864
Chadayamangalam	12434	21632	2269	23901
Vettikavala	13076	14311	2787	17098
Elanthoor	9439	9474	1153	10627
Konni	12858	14088	928	15016
Mallapally (half)	5746	6136	487	6623
Parakode (half)	8932	10372	1130	11502
Ranni	16022	25784	302	26086
Erattupetta	26998	33729	207	33936
Kanjirapally	20236	21758	29	21787
Lalam	18978	20328	1295	21623
Vazhoor	15021	16257	218	16475
Total	250412	341403	18391	359794

* Data relate to the entire block area, eventhough portions of some of these blocks do not fall under the situation. Panchayat / Village-wise data are not available for discussion.

2. Physiography

The sub-zone lies at an elevation of 75 m to 750 m above MSL and is located in close proximity to the High Ranges. It consists of the rolling land with normal to excessive relief and excessively drained soils. Isolated hillocks are also occasionally seen. The valleys of some of the areas adjoining the High Ranges are also included in this sub-zone. Undulating topography with gentle slopes and steep slopes of gradient upto even 50 per cent and low hills are the physiographical features of the sub-zone. Portions of mountainous tracts and the thick ever-green forests which have recently been denuded or clear felled for the purpose of human settlement or cultivation of crops suitable to that area are also covered. All the rivers detailed under the midland sub-zone (Situations 4 and 5) are seen in this sub-zone as well. Soil erosion is a problem faced by many farmers and many of them adopt suitable preventive measures within their reach. The State Soil Conservation Research Station and the connected laboratory under the Department of Agriculture are functioning at Konni in this sub-zone.

3. Climate

As with the other sub-zones, humid tropical climate is experienced in this sub-zone also, with hot days and cooler nights. The maximum temperature ranges from 28^{o} C to 35^{o} C and the minimum temperature ranges from 18^{o}C to 25^{o}C. Temperature is not a limiting factor for the cultivation of crops. The mean annual rainfall ranges from 2,500 mm to 4,000 mm, which is higher than that of the other sub-zones. South West monsoon during June to August which is more dominant and more reliable and the North East monsoon during September to November are the two rainy seasons controlling the water regime in the zone. The former contributes to 60-65 per cent of the annual precipitation. The high rainfall is conducive to the growth of more luxurient vegetation in this sub-zone. During December to February dry weather and from March to May hot weather with lesser relative humidity of the atomosphere than that during the rest of the year, are the common phenomena. The air is humid, practically all the year round, but the percentage of relative humidity is less (50 - 60 per cent) when compared to the other sub-zones (80 - 90 per cent) of the zone. Rubber is cultivated on a large scale in many locations, particularly in the Kottayam district where coconut ranks second only. Rice cultivation is rare. Fluctuation in ground water table is seen ranging from 10 m to as low as 0 m or even more.

. Soils

The soils in this sub-zone fall into the following series: Karamana series, Vembayam series, Trivandrum series, Vilappil series, Vizhinjam series, Marukil series, Kuttichal series, Kunnathukal series, Yeroor series, Malayathumannil series, Kunnamkara series, Mylom series, Mullanikkad series, Kodumthara series and Kottenkara series. All these relate to hydromorphic soil Situation (Situation 7) where paddy is the main crop with or without vegetables or pulses grown in off-seasons. Nedumangad series, Ezhucone series, Perinad series and Manniyar series relate to laterite soils occuring in Situation 8. Palode series, Mukkunni series and Channanakad series relate to forest soil which also rarely occurs. The characteristics of these soil series are explained in Chapter II. The soils of the wetlands are generally acidic with pH ranging between 4.5 and 6.0. These are essentially laterites with a high content of surface gravel. The texture of the hydromorphic soil ranges from loamy to clayey. These soils have fair amounts of organic matter and nitrogen but are low in phosphorus and potassium, which respond to management practices. In some upland locations, particularly those adjoining the High Ranges, the soil has slight resemblance to forest soil. The laterite or lateritic soils contained in the uplands of the sub-zone sustain the major garden land for plantation crops like coconut, rubber, pepper, tapioca, banana, root crops, fruit trees etc. Heavy rainfall and high temperature prevalent in the sub-zone are conducive to the process of laterisation as in the midland sub-zone. In situ laterites have been formed by leaching of bases and silica from the original parent rock with concurrent accumulation of oxides of iron and aluminium. The surface soil is mostly reddish brown to yellowish red in colour. The texture of the surface soil ranges mostly from gravelly loam to gravelly clay loam. They are acidic in reaction and the surface layers often contain appreciable amounts of gravel. Laterite profiles are very deep and the depth of plinthite varies depending on topography. The plinthite is characterised by a compact vesicular mass below B horizon, composed essentially of a mixture of hydrated Fe and Al. These profiles are well drained and are poor in available plant nutrients, with low base saturation and organic matter content in the lower layers.

The characteristics of the soil types found in this sub-zone are presented under 2.3 in Chapter II.

5. Irrigation

For the wetland paddy which is grown in small patches of areas, irrigation is provided from canals. However, the dry sown paddy is grown under rainfed conditions. The dryland crops, except those grown in a few homesteads, are also cultivated in this sub-zone under rainfed conditions. In homesteads, however, pot watering from wells is practiced to a limited extent. Rivers and canals are useful for the crops cultivated in their vicinity and where flow by gravity is possible, otherwise pot watering alone is feasible. The rivers which bring benefit to the crops in the sub-zone are those of Karamana, Neyyar, Vamanapuram, Kallada, Pamba, Achankoil, Manimala, Meenachil and Moovattupuzha. However, the only major irrigation scheme commissioned so far is the Neyyar project. In Kottayam district, minor irrigation and lift irrigation schemes operate. Due to want of proper water management techniques drought situations often occur during off-monsoon months. Exploitation of the groundwater potential can improve irrigation facilities.

6. Land holding pattern / population / socio-economic characteristics

The total geographical area of this agro-ecological Situation is 2,000 sq.km which constitutes 28 per cent of the zone. The population under this sub-zone works out to 17.4 lakhs, which constitutes 23 per cent of that of the zone. Highest density of population is seen in Anchal block and lowest in Lalam block. As in the midland sub-zone consisting of Situations 4 & 5, predominance of marginal and small holdings is seen in this sub-zone also. However, small holdings and holdings held by more affluent sections of the farming communicity are more than in the midland zone. Many of such holdings are covered under rubber plantation or coconut gardens. Cultivators and agricultural labourers together constitute about 70 per cent, while the rest are engaged in house-hold industry and business activities. Rubber cultivation is considered as very remunerative and many cultivators own rubber estates and smoke houses in this sub-zone with areas varying between 0.5 hectare to 25 hectares or even more. Many industries based on rubber and rubber products thrive in Kottayam district.

The literacy rate in the sub-zone varies from 59.3 per cent to 83.7 per cent. Lowest literacy rate is found in Amboori and Ariencavu Panchayats and highest rate in Melukavu and Vazhur panchayats.

Situation 7

Highland wet - higher elevation - hydromorphic soil -irrigated crop (HLW-HE-HS-IC)

1. Major crops / cropping patterns / cropping sequence

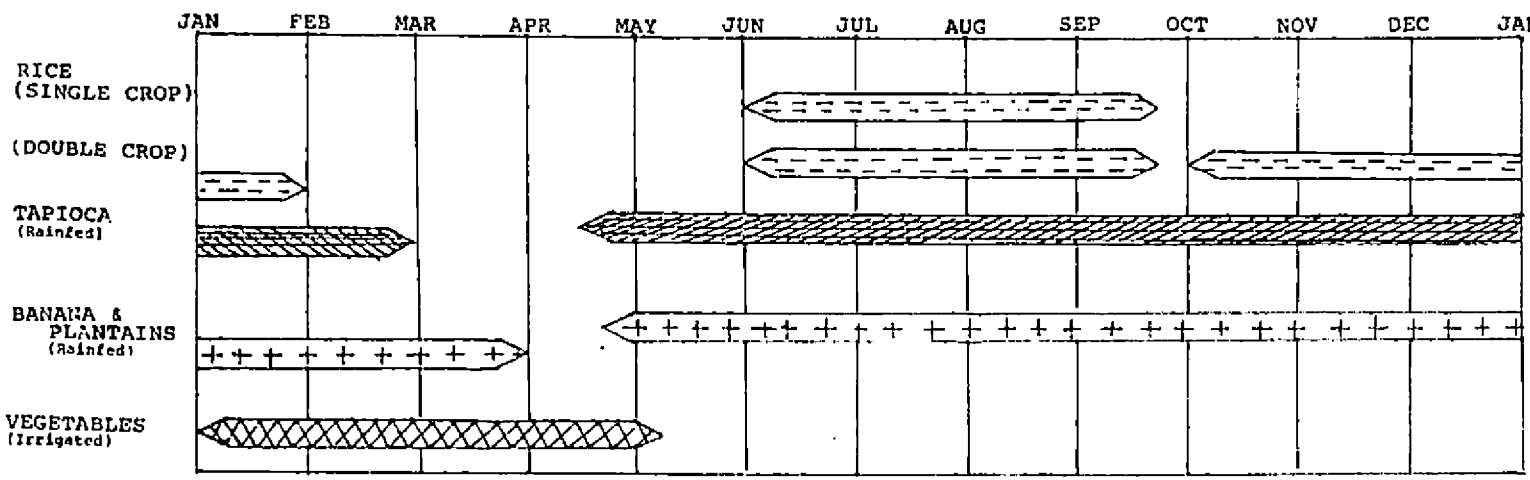
In view of the uneven terrain in the highland sub-zone, paddy fields under wet land conditions are rare. Such wet land areas in small patches are seen distributed in the taluks/panchayats earlier listed under the highland sub-zone. The extent of area now available under wet land paddy, however, differs considerably in the different panchayats. Minimum area under paddy is noticed in Meenachil and Kanjirapally taluks, where larger areas are cropped to rubber. In Kottayam district the highland wet situation under paddy is becoming extinct. Larger areas which were earlier under paddy have been reclaimed in recent years, for growing more remunerative crops such as rubber, coconut, banana etc. This situation therefore constitutes only less than 10 per cent of the total cropped area in the highland sub-zone. Rice farmers also constitute less than 10 per cent. Irrigated paddy accounts for 80 per cent of the total paddy area in the sub-zone.

Cropping systems (Fig. 76) followed are:

Paddy - fallow
Paddy - paddy - fallow
Paddy - paddy - pulses/vegetables
Paddy - tapioca -
Paddy - banana or other plantains
Crop cafeteria of banana, yam, colocacea, tubers, vegetables etc. in wetlands.

Cropping seasons are May to September for the 1st crop and September to January for the 2nd crop. When compared with Situation 4 existing in the midland sub-zone, the area under fallow is more in this Situation. Three crops of paddy are extremely rare. Two crops are

Fig.76 SITUATION 7 CROPPING PATTERN



raised in areas where irrigation facility is available. Information on the exact area covered by the different cropping patterns is not available. However, a recent random survey conducted in the southern zone revealed that single cropped area under this Situation constituted 5 per cent, double cropped area 9 per cent and area under paddy - paddy - pulses 2 per cent. The crop sequences under paddy - banana and paddy - tapioca are rare. Both wet sowing and dry sowing of paddy are practiced by farmers during the first crop season on a roughly 50:50 basis. Dry sowing starts in early May, so that the crop gets benefited by South West monsoon during June and July. Wet sowing and seedling transplantation are, however, done in early June. Both HY and local paddy varieties are cultivated, with preference to local varieties given by about 50 per cent of the farmers. Bharathi, Jyothi, Jaya and Annapoorna are the main HYV grown. H4, PTB 22 and other improved PTB varieties are also grown. In Ottasekharamangalam area Suvarnamodan is successfully cultivated. Among the local varieties "Cheradi" is dominant.

2. Extent of adoption and production constraints

The data on the extent of adoption of agricultural technology by the rice farmers under this Situation are furnished in Volume 2. Major constraints in agricultural production are:

Lack of timely and adequate availability of various inputs such as seeds, fertilizers, plant protection chemicals etc.

Soil erosion and silting in the rice growing valleys in monsoon seasons indicates the need for proper soil conservation methods and agronomic practices.

Fallowing of paddy fields, where paddy cultivation is not technically feasible, due to want of water during January to April-May, necessitates the development of a cropping pattern for wetland with food crops and cash crops with proper management techniques.

Waterlogging and lack of proper drainage in the first and second crop seasons in marshy areas, indicating the need for improving the drainage systems and identifying varieties tolerant to the submerged conditions.

Lack of scientific manurial recommendation considering soil fertility status and other factors for the crop combinations in wet lands.

Lack of suitable varieties of different vegetables with high yield potential to be grown in rice fallows.

Pest and disease infestation in paddy fields at different growth stages.

High cost of labour.

Lack of stability in demand and supply of paddy and unremunerative price for the produce and lack of marketing facilities.

3. General production constraints

Uncertain nature of the monsoon and drought situations during the recent years.

Lack of unwillingness to take risks due to the farmer's poor economic condition and the lack of conviction in the usefulness of some of the recommended technologies, particularly for HYV.

Difficulty experienced in the marketing of the produce by transport to distant, better marketing centres in urban areas, leading to distress sale by farmers to middle men.

The general feeling among the rice farmers that rice cultivation is not remunerative, thereby tempting them to reclaim paddy areas for growing more remunerative crops such as rubber, coconut etc.

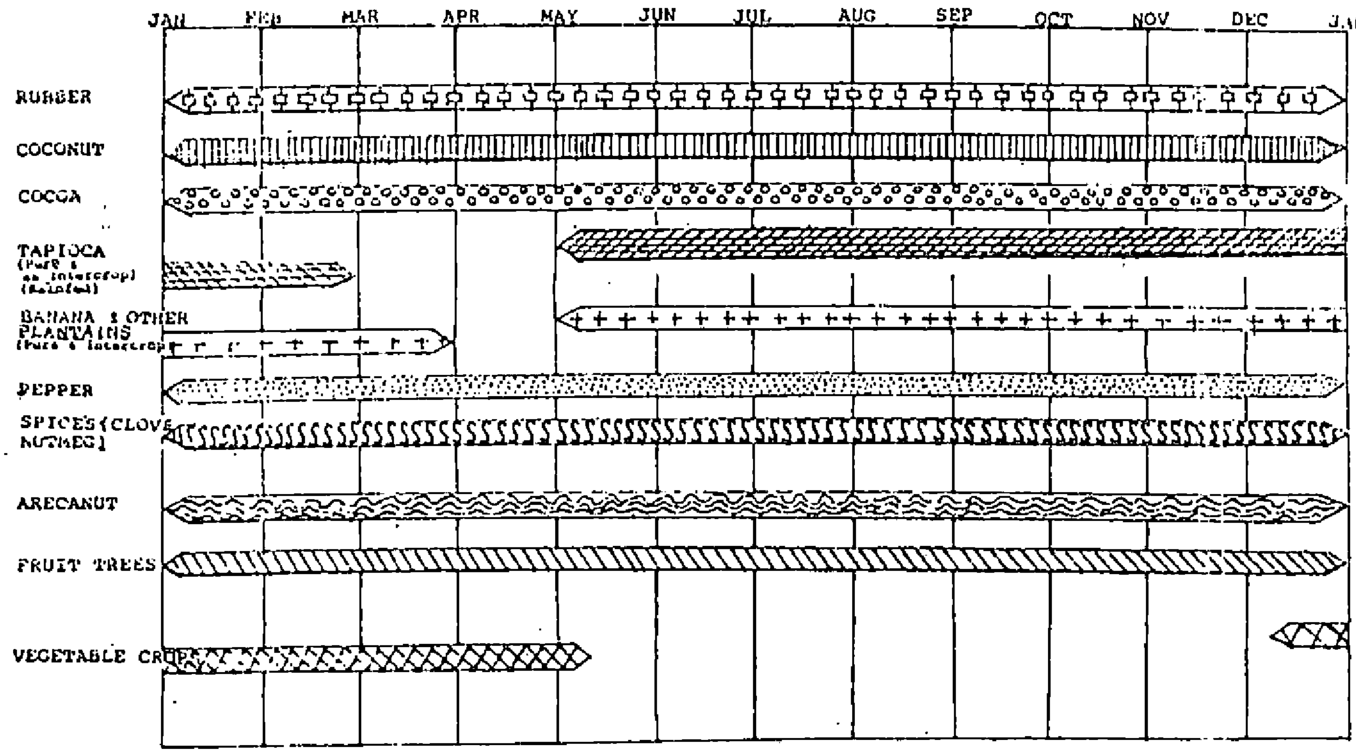
Situation 8

Highland dry - higher elevation - laterite soil - rainfed crop (HLD-HE-LS-RC)

1. Major crops / cropping patterns / cropping systems

The garden lands including rubber plantation and the dry lands of the highland sub-zone covered by the blocks listed in Table 44 are covered under this Situation. The Situation is mainly rainfed and the soil type is acid laterite with occasional forest loam. Well irrigation is followed only in homesteads. Large areas under this Situation constituting 60 per cent are cropped to rubber and coconut which are the major perennial crops. Arecanut, pepper and cashew are also cultivated. Perennial crops invariably have intercrops with other perennials such as, coffee, cocoa, clove, fodder crops, fruit trees such as, mango, jack, guava, tamarind etc. and hardwood trees such as, anjili, teak etc. or annuals, such as, tapioca and banana and other plantains (Fig. 77). Some rubber growers profitably exploit the inter-spaces in rubber plantation by cultivating cocoa, banana, and tapioca during the first five to seven years of planting rubber. Tuber crops and fodder crops are grown in open and partially shaded conditions. Minimum area cropped to tapioca under this Situation is seen in Kottayam district and maximum in Trivandrum district. Colacacea, yam, dioscorea, ginger, turmeric, vegetables etc. are also grown based on farmer's preferences. Among the coconut varieties cultivated, West-coast-tall is most popular in this situation. However, high yielding varieties such as T x D or D x T are seen planted in limited numbers in a few homesteads. Irrigation is not given to coconut palms. In tapioca the local varieties have more prominance. However, among the improved varieties of tapioca M_4 is very popular. Other HYV such as H 165, H 97, H226, Sree Vaisakh, Sree Sahya, Sree Prakash etc. are not popular, as the farmers are not aware about the merits of these varieties and the source of availability. In the southern areas of the highland sub-zone red banana is grown as pure crop and consumed with preference. It is a choice table variety with creamy pulp and characteristic flavour. With the red fruit skin enhancing its glamour, it invariably occupies a conspicuous place in religious ceremonies, wedding and other auspicious functions. These types generally yield

Fig.77 SITUATION & CROPPING PATTERN



heavy bunches, carrying around 100 round and plumby fruits arranged in 6 to 8 hands. It performs well in higher elevations and is a tall triploid variety. It is also an exported commodity in the recent days. No studies are available on the different aspects of its cultivation, post-harvest storage etc. pepper is another important crop in this situation. However, local varieties have more prominance. Farmers are becoming aware of HYV pepper such as Panniyur-1. Development of sericulture has vast potentialities. High yielding mulberry can be cultivated in the hill slopes of highland sub-zone utilising groundwater resources. Rearing of silk worms, the raw material for the silk industry, can be undertaken on large scale and this can improve the economy of the State. A small sericulture project has recently been initiated at Mithranikethan, Trivandrum district in collaboration with Central Silk Board.

2. Adoption pattern and constraints in agricultural production

Adoption pattern on coconut, tapioca and other major crops in this agro-ecological situation are detailed in Volume 2. In coconut cultivation, the farmers do not follow the recommended spacings. Though the farmers are convinced about the need for the recommended spacing, they are unable to change the existing spacings for the old and still yielding coconut palms, which were planted years ago by their ancestors. New plantings of coconut are, however, almost based on recommendations. Irrigation to coconut is not given except in small homesteads, probably due to the non-availability of water sources and the high cost of labour involved. Due to the same reason, tapioca is also not irrigated, except at the initial stages of planting to help the sprouting of planted stems. However, the planting time is so adjusted to accrue the benefit of South-West or North-East monsoon. Accordingly, April-May planting and September-October planting are practiced. Also, no fertilizer application is given to tapioca, probably due to the non-irrigation of the crop. About 10 per cent of the tapioca crop is subjected to damage by rodents and this is, among others, a major constraint in the production of this crop.

3. Constraints

Lack of irrigation facilities and low moisture conservation indicate the need for developing moisture conservation measures and water harvest techniques for use in non-monsoon seasons.

A declining trend in the area under tapioca as a pure crop during the past few years, accompanied by a more or less commensurate increase in the area under rubber, is noticed in the highland sub-zone. Expansion of rubber cultivation which has encroached even on marginal lands of the farmers was made possible through attractive incentives offered by Rubber Board which functions in the zone.

Abnormal button shedding in coconut.

Lack of availability of HYVs of vegetables to replace or supplement the existing local varieties.

Root (wilt) disease of coconut gradually appearing in this situation during the recent years and no method of control.

Rodent attack on tapioca crop.

Bunchy top disease of banana.

"Quick wilt" disease and "Pollu" beetle attack on pepper.

Lack of suitable management recommendation for the red banana crop.

Lack of availability of HYVs of pepper, disease free banana suckers etc.

Lack of high yielding fodder varieties suitable to be grown as pure crop and intercrop in coconut gardens and fodder trees like Subabul, stands in the way of developing a crop-livestock farming system. There is need to screen the available popular varieties of fodder for shade tolerance in coconut plantations.

Lack of stability in demand and supply of various agricultural produce and lack of proper marketing system.

Transport of the harvested produce to long distances to townships for marketing purposes is difficult and costly. To avoid this and due to unawareness of the cheap technologies for processing, preservation and post harvest handling of agricultural produce, the marginal farmers are forced to effect distress sale of their produce to local middlemen.

4. General constraints

Soil erosion and depletion of fertility status of the top soil due to the uneven terrain of the situation. Though very few cultivators consider this problem as serious and follow soil conservation measures in their small holdings, many others are unable to attend to this work due to financial difficulties.

Unsettled farming in trial areas necessitate the development of a suitable crop combination catering to the needs of the trial people with adequate control/protective measures against wild animals. Pigs, elephants and monkeys occasionally destroy sugarcane, banana and even coconut.

Low labour productivity in rubber plantations. About 50 per cent of the cost of production of rubber is on tapping of latex. The number of trees tapped by one tapper is 250 to 300, while in other rubber growing countries it is 400 to 500 trees. Cost of tapping per tree is also high in the zone.

Diseases in rubber such as "abnormal leaf fall" and the need to take prophylactic plant protection measures every year. Aerial spraying is desirable but many farmers cannot afford to meet the expense.

Want of sufficient research information on the possible intercrops in rubber plantations. Some rubber farmers, however, exploit the inter-spaces by cultivating cocoa, banana and tapioca during the first five to seven years of planting rubber in their own way.

Lack of indentification of suitable subsidiary occupation for the tribal people using agricultural raw materials.

Lack of development of a suitable crop-livestock - fish farming system for the trial communities to provide increased income and family labour use.

Lack of marketing facility in the vicinity for the agricultural produce and consequent exploitation by local middlemen.

High cost of labour, prohibiting the labour availability to poorer sections of the farming community.

Situation 9

Homestead farming (HF)

1. Delineation of the area

It is extremely difficult to delineate the area under the homestead farming system, since this farming system is part of the definition of Homestead. Homestead is defined as an operational farm unit or farming environment in which crop, livestock, poultry and/or fish production is carried out mainly for the purpose of satisfying the farmer's needs. In consequence, a complex interaction exists among the soil, plants, animals, other inputs and environmental factors in the farmer's plot, where he lives and manages. This type of farming is unique to Kerala, where the farmers utilise the available backyards of their houses for growing a variety of annual and seasonal crops of their own choice, based on home requirement and marketing preferences if surplus is harvested. In view of the possibilities of actual practice of terrestrial agriculture relating to crop husbandry and animal husbandry, combining in certain situations with aqua culture and aqua animal culture like duck farming, homestead farming is a potential possibility right from the western coastal areas to the eastern fringes of the High Ranges encompassing the entire midland and highland sub-zones from South to North. Thus, the eight Farming Situations described earlier have thousands of homesteads coming under the homestead farming situation. In view of the scattered occurrence, the delineation of the area covers the entire southern zone wherein more than 50 per cent of cultivated area is under this Situation.

2. Physiography

The Situation occurs in the entire area covered under different elevations ranging from 0 to 750m above MSL with topographical features ranging from level to undulating terrains with slight slopes; except in coastal sandy locations, hill slopes, steep slopes, terraced wet paddy lands, garden lands of pure crops such as coconut, tapioca etc. and sites of rubber plantations.

3. Climate

The climatic features explained in Chapter II under the sub-title on Climate is applicable in this Situation.

4. Soils

Homestead Farming Situation exists in all the soil types identified in the zone, the characteristics of which are explained under Chapter II. All the soil series explained under Situations 1, 2, 3, 5, 7 and 8 are covered by this Situation. Besides soil, the Situation encompasses the recycling of the wastes from one system as a nutrient to the other. It also includes ponds, lakes and other water bodies suitable to aqua culture - adjoining terrestrial Agriculture.

5. Land use pattern

A homestead has normally a home, thatched or tiled cattle shed, small poultry shed, well or wells, compost pits, hay stacks, a seed store, pumpset and water tank, implement shed, with or without cultivable waste, a coconut-based (or rarely tapioca-based) intercropping system with high density of polycrops suited to the farmers' home needs, occasionally a paddy threshing yard with cowdung plastered or cement plastered flooring and rarely a fish pond or tank. Except for the small area in front of the home where flowering plants or ornamentals are grown or no vegetation exists, the remaining vacant area in the homestead are fully exploited by the farmer for growing various crops closely spaced and utilising maximum sunshine either fully or partially. In urban homesteads in recent years, innovative terrace cultivation is practiced by homesteaders though much research input has not gone into this system, wherein attempts are made to maximise the sunshine harvest.

6. Irrigation

Most of the crops in the homesteads are irrigated by pot watering. Homesteads, where crops are either partly and occasionally irrigated or not irrigated at all, except for banana, assorted plantains and vegetables, also exist in the zone. The source of irrigation is invariably the wells situated within the homestead. In some homesteads, electric pumpsets and overhead reservoirs are available which makes irrigation easier.

7. Land holding pattern / socio-economic characteristics

Majority of the operational holdings in the southern zone are under homestead farming. A farming unit of generally more than 50 cents (0.2 ha) will not normally constitute a homestead situation. Similarly, a farming unit of even lesser dimension but without a home within the farming area will also not constitute a homestead. In view of this, the number of homesteads in the zone could be as many as the number of families in the zone, including the highly urbanised areas, where also the home is always surrounded by a small piece of land, where polycrop combinations are cultivated besides animals and poultry. The operational holdings under this Situation in the zone are relatively small. Maximum number of holdings is within the range of 0.04 to 0.25 ha size. A predominance of marginal (ie. below 1 ha holdings) and small farmers is seen. The homesteads raised in areas exceeding 1.0 ha are not uncommon but are rare. In the Trivandrum and Alleppey districts the area of the homesteads will normally fall within the area as defined for homestead but in Kottayam district particularly in the Meenachil and Kanjirappally taluks, smaller sized homesteads are rare. In these locations, the definition with regard to the size of the homestead cannot be strictly made applicable. In Quilon and Pathanamthitta districts also, the homesteads of size 0.2 ha and above are normally confined to the eastern highland sub-zone. The coastal belt and midland sub-zone contain relatively smaller sized homesteads of less than 0.2 ha in fairly large numbers.

The socio-economic characteristics detailed under Chapter II hold valid for this Situation also. Homestead farming is not the main occupation for more than 50 per cent of the farmers. In fact, several of these farmers may be having other major occupations such as, business or service or having larger areas of wet land or garden land in the vicinity or in areas not very far away from the site of the homestead, where the farmers prefer to concentrate more. For such farmers therefore, homestead cultivation is only a secondary occupation.

8. Crops / cropping patterns / cropping systems

Homestead farming is unique to Kerala, particularly to the southern zone, where farmers utilise the available sunshine and backyards of their houses for poly-cropping with a variety of perennial, annual and seasonal crops of their own choice. Mainly two types of homestead farming are noticed.

1. Coconut-based homesteads - most popular
2. Tapioca-based homesteads - rare

The former dominates in more than 80 per cent of the cultivated homesteads. Here, coconut is the main crop which is inter-cropped with perennials, including miscellaneous fruit trees, annuals and/or seasonals listed below:

Perennials

Main crop - Coconut. Rubber is also profitably cultivated as a major crop in the backyards of several bigger homesteads in the Kottayam district.

Intercrops

Perennials: Fruit trees viz., mango, jack, guava, tamarind and cocoa, pepper, clove, nutmeg, fodder grass. Glyricidia on fences.

Annuals:	Tapioca, banana, including red banana and assorted plantains, yam and other tubers viz., dioscorea, colocacea, ginger, turmeric, pineapple etc.
Seasonals:	Vegetables, pulses, sweet potato etc.
Others:	Miscellaneous crops, such as papaya, curry leaf, drum stick etc.

A crop cafeteria consisting of combinations of the said crops is available to the farmers. The multi-tier system is in vogue in the zone as the agro-climatic conditions favour the raising of a wide variety of crops. Tapioca and/or banana / other plantains are the essential crops in almost all the homesteads. Cattle rearing is also undertaken in many homesteads, particularly in the suburban and rural areas as a complimentary enterprise. Crop plus livestock is almost the general rule. In some homesteads, mixed farming of crop-livestock or crop-livestock-fish is practiced, where the waste from one component can be recycled to serve as food for the other. The dwindling size of the farm holdings causes problems to the farmer. To make his farm around his home viable he follows either the polyculture or monoculture as opposed to mixed farming, though a lot of horizontal and vertical space is left unutilised. Information on the exact areas covered under different crops in these homesteads is not available. Majority of the homesteads of marginal and small farmers in the Trivandrum, Quilon and Pathanamthitta districts and few in Alleppey district and still fewer in Kottayam district are cropped to tapioca. Rubber is cultivated as pure crop or in between coconut in a portion of the bigger sized homesteads popular in the taluks of Kottayam, Meenachil and Kanjirappally which are under the highland sub-zone. Red Banana, exclusively grown and consumed with a preference in the southern zone, has a place in the crop cafetaria in some of the homesteads existing in the Trivandrum and Quilon districts and more concentrated in the Nedumangad, Trivandrum and Neyyattinkara taluks. In view of the air lifting of vegetables from Trivandrum to Gulf countries, truck gardening is becoming an innovative practice, not only for banana but also for vegetable crops such as cowpea, brinjal, bhindi, chillies, amaranthus (red and green) etc. Investigations to evolve high yielding varieties of vegetables to replace or supplement the existing local varieties, will be of considerable importance. In urban areas in the city and municipal towns in the zone, vegetable cultivation is attempted by homesteaders on top of re-inforced concrete terraces of buildings, either on loose soil or on soil in pots with good management given. In several homesteads in the zone a goat or a milch cow and a few birds (poultry) are also found. Duck farming is also popular. Pig rearing is very popular in Kottayam district. Rabit rearing is, however, rare in the zone. It is noticed that urban homesteads are smaller in size when compared with those in suburban or rural areas. Here, the size of homesteads may vary from 0.02 ha (5 cents) to 0.80 ha (2 acres). A small area of about 0.5 ha is found to support coconuts, mango and/or jack, a few thousands of tapioca, a few hundreds of minor tubers like yam, colocacea, a few bananas, assorted plantains, a few pineapples and vegetables. This type of high cropping intensity exists in lesser sized homesteads also, though reduced in number. Areas as small as 0.02 ha (5 cents) are also utilised for this type of cultivation. Farmers choose crops and crop combinations without any scientific basis, the only criterion being their home requirement. From theoretical considerations, there are definite advantages for such poly crop systems over mono crops. Under mono culture, the height to which plants grow is more or less identifical. Under such situations, the shading effect is likely to restrict the absorption of light and thereby reduce photosynthetic activity. The proximity of many plants of the same species always increases the danger of pest epidemics. These aspects, however, need research investigation.

9. Adoption pattern and production constraints

The adoption pattern and constraints in production with regard to the various aspects of homestead cultivation require detailed consideration. In majority of the homesteads, the production can be increased by following proper management practices, which are seldom attended to by the farmers, particularly in the small holdings of marginal and small farmers, which constitute more than 50 per cent of the cultivated homesteads in the zone. The most suitable polycrop combination has to be identified for the marginal and medium sized homesteads after detailed study.

The pattern of adoption is discussed below:

1. <u>Manuring</u>

Organic manures:

Organic manures such as green leaf, FYM, barn waste (if available), ash, fish waste, kitchen waste, farm sweepings etc. are used in homesteads depending on availability. Some farmers, however, restrict the manuring to coconut palms only, to the exclusion of other crops in the homestead. Few homesteads exist where no management is practiced even for coconut, due to costs prohibitive to the farmer. In general, about 65 per cent of the farmers have 100 per cent adoption, 20 per cent have 80 per cent adoption and about 8 per cent have 50 per cent adoption and the rest have zero adoption with regard to manuring of coconut. On the whole, the adoption of this practice in coconut is nearly satisfactory. For tapioca, except for the initial application of cowdung and ash according to availability (dose normally less than recommendation) at the time of planting, followed by a light irrigation, no further manuring is done. Some farmers apply another small dose of ash or ash + dung at the time of first weeding and light earthing up. For banana and other plantains, organic manure and ash are basally applied once at planting. For minor tuber crops and vegetables, FYM and ash are applied initially and rarely thereafter.

Fertilisers:

Adoption with regard to the use of chemical fertilisers for coconut is unsatisfactory and the cultivators need more awareness. Cultivators use either insufficient quantities of fertilisers or no fertiliser at all. For nearly 60 per cent farmers, fertiliser application adoption is zero. For about 15 per cent farmers, adoption is nearly 75 to 100 per cent. The rest of the farmers have adoption below 50 per cent. Few farmers avoid fertiliser application on the belief that coconut palms receiving fertilisers should continue to receive it every year without break, and any such break will result in the progressive reduction in yield thereafter. For tapioca, no chemical fertilisers are used by more than 70 per cent of the farmers. Among those farmers using fertilisers, nearly 80 per cent use less than 10 per cent of the recommended N:P:K. Adoption of fertiliser application for tapioca is, in general, unsatisfactory. In the case of banana and other plantains, the position is slightly better. Though nearly 50 per cent of the farmers have zero adoption, the rest have a fairly wide range of adoption. Split application of fertilisers for banana is practiced in several homesteads. In the case of minor tubers and other crops, adoption is very low. Lack of irrigation and economic condition of the farmer appear to be the limiting factors to the non-application of fertilisers.

2. Irrigation

In more than 60 per cent of the homesteads, practically no irrigation is given for perennial and annual crops, except banana and plantains. However, young coconut palms and freshly planted seedlings of coconut receive occasional or regular irrigation. For tapioca, pot irrigation is initially given for the sprouting of the planted cuttings. Most of the homesteads restrict irrigation to plantains and vegetables. In brief, no systematic irrigation is practiced in many homesteads and the crops are grown rainfed, except the seasonal crops. Normally, the planting time of coconut, tapioca and plantains is adjusted to coincide with the monsoon season, to avoid irrigation.

3. Spacing

The spacings adopted for the main crop of coconut are normally in the range of 4m to 6 or 7m. However, coconuts planted as close as even 1.5m are not uncommon, while the recommended spacing is 7.6m. Moreover, the spacings are not uniform between plants even in the same homestead, for eg. coconut palms planted 4m, 6m and 7.5m all in the same homestead are of very common occurrence. Though the farmers are aware of the need for wider spacings for maximum yield benefits, several of the existing yielding palms were planted at closer spacings years ago by their predecessors. The recommended basin radius of 1.8m for coconut, can be seen only in a very limited number of homesteads. For tapioca, the recommended spacing of 75 to 90 cm is followed in about 30 per cent of the homesteads only. Pit method and ridge/mound method are followed in planting tapioca. Ridge/mound method is more popular in the southern districts of the zone, while pit method is dominant in the Kottayam district. Method of digging out small pits and covering with FYM and farm sweepings followed by taking mounds over the same prior to planting is adopted in hard soil areas. Method of planting banana and miscellaneous plantains is found unsystematic. The suckers are seen planted haphazardly in several homesteads without following definite spacings. Removing the suckers and planting them separately is not regularly practiced by many homesteaders, who take pains to do this, once in two years or three years only. The spacing followed for yam, colocacea, dioscorea, pepper, ginger etc. are more or less in accordance with the recommendation.

4. Variety

West Coast Tall coconut is the most popular variety in the zone. HYV such as T x D, D x T etc. are seen in about 30 per cent of the homesteads. In the case of tapioca, local varieties and improved M_4 are most popular. HYV of tapioca is absent in most of the homesteads, since the farmers prefer M_4 for their home needs and are not convinced of the superiority in quality over M_4. Non-acceptability of the cooking qualities or unawareness of the source of availability of HYV are the other reasons attributed for the non-adoption of HYV such as, H-97, H-226, H-165, Sree Vaisakh, Sree Sahya and Sree Prakash. Spraying prior to planting of the stem with insecticides to control scale insects is never done. Pepper is another crop cultivated in the homesteads. Due to non-availability of HYV pepper such as Panniyoor-1, more than 75 per cent farmers grow local varieties such as Karimunda, Kalluvally, Kottanadan etc. The average yield of black pepper is 1,000 kg/ha in a well managed garden. Yield of vines normally declines after 25 years.

5. Yield

The annual yield of nuts per coconut tree in the homesteads varies from 10 to 90 against the State average of 29. The average yield of tapioca tuber is roughly 5 t/ha in the southern districts. As high as 15 t/ha is not uncommon in Nedumangad taluk. In portions of the highland zone in Kottayam district, the average yield is still higher. The average per plant yield of tapioca tuber is in the range of 0.5 to 2 kg in the southern districts of the zone, while in Kanjirappally and Meenachil taluks it is as high as 10 to 15 kg, probably due to the loose texture and higher fertility status of the soil derived from proximity to High Ranges. Other crops normally give lower yields. Maximisation of yield from polycrops with the limited facilities available in the homesteads of the zone has to be planned with scientific approach.

Constraints

The existing polycrop combinations in the homesteads are based on trial and error experience of the cultivators rather than on scientific findings.

Fertiliser doses and other agro-techniques, including water management pertaining to individual crops are available, which will not hold good for the homestead gardens. The recommendations pertaining to "whole poly cropping system" has not been formulated.

The rooting pattern and crop competition for nutrients and water from the soil and sunlight in the multi-tier system in homesteads have not been studied.

No research data are available on the compatibility of different crop combinations and their effect on soil fertility, moisture conservation, weed suppression, pest and disease control etc. Even among the farmers, no uniformity in the selection of crops or season for raising the crops in different homesteads, is observed. The system thus functions in a "disorganised" manner.

Plant protection becomes a crucial problem in the homestead garden, especially for the vegetable crops grown along with other crops. Individual crop protection becomes meaningless in the homesteads and as such, integrated plant protection measures have to be developed for various crops together, including the vegetable crops in the kitchen garden.

Nematodes cause serious damage to banana and vegetables in the homesteads and therefore, the most effective and economically viable measures have to be developed.

Non-availability of land is a serious limitation especially in the homesteads in cities and towns. Under such circumstances it may become necessary to utilise even the R.C.terraces of buildings for vegetable cultivation. For this purpose, suitable agro-techniques have to be developed.

Non-availability of HYV seeds/cuttings/seedlings to meet the requirement of the farmers of the zone.

Lack of recommendation of suitable crop combination to enable maximisation of solar, water and soil resources in the coconut-based homesteads.

Soil erosion particularly in the monsoon season in the homesteads of the mid upland zone situated in hill slopes, which impaires soil health and soil fertility.

Lack of suitable technology for the integrated crop production, livestock production and/or pisciculture with an accent on recycling, to minimise input and maximise output in homesteads.

Lack of post harvest technology of storage, preservation and processing methods at the homestead level, especially for perishable foods, leading to deterioration and wastage of harvested produces such as tapioca, jack, mango, pineapple etc.

Lack of information on the multi-storied cropping systems suitable for the coconut-based and tapioca-based homesteads of different sizes, owned by marginal, sub-marginal and small farmers based on scientific study and water and nutritional requirements for each such system as a "whole", instead of for individual crops.

Meagre information on the shade tolerant varieties of cowpea, forage crops, ground nut, sesamum etc. with high yield potential and oil content suitable for intercropping with coconuts and tapioca grown in the homesteads.

Infestation of coconuts by Rhinoceros beetle during monsoon seasons.

Button shedding in coconut palms due to several reasons.

Coreid bug attack on coconut is very severe in many locations, particularly in Trivandrum and Kottayam districts. Farmers are not aware of the nature of attack and control measures.

Root (wilt) disease in coconut is grave in some locations in Nedumangad and Chirayinkil taluks and is spreading fast in alarming proportions.

Bunchy top disease of banana and miscellaneous plantains is very common. Though destruction of the infected plants by burning, is known to many farmers, several of them ignore control measures. Application of granular nematicide to control of vector is not known to several farmers, particularly in rural homesteads.

Mosaic virus disease in tapioca can be seen in many homesteads though not in a severe form. The farmers ignore this disease.

Rodent attack of tapioca tubers is serious in several locations.

Pepper is mainly a crop of small and marginal farmers and therefore the size of holdings in most cases are small ie. below 1 ha. The system of cultivation is largely traditional and the vines being trailed on to tree crops of several kinds found in the homesteads. Due to lack of capital resources, many farmers do not adopt proper agronomic and plant protection practices. Wilt disease and pollu beetle are endemic in some locations in Pathanamthitta and Nedumangad taluks, which takes a heavy toll of vines every year.

Cocoa is affected by many diseases and pests, but the loss inflicted by animal pests like squirrel and rat is considerable.

Lack of sufficient number of processing units for cocoa in the zone. Moreover, due to high cost of production of Indian cocoa and widely fluctuating international prices, it is difficult to maintain a steady export market. Setting up of cocoa processing units will be helpful in the indigenous consumption of cocoa.

Before cocoa is marketed or stored, the beans have to be carefully and properly fermented and dried. This is a skilled job which many farmers do not undertake. Drying of cocoa harvested mostly in the monsoon season, is again a problem. Many farmers cannot afford to maintain artifical drying units.

Innovative agricultural practices followed by farmers in the southern zone with rationale

Farmers in the zone have evolved certain practices based on their experience, for which they have their own justifications. Most of these practices have been existing for the past several years, being followed traditionally, while a few of them are of recent origin.

Farmers' practice	Rationale
Sprinkling diluted cowdung slurry to hasten germination of paddy seeds. [The seeds are soaked in water for 12 hrs. and kept moist for a day. If sprouting is slow, dilute cowdung slurry is sprinkled and the seeds raked carefully with hand and kept pressed for another one day to hasten germination].	This is an age old practice followed traditionally by most of the farmers all over the zone. Uniformity in germination and increased vigour of the seedlings are achieved by the treatment.
Sprouted paddy seeds are soaked in cowdung and the pelleted seeds are sown.	This is a practice normally followed by many farmers in Nedumangad taluk. FYM treatment at the time of field preparation is either dispensed with or minimised.

At ear head emergence and grain setting stages of paddy, wooden poles with cloth (dipped in oil) wound round one end are planted and lit as torches.	Rice pests particularly the rice bug get attracted and die.
In the paddy fields of Chirayinkil and Varkala, fronds of coconut trees are cut to small lengths and fixed in the drained field with their wider end upwards.	The pole can serve as convenient seat for owls and other birds to enable them to locate the rats. Used mainly to control rats in rice fields.
White cloth pieces in small poles fixed in paddy fields.	To ward off the attack of rates.
Spraying a mixture of highly pungent chilli mash and garlic juice over paddy crop	This is done for controlling rice bug.
Ammophos is broadcast at panicle initiation or late tillering stage of paddy, against the package recommendation of entire P to be applied as basal. This is done by more than 50 per cent farmers in the zone.	This practice is followed during the past several years and some farmers have strong belief that water soluble N and P in the form of ammophos if applied at PI stage would improve the quality and quantity of paddy grain.
Mixing grains with dried tender stems of clerodendron.	To ward off store pests.

Prior to monsoon season the coconut cultivators apply a mixture of common salt and ash @ 1-1.5 kg each or even more, to the coconut basin and also in the crown, once or twice every year (quantity depends on the age of the palm).	This is an age old practice. The sodium appears to serve as partial substitute for potassium. Farmers believe that the mixture has insect repelling ability apart from its ability to retain soil moisture and control of button shedding. Also effective in controlling the transpiration loss of water and in preventing diffusion of salts toxic to the palm.
Common salt alone is applied to the coconut basin.	Application of common salt to the basin is helpful in loosening the hard laterite soil, in controlling white ants and in the retention of soil moisture apart from functioning as a partial substitute for potassium. Can also reduce the formation of barren nuts. Recent studies reveal that salt application increases coconut yield.
Growing plantain in coconut basins, in Nedumangad Sub-Division.	Plantains need irrigation and this will help to protect the palm from drought situations.

Growing Amomum (Kolinchi) and Chithratha in planting pits at the time of planting coconut seedlings.	To ward off attack by white ants. This is a practice in vogue in Nedumangad taluk.
White washing of the fronds of coconut seedlings.	To protect the seedlings from sunstroke.
In banana cultivation, after full emergence of fingers, the "male bud" is cut and the cut end is plugged with a piece cf cloth or dry leaf containing a little ammonium sulphate or urea.	The size, weight and shape of the banana fingers will be improved so that market value will be more.
Fixing sticks on either sides of vegetable seedlings in Nedumangad taluk.	To protect the seedlings from mole cricket and grasshopper attack.
Raising seedlings of Cucurbitaceous vegetables in jack leaf cones.	To aid in the establishment after transplanting (Cucurbitaceous crops do not stand transplanting).
Filling zinc phosphide inside the outer skin of rhinoceros grubs	For rodent control.
Sprinkling fish wash over brinjal crop.	For the control of pests.
Spreading rice powder or broken rice around amaranthus nursery.	To protect amaranthus from ants. Ants take away the rice leaving amaranthus seeds unaffected. This practice is followed in many rural homesteads.

Smoking around the bitter gourd pandals during evening hours.	To ward off fruit flies.
Sprinkling brick + charcoal powder to snake gourd crop.	To ward off the attack of semi-loopers in snake gourd.
Pinching the tip of the vines of cucurbitaceous plants.	This is done to induce profuse branching.
Removal of excess leaves in pumpkin.	This is done to induce early flowering in pumpkin.
Preservation of vegetable seeds in the hearth of home kitchens. In rural households, vegetable cultivators preserve seeds of cucumber, ash gourd, bitter gourd, pumpkin, snake gourd etc. by pressing over cowdung paste fixed on walls of kitchen over the hearth. Cowdung and seeds get dried gradually.	To protect the seed from insect attack and to improve the viability of the seeds. This is a very old practice followed in many rural households.
Dusting wood ash over vegetable crop.	Farmers believe that the dusted ash would be helpful in controlling vegetable pests.
Cut rhizomes of yam and dioscorea are dipped in cowdung slurry, dried in shade and stored before sowing.	For faster and vigorous germination and growth.
Application of cowdung slurry.	To control mealy bug attack.
Tapioca tubers along with the stem part of the tuber are preserved in shallow underground pits dug and covered with moist soil and kept moist.	This is a post-harvest indigenous technology to preserve the tuber fresh for 5-6 days.

During transport of tapioca tubers in baskets to marketing centres, a layer of fresh tapioca leaves is spread on top of the tubers by vegetable vendors.	This is a practice followed by small vendors to prevent drying and to maintain freshness to the tuber.

CHAPTER IV

RESEARCH AND EXTENSION LINKAGES

4.1. Linkages between Research Stations

The Kerala Agricultural University, the only one of its kind in the State, was started in February, 1972 with its main campus at Vellanikkara, Trichur. It has presently under its control, eight colleges, 26 research stations, four Centres of Excellence, three Krishi Vigyana Kendras and four farms functioning at different locations in the State, of which two, eight, one, zero and one, respectively exist in the southern zone. In addition, one Krishi Vigyana Kendra at Mitraniketan, Vellanad, Trivandrum district is also functioning under private sector.

Three ICAR *ad hoc* schemes and five ICAR Co-ordinated Research Projects are under implementation in the zone, in addition to three Department of Science and Technology projects and two schemes financed by the Kerala State Committee on Science, Technology and Environment, a list of which is furnished on pages 272 to 275. Prior to the introduction of the National Agricultural Research Project (NARP), the field problems were being independently tackled by individual disciplines without much mutual collaboration and without considering the location specificity of the problem. Introduction of the NARP enabled intensification of research efforts with priority given to location specific field oriented problems and tackling of such problems by an inter-disciplinary approach, for which purpose, some of the major research stations under the University , located in different zones of the State were elevated to the status of Regional Agricultural Research Station. To tackle the field problems of the farmers of the southern zone, a separate Regional Research Station started functioning at Vellayani with effect from February, 1982. This project was formulated by the ICAR on 30-11-1981 for the purpose of strengthening the research capabilities of the Agricultural University under financial support from the World Bank. The initially sanctioned period of five years expired on 29-11-1986 and the project is now operated by the Kerala Agricultural University.

The main objective of the NARP is to improve the regional research capabilities of the SAUs permanently. This strengthening is considered to be an important means of finding solutions to location specific problems in the different agro-climatic zones in the service area. For this purpose, intensification of research efforts is promoted in respect of (1) food-grains (cereals and millets), pulses and oil seeds, particularly those that are grown under rainfed conditions, (ii) farming systems involving crop-livestock and crop-fish production systems, (iii) agronomic practices, (iv) soil and water conservation techniques and (v) land use patterns for more efficient use of natural resources and ecological potential. These objectives are achieved through rationalisation of the research programmes and the research set-up of the University as well as by strengthening the capability of the University to undertake advanced research on location-specific problems. This has been achieved by (i) development of one main station for each zone under the University, supported by necessary sub-stations and providing resources for staff, equipment and infrastructure needed for the ongoing research as well as to pursue new applied research problems, (ii) Provision of resources including infrastructure for verification of research results both at the main station as well as the sub-station and (iii) Provision of resources to initiate, strengthen and accelerate basic research on topics, which are crucial for the long term agricultural development of the State.

The Regional Agricultural Research Station at Vellayani maintains close linkage with other Regional Research Stations in the State, with the Directorate of Research of the Agricultural University and with the various Departments in the College of Agriculture, Vellayani and also with the Central Research Institutes located in the zone, namely, Central Tuber Crops Research Institute (ICAR) at Trivandrum, Regional Research Station at Kayamkulam and the Research Centre at Palode, both under the Central Plantation Crops Research Institute (ICAR), Kasaragod. Close linkage is also maintained with the Regional Research Laboratory under the CSIR Complex, located at Trivandrum and the research departments under the University of Kerala. The Directors of the above mentioned Central Institutes and/or their representatives regularly attend the six monthly Zonal Workshops and actively participate in the deliberations of the

Workshops. Many of the technologies evolved at the other research stations of the Kerala Agricultural University are being tested in the Regional Station, Vellayani for their adaptability for the southern zone. With the implementation of the National Agricultural Research Project, Vellayani in November 1981, the research capabilities of the different departments in the College have been considerably strengthened through:

Procurement and putting into operation sophisticated and imported research equipment, to serve as a common facility to different departments in the College,

Remodelling the research laboratories of these departments,

Construction of glass house and green house,

Reclamation of kayal land from the adjoining Vellayani lake for conducting field experiments on rice and rice-based cropping system,

Development of garden land area of the Instructional Farm of the College for conducting field experiments on upland crops,

Provision of irrigation and drainage facilities by deepening the existing perennial water source, by putting up bunds to prevent flooding from the adjoining lake and by installation of pumpsets,

Procurement of reference books and journals useful for research, thereby strengthening the library facility and

Implementation of multi-disciplinary research projects to solve location-specific problems.

Periodical reviews on the progress of the research activities have been made at the Zonal Workshops held twice a year and attended by the T&V personnel of State Department of Agriculture, Project Leaders as well as the senior scientists of the University and representatives of the Central Research Institutes in the zone. The research problems were identified through the feed back from T&V Monthly Workshops, Zonal Workshops, farmers' group meetings and periodical visits to the farmers' fields by scientists' diognostic teams. More than 75 research projects and several adaptive trials and observational trials were handled by the Scientists of the zone during the five-year period of aid from ICAR / World Bank. Different departments of the College of Agriculture, Vellayani were actively associated in the implementation of these projects. On cessation of the Central aid with effect from November, 1986, the Regional Station continued to operate these projects, in addition to the implementation of newer projects with relevance to the field problems of the farmers, on priority basis. Several farm trials, to test the efficacy of the newer technology developed by the Regional Research Station, also progressed.

4.1.1. Linkages within the zone

The Research Stations / Centres in operation within the zone and their lead functions are given below:

Name of Station / Centre	Functions
Regional Research Station, NARP (Southern Region), Vellayani	Lead Centre for Tapioca and other tubers. Testing Centre for rice, pulses, sweet potato, coconut, pepper, banana and homestead crops.
Special Station, NARP (Southern Region), Sadanandapuram, Kottarakkara	Lead Centre for homestead farming. Testing Centre for tapioca and other tubers.
College of Agriculture, Vellayani	Teaching and guiding basic and applied research programmes of PG students in different agricultural disciplines.
College of Rural Home Science, Vellayani	Teaching and guiding the research programmes of PG students in Rural Home Science and undertaking research in the field.

Centre of Excellence for Tropical Soils, Vellayani	Advanced research on laterite and other humid tropical soils.
Coconut Resrarch Station, Balaramapuram	Lead Centre for studying the agronomic aspects of coconut cultivation. Popularisation of HYV and WCT varieties.
Cropping Systems Research Centre, Karamana (ICAR project)	Lead Centre for cropping pattern studies on rice-based farming system. Manurial & agronomic trials on HYV rice & rice-based cropping systems.
Experiments in Cultivators' Fields (ECF), Quilon (ICAR poject)	Conducting AICARP experiments in cultivators' fields.
National Demonstration Scheme, Kottarakkara (ICAR project)	Conducting demonstrations in cultivators' fields, applying package recommendations.
Agricultural Research Station, Kayamkulam	Lead Centre for breeding rice & sesamum varieties suitable for Onattukara tract. Testing Centre for pulses suited to rice fallows.
Sugarcane Research Station, Thiruvalla	Lead Centre for sugarcane research.
All India Coordinated Research Project on Forage Crops, Vellayani	Intensive research on forage crops.
All India Coordinated Research Project on Nematode Pests, Vellayani	Nematode diseases of crop plants and their control.
All India Coordinated Research Project on Pesticide Residues, Vellayani	Estimation of residues of pesticides in different crops of Kerala.

All India Coordinated Research Project on Oil Seeds, Vellayani	Standardisation of management practices in sesamum and groundnut.
All India Co-ordinated Project on Tribal Area Research, Amboori	Development of viable technology in Agriculture, Animal Husbandry, Home Science, ayurvedic medicines and small scale industries suited to the socio-economic situation and genius of the tribal people.
Dept. of Science & Technology Action research on the use of labour saving devices in rural houses of Kerala, Vellayani	Improvement of quality of life of women and children among the poor and under-privileged, through the introduction of labour saving devices such as hay box and smokeless <u>choola</u>.
Department of Science and Technology project on Mycorrhizae and Forest eco-systems in Kerala, Vellayani	Studies on ectomycorrhizae of the forest eco-systems of Kerala with particular reference to Idukki.
Department of Science and Technology project on Mushroom Flora of Kerala, Vellayani	Survey of edible mushroom flora of Kerala.
Kerala State Committee on Science & Technology scheme on <u>Pleurotus</u>, Vellayani	Standardisation of the techniques for large scale cultivation of <u>Pleurotus</u>.
Kerala State Committe on Science & Technology scheme on Hazards of Food Adulteration in Trivandrum district, Vellayani	To detect the common adulterants in foods sold, to devise simple tests to detect the adulterants and to educate the housewives on the hazards of food adulteration.

ICAR *ad hoc* scheme on Rice Cyst Nematode, Vellayani	Survey, biology, host-plant relationship and assessment of crop loss.
ICAR *ad hoc* scheme on Post harvest technology in perishable foods, Vellayani	Identification and popularisation of suitable technologies with respect to storage and processing of tubers and fruits.
ICAR *ad hoc* scheme on tapioca consumption and goitre incidence in Kerala, Vellayani	Detailed diet survey of goitre patients, w.r.t. their tapioca consumption, to find out the frequency of use of tapioca in their diet.

The activities of the schemes and research stations under the zone are being co-ordinated by the Zonal Associate Director. At the Regional Research Station itself, several research projects are at various stages of implementation. Some projects have been concluded.

4.1.2. Linkages between different zones and headquarters

Five Regional Agricultural Research Stations are presently functioning under the Kerala Agricultural University in the different agro-climatic zones in the State as follows:

Research Station	Area of operation	Lead function
Regional Agricultural Research Station, Pilicode	NORTHERN ZONE: Kasaragod, Cannanore, Calicut and Malappuram districts	Research on coconut and pepper
Regional Agricultural Research Station, Ambalavayal	ZONE OF HIGH RANGES: High elevation forest areas situated in the different districts of the State.	Research on Horticulture

Regional Agricultural Research Station, Pattambi	CENTRAL ZONE: Palghat, Malappuram and Trichur districts	Rice research
Regional Agricultural Research Station, Kumarakom	PROBLEM SOILS ZONE: Problem areas of rice cultivation in acid sulphate soils, including submerged soils of kari, karapadom and kayal lands of kuttanad (Alleppey district), problem soils in Kottayam district, acid saline soils of Ernakulam district, submerged kole areas in Trichur district and sandy Onattukara tract in Alleppey and Quilon districts.	Problem soils, their detailed studies and amelioration for increased rice production
Regional Agricultural Research Station, Vellayani	SOUTHERN ZONE: Trivandrum and major portions of Quilon, Pathanamthitta and Kottayam districts and parts of Alleppey district that are not covered by the Problem Soils Zone.	Cassava and Homestead farming

Each of the above has supporting Research Stations / Special Stations, located within its area of operation and control. Accordingly, the Regional Agricultural Research Station, Vellayani, has under its control, a Special Station at Sadanandapuram at Kottarakkara, and the following supporting Research Stations:

1. Coconut Research Station, Balaramapuram

2. Cropping Systems Research Centre, Karamana

The Regional Research Station is responsible for

- Identifying the location specific research problems

- Conducting basic as well as applied research and attempting to tackle the problems

- Assigning research programmes for sub-stations within the zone

- Co-ordinating and evaluating the progress of research work, and convening zonal workshops every six months and

- Transferring new technology and research high lights to the farming community through T&V monthly workshops, Zonal Workshops and other means of communication and thereby increasing the agricultural production in the operational area within their jurisdiction. The administrative and technical control of all the Regional Research Stations in the State is vested with the Director of Research of the Agricultural University.

4.1.3. Linkages with Central and other Laboratories and Universities

Assistance has been received by the Regional Station, Vellayani from the following Central Institutes / International Institutions / Universities located within and outside the zone / State in tackling problems in Agriculture.

Research Station/Institute	Crops/aspects of research assisted
1. Central Tuber Crops Research Institute (ICAR), Sreekariyam Trivandrum.	Tapioca & other tubers. Supply of high yielding varieties and technical assistance.
2. Central Plantation Crops Research Institute(ICAR), Research Centre, Palode.	Technical assistance on arecanut, oil palm and pepper.

3.	CPCRI Regional Station, Krishnapuram, Kayamkulam.	Pathological aspects of coconut and technical assistance.
4.	International Crop Research Institute for Semi Arid Tropics, Hyderabad.	Germplasm resources.
5.	All India Co-ordinated Rice Improvement Project, Rajendranagar, Hyderabad.	For technical guidance on Cropping Systems research at Karamana.
6.	Bhabha Atomic Research Centre, Trombay, Bombay.	For irradiating seed and for assistance in tracer techniques.
7.	Regional Research Laboratory (CSIR Complex), Pappanamcode, Trivandrum.	Technical assistance on post-harvest technology and food preservation.
8.	Research Depts. of the University of Kerala, Kariavattom, Trivandrum.	Technical assistance in Statistics, Entomology and Plant Breeding.
9.	Rubber Research Institute of India, Puthuppally, Kottayam.	Technical assistance.
10.	Centre for Earth Sciences, Akkulam, Trivandrum.	Equipment facility for micro-morphological studies on soils and clay minerology.
11.	India Meteorological Department, Trivandrum.	Weather data.

4.2. Linkages with Extension agencies

Extension agencies have the responsibility of transferring new technology and research high lights to the farming Community through different media without delay. The Extension agencies through direct contact with farmers can also help in obtaining the necessary feed back of field problems for investigation and solution by researchers. Linkage with extension agencies is, therefore, a must for ensuring popularisation of recommended technology among the farmers in the zone and for maximum adoption of these technologies by farmers. In this item of work, the following agencies in the zone actively collaborate:

1. T&V personnel viz. PAOs, SDAOs, SMSs, JAOs and Agricultural Demonstrators / Fieldmen of the State Department of Agriculture

2. Rural Development Department

3. Co-operative Agricultural Credit Societies

4. Agricultural Marketing Wing of the Department of Agriculture

5. Nationalised Banks and Regional Rural Banks

6. Krishi Vigjana Kendra

7. Department of Extension of the College of Agriculture, Vellayani

8. All India Radio, Trivandrum

9. Doordarshan, Trivandrum

10. Farm Information Bureau, Government of Kerala

11. Fertiliser and Pesticide supplying agencies

12. Department of Animal Husbandry

13. Contact farmers of the T&V Sub Divisions

4.2.1. Pre-monthly Workshop meeting

At least one week prior to every monthly T&V workshop for the Trivandrum district, pre-workshop meetings are held at the Regional Research Station, Vellayani. During this meeting, the reports of the Sub Divisional Agricultural Officers are taken care of, based on which the practices for which the messages are to be framed, are identified and discussed with the master trainers (Resource Persons drawn from the Agricultural

University). The messages for the ensuing two fortnights are thus finalised during the meeting, after a detailed consideration of available research as well as feed back details. The participants in such meetings are the SDAOs and District SMS of the Agricultural Department and the Resource Personnel from the University. Similar meetings are organised at Kayamkulam for the T&V Sub Divisions of Quilon and Pathanamthitta districts. In addition to the T&V personnel from these districts, the Scientists from the Research Station at Kayamkulam and experts from the Regional Station of the CPCRI, Kayamkulam also attend such meetings.

4.2.2. T&V Monthly Workshops

Workshops are arranged at the College of Agriculture, Vellayani, once every 28 days (two fortnights), which will be attended by the T&V personnel of the Trivandrum district. The extension functionaries of the Quilon and Pathanamthitta districts attend similar workshops at Kayamkulam, the venue being CPCRI Regional Station or Rice Research Station of the University. The monthly workshops for the Alleppey and Kottayam districts are held at Rice Research Station, Moncompu and RARS, Kumarakom, respectively. The messages for the ensuing two fortnights as formulated earlier by the pre-monthly meeting, are discussed and finalised during these workshops. In monthly workshops, emphasis is given to appropriate skills necessary for the technologies identified for dissemination among farmers.

The objective of the T&V system and of the said monthly workshops is to ensure regular schedules of visits by the Junior Agricultural Officers and the Agricultural Demonstrators of the concerned Agricultural Sub Divisions to the selected farmer's groups assigned to the officers and to train the farmers on the efficacy of the recommendations relating to the various agricultural practices relevant to that fortnightly season and to the area. Such close contacts with the so called "Contact Farmers" motivates them to adopt the recommended technology conveyed to them. These contact farmers in turn are expected to convey the message to other farmers of that locality, thereby resulting in a wider spread of the recommended technology and improvement of the professional skills of the farming community in general.

The Joint Directors (PAO) and Deputy Directors of Agriculture (SDAO) of the Directorate of Agriculture also make periodical visits to the contact farmers and farmer's group, to ensure the effective implementation of the scheduled programmes. This is in a nutshell the concept of the Training and Visit system implemented under the Kerala Agricultural Extension Project (KAEP) of the Directorate of Agriculture with financial support from World Bank for the first five years ending 1987. The T&V Sub Divisions and the Agricultural Extension Units in the southern zone are listed in Annexure CXV.

Review of the agricultural situation in the Sub Divisions, examination of field problems and live specimens of affected plants or plant parts brought by the T&V personnel, discussion on the reports on the visits made by the diagnostic team, discussion on the slow moving technology, skill demonstration, recommendations on fixing Target Groups and formulation of special production recommendations, formulation of messages for the ensuing fortnight, review of monitoring and evaluation report, special lectures on topics of relevance etc. are the main items of discussion during the monthly workshops.

Skill demonstration by experts is intended for acquiring detailed practical knowledge for the efficient transmission of the improved technology to farmers for the benefit of the officers of the Directorate of Agriculture. It is one of the very effective extension teaching methods to teach 'skill' or new technology to the farmer or a group. The diagnostic team visiting the field also conduct skill demonstration to benefit the farmers. Skill demonstrations are arranged on the following aspects:

<u>Rice</u>

1. Paddy seed treatment - wet, dry and hot water.

2. Line planting of paddy seedlings.

3. Seed germination test.

4. Age of seedlings, spacing or depth of planting.

5. Identification of PI stage of paddy plant in local, improved or HYV.

6. Incubating urea with slightly moist soil and oil seed cakes.

7. Identification of major pests and diseases.

Coconut

1. Selection of quality coconut seedlings. Taking pits and planting coconut seedlings.

2. Preparation of basins and manuring of coconut trees.

3. Selection of mother palms and hybridisation techniques for the production of TxD, DxT.

4. Husk burial in coconut garden for moisture conservation.

5. Electronic devise developed by CPCRI for early detection of red palm weevil inside coconut palm.

6. Identification of pests and diseases.

7. Preparation and application of BHC-sand mixture against rhinoceros beetle.

8. Integrated pest control of nephantis.

9. Poison bait for fruit flies.

10. Trapping red palm weevils by using locally available baits like toddy and gur.

Banana

1. Selection of quality banana sword suckers.

2. Application of Thimet.

3. Application of hormones for inducement of uniform flowering.

4. Destruction of Bunchy top affected banana plants.

Pulses

1. Seed inoculation with rhizobium culture.
2. Identification of pests and diseases.
3. Application of second dose of fertiliser as foliar spray (2% Urea + Dimecron).
4. Oil treatment of pulses against store pests.

Vegetables

1. Preparation of tobacco decoction.
2. Preparation of kerosine oil emulsion.
3. Hardening of cucurbits at 4 to 5 leaf stage for inducement of more female flowers (pricking).
4. Identification of pests and diseases.

Pepper

1. Raising of pepper rooted cuttings.
2. Heat treatment of green pepper.
3. Identification of slow and quick wilt diseases.

Ginger and Turmeric

1. Preservation / storage of rhizome seed material.
2. Curing and processing techniques.

Tapioca

1. Preparation of setts and planting.
2. Preparation of baits using zinc phosphide, Warfarin etc.
3. Application of aluminium phosphide in live burrows.

Others

1. Preparation of super-compost.

2. Preparation of Cheshunt compound.

3. Preparation of Bordeaux Mixture and paste.

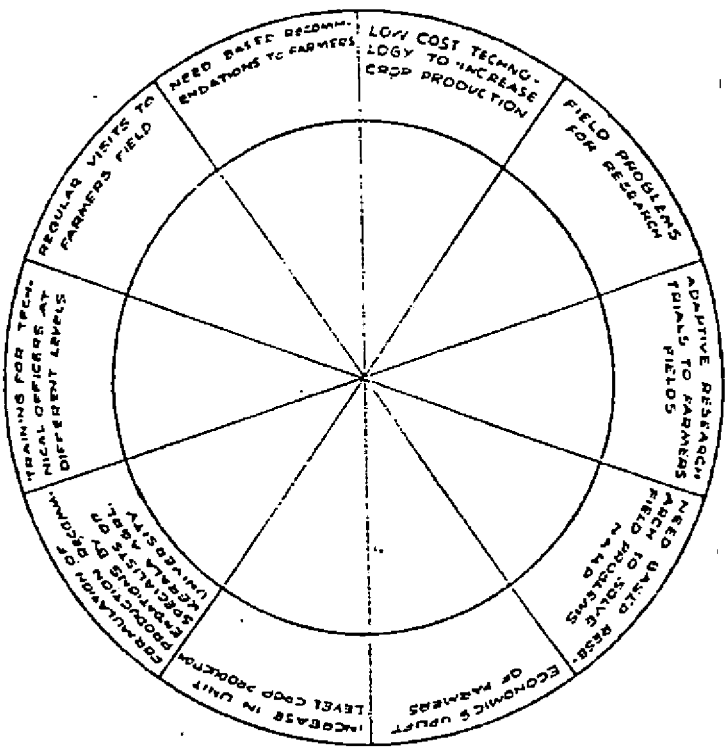
4. Effective communication of messages.

5. Layering (cashew), grafting (jack, mango) and budding (rubber, rose) methods.

Impact on the implementation of the T&V system

The T&V system, commenced in 1981-82 with a view to raise the farm income of small and marginal farmers through adoption of proven technology, has completed five years in the zone. The major objectives of the T & V system are summarised in Fig. 78. The impact of the system has been critically assessed by the Agricultural Sub Divisions in the zone by a comparative study of Agricultural situation for the five year period 1980-81 to 1985-86 and the reports have been published. The study has brought out production and productivity trends of various crops and steady increases in the consumption of fertilizers and plant protection chemicals, increased rate of adoption of recommended technology by farmers, and impact of production recommendation for major crops in quantitative terms. The report also carries the results of several Farm trials conducted, Farm trials in progress, special set of messages for Target Groups, field problems identified for research and constraints in agricultural production, particularly with reference to paddy, coconut, tapioca, banana and pepper, follow up of the suggestions of the M&E cell and World Bank consultants and achievements under (1) Fertilizer promotion programme for coconut and (2) intensive programme for boosting paddy production. Rubber, which is also a major crop in the zone is, however, not normally emphasised, since the Rubber Board, Kottayam looks after its technological aspects of cultivation and extension activities including supply of inputs. The T&V personnel could create awareness among the farmers on the need for growing HY and improved crop varieties, the type, doze and time of fertilizer application, PP

Fig. 78 TRAINING AND VISIT SYSTEM - OBJECTIVES



chemicals, identification of pests and diseases and solution of field problems. Rate of adoption of recommended technology has increased in the zone as a result of implementation of the T&V system and the system had considerable impact on the agricultural situation in the zone.

With effect from 1.9.1987, a long term master plan for the integrated development of agriculture in the State, is under implementation by the State Government by setting up Agricultural Development Unit in each of the 1000 Panchayats, 44 Municipal towns and 3 Corporations in the State. These units are named Krishi Bhavans.

4.2.3. Zonal Workshops

The Zonal Workshops for the southern zone are organised at Vellayani, twice in an year. These workshops are organised, each before the commencement of Kharif and Rabi seasons and attended by the senior scientists of the Kerala Agricultural University, Directors or their nominees from the Research Station of the CPCRI, CTCRI and CSIR Complex and the Senior Extension Personnel of the T&V programme from the Directorate of Agriculture. During the workshop, the progress of research done during the previous cropping season is reviewed and new projects formulated on priority basis or current projects modified for the ensuing season. The farming constraints are also identified. The Extension Specialists from DOA bring with them the farmer's field problems and present them during the workshop for further follow up by the scientists of the southern zone. Live specimens of the diseased or pest attacked or malformed plants and plant parts are also often presented for a detailed on the spot investigation by the scientists of the University, who are also the active participants in the workshop, and for technical advice enabling early rectification of the adverse situation. Sometimes, the diagnostic team of scientists visit the standing crop in the field for further detailed investigations in the matter, in the presence of farmer or farmer's group of the locality. All the KAU scientists of the southern zone will also be available for discussions during the workshop. On the second day of the workshop, extension functionaries get an opportunity to attend special lectures by experts on particular scientific topics of interest and to see demonstrations of various techniques conducted by research scientists, besides visiting the local or nearby experimental plots and or farm trials laid out in farmer's field. The Zonal Workshop serves as a means for identification of the constraints and the research requirements of the zone.

4.2.4. Zonal Research Advisory Council

For improving the linkage with extension agencies, a Zonal Research Advisory Council is being constituted including the senior scientists of the University, officers of the DOA and supply service agencies as members. Constitution of the proposed Council is as follows:

Director of Research, KAU or Additional Director of Agriculture (T&V)	Chairman
Associate Director, Regional Research Station, NARP, Southern Zone, Vellayani	Convenor
Heads of Departments of the College of Agriculture, Vellayani	Member
Co-ordinator, T&V monthly workshops	Member
Concerned Crop Co-ordinators of the University and State Level Scientists in the concerned fields of Specialisation	Member
All the Agricultural Scientists of the zone upto the rank of Associate Professor of the University	Member
Regional Officers (T&V) from the Department of Agriculture (of the influence area), including PAOs, SDAOs, SMSs and JAOs	Member
Representatives of the concerned development departments (DRDA, Fisheries, Forestry, Animal Husbandry, Irrigation / Command Area Development Agency) depending on the farming situation and need of these representatives, upto the rank of district officer from the influence area	Member

Representatives from ICAR and other Central Institutes located in the influence area	Member
Progressive farmers representing the important crops of the zone	Member
Extension Specialists posted in the influence area	Member

The Council has to review seasonally, the adoption of production recommendations made earlier, to identify constraints in their adoption and to develop research programmes relevant to the needs of the farmers of several agro-climatic situations existing in the zone. The major functions are to review the zonal research efforts, to assist in identifying the farming constraints / problems at micro level, to make recommendations on the regional extension as well as field testing programmes in the ensuing season, to review the transfer of technology developed by the research station and problems encountered in its effective implementation and to finalise the package of practices for all the important crops of the zone.

4.2.5. Short training programmes

Various training programmes have been designed and conducted by the Department of Extension, College of Agriculture, Vellayani in the southern zone. The technology developed in the zone are thus passed on to the different categories of beneficiaries such as the personnel from the Department of Agriculture, Social Forestry, agricultural input agencies, the field officers of the Central Commodity Boards, Farming Corporation, Nationalised Banks, Regional Rural Banks, Kerala State Co-operative Agricultural Developement Bank, managerial staff of the Co-operative Societies and other credit institutions etc.

Senior scientists of the College of Agriculture, Vellayani and Experts from the Department of Agriculture regularly handle classes for these trainees on various topics related to Agricultue as and when training programmes are organised. The resource personnel also undertake pery-pattetic training programmes in different parts of the zone. Since the women community in many rural households in the zone either assist the men farmers in various farming activities or manage the farming operations independently, the training programme for women in farming deserves consideration.

Short training programmes are also conducted by the Department of Plant Pathology, College of Agriculture, Vellayani which include Advanced training in plant protection, training in Microbiology, Mushroom cultivation and control of diseases affecting paddy and coconut. Such short training programmes are conducted by the Department of Entomology as well. At the Coconut Research Station, Balaramapuram, intensive training is imparted to the Demonstrators deputed from DOA on various activities of the Station, in addition to the vocational training for the students of the Higher Secondary School on various aspects of coconut cultivation. The National Demonstration Scheme, Sadanandapuram has been conducting three pre-season training programmes at different locations, for the farmers of the Kottarakkara taluk ie. before Virippu, Mundakan and Punja cropping seasons. Various training programmes are also conducted by the Training Cell of the College of Rural Home Science at Vellayani which include First Aid and Home Nursing, Child Development for the benefit of Anganwadi workers and rural women, Hazards of Food Adulteration for the housewives of the Trivandrum district, Safe Food Practices for the field functionaries and rural women of the district, Preservation of Fruits and Vegetables for the rural women in the district, Household Arts for rural women, correspondence course on better infant feeding practices in Malayalam and English to the public, Publication of Newsletter to the field level agents and orientation training on Communication Methods for the Anganwadi workers.

4.2.6. Diagnostic team

Diagnostic teams involving the Subject Matter Specialists of the DOA and Scientists of the Agricultural University constituting the district level joint diagnostic teams, undertake field visits during the crop seasons, to study the field problems and to find out solutions to location specific problems reported to them by the farmers. The main purposes which could be served from such joint visits include:

Diagnosis of specific field problem (production constraint) observed and suggestion of appropriate remedial measures.

Inclusion of problems in the research programmes of the University for detailed investigation to find out solutions on priority basis, if necessary.

Selection of groups of farmers as Target Group for a particular crop.

Study of the adoption of technology by farmers and analysis of the reasons for the low or non-adoption of improved technology advocated and suggest improvements.

Frequent visits to Farm Trial plots and Observational Trial plots and offer necessary guidance for laying out trials, collection of data etc.

The leader of the team would be a senior scientist of the College of Agriculture, Vellayani. One or Two members are drawn from suitable disciplines, depending on the nature of the field problem. The SMS (Trg) or SMS (PP) of the concerned PAO Office and one or two specialists from the concerned Sub Division would also be nominated as members of the team. Atleast once in a month, the diagnostic team visits farmers' fields as decided by the monthly workshop. Interaction with farmers (both contact and non-contact farmers) during these visits could be achieved. The findings of the teams were promptly presented during the ensuing monthly workshop for detailed examination. Usually, the visits by such teams are decided in the workshop sessions at the time of discussion of field problems presented by the staff of the DOA. These visits to the farmers' fields were very successful in the zone. The reports of the diagnostic team are communicated to the Director of

Agriculture and the Director of Research of the University also. The details of field visits during 1985-87, made by the diagnostic teams constituted for the southern zone are furnished in Annexures CXVI (a) to (c).

4.3. Extension oriented activities of the University

Village Adoption Programme has been launched by the University in the zone. Two villages viz. Muttacaud and Kalliyoor have already been adopted by the College of Agriculture, Vellayani to make them models of agricultural development for the neighbouring villages. Palappore village, where vegetable cultivation is intensively done, has been additionally selected from 1986. Muttacaud is situated about 3 km, Kalliyoor about 4 km and Palapore 1 km from the College of Agriculture Vellayani. The Cropping Systems Research Centre, Karamana has also adopted Nemom Village under the programme.

4.3.1. Krishi Vigyana Kendra

Only one Krishi Vigyana Kendra exists in the zone at Mitranikethan, Trivandrum district and that too under the private sector. However, in the zone, one Extension Training Centre at Kottarakkara under the Development Department and one Farmer's Training Centre at Quilon under the DOA are functioning.

4.3.2. Lab to Land programme, Field days and Farmers' camps

Lab to Land programme, Phase I was implemented by the Agricultural University from 1979-80 to 1981-82 for three years, Phase II from 1982-83 to 1983-84 for two years and Phase III from 1984-85 to 1986-87 for two years. The programme financed by ICAR has been implemented at the Transfer of Technology Centres in the zone, as listed in Table 45.

Table 45. Institutions in the Southern Zone implementing the Lab to Land Programme.

Name of Centre	No.of families adopted	Period	Name of implementing Institution
Trivandrum District			
Muttacaud	25	Till 1986	College of Agriculture, Vellayani.
Kalliyoor	25	Till 1986	College of Agriculture, Vellayani.
Balaramapuram	25	Till 1986	CRS, Balaramapuram.
Karamana	25	Till 1986	CSRC, Karamana.
Palappore	25	Continuing	College of Agriculture, Vellayani.
Amboori	100	Continuing	College of Agriculture, Vellayani.
Quilon District			
Kottarakkara	25	Till 1986	NDS Sadanandapuram, Kottarakkara.

Varieties/breeds for distribution

1. Paddy : Jaya,Jyothi,Triveni,Mashoori
2. Sesamum : Kayamkulam - 1
3. Pulses:
   - Cowpea : K 1552, Kanakamani, C-152
   - Blackgram : T9
   - Greengram : KM 1
   - Groundnut : TMV 2
4. Goat : Sannen Malabari
5. Poultry : Austrowhite

Critical inputs supplied

a) Goats
b) Horticultural plants
c) Seeds/Seedlings/grafts
d) Poultry
e) Fertilisers
f) Poultry cage (simple type costing not more than Rs.50/- each)
g) Agricultural implements
h) Plant protection chemicals
i) Cottage industry (Coconut leaves, plastic cane for chair making)
j) Medical care (Medicines)
k) Fish fingerlings
l) Supplementary feed
m) Feed trays for poultry
n) Smokeless choolas

Community inputs supplied

1) Sprayers
2) Goats (Bucks)

Vegetable cultivation among the adopted families was also encouraged. About 1,500 packets of vegetable seeds were distributed under this programme. This has served as an incentive to the farmers for producing vegetables under limited land resource. An average of 0.750 kg vegetables could be harvested per farmer per week during the crop season from their homesteads. Studies have been initiated on the impact of these farmers towards adoption of technologies, after withdrawal of the subsidies under the Lab to Land programme.

Field days (Kisan Melas) and Farmer's Camps are invariably conducted in the zone, based on the problems identified as well as the technology developed at various locations. Such melas have been organised by the Cropping Systems Research Centre, Karamana, Coconut Research Station, Balaramapuram and National Demonstration Scheme, Sadanandapuram and the Extension Wing of the College of Agriculture, Vellayani. The demonstrations, field days and farmer's camps and farmer's group discussions conducted by NDS, Sadanandapuram are given below:

Demonstrations

Rotation/Crop	Number	Location
1. Paddy-paddy-pulse	54	Puthur & Elampel
2. Paddy-paddy-sesamum	17	Karunagappally
3. Sesamum block demonstration	26	Karunagappally

Group discussions

Location	Number	No. of participants
Adinadu	12	195
Puthur	14	300
Elampel	18	285

Kisan Mela and Seminar

Six Melas were conducted at different locations in Quilon district.

Group discussions with farmers, method demonstrations and farmer interview, formed part of the field day programmes conducted by the Research Stations. The research activities of the Stations are highlighted to the selected progressive farmers of the concerned localities. The Scientists of the University formed part and parcel of the field day programmes in the zone. The experts from the Departments of Animal Husbandry, Fisheries and Rural Development also handle classes and suggest remedies to the farmer's problems in the sessions separately conducted during the field day. The staff of the College of Agriculture, Vellayani have also been associated with the student's activities of the National Service Scheme such as social forestry, farm clinic, pests and disease identification etc.

Transfer of technology

Technology development, technology transfer and technology adoption are the three facets of agricultural development. Success in the area of technology development and technology transfer largely depends on the competence of the personnel employed in the concerned system. It is essential to provide training on a continuing basis to the functionaries of the technology transfer. Thus, short inservice training programme organised for the VEWs in the zone on a continuing basis would enable them to function more efficiently. Several technologies evolved at the Regional Research Station, Southern Zone, Vellayani are in the process of dissemination to the farmers.

The College of Agriculture, Vellayani has identified the following technologies for transfer to the farmer beneficiaries at the adopted village of Palappore.

1. Introduction of recommended high yielding coconut seedlings and scientific management.

2. Homestead development by introducing horticultural crops.

3. Scientific and economic management of banana.

4. Pulse cultivation in homesteads.

5. Scientific cultivation of vegetables in the homesteads and rice fallows.

6. Scientific management of the existing horticultural crops in the homesteads - cultural practices including application of recommended dose of fertiliser.

7. Agricultural equipment and implements for selected agricultural labourers and marginal farmers for generating employment opportunities.

4.3.3. Seed multiplication and distribution programme

At present, the Agricultural University maintains only a breeder stock of the varieties of seeds released

Table 46. Seed multiplication Research Centres under the KAU

Crop	High Yielding Variety	Research Station
Paddy	PTB 35 (Annapoorna) PTB 36 (Rohini) PTB 37 (Aswathy) PTB 38 (Triveni) PTB 39 (Jyothi) PTB 40 (Sabari) PTB 41 (Bharathi) PTB 42 (Suvarna modan) PTB 43 (Swarna prabha) PTB 44 (Rasmi)	RARS, Pattambi
	Mo 4 (Bhadra) Mo 5 (Aasha) Mo 6 (Pavizhom) Mo 7 (Karthika)	RRS, Moncompu
	Kayamkulam 1 (Lakshmi) Kayamkulam 2 (Bhagya)	RRS, Kayamkulam
	Vytilla 1 Vytilla 2 Vytilla 3	RRS, Vytilla
Coconut	TxD, DxT TxGB, LOxGB	RARS, Pilicode
Pepper	Panniyoor-1	Pepper Research Station, Panniyur
Gingeley	Thilothama	Rice Research Station, Kayamkulam
	Soma Surya	College of Agriculture, Vellayani
Cashew	Anakayam 1	Cashew Research Station, Anakayam

by it. The seeds are multiplied by the Government Seed Farms under the Department of Agriculture, for distribution among the farmers. The National Seeds Corporation also undertakes distribution of certified seeds to farmers. Mini-kit programmes are arranged by the Department of Agriculture, in collaboration with the University, wherein seeds and other inputs are supplied to farmers. The HYV of the following crops have been evolved by the University as given in Table 46.

Institutions in the southern zone, under the Department of Agriculture, where seeds and planting materials are produced are given in Annexure CXIV.

4.3.3. National Demonstration

National Demonstration Scheme financed by ICAR has been in operation in the zone under the University, with Kottarakkara (Quilon district) as the Centre from 1.6.1983. The Scheme, on completion of its normal five year tenure in the district, will be shifted to Pathanamthitta district by 1988. Under this programme, the production potentiality and economic viability of new technologies to be transferred by the University, are put to practice on large scale, both individually and in groups of farmer's fields in Quilon and Kottarakkara taluks. The field demonstrations are supervised by the scientists themselves, so that the transfer of technology is possible in the minimum time gap. Field demonstration in farmer's fields at various locations in the district, applying various components of the production technology and other extension activities like Seminars, Field days, Group discussions, Film shows, publication of leaflets, broadcasting of radio talks etc.are some of the major functions of the Scheme. Details of demonstrations, kisan melas, seminars, group discussions and training programmes conducted have been briefed earlier. Two Krishi Dharsan Programmes, one at Adinadu and other at Puthur with 200 farmers in each, were also conducted and the farmers were taken to the ND plots and various technologies adopted were explained to them. Earlier, three film shows by M/s Indian Potash Limited, were arranged for the benefit of the farmers, one each at Vilakudy, Elampel and Puthur.

4.3.3.1. Frontline demonstration

Frontline demonstration has been conducted at Muttacaud under the Southern Zone, to transfer the technologies developed by the University to the farmer's fields. The most important of the technology transferred was as follows:

Frontline demonstration of Gingely Variety - Thilothama, in the summer rice fallows.

Twenty demonstration plots of 10 cents each, were used for the trial at Muttacaud and Kalliyoor adopted villages. The variety Thilothama was found to perform well as a third crop in summer rice fallows.

Frontline demonstration on companion cropping of short duration variety tapioca (Sree Prakash) with cowpea (Var. C-152) in the adopted village Kalliyoor is in progress.

4.3.3.2. Farm trials

The technologies with identified potentialities developed by the University are tested, both in the University campus as well as in the farmer's fields. As a regular practice, the resource personnel have been conducting experiments in the laboratory and under field conditions satisfying all the norms of the research methodology pertaining to the practice built in within the messages. Once the laboratory or field trials have given promising results, the technology is tested in farmers' field in different locations of the zone, under the joint responsibility of the University and DOA. Programmes on farm trial are discussed and finalised in zonal workshops before laying out. Such programmes can also be discussed in the Zonal Research Advisory Council meetings to verify the refinements in technologies developed in the Station, to suit the resource and risk situations of farmers. To enable farmers with limited resources to adopt atleast some of the components of recommended technologies to suit their financial capability, "Steps in technology" trials can be included in the farm trial programme as recommended in the National Seminar on T&V system held in New Delhi in December, 1986. The planning of these trials is the responsibility of the researchers of the University, while the implementation, identification of participating farmers and subsequent supervision, collection of data including identification of constraints in their adoption and study of field problems arising out of the steps in technology transfer, have to be looked after by the DOA personnel. The economic viability of the suggested technologies deserves due consideration while analysing the results of farm trials.

Adaptive trials

Multi-locational trials are carried out to check whether the new technology developed by the University or elsewhere, would suit the farmer's field condition in different locations or in different agro-ecological situations. When the results of such trials are promising and consistant, the new technology can be popularised in the zone. With the co-operation of the T&V personnel of the DOA and independently, the University has been conducting several such trials on identified technology. To cite an example, the performance of semi tall high yielding rice culture 25100 evolved at RARS, Pattambi was tested in four locations in the southern zone viz. Adoor, Kottarakkara, Kadackal and Karamana to find out whether it could replace the already popular variety - Cheradi in the zone. However, the findings of the trial indicated that Culture 25100 was not that much superior as to warrant recommendation to the Cheradi tract. In another adaptive trial, the performance of rice Culture 24-20 evolved by KAU as a short duration crop (70-75 days) for the Puncha season in flood prone areas in the zone was assessed using Annapoorna (presently popular short duration HY rice variety) as check. Harvest of rice Culture 24-20 could be completed before the flooding season expected in June, but the Culture was not found very superior when compared to Annapoorna.

4.3.4. Publication programme

Correspondence courses in the field of agriculture and rural home science, print media information on agricultural news (in daily newspapers, weeklies and monthly journals), exhibitions, agricultural films and the likewise are being handled by the scientists in the zone, with a view to enlighten the farming community on the new technologies developed by the University. To facilitate information co-ordination between the University and DOA staff, information support can be constituted at the regional level to develop and document recommended practice to the farmers. Action is being taken by the University to constitute regional level information support committees. The monthly agricultural publications such as "Kerala Karshakan" published by Farm Information Bureau, Government of Kerala and "Kalpadhenu" published by the University carry scientific articles on various agricultural aspects contributed by the scientists in the zone. The KAU News letter published by the Extension Wing of KAU, Mannuthy also, convey the highlights of research done in the zone. The monthly "Ksheerasandesam", a publication by the State Milk Marketing Federation carry articles on milk production programmes.

4.3.5. Radio/T.V. programmes

The scientists and the extension personnel in this zone have been frequently associated with the activities such as Radio broadcast on various aspects of crop improvement, crop management and crop protection, covering different crops in the zone, cropping pattern, pest surveillance, and also on topics relating to soil management, fertilizer efficiency, biofertilizers, soil conservation, post harvest technology, agricultural production and distribution aspects, marketing analysis etc. The messages are broadcast at the appropriate season of cultivation so as to provide maximum benefit to the farmers. Some of these programmes are covered by Trivandrum Centre of Doordarsan also.

4.4. Feed back

The concept of the NARP has been fully structured and streamlined under the Zonal Workshop system. Under this system, the extension personnel of the DOA feed the scientists with the field problems on a half yearly basis, which will be discussed, analysed and research areas framed out for the research programmes. Apart from this, additional areas for research are being identified within the framework of the T&V monthly workshop system, wherein seasonal, location-specific, crop and practice oriented problems are discussed. Incidentally, this monthly workshop system fully takes care of the stress conditions of the farming environment and monitor as well as surveillence programmes to meet the specific crop-weather-input situations reported by Agricultural Sub Divisions from time to time. As a follow up of the monthly Workshop, the resource personnel make frequent visits to Farm Trials, Adaptive Trials and the Demonstration Trials conducted in the zone with a diagnostic approach, as a support to the feed back system. Research programmes are essentially framed on a problem oriented and location specific basis. Such programmes have a great relevence to the field visits and discussions made with the farmers by the resource personnel. Under the NARP programme, reports of various nature and kind, like monthly report, quarterly report, six monthly report, seasonal summary report, annual report etc. are prepared. The project bank maintained at the University level is also being considered while selecting and formulating research projects.

4.5. Strategy for strengthening research extension linkages

Phase II of the National Agricultural Research Project identifies research programmes on the areas of Agricultural development, like Vegetables (sweet potato, bhindi, amaranthus, cucurbits, cowpea), Water Management and Drainage and Recycling at Vellayani and Horticulture and Agro-Forestry at Kottarakkara. Since the information pertaining to these areas are inadequate in the report of the Basic Socio Economic Survey already conducted during Phase I of the Project, an additional survey in support to the Basic Survey has to be undertaken to identify the constraints. The additional survey will involve collection of more detailed information on the projects likely to be formulated under the specified areas. Priorities will be fixed for the NARP Project based on the preliminary work done during the Phase I as well as the requirement of the field personnel in agriculture in different localities of the zone. Simultaneously research gaps will be identified on the research done during Phase I, which will be matched and built in within the new projects taken in the new area. The additional programmes suggested for implementation under Phase II of the NARP are outlined in Chapter V. For the new fields of research, removing the constraint will also be taken up in addition, within the framework of achieving high productivity in the research areas, like water management and command area research projects, involving groups of farmers on cluster basis. Such potential projects will be identified on location specific basis, with the help of the DOA and Ground water Department. Research on watershed management will also be taken up on priority.

CHAPTER V

RESEARCH NEEDS, RESEARCH PRIORITIES AND RESEARCH STRATEGIES

5.1 Research gaps / needs

Until the advent of the National Agricultural Researh Project (NARP), the Agricultural University was concentrating on agricultural research without strong base at regional levels. The NARP was launched in 1980 with the objective of permanently strengthening the research capabilities of the University at the regional level, to conduct location-specific, production oriented research needed for the different agro-climatic zones in the State, to solve the field problems of farmers with multi-disciplinary research approach and to establish strong linkage between research and extension workers. For achieving this goal, some of the major research stations were elevated to the status of Regional Agricultural Research Stations, providing sufficient infrastructure facilities by way of building, staff, equipment, farm machinery, farm land development etc., thereby stressing the regional concept and production-oriented research in solving the field problems. Accordingly, the Regional Research Station of the Southern Zone of the State was started at the premises of the College of Agriculture, Vellayani on 30.11.1981. After the initial five years of funding by the ICAR and the IDA, the project now continues under funding by the KAU. The research departments in the College were strengthened and a Central Instrumentation Laboratory with sophisticated, imported items of equipment was set up during this period. The Regional Research Station working in collaboration with the different departments of the College of Agriculture has the lead function of research on tapioca (cassava) based farming system, while the Special Station established at Sadanandapuram, Kottarakkara, under the control of the Regional Station, Vellayani, has the lead function of research on Homestead Farming System. The testing and verification functions for the Vellayani and Kottarakkara Centres included research on homestead, rice-based, tapioca-based and coconut-based farming systems. Priority in research was focussed on food grains, pulses and oil seeds grown under rainfed conditions and irrigated crops of the homesteads, for developing appropriate cropping patterns and viable mixed farming systems. Substantial work was carried out during Phase I, on the genetic improvement of vegetable crops for the homesteads and for rice fallows, varietal improvement of oil seeds and pulses suited to summer rice fallows and uplands in the zone, identification of companion crops for tapioca, identification of suitable intercrops for the partially shaded conditions in coconut gardens, crop protection of vegetables, coconut, rice, banana and pepper, formulation of nutritional schedules for crops, and studies on crop suitability. Research efforts have to be continued for evolving newer technologies relating to crop improvement, crop management and crop protection, fixing priorities. Major areas of research needed in the zone are given below, crop-wise and discipline-wise.

5.1.1 Rice

Rice is the staple food of the entire population in the zone. However, the area under rice records a declining trend due to the general feeling among the farmers that rice cultivation is not remunerative. This feeling has tempted many farmers to reclaim wet lands for more remunerative crops such as coconut, rubber etc.

Most of the popular HYV are white rice varieties with limited straw. Farmers in the southern districts of the zone have preference for growing red rice varieties with higher straw yield, particularly because straw is also a costly item. In view of this, farmers cultivate local, tall varieties such as "Cheradi", which satisfies their preference, even though grain yield is less. Research efforts are needed to replace the local "Cheradi" by suitable HYV acceptable to the farmers.

Though rice is grown mainly in the wet lands in the zone, upland paddy is also attempted by the farmers in the Quilon district in limited areas. Suitable varieties for dry cultivation have to be identified. Rice variety suited for cultivation as intercrop in coconut gardens has also to be evolved.

Studies on herbicides for dry sown first crop and transplanted second crop of paddy are required along with the development of a herbicide management pattern for rice-based cropping system. Human labour in removing "Kora" and "Kavada" weeds in dry sown paddy fields in Quilon district is expensive.

In view of the high cost of cultivation of paddy, studies have to be undertaken to find out whether organic manures can be combined with chemical fertilizers. Low cost technology, especially in the management aspects of paddy, are to be evolved.

Problems in rice cultivation arising out of uncertain and erraneous rainfall pattern need investigation. First crop of dry sown paddy suffers from drought in early stages and floods in the mid growth stages, while the second crop is affected by drought in its later stages. Performance of drought resistant, short duration rice varieties have to be tested for their adaptability. Research is needed to identify suitable rice varieties capable of withstanding temporary floods in lowlands.

Technology has to be evolved for rice manuring in locations where saline intrusion from sea poses problems..

It is widely noticed that the yield of second crop paddy is lower compared to that from first crop. The association between climatological parameters, irrigation management, pest and disease problems during the second crop may play major roles in deciding the yield. However, detailed investigation on this aspect is needed.

Suitable technology/technologies, including manurial recommendation has to be standardised for furthering the 'Koottumundakan' system of rice cultivation popular in Attingal, Adoor and Kottarakkara Agricultural Sub Divisions, wherein farmers resort to mixed sowing of two paddy varieties of different durations. Suitable variety mixes have to be evolved. The system is, however, slowly becoming extinct due to less economic returns.

Lack of suitable recommendations for crop combinations and crop rotations in the rice-based farming system acceptable to the farmers necessitates research on these lines.

Paddy fields remain fallow in many locations after harvest of the second crop of paddy. Pulses such as cowpea, kolinchi and oil seeds are rarely grown in these fallows during summer using the residual soil moisture. Evolution of short duration pulse varieties suitable for summer rice fallows is needed.

Vegetable crops such as vegetable cowpea, bhindi, bitter gourd, snake gourd, pumpkin, ash gourd, amaranthus (red and green) and sweet potato are grown in rice fallows provided irrigation is possible. Varieties used are mostly local and yields are not very encouraging. Drought tolerant high yielding or improved varieties of vegetables suitable for fallow cropping with low cost manurial schedules and plant protection recommendations have to be evolved by research.

High soil acidity leading to problems of iron and aluminium toxicity under conditions of waterlogging and restricted drainage which limit crop production needs investigation. Suitable varieties showing tolerance to iron toxicity have to be screened.

Use of systemic insecticides such as carbofuran in vegetable cultivation by farmers, aiming at obtaining highest market value, has to be discouraged. Research is needed on the waiting period of insecticides in relation to different crops. Insecticide residues in the harvested crops have also to be evaluated.

The innovative practices by the farmers in the zone have to be examined and on-farm trials taken up to compare the relevance / validity of such practices against those recommended.

Endemic occurrence of sheath blight/sheath rot of paddy in Adoor, Kottarakkara, Quilon and Neyyatinkara Sub Divisions necessitates research on the evolution of disease resistant varieties. High yielding varieties having resistance to major pests such as BPH, stem borer etc. have to be identified and popularised. Compatibility chart of presently available fungicides and insecticides has to be reviewed in view of the several brands of chemicals appearing in the market.

5.1.2. Coconut

This is the most extensively cultivated crop in the zone. Constraints attributable to the poor performance of the crop include: low productivity of the palms, large proportion of nonbearing palms, abnormal button shedding, inferior genetic base, poor fertiliser and water management, incidence of pests and diseases and lack of proper product diversification and marketing.

The yield of coconut can be increased by cultivation of hybrid and improved varieties. However, the non-availability of these varieties in sufficient numbers needed for the farmers is a major constraint in the zone. Planting materials of such varieties have to be produced in abundance for popularisation.

The innovative practice of applying common salt alone or mixed with ash to the basin and/or to the crown of the palm by several farmers aiming at higher yield, has to be tested and further refinements are to be made.

Abnormal button shedding and sometimes drying up of inflorescence is a constraint in coconut production. Several reasons can be attributed and the solution of this problem is to be attempted by multi-disciplinary research.

The inter-spaces between coconut palms can be utilised for growing pulses and oil seeds, in addition to tapioca, banana and cocoa. Suitable shade tolerant varieties of pulses, oil seeds, rice and fodder have to be evolved and popularised.

Attack of coconuts by coreid bug affects nut production in the zone, particularly in the southern districts. Control measures have been worked out and alternate method(s) of application is under investigation. No biological control method is available.

Red palm weevil attack on coconut trees is noticed in many parts of the zone. Control measures are needed.

Though recommendations are available for the control of pests of coconuts, diseases such as root (wilt), bud rot, leaf rot, quick yellow decline, mid-whorl yellowing and stem bleeding, all leading to faster decline of the palm, need detailed investigation and control measures. Combined disease incidence often make diagnosis more difficult. Most of these problems are, however, being investigated by CPCRI and KAU Scientists. No technology is yet available to control root (wilt) and mid-whorl yellowing which are spreading to other trees. Identification of a resistant cultivar if located, can be a practical solution to the problem.

Post-harvest operations are restricted, only to the production of oil and fibre from husk. In addition to oil extraction, the kernel can also be processed into various food products such as coconut cream or cream powder which can be conserved by available technology evolved at Regional Research Laboratory (CSIR), Trivandrum.

Research efforts are needed to achieve the complete utilisation of coconut products in the most remunerative manner.

5.1.3. Tapioca

The main planting seasons of tapioca are April-May and September-October, to obtain the benefits from both the monsoons.

Farmers use mostly local varieties and improved M4. However, HYV evolved by CTCRI such as Sree Sahya, Sree Vaisakh, Sree Prakash etc. have to be popularised in farmer's fields. Pure line selections have to be carried out in the local varieties such as Manchapattu Vella, Panni Vella, Adukkumuttan, Mankozhanthan, Karukannan etc.

Study of the mycorrhizal association in cassava roots to exploit their beneficial effect is needed.

Management schedule for the September - October planting has to be worked out.

Post-harvest storage of cassava tubers is another field of study where immediate results are needed.

Tapioca is also grown in paddy fields after the harvest of first crop paddy. Lack of availability of suitable short duration tapioca is a constraint. A variety of six months duration has to be evolved and popularised for the wetland situations.

Tapioca is grown as pure crop and as intercrop in coconut plantation. In the latter case, the yield is not always very encouraging. Suitable recommendations for this intercrop is needed by many farmers.

Pulse varieties such as cowpea, horsegram etc. or oil seeds such as sesamum, ground nut etc. can be intercropped with tapioca. Suitable varieties of these seasonals to serve as companion crop to tapioca and fertilizer schedule for this cropping system are to be evolved.

Cassava starch has utility in Sago industry and as an animal feed, apart from its nutritive value as human food. Other industrial applications have to be developed. The use of tapioca starch as raw material for alcohol production cannot be under-estimated. The CTCRI has obtained a patent to produce alcohol. One ton of tapioca starch can give 110 - 120 litres of alcohol. Technology on this aspect has to be further refined.

5.1.4. Banana

The major cultivated varieties of banana include Palayankodan, Njalipoovan, Poovan, Robusta, Nendran and Red Banana.

Nendran and Red Banana are high value crops, widely grown as pure crop in drylands and used for crop sequences in wetland paddy fields, both as rainfed as well as irrigated crops. Fertilizer and other management recommendations are to be formulated through research for Nendran and Red Banana, grown under rainfed and irrigated conditions.

Research is needed on the effect of split application of fertilizers on yield. The necessity of fertilizer application to Nendran crop after the fourth month of planting is to be ascertained.

Fertilizer recommendation for the ratoon crop of banana has to be worked out.

Though the insects and pests can be satisfactorily controlled, nematode attack of the rhizome causes problems which needs detailed study.

Bunchy top disease of banana is still a very serious problem, although appreciable reduction in the spread of the diseases is possible by controlling the vector. Prevention of this dreaded disease is possible, only by the use of disease-free suckers for planting. Technology is, however, needed for the early identification of disease-free suckers.

Sigatoka and kokkan diseases in banana, seen in different parts of Quilon district, also need control measures.

5.1.5. Pepper

Pepper is grown extensively in the midland and highland subzones.

Cultivators traditionally grow local varieties such as Karimunda, Narayakodi, Kumbakodi, Chumala, Kuthiravally, Poonjarmunda, Karuvilanchi, Perumkodi etc. The only HYV pepper available for distribution to the needed farmers is Panniyoor 1. Research has to be focussed on the evolution of more HYV, resistant to pests and diseases, particularly wilt.

The feasibility of using coconut tree as a standard for pepper has to be confirmed and manuring schedule refixed through farm trials.

Quick wilt and slow wilt of pepper are two serious diseases reported in the zone. Little leaf is also reported as another pathological situation. Research is needed to check these diseases.

"Pollu" beetle attack is another constraint in the production of this crop. Control measures have to be evolved.

Root knot nematodes and burrowing nematodes found in homesteads need special study.

5.1.6. Vegetables

Vegetables are grown in the traditional lowland rice fields in rotation with rice or in the uplands as a component of the polycropping system, in homesteads.

Vegetable cowpea, snake gourd, bitter gourd, bhindi, ash gourd, brinjal, pumpkin and amaranthus (green and red) are the popular vegetables of the zone. The minimum nutritional requirement is 90g / day / head. Vegetable consumption, excluding tuber crops, is only 23 g / day / head, as against the recommended moderate daily requirement of 150 g /day /adult and ICMR recommendation of 258 g / day / adult. A working plan has to be evolved to bridge the gap between the present day consumption and requirement and also to consider the requirement for another five years.

Farmers cultivate only local varieties of vegetables. Research work has to be concentrated in evolving pest and disease resistant high yielding varieties.

Seed processing technology, dormancy and viability of seeds of common vegetables have to be studied. Dormancy period and drying requirements of vegetable seeds have to be studied and conveyed to vegetable farmers.

Many farmers in this zone have developed their own technology for raising vegetable crops. Research is needed to study the farmer's practice and to make suitable refinements.

Yellow vein mosaic disease and root knot nematode attack in bhindi, little leaf in chillies, fruit fly attack of snake gourd and bitter gourd (often assuming destructive levels) are to be controlled by research efforts.

Major share of the family expenditure goes for the purchase of vegetables (sold in the market) which have often contaminations of pesticide residues due to unscientific and excessive plant protection measures followed by some vegetable cultivators. Research is needed to investigate the long term effects of hazardous insecticides and pesticides.

5.1.7. Rubber

This remunerative, rainfed crop occupies an area of 1.66 lakhs ha in the zone, mostly concentrated in the

Pathanamthitta and Kottayam districts. The problems relating to rubber are mainly handled by Rubber Research Institute of India, Kottayam.

The crop has made steady and impressive progress in the zone during the last four decades. Vast potential exists for increased production through productivity improvement. The average yield of rubber in the Estate sector is 1,110 kg/ha and in big plantations 1,800-2,000 kg/ha. However, the productivity in the small grower sector is only 900 kg/ha, in spite of providing various incentives of subsidy, loan, budded planting materials of high yielding varieties, clonal seedlings and remunerative price by the Rubber Board. The economic life of rubber tree is nearly 30 years, after which it has to be slaughter tapped and removed for replanting. Marginal and small farmers are generally reluctant to do this, on grounds of non-receipt of any income for initial five to six years of replanting. Effect of irrigation on rubber during summer months has to be investigated. Research is also needed on the diversification of rubber products. Annuals or seasonals suitable as intercrops in the early stages of growth of rubber have to be identified.

5.1.8. Ginger / turmeric

Research is needed to evolve cultures possessing high yielding character, with low fibre and high oleoresin content.

Soft rot and thread blight in ginger affects its productivity in the zone, which need control measures.

Studies are needed on the seed rate, planting time, spraying schedule, post harvest technology, intercropping etc. suited to different agro-climatic situations in the zone.

Most of the turmeric growers fall under small and marginal grower sector. Non-availability of improved varieties to suit different agro-climatic situations, incidence of pests, diseases and drought (in rainfed areas), poor adoption of scientific cultivation and unscientific post-harvest operations are the major constraints in the production of turmeric. Research efforts are needed to overcome these constraints.

5.1.9. Cashew

In spite of cashew cultivation in 21,136 ha in the zone, mostly in and around Kottarakkara, the crop suffers from pest infestation and an overall neglect in scientific management. The productivity of this plantation crop is declining. Following the decline in indigenous availability of raw nuts, substantial quantity of imported nuts is being processed in the several cashew factories functioning in the zone. Cashew varieties of high productivity have to be identified and techniques standardised for the production of high yielding clonal planting materials. However, generation of clones to the extent required by farmers still remains to be attempted.

Systematic survey in cashew growing tracts to identify elite types is needed. These types can later be used for multiplication programmes.

Proper utilisation of cashew apple now being wasted, can generate 50 per cent more income to the farmer. The technology developed elsewhere has not reached the farming community. Maximum efforts should, therefore, be taken for the effective and economical industrial utilisation of cashew apple for production of feni, alcohol, jam, jelly, beverages etc.

Cashew shell liquid is a bye product of processed nuts. Technology has to be developed for the proper utilisation of this bye product.

5.1.10. Arecanut

The area under arecanut in the zone is 11,759 ha. The average nut yield in the zone is 500 kg/ha, as against the State average yield of 700 kg/ha and the national average of 1,200 kg/ha. Productivity can be improved by adopting proper management practices including irrigation. Yellow leaf disease known locally as "Kattuveezhcha" inflicts damage to arecanut palms, reducing the yield of nuts. Effective control measures are yet to be made available through research efforts. Etiology has to be probed into and technology has to be evolved to effectively control the disease. At present, research has reached only upto the level of suspecting the disease as due to MLO. Fruit rot (Mahali) is another major disease, for which control measures available are not adopted by majority of the arecanut growers, with the result that sizeable share of the crop in the zone is lost annually.

5.1.11. Cropping systems

In the wetlands, paddy-banana is the crop rotation followed in some locations wherein banana is cropped under irrigated as well as rainfed conditions.

Separate fertilizer schedules are to be formulated for irrigated and rainfed banana.

Red Banana is a prestigeous crop of the southern zone, cultivated mostly in Neyyattinkara and Nedumangad taluks in wetlands as well as in garden lands. Separate manurial schedules are needed for this crop of high market value.

In the paddy-tapioca crop rotation in wetlands, suitable short duration (6 months), high yielding tapioca variety is needed.

Cocoa is cultivated as an intercrop in several coconut gardens in the zone. Squirrel and rat attack on cocoa pods have to be controlled by viable methods.

Homestead farming system is to be studied under different soil fertility status for evaluating the suitability of different crops for such a polycrop system.

Research is needed to study the rooting pattern and crop competition for nutrients, water and sunlight in the homesteads.

No research data are available on the compatibility of different crop combinations and their effects on soil fertility, moisture conservation, weed suppression and pests and disease control. Nematodes cause damage to banana and vegetables in homesteads. Effective and economically viable solutions have to be developed.

Most suitable polycrop combination has to be identified for the marginal, medium sized homesteads enabling maximum exploitation of solar, water and soil resources, under irrigated and rainfed conditions.

At present, fertilizer recommendation is available for individual crops only. Manurial schedules for the poly-cropping system as a whole is needed.

5.1.12. Water management

The only irrigation project available in the zone is the Neyyar Project. Water is not available in the canals during the summer months. Hence irrigation is a constraint. Moreover, the projects are designed primarily to benefit the low lying paddy fields and hence garden lands situated at higher elevations receive only little attention. Even with respect to paddy, the contribution of irrigation schemes has been mainly to help the stabilisation of the crop through supplementing the existing water sources. Hence the possibility of exploring the immense ground water resources in the zone have to be continued.

Water requirement of major cultivated crops have to be worked out, so that judicious use of water is possible.

Drip irrigation techniques have to be standardised and popularised among the farmers.

During the recent years, monsoons are erratic and drought situations recur in the zone. There is urgent need to conduct research on short and long term measures to combat the drought situation. Water harvesting and management are important since sizeable area under cultivation is rainfed.

Development of economic and efficient water management systems for tree crops, orientation of cropping system to match the best use of rainfall and identification of crops according to water availabililty and water need in the different locations in the zone are the research priorities needed.

5.1.13. Farm implements

In the zone, there is scope for large scale farm mechanisation. The agricultural implements and tools now in use have low efficiency. Improvements have to be made for increasing their efficiency.

Rice

Most of the marginal and small farmers perform agricultural operations using the traditional tools and farm implements. They follow the age old practice of ploughing the field and puddling the soil with the aid of country ploughs driven by bullocks or buffaloes. Sowing or broadcasting of seeds and transplanting of seedlings, harvesting, threshing and winnowing are done manually. This is labour involving, less efficient, time consuming and costly. The available refined tools and implements have to be tested. The Research Testing and Training Centre, Vellayani, functioning under the Department of Agriculture has developed improved agricultural implements such as mould board plough, wetland puddler, paddy weeder, pedal operated thresher etc. Seed-cum-fertiliser drills, simple enough to be repaired by local village artisans, have to be popularised. Rice transplanters used in levelled land will enable uniform and correct depth and spacing as well as number of seedlings per hill. In spite of fragmentation of land holdings, use of tractors and power tillers needs encouragement. KUBOTA power tiller is produced by Kerala Agro-machinery Corporation Ltd, a Government undertaking.

Baby combine harvesters suitable for even the smallest plots have to be developed and popularised. It can cut, convey, thresh, winnow and collect the paddy in the bag attached to it, with no loss of paddy. In its absence, power threshers operated by small electric motors or diesel engines can be tested and popularised to serve as labour saving device. There is also need to popularise low cost winnowers to replace the wind winnowing practice now followed. Seed driers, not known to many farmers, have to be developed and tested.

In view of the facility of bank loan and Government subsidy, many farmers in the zone own pumpsets. However, technical advice to the farmers in the selection of suitable pumpsets is lacking.

Coconut

Being a tall tree, climbing is the only method possible for harvesting the nuts. Professional skilled climbers are gradually giving up this tradition. A coconut climbing device, recently fabricated, appears to be suitable and this has to be tested for its feasibility. Red palm weevil attack is noticed in many parts of the zone and farmers are unable to detect the weevil attack in advance. The CPCRI, Kayamkulam has recently fabricated an elctronic device for early detection of the weevil. This has to be tested for its feasibility.

Manual dehusking of the coconuts, particularly when required to be done on a large scale, becomes strenuous and time consuming. Mechanical dehuskers developed by the CPCRI have to be tested. Drying of copra becomes difficult during the rainy seasons. Very often the residual moisture in the copra leads to the formation of aflatoxins. Dryers will be of great help to the copra processors in the zone.

Arecanut

Dehusking of arecanuts, now done manually, has to be replaced by suitable mechanical dehusking device.

5.1.14. Post-harvest technology and processing

Research work has to be intensified to develop suitable low cost technology for the preservation and processing of fruits, such as jack, mango, pineapple etc., vegetables, fish and livestock products.

5.1.15 Animal management

Plan schemes on animal management always aim at augmenting production and productivity by improving the genetic capability, management practices and disease control of livestock and poultry.

Cattle rearing is a complimentary enterprise in many suburban and rural homesteads. Suitable technology has to be developed for the integrated poly crop-livestock, crop-livestock-feed/fodder or crop-livestock-fish farming, where the waste from one component can be recycled to serve as food for the other.

Poultry management is a remunerative enterprise in majority of the rural homesteads. Attempts to replace local breeds of poultry by improved and high yielding varieties suited for the zone have to be continued.

Research priorities include development of economic and efficient management systems for livestock and poultry, and increasing the fodder resources in the zone.

5.1.16. Soil management

Hard laterites in some locations of the midland belt and sandy loam soils in the coastal zone pose problems, in addition to soil erosion noticed in many locations of the highland subzone.

Saline intrusion in some paddy fields in the Quilon and Trivandrum districts points to the need to identify saline resistant varieties suited to the situation or to adopt suitable reclamation procedures.

High soil acidity is a problem to be tackled by liming. Iron toxicity is a problem in ill-drained paddy fields and the methods to suppress iron toxicity to rice have to be investigated.

Soil erosion in highland subzone has aggravated by faulty land management practices and unscientific land use. Soil conservation measures, now adopted by DOA, is restricted only to contour bunding. Gully plugging, terracing, using more grass, strip cropping etc. are also feasible propositions which are to be tested under local conditions.

5.1.17 Agricultural Extension

Extension methods have to be strengthened at the village level, to educate the farmers on the merits of newer technologies generated from time to time. Several farmers are unaware of the latest technologies in scientific farming.

5.1.18 Agro-eonomics

A detailed scio-economic survey of the households in the southern zone has recently been concluded, wherein the critical constraints in crop production and economics of cultivation of major crops have been analysed. The pattern of adoption of the various technologies by the farmers in the zone has also been studied in another survey. The result of this survey are presented in Vol.II. Economics of integrated farming system, reasons for the slow growth in crop production and productivity have also been studied. The socio-economic reasons why farmers do not use some of the useful farm implements already developed and tested, have to be studied. Research is also needed on the constraints experienced by the farmers in the marketing of farm produce.

5.2 Research priorities

The major thrust areas which demand detailed investigation are given below:

5.2.1 Homestead farming system

Attempts to increase the production and productivity in the homesteads of different sizes and to increase the net return per unit area with the ultimate aim of improvement of the living standards of small and marginal farmers, have to be intensified. Research should be oriented towards developing low cost technology.

The following thrust areas have been identified under this farming system:

Soil productivity of the homesteads of the southern zone and its improvement	RRS, Vellayani, and Special Stn., Kottarakkara
Evolution of high yielding varieties of component crops suited to the homesteads	RRS, Vellayani, AICRP (Forage), and Special Stn., Kottarakkara
Standardisation of the agrotechniques for the management of the homesteads.	RRS, Vellayani, AICRP (Forage), Vellayani and Special Station Kottarakkara
Assessment of the crop loss and management of the pests/diseases under the homestead farming system in the zone	RRS, Vellayani, AICRP(Nematodes), and Special Stn., Kottarakkara
Augmenting the unit level income of the homestead farmers	RRS, Vellayani, DST Project (Mushrooms), KSCST Project (Pleurotus), Special Station, Kottarakkara
Economic analysis of the existing homestead models and working out models (combinations, agro-techniques, etc.) with increased efficiency	Special Station, Kottarakkara

5.2.2 Other farming systems

Thrust areas identified for the other farming systems in the zone are:

Tapioca-based farming system

Evolution of short duration (six months duration) cassava varieties	CTCRI, Trivandrum & RRS, Vellayani

Evolution of cassava varieties suited to partially shaded conditions	CTCRI, Trivandrum & RRS, Vellayani
Evolution of high yielding varieties of component crops in the cassava-based farming system	RRS, Vellayani & AICRP (Forage), Vellayani
Standardisation of the agro-techniques for rice-tapioca system	RRS, Vellayani & Special Station, Kottarakkara
Standardisation of agro-techniques for cassava grown under partially shaded conditions	RRS, Vellayani and CRS, Balaramapuram
Improvement of agro-techniques for the cassava-based farming system	RRS, Vellayani & Special Station, Kottarakkara
Evolution of low cost technology for cassava-based farming system	RRS, Vellayani
Assessment of crop loss and management of the pests/diseases of the cassava-based farming system	RRS, Vellayani, AICRP (Nematodes) and Special Stn., Kottarakkara

<u>Coconut-based farming system</u>

Evolution of crops (vegetables, tubers etc.) suited to the partial shade conditions of coconut gardens	RRS, Vellayani
Standardisation of the agro-techniques for the component crops in the coconut-based farming system	RRS, Vellayani and Spl.Stn., Kottarakkara
Forage improvement and standardisation of the agro-techniques	AICRP (Forage), Vellayani
Development of viable coconut-based multi-tier cropping models	For redsoil areas, Coconut Res.Stn., Balaramapuram. For laterite areas, Spl. Stn., Kottarakkara

Assessment of the crop loss and manageement of the pests/diseases of the component crops in the coconut-based farming system	RRS, Vellayani, AICRP (Nematodes), and Special Stn., Kottarakkara
Coreid bug incidence and its control	RRS, Vellayani
Rice-based farming system	
Fertility status of the rice soils	RRS, Vellayani
Improvement of component crops in the rice-based farming system	RRS, Vellayani
Standardisation of the agro-techniques for component crops in the rice-based farming system of the region	RRS, Vellayani, AICRP (Oil Seeds) CSRC., Karamana
Evolution of low cost technology for rice-based farming system	RRS, Vellayani & CSRC., Karamana
Problems of rice soils of the zone and their solution	RRS, Vellayani
Assessment of crop loss and management of pests/diseases of component crops in rice-based farming system	RRS, Vellayani, AICRP (Nematodes), ICAR ad hoc sch. (Rice cyst nem.) & CSRC, Karamana
Improvement of oil seeds (ground nut & sesamum) and standardisation of their agro-techniques	AICRP (Oilseeds), Vellayani
Analysis of the causes of low yield of HYV rice during Mundakan season and evolving solutions	RARS, Pattambi, RRS, Vellayani and Spl. Stn., Kottarakkara
Improvement of Cheradi and standardisation of agro-techniques for the same	Special Stn., Kottarakkara & RRS., Vellayani
Standardisation of the technology for increasing the yield of rice under "Koottumundakan" system of rice cultivation	Special Station, Kottarakkara

Banana-based farming system

Standardisation of agro-techniques for Red Banana (rainfed & irrigated), Nendran (in wetlands) and other banana varieties (in partial shade)	RRS, Vellayani
Standardisation of agro-techniques for the component crops in the banana-based farming system	RRS, Vellayani and Spl. Stn., Kottarakkara
Assessment of the crop loss and management of the pests/diseases of the component crops in the banana-based farming system	RRS, Vellayani, AICRP (Nematodes) & Spl. Station, Kottarakkara

5.2.3. Vegetable improvement

Evolution of vegetable varieties (suited for open, partial shade and summer rice fallows)	RRS, Vellayani
Standardisation of the agro-techniques for vegetable cultivation in open, in partial shade and in the summer rice fallows	RRS, Vellayani & Special Station, Kottarakkara
Seed production technology (including storage and viability aspects) of vegetables important to the zone	RRS, Vellayani & Special Station, Kottarakkara

5.2.4. Land use planning

Land capability and crop suitability studies	RRS, Vellayani

5.2.5. Drought management

Assessment of the impact of drought on annual and perennial crops and working out methods to lessen the impact, contingency plans etc.	RRS, Vellayani, Special Station (Kottarakkara), Coconut Res.Stn., Balaramapuram & CSRC., Karamana

5.2.6. Biotechnology: Rapid multiplication of tree crops

Standardisation of tissue/apical meristem culture techniques of horticultural crops of Kerala	Cashew and nutmeg (PL 480 project), others by RRS, Vellayani

5.2.7. Agricultural chemicals & environmental pollution

Pesticide residue studies	AICRP (Pesticide residue), Vellayani

5.2.8. Agrostology

Agrostology with special reference to enhancement of fodder production, fertility management and soil conservation.	AICRP (Forage), Vellayani