CHAPTER 6

AGRICULTURAL LAND USE AND ITS SPATIO-TEMPORAL VARIATIONS IN RELATION TO CLIMATIC FLUCTUATIONS

Kerala, like many other states of the country, has an agrarian economy. Agriculture and allied sectors contribute about 37% of the State's total income and employ about 50% of the work force. Nearly 58% of the total geographical area of the State is under cultivation.

Agricultural landuse is the way in which the land is utilised for the cultivation of crops and other agricultural activities and is reflected in the cropping pattern of the region. Cropping pattern is the allocation of the total cropped area among the various crops grown by farmers. This depends on many factors such as soil types, topography, climate, cultural practices and government policies of the particular region. Changes in agricultural landuse of a region occur due to the changes in these factors. The changes in soil types and topography usually occur over a very long period of time. Hence, the other factors have more influence on the agricultural landuse changes. Among these, the climate is the most dynamic element and plays a dominant role the short-term changes of landuse.

Of the various climatic elements the two dominant controls of agriculture are temperature and rainfall. For the successful agriculture both these parameters are of utmost importance. When sufficient thermal and moisture inputs (solar radiation and precipitation) are avilable agricultural prodution would be at potential levels. In areas where one of these elements is in short

supply, that element would be the critical factor in determining agricultural yields. In higher altitudes and latitudes, therefore, temperature becomes the limiting factor. Whereas in Tropical regions more than sufficient heat input is available, prcipitation avilability becomes the limiting factor. In the present study, therefore, rainfall fluctuations are related to agricultural area, production and yields, in an attempt to study their inter-relationships.

The first Section of this Chapter presents a detailed description about the cropping pattern of the State and its spatio-temporal variations. The second Section describes the influence of short-term fluctuations of rainfall on the agricultural landuse of the State.

6.1. AGRICULTURAL LANDUSE OF KERALA.

The favourable climate and topographic conditions of the State allow a wide variety of crops to be cultivated. Agriculture in Kerala is unique with respect to its homestead farming, which is practised in all parts of the State. A homestead consists of the area surrounding the house. A major feature of this system of farming is the cultivation of all varieties of crops which include coconut, arecanut, fruits and vegetables, and some livestock. "More than 80 percent of the produce generated in the homestead is consumed in the house itself and the remaining 20 percent provide subsidiary income to the house owner".(NARP,1989).

The crops cultivated in the State include cereals such as paddy, jowar and ragi, pulses, sugar crops, spices and condiments such as pepper, ginger, chilli, clove, cardamom, turmeric and arecanut. Also cultivated are fruits and vegetables

like banana, pineapple, jack, mango and cashew. The major non-food crops include coconut, coffee, tea, rubber and cocoa.

It is evident from Table 6.1 that the State has experienced a shift in cropping pattern in favour of non-food crops during the three decades since 1961. Food crops accounted for 66.2%of the total cropped area of the State in 1961,which declined to 49.5% in 1990, a decrease of 17.1%. At the same time the area under non-food crops registered a corresponding increase (17.1%).

YEAR	FOOD CROPS	CHANGE	NON-FOOD CROPS	CHANGE	TOTAL CROPPED AREA	CHANGE
1961	1565 (66.2)		784 (33.8)		2349	
		+28.7		-4.41		+94.39
1991	1496 (49.5)		1529 (50.5)		3020	

AREA IN '000 HECTARES. FIGURES IN PARENTHESIS SHOW PERCENTAGE AREA

Table 6.1.SHIFT IN CROPPING PATTERN IN KERALA

When considering the absolute area it is obvious that there is a phenomenal 94.4% increase in the area under non-food crops and only a marginal decrease of 4.41% under food crops. The increase of total cropped area during this period was 28.6%. This shows that Kerala is one among the few States where farmers respond quickly to price incentives as new crops can be planted to take advantage of the changing prices.

6.1.1. CROP COMBINATIONS

"The geographical investigation of agriculture which purports to select various crops or agricultural elements to be studied collectively in an area, may be termed as combination

analysis or combinational analysis". (Singh and Dhillon, 1994). The crop combination of a region reflects its agro-ecological conditions. Many studies have been done in Kerala using different techniques of combination analysis. Weaver's methodology was used by the Centre for Earth Science Studies in its 'Resource Atlas of Kerala'.(1984). It gives various combinations in different districts which range from five to ten crops. Saravanan(1994) used both Weaver's and Doi's methods to evaluate the crop combination of the State.

In this study, the technique developed by Coppock(1964) has been used for the analysis of crop combination. The detailed methodology and the advantage of this technique over others is described in Chapter 2. The derived combination vary from two crops in Alappuzha, Thrissur and Kozhikode districts to five crops in Idukki district. (Fig.6.1). Coconut forms the first ranking crop in nine districts, while rice is the first ranking crop only in Palakkad district. Idukki has pepper as the first ranking crop, followed by rubber, cardamom, tea and coffee. This indicates that the district has predominantly plantation crops. Another noticeable combination is in the Palakkad district where groundnut forms one of the major crops, which occupies the fourth position.

In the northern districts of Kannur and Kasargod, cashew forms a predominant crop occupying the second position. Malappuram district also has cashew, as the fourth ranking crop.

A significant proportion of coffee is grown in Wayanad district where it is the first ranking crop. Tapioca appears in the combination only in the southern districts of Pathanamthitta, Kollam and Thiruvananthapuram.

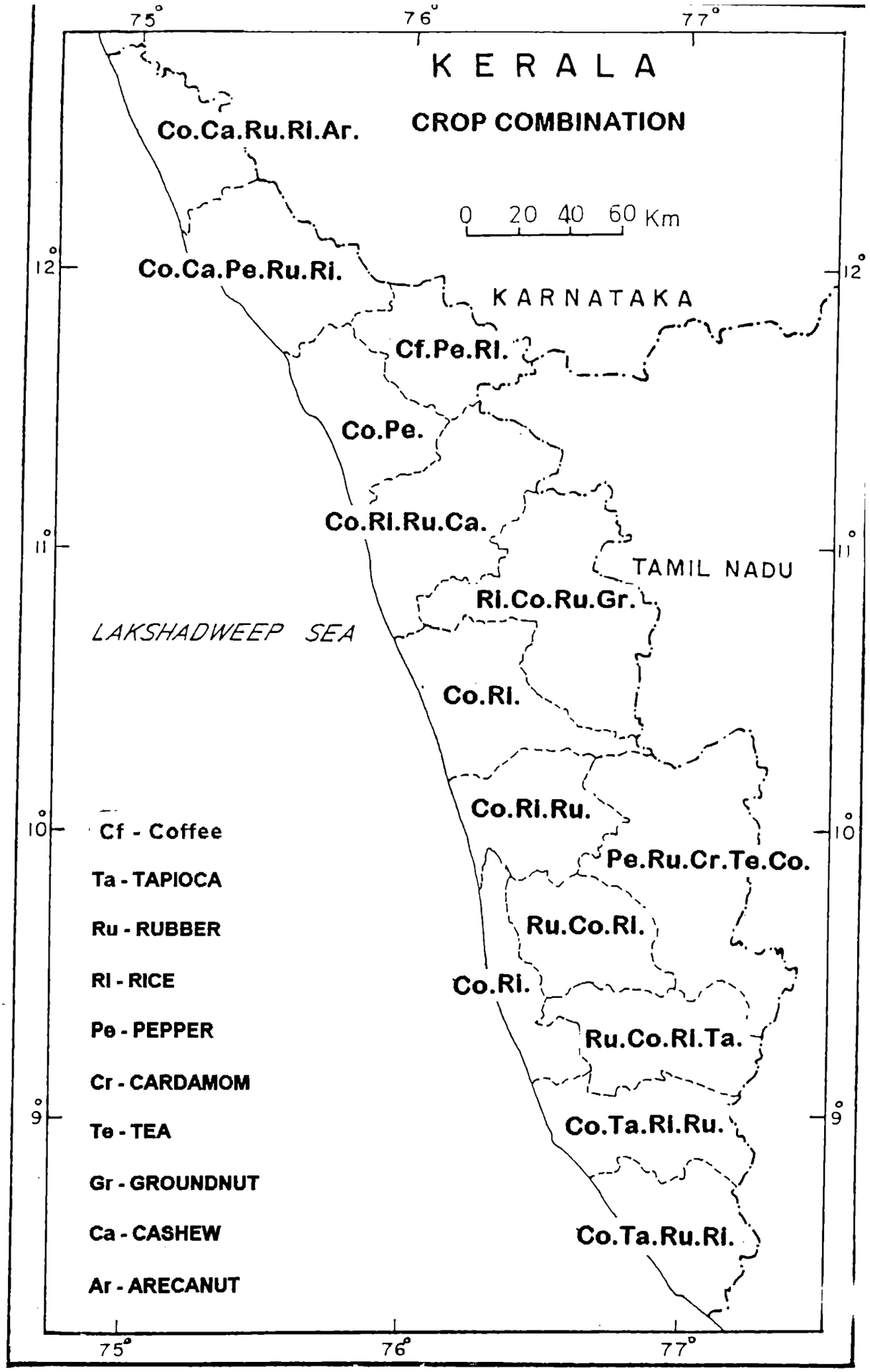

Fig. 6.1. KERALA - CROP COMBINATION

6.1.2. REGIONAL CONCENTRATION AND SPATIO-TEMPORAL VARIATIONS OF MAJOR CROPS

Four major crops have been selected in this study.viz., paddy, tapioca, coconut and rubber. Even though a variety of crops are cultivated in different parts of the State, these four major crops together occupy more than 75% of the total cropped area in most of the districts.

6.1.2a. PADDY *(Oryza sativa)*.

Paddy is cultivated in Kerala under a wide variety of agro-ecological conditions such as in water logged areas, high altitude areas and coastal saline tracts. Paddy requires a mean temperature of 16^0 C to 20^0 C during the flowering stage and 18^0 C to 32^0 C during the ripening stage. In Kerala, paddy is cultivated mainly during the following three seasons.

1.Virippu - Autumn (first) crop.
April / May to September / October

2.Mundakan - Winter (second) crop.
September / October to December / January

3.Punja - Summer (third) crop.
December / January to March / April.

The Kerala Agricultural University has developed varieties of location and season specific, both ordinary and high yielding, paddy for different parts of the State.

The highest concentration of paddy is found in Alappuzha and Thrissur districts. In Alappuzha paddy occupies 34.9% of the total cropped area and in Thrissur it account for 34.5%. This

is followed by Ernakulam and Palakkad districts where paddy occupies 25.6% and 27.3% respectively (Fig.6.2).

Inspite of the fact that rice is the staple food of people of Kerala, paddy shows drastic reduction in area in the State. From 752690 hectares in 1961 it reduced to 541327 hectares in 1991, a decrease of 28%. Individual districts also follow the same trend. Table 6.2 shows the changes of area, production and yield of paddy in Kerala.

Excepting Ernakulam district, which registered a 4.6% increase in area, all other districts had a phenomenal decrease in area under paddy. The highest decrease was in Kozhikode district (78.4%), and the lowest was in Alappuzha (1.8%).

Corresponding to the decrease in area, paddy production also decreased in many districts. Here again Kozhikode district registered about 80% decrease in production. Alappuzha, Kottayam, Ernakulam and Thrissur districts marked an increase in paddy production during the period 1961-1991.

Inspite of reduction in area and production, paddy yields show increase in all the districts, except Kollam and Kozhikode. In these two districts the yield declined by 40.1% and 44.5% respectively. The increase in yield is result of the use of high yielding varieties of paddy and better management practices.

At this juncture it is necessary to caution that with the increasing population, increase in yield alone is not sufficient to meet the ever increasing demand. "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

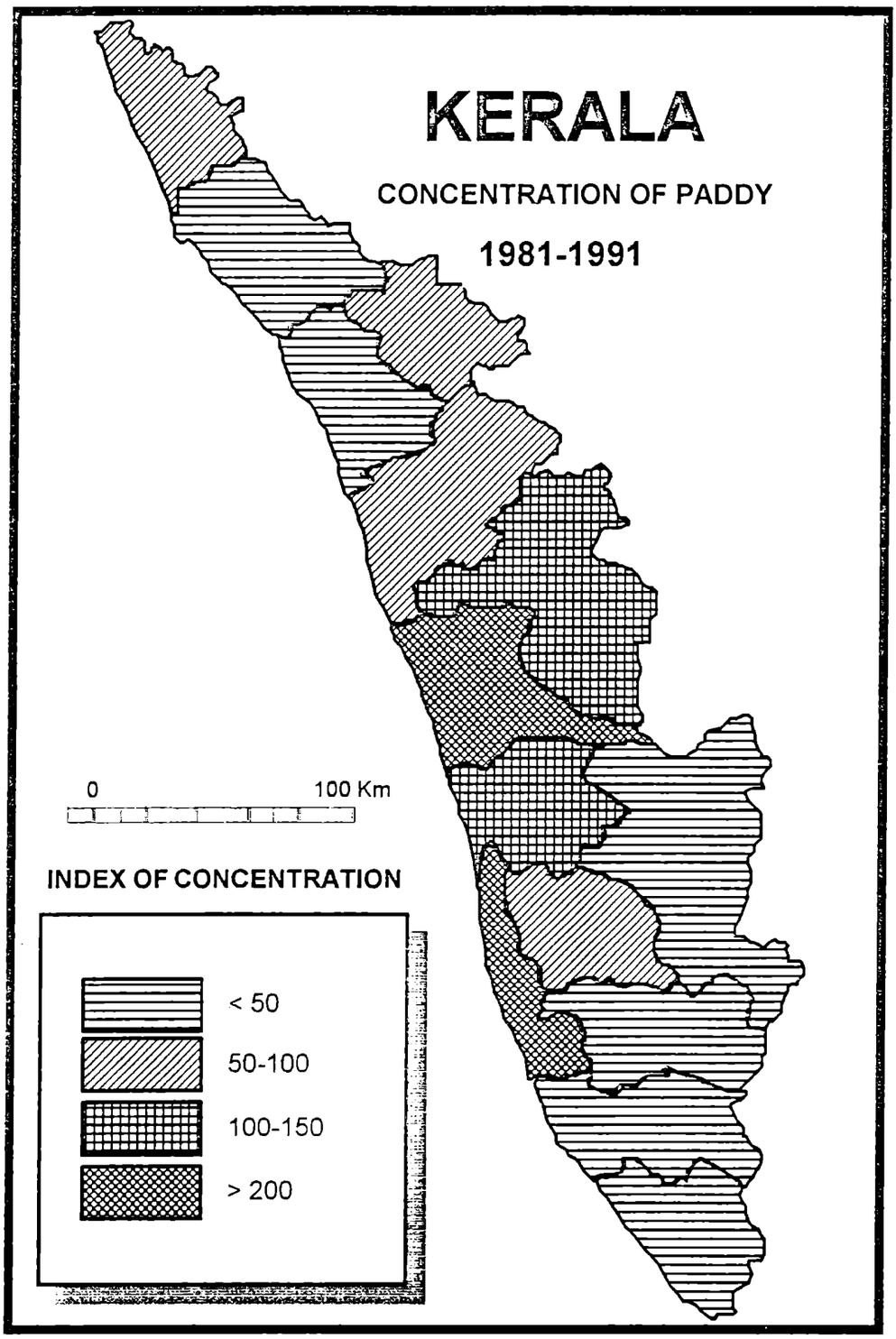

Fig. 6.2. KERALA - CONCENTRATION OF PADDY

DISTRICTS	AREA			PRODUCTION			YIELD		
	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE
Thiruvananthapuram	38661	26435	-31.6	55145	42023	-23.8	1427	1606	12.5
Kollam	49364	38426	-22.2	148396	64256	-54.7	2805	1679	-40.1
Alappuzha	81840	80367	-1.8	116521	136380	17.8	1424	1927	35.3
Kottayam	42215	32176	-23.8	59016	66745	13.1	1391	1734	24.7
Idukki	12797	7484	-41.5	20999	14874	-29.2	1331	2011	51.08
	(1971-81)								
Ernakulam	84563	88473	4.6	106640	124168	16.4	1262	1405	11.3
Thrissur	107423	96161	-10.5	135668	142865	5.31	1261	1499	18.5
Palakkad	197679	162145	-17.9	331922	328074	-1.2	1677	2029	23.9
Malppuram	89290	67709	-24.2	124471	93475	-24.9	1392	1392	0
	(1971-81)								
Kozhikode	103132	22312	-78.4	121883	24668	-79.8	1985	1102	-44.5
Kannur	94007	42417	-55.2	113612	57955	-48.9	1207	1418	17.5
STATE	752690	641327	-28.1	1003930	1060350	5.6	1334	1959	46.9

Table.5.2

CHANGES IN AREA, PRODUCTION AND YIELD OF PADDY IN KERALA

AREA IN HECTARES : PRODUCTION IN TONNES : YIELD IN Kg. / Hect.

CHANGES IN PERCENTAGE

internal production".(NARP,1989). Hence efforts should be made to increase the production substantially.

6.1.2b.TAPIOCA *(Manihot esculenta).*

Tapioca is known as the poor man's staple food. It is also an essential raw material for a number of industries. The area under tapioca in the State declined from 236670 hectares in 1961 to 140881 hectares in 1991, a decrease of 40.1%. Production of tapioca increased from 1644600 tonnes in 1961-1971 to 2657865 tonnes in 1981-1991, an increase of 61.5%. Table 6.3 shows area, production and yield of tapioca in different districts of the State.

Tapioca is mainly concentrated in the southern districts. High concentrations are found in Thiruvananthapuram and Kollam districts, where it accounts for 24.2% and 17.1% of total cropped area respectively. A secondary concentration is found in Pathanamthitta and Kottayam districts. (Fig.6.3).

The three districts which registered increases in area under tapioca are, Kannur, Palakkad and Idukki, where the increase was 73.5%, 41%, and 11.6% respectively. In all other districts, the area under tapioca declined. Kozhikode district had a substantial decline of 76.2% during this period.

Tapioca production declined in Kollam, Alappuzha, Malppuram, and Kozhikode districts too. An appreciable increase of 189.8% in Kannur and 102..8% in Palakkad districts in seen during this period. All the districts show increase in the yield.

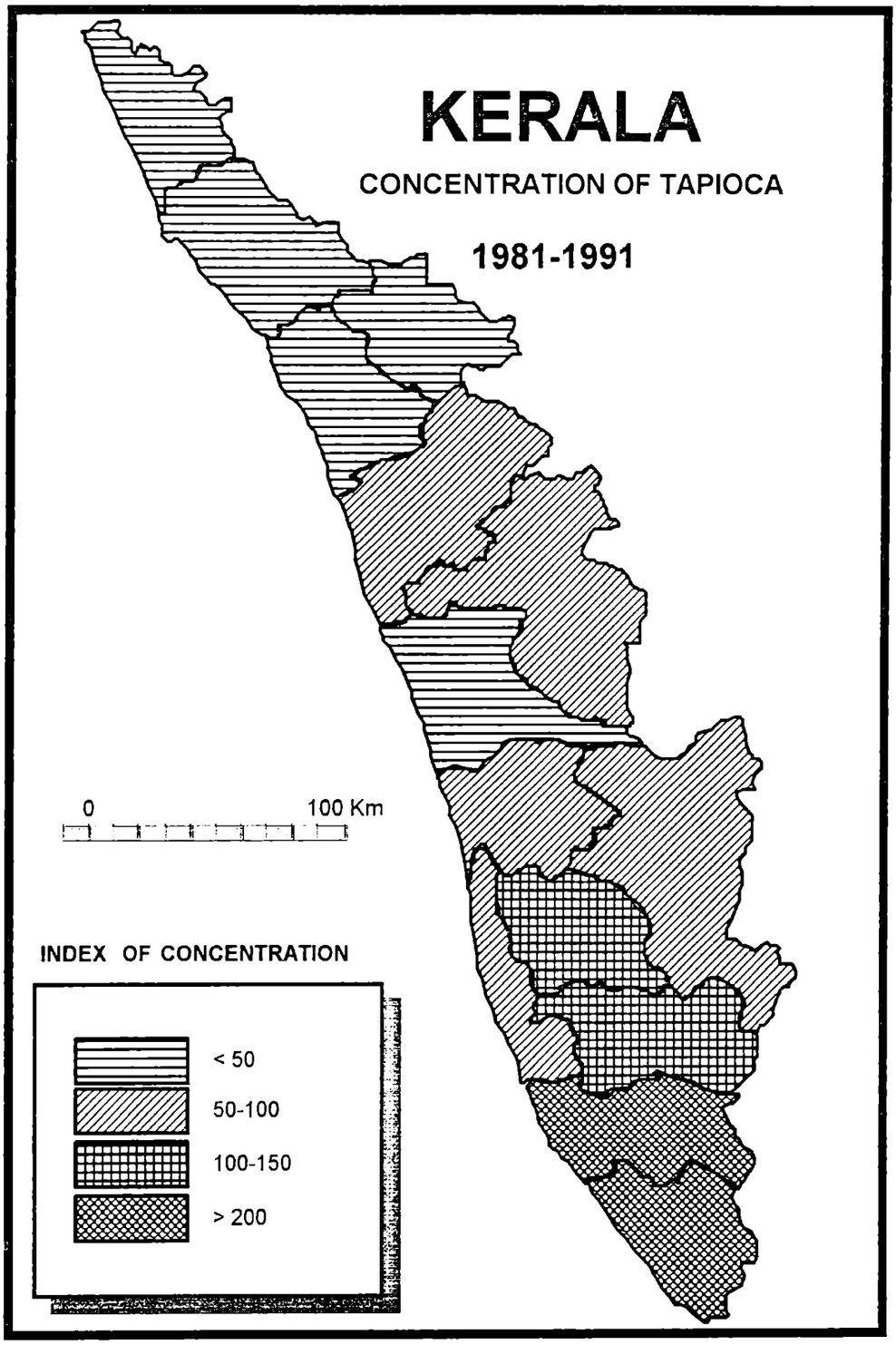

Fig. 6.3. KERALA - CONCENTRATION OF TAPIOCA

DISTRICTS	AREA			PRODUCTION			YIELD		
	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE
Thiruvananthapuram	57809	49889	-13.7	668028	808150	20.9	11486	16259	41.5
Kollam	69335	42884	-38.1	845515	686868	-18.7	11534	16154	40.1
Alappuzha	25416	19667	-22.6	295321	286372	-3	11926	15348	28.7
Kottayam	37056	30413	-17.9	571872	559137	-1.3	14385	18484	28.5
Idukki	7412	8270	11.6	153201	173236	13.1	21199	21396	0.9
	(1971-81)								
Ernakulam	15476	13115	-15.3	163907	205711	23.7	10578	16050	51.7
Thrissur	6658	5337	-19.8	94124	140854	102.8	9823	15987	62.1
Palakkad	8507	11996	41	94124	190854	102.8	9823	15987	62.7
Malappuram	24186	15622	-35.4	337369	226540	-32.9	14078	14770	4.9
	(1971-81)								
Kozhikode	17185	4087	-76.2	186375	51079	-72.6	10715	12413	15.8
Kannur	7353	12759	73.5	73934	214241	189.8	10135	17310	70.8
STATE	236670	141881	-40.1	164460	2657865	61.6	6949	18733	169.6

Table.6.3

CHANGES IN AREA, PRODUCTION AND YIELD OF TAPIOCA IN KERALA

AREA IN HECTARES : PRODUCTION IN TONNES : YIELD IN Kg. / Hect.

CHANGES IN PERCENTAGE

6.1.2c.COCONUT. *(Cocos nucifera)*

Coconut is extensively grown through out the State. It is grown mainly in homesteads and small farms. There are about 2.5 million coconut holdings in Kerala, with about 170 million palms and with an average palm density of 229 palms per hectare. Coconut requires a mean annual temperature of 27^0C. Prolonged spells of extensive variation in temperature is harmful to the plant. It requires 1300-2300 mm. of annual rainfall. In Kerala it is grown in a wide variety of soil types such as laterite, sandy loam, alluvium and reclaimed marshy lands. In 1961, the State had 504820 hectares of coconut land, which increased to 863061 hectares in 1991, a phenomenal 70.9% increase. Table 6.4 shows the district wise details of changes of area, production and yield of coconut.

Coconut displays a widespread distribution rather than a localised concentration like other crops.(Fig.6.4). Highest concentration is found in Kozhikode district, where it has 24.8% of total cropped area under this crop. A major noticeable feature of coconut is the concentration in the coastal districts.

A reduction in area is noticed in Alappuzha, Kottayam, Idukki and Kozhikode districts. Thrissur registered 61.5% increase in area. The mean production of coconut declined in most of the districts. Here again only Thrissur district shows a noticeable increase in production (57.2%). Another conspicuous feature is the decline of yield in all the districts.

6.1.2d. RUBBER (*Hevea brasiliensis*)

Rubber is grown in Kerala under a wide variety of topographical conditions, from sea level to 500 m.of altitude. It needs about 2000 mm.of annual rainfall, well distributed through

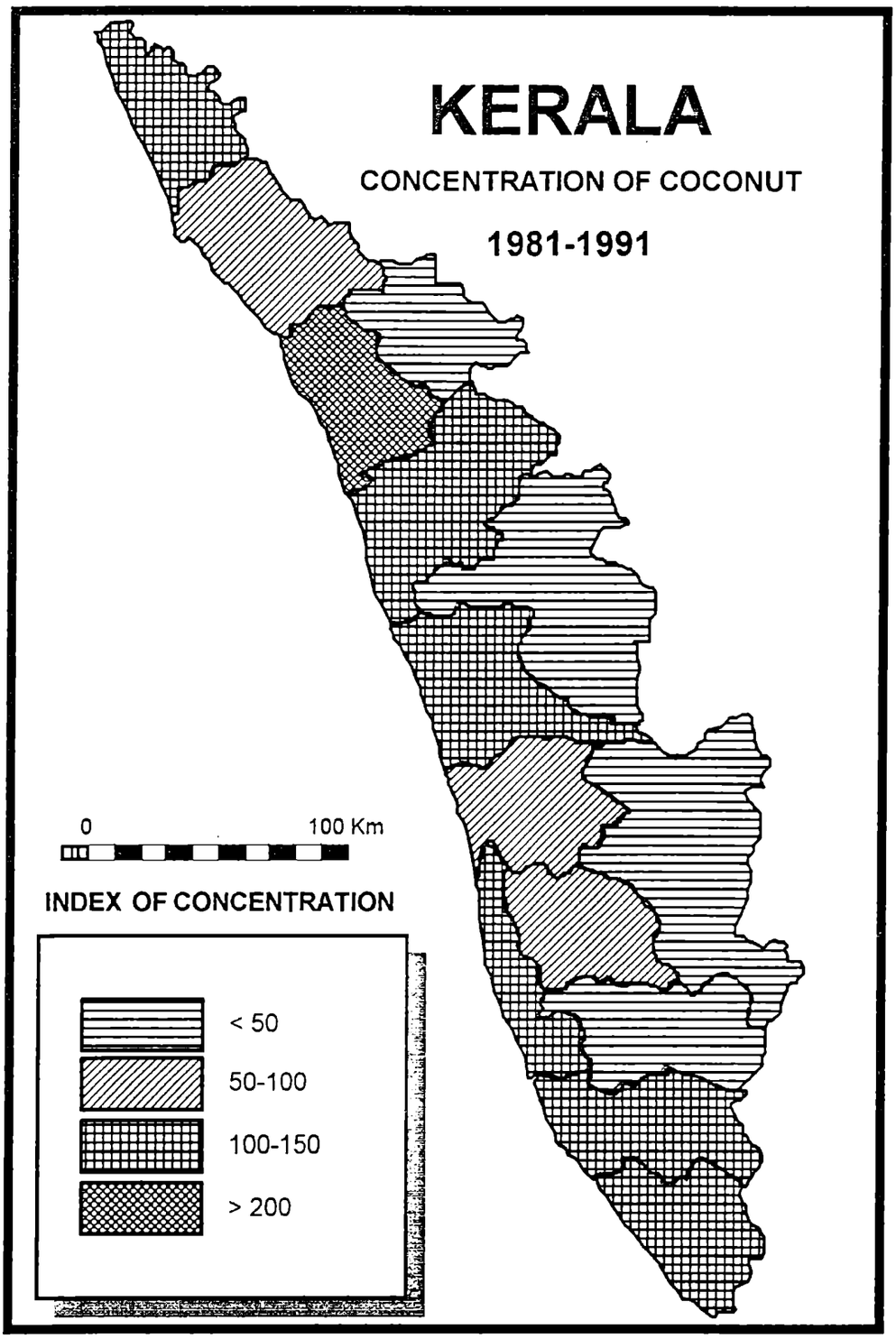

Fig. 6.4. KERALA - CONCENTRATION OF COCONUT

DISTRICTS	AREA			PRODUCTION			YIELD		
	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE
Thiruvananthapura	61609	77314	25.5	388	3920	1	6277	5042	-19.7
Kollam	75225	76948	23	443	299	-32.5	5910	3876	-34.4
Alappuzha	75805	67782	-10.6	498	399	-19.9	6563	5828	-11.2
Kottayam	67968	59832	-12	362	281	-22.4	5395	4629	-14.2
Idukki	18720	17749	-5.2	74	62	-16.2	3786	3363	-11.2
	(1971-81)								
Ernakulam	52467	57413	9.6	315	325	3.2	6032	5677	-5.9
Thrissur	39871	64295	61.3	250	383	57.2	6277	6035	-3.8
Palakkad	24329	26487	8.9	115	85	-26.1	4925	3229	-34.9
Malappuram	66591	67314	1.1	311	282	-9.3	4689	4156	-11.4
	(1971-81)								
Kozhikode	117679	106764	-9.3	743	580	-21.9	6331	5434	-14.2
Kannur	71349	75268	5.5	330	288	-12.7	4824	3854	-20.1
STATE	587723	719733	22.5	3444	3438	-0.07	5888	4760	-19.2

Table.6.4

CHANGES IN AREA PRODUCTION AND YIELD OF COCONUT IN KERALA

AREA IN HECTARES : PRODUCTION IN MILLION NUTS : YIELD IN NUMBERS / Hect.

CHANGES IN PERCENTEGE

out the year. Rubber plants require a mean temperature of 21^0C to 35^0C.

Rubber registered a marked increase in area in the State. From 133080 hectare in 1961, it increased to 425768 hectare in 1991- an outstanding increase of 220%. Production of rubber also show an incredible increase- it went up from 24890 tonnes in 1961 to 263109 tonnes in 1991. Various districts within the State also show the pattern of growth. (Table.6.5.).

Kottayam district has the highest concentration of rubber (Fig.6.5), where it accounts for 34.4% of total cropped area. A secondary concentration is found in Kollam, Pathanamthitta and Idukki districts.

A substantial increase in area is noticed in Thiruvananthapuram and Palakkad districts, while in Kozhikode district it declined by 14.4%. The increase in production of rubber was exceptional in Thiruvananthapuram and Kannur districts. These two districts registered an incredible increase of 515.9% and 474.4% respectively. Corresponding to this the yield also increased considerably in all the districts, except in Idukki where it suffered a marginal decline.

6.1.3. SPATIO-TEMPORAL VARIATIONS OF CROP PRODUCTIVITY

The varying topographic, edaphic and climatic conditions of the State result in the spatial variation of crop productivity. Temporal variations of agricultural productivity occur because of changes in any of the above mentioned factors and also because of changes in socio-economic conditions of the region, technological advancements and changes in government policies.

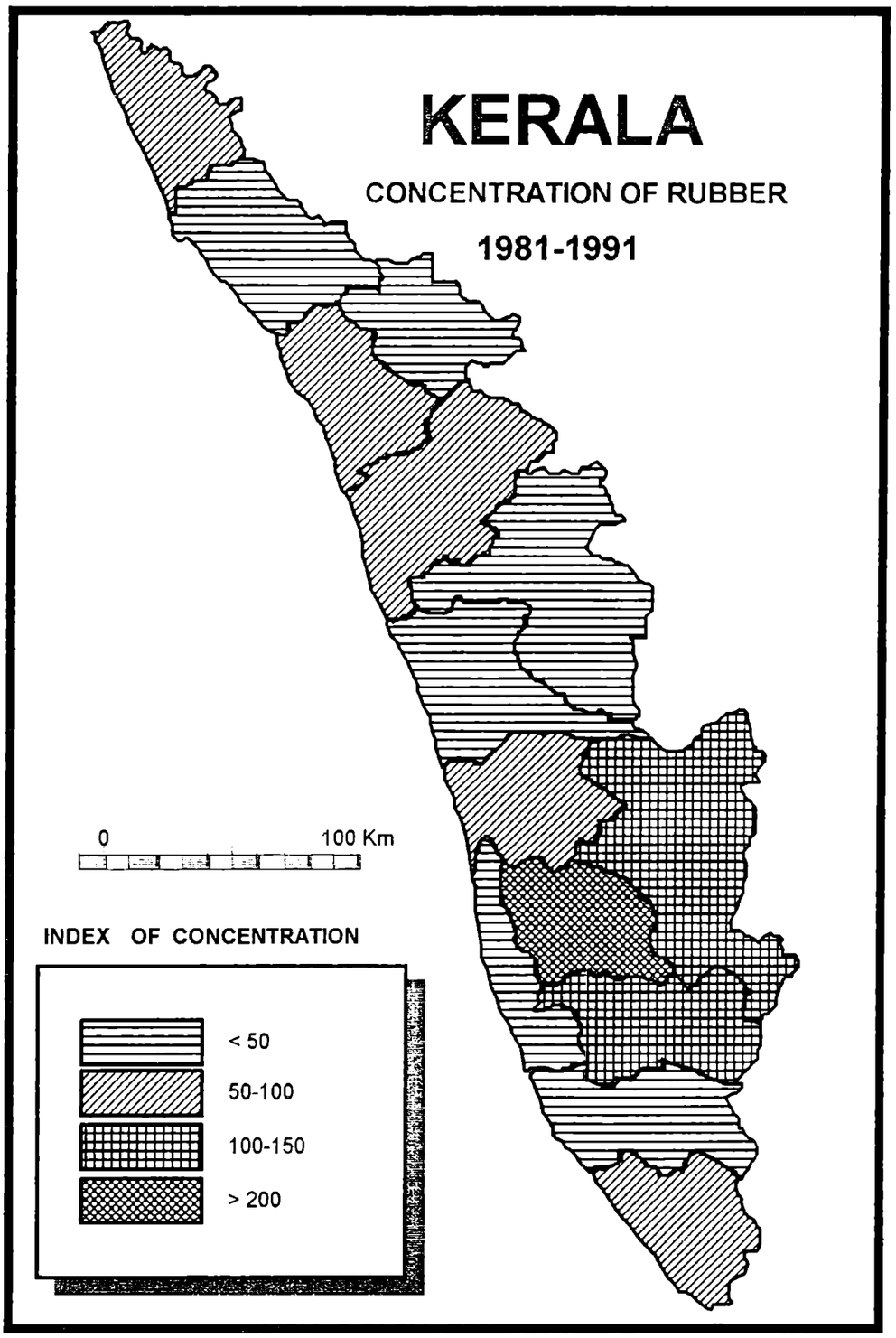

Fig. 6.5. KERALA - CONCENTRATION OF RUBBER

DISTRICTS	AREA			PRODUCTION			YIELD		
	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE	1961-71	1981-91	CHANGE
Thiruvananthapura	5030	13918	176.7	1372	8450	515.9	255	609	138.8
Kollam	25721	35022	36.2	9203	21355	132	350	611	74.6
Alappuzha	2756	3533	30.1	552	1529	177	185	513	177.3
Kottayam	46662	60955	30.6	14688	31758	116.2	312	502	60.9
Idukki	15674	21484	37.1	9835	12570	27.8	627	598	-4.6
	(1971-81)								
Ernakulam	21154	22733	7.5	5064	14686	190	229	688	200.4
Thrissur	7442	9519	27.9	3656	6938	89.8	486	744	53.1
Palakkad	6923	14890	115.2	1852	7482	30.4	253	492	94.5
Malappuram	16349	18331	12.1	8746	11677	33.5	531	636	19.8
	(1971-81)								
Kozhikode	195626	167385	14.4	7019	9999	42.5	349	583	67
Kannur	12864	20853	62.1	2017	11586	474.4	150	508	238.7
STATE	133080	425768	219.9	24980	263109	953.3	188	618	228.7

Table.6.5

CHANGES IN AREA, PRODUCTION AND YIELD OF RUBBER IN KERALA

AREA IN HECTARES : PRODUCTION IN TONNES : YIELD IN Kg. / Hect.

CHANGES IN PERCENTAGE

The technique propounded by Singh and Dhillon(1994) is used in this study to evaluate the spatio-temporal variations of the selected crops. Since this technique takes into account both the yield index and concentration index, it gives a better picture of the levels of productivity.

6.1.3a. PADDY.

The State's average crop yield and concentration indices ranking coefficient of paddy was 5.8 in 1961-1971. Alappuzha and Kozhikode districts had high productivity levels (Fig.6.6). A low level of productivity prevailed in Idukki and Kannur districts.

A considerable change in the levels of productivity of paddy can be noticed during 1981-1991 period (Fig.6.7). It changed from medium level to high level in Kottayam, Ernakulam and Thrissur districts, while in Kozhikode it dropped down to low level from the high position it had in 1961-1971. This decline in Kozhikode is mainly due to the drastic reduction of paddy area and corresponding decline in production during the period.

6.1.3b. TAPIOCA.

In consequence to the concentration of tapioca in the southern districts, they had a high level of productivity 1n 1961-1971. (Fig.6.8).The productivity of Idukki increased resulting in the shift from low level to high.(Fig.6.9.). Another conspicuous feature is a drop in productivity levels of Malappuram and Kozhikode districts.

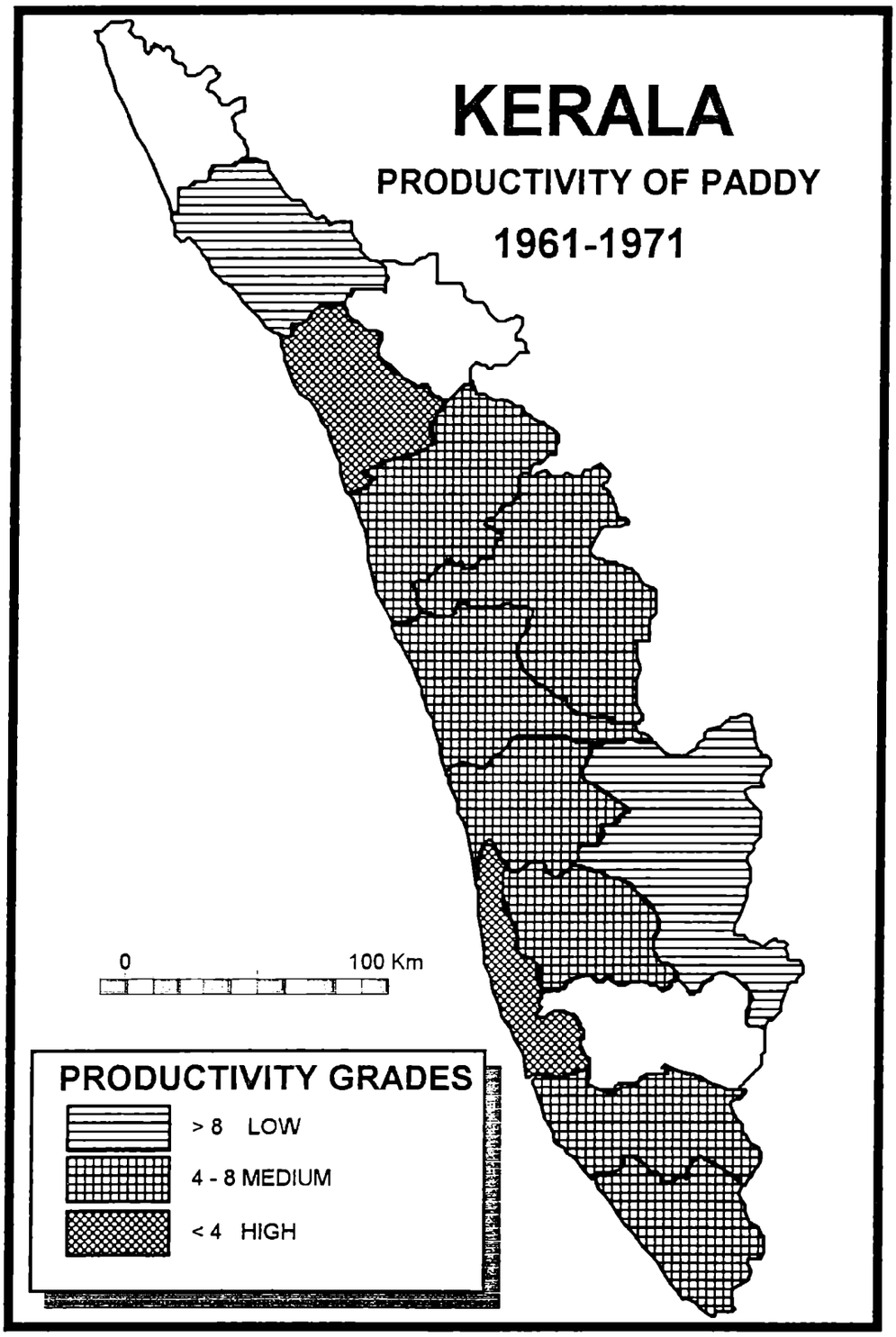

Fig. 6.6. KERALA - PRODUCTIVITY OF PADDY : 1961-1971

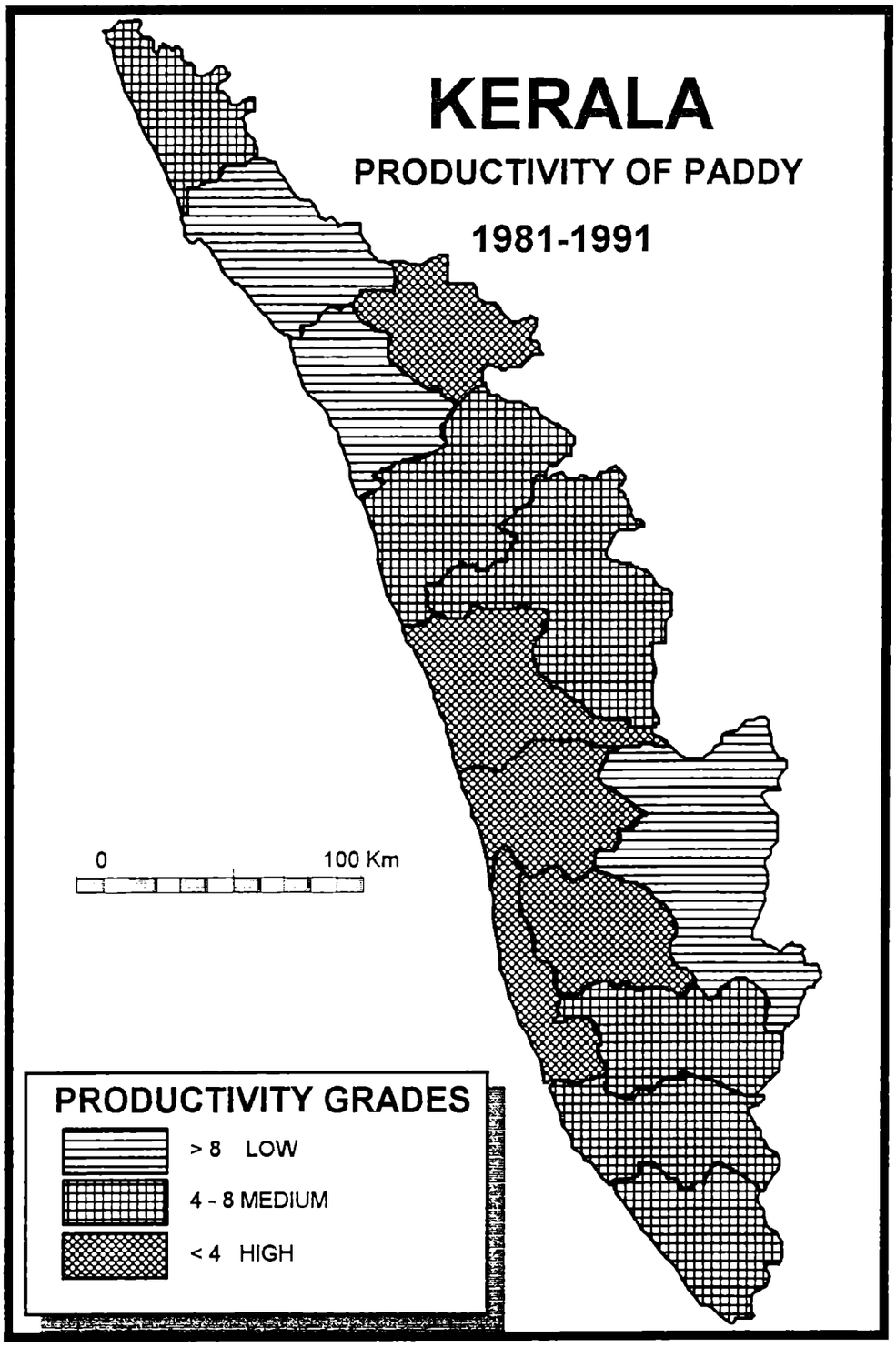

Fig. 6.7. KERALA - PRODUCTIVITY OF PADDY : 1981-1991

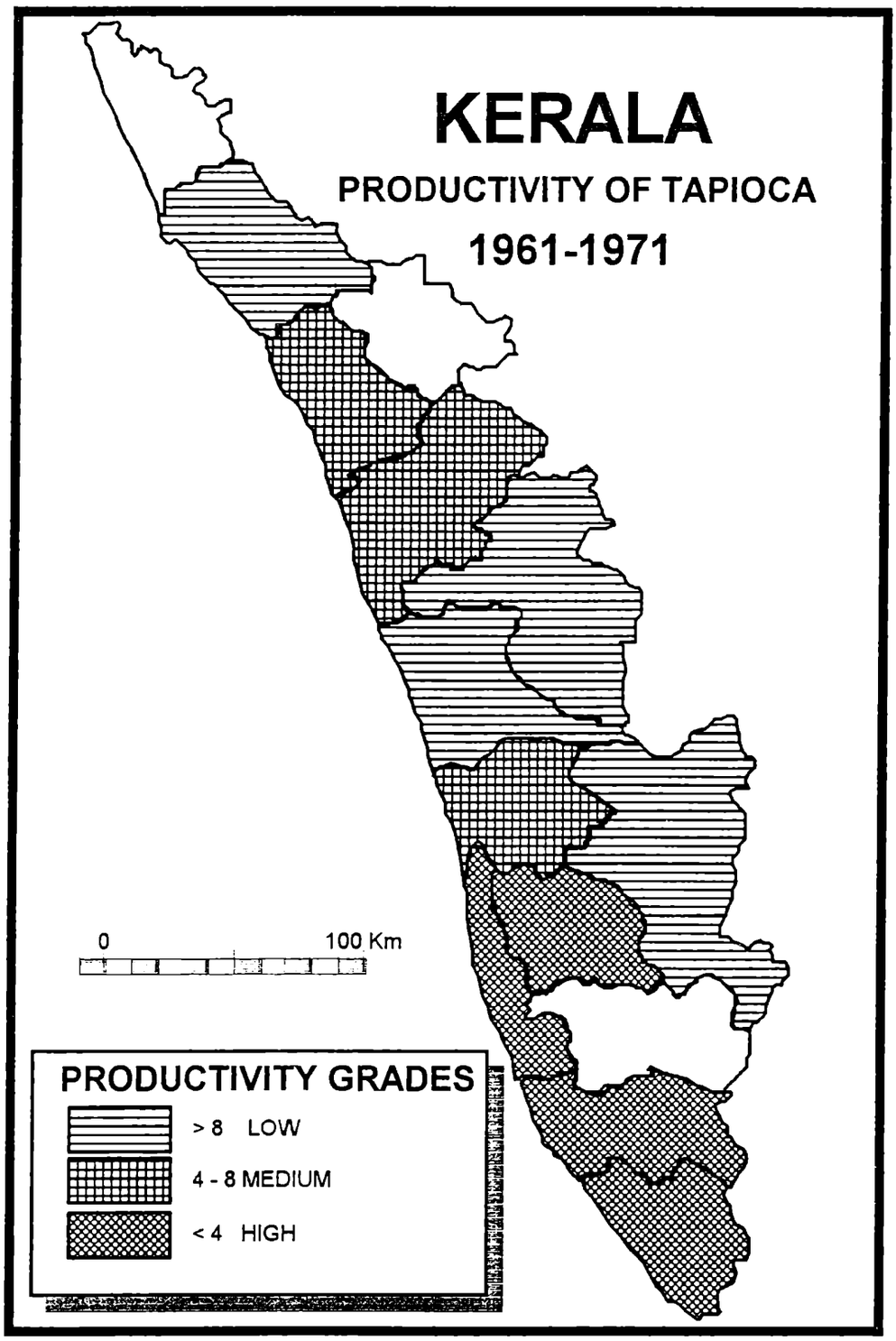

Fig. 6.8. KERALA - PRODUCTIVITY OF TAPIOCA : 1961-1971

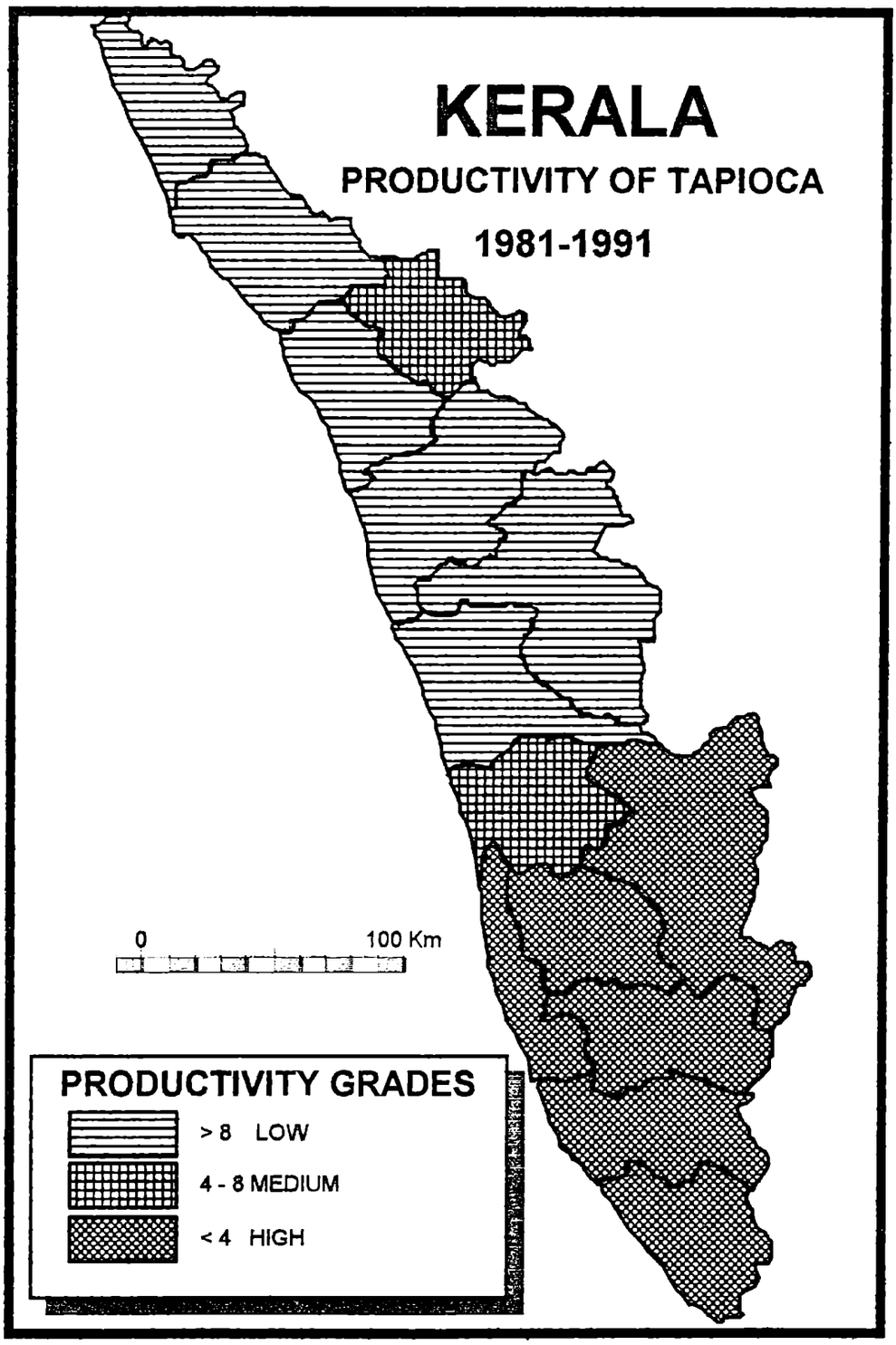

Fig. 6.9. KERALA - PRODUCTIVITY OF TAPIOCA : 1981-1991

6.1.3c. COCONUT.

Thiruvananthapuram, Alappuzha and Kozhikode districts had high level productivity during the period 1961-1971.(Fig.6.10). These districts remained in the high productivity gategory in 1981-1991 period also. Major changes noticed are the decline in Kottayam and increase in Thrissur.(Fig.6.11).

6.1.3d RUBBER.

The productivity of rubber follows the regional concentration of the crop. Kottayam district had the highest level of productivity during 1961-1971. (Fig.6.12), which continued in 1981-1991 also. (Fig.6.13). Palakkad district registered an increase in productivity, while Thiruvananthapuram, Kollam and Malappuram districts had a decline.

6.1.4. SPATIAL VARIATION OF AGRICULTURAL EFFICIENCY.

Agricultural efficiency of a region depends on the inputs such as the number and types of crops cultivated, their areal extent, climatic and edaphic conditions agricultural practices, and the output in the form of yield per hectare of various crops. The average yield of the crops reflect all these parameters, and hence is taken as the best index of agricultural efficiency. In some cases the areal extent of the crops often influence the yield. Hence an index which takes into account both the per hectare yield and the areal extent of crops, is a most useful tool for assessing the agricultural efficiency.

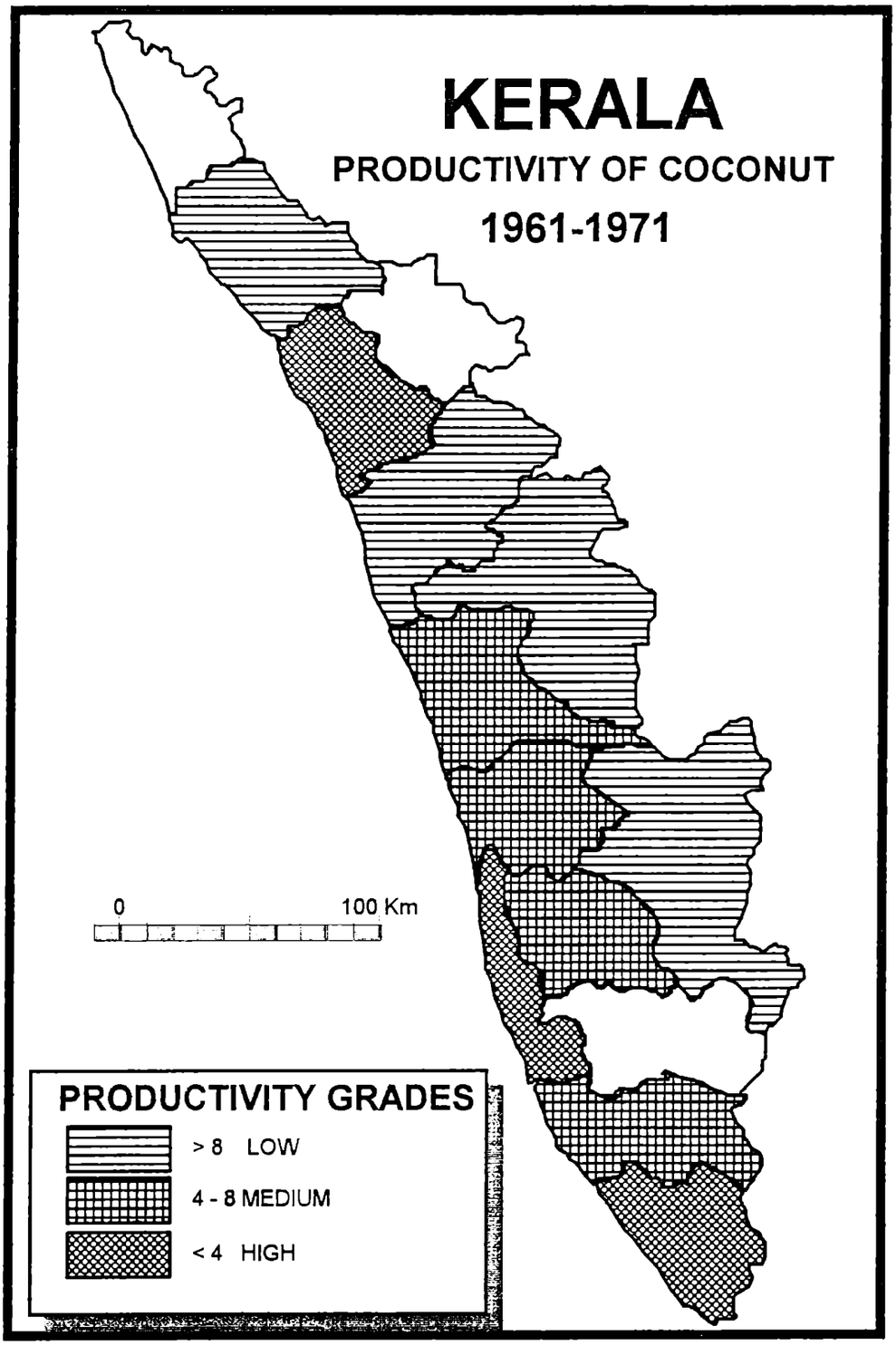

Fig. 6.10. KERALA - PRODUCTIVITY OF COCONUT : 1961-1971

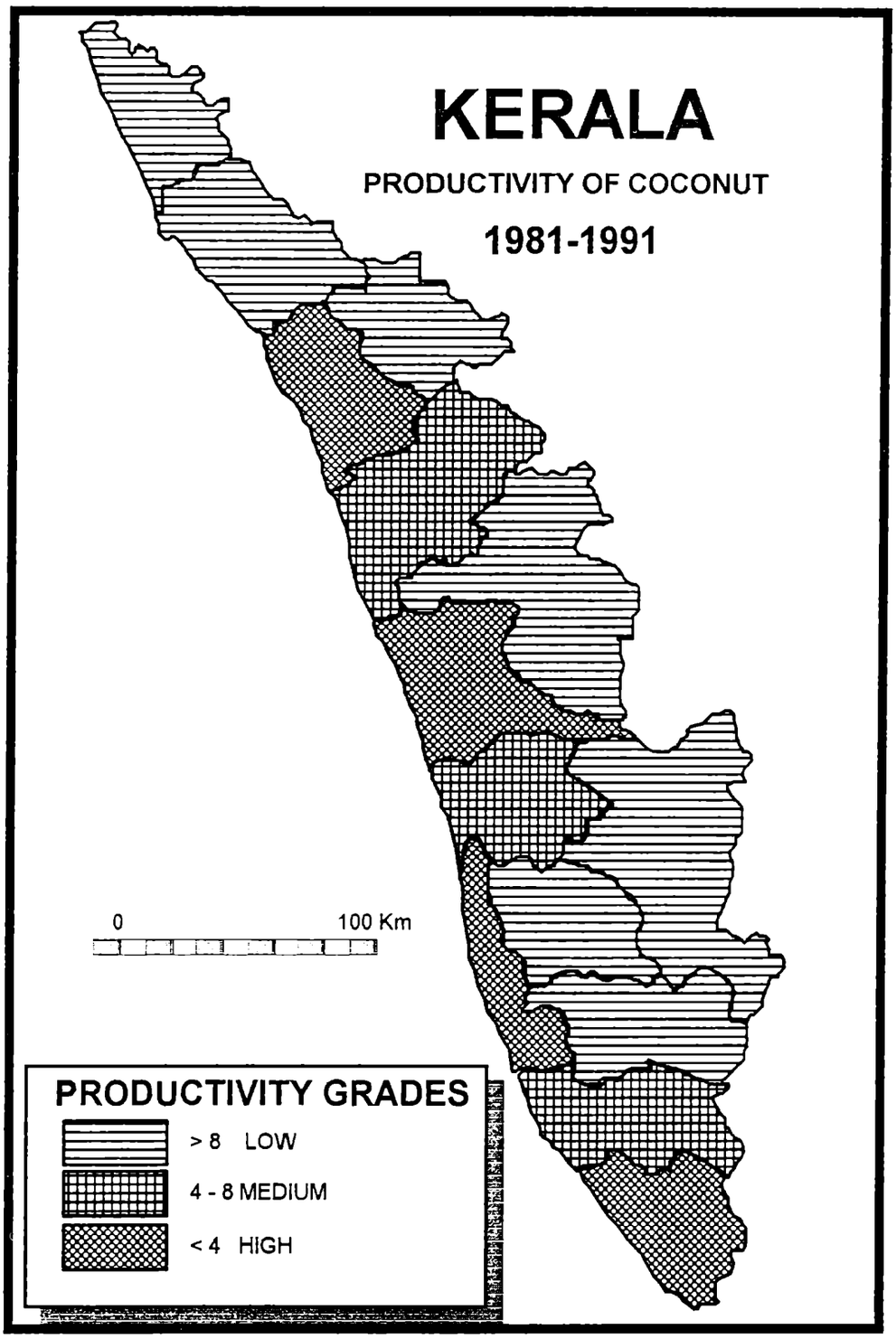

Fig. 6.11. KERALA - PRODUCTIVITY OF COCONUT : 1981-1991

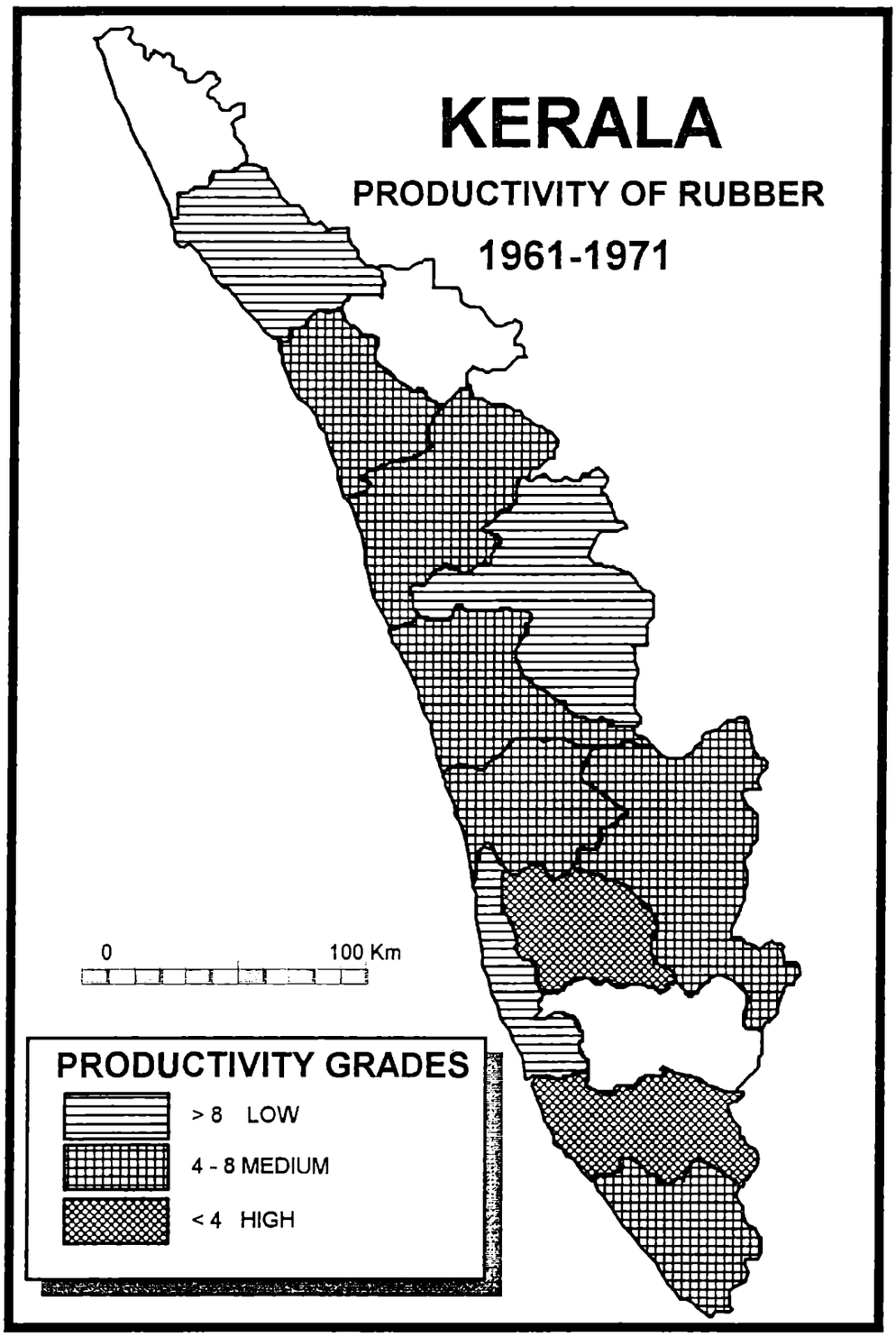

Fig. 6.12. KERALA - PRODUCTIVITY OF RUBBER : 1961-1971

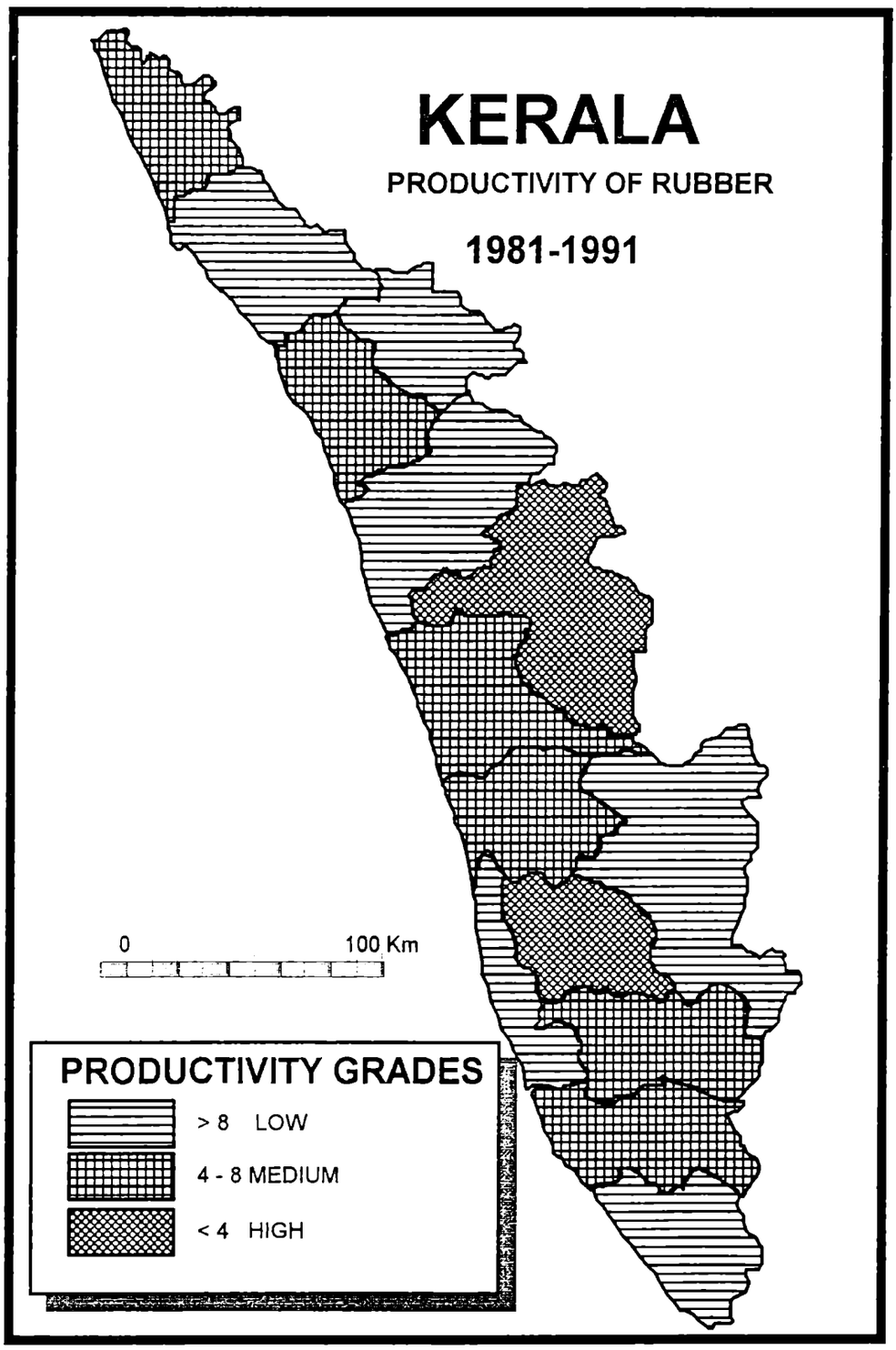

Fig. 6.13. KERALA - PRODUCTIVITY OF RUBBER : 1981-1991

In this study the Weighted Composite Index of regional inequality in Agricultural efficiency proposed by Singh et.al.(1994), is followed.

The Weighted Composite level of Agricultural Efficiency (V_W) values range from 83 in Palakkad to 584 in Idukki. Table 6.6 gives the district wise V_W values.

In order to identify the spatial characteristics of agricultural efficiency the V_W values are plotted on a map.(Fig.6.14). It is possible to identify five regions of different levels of efficiency. Out of the 14 districts in the State, 5 districts have very high and high efficiency levels. Six districts have low to very low levels and the remaining three districts have medium level. This clearly indicates that those districts where the number of crops are more, with almost equal share of crop lands, the efficiency is high. This invariably is found in the hilly districts of the State, where the efficiency level is remarkably very high.

DISTRICTS	V_W(%)
1. THIRUVANANTHAPURAM	130
2. KOLLAM	132
3. PATHANAMTHITTA	210
4. APPUZHA	92
5. KOTTAYAM	122
6. IDUKKI	584
7. ERNAKULAM	109
8. THRISSUR	87
9. PALAKKAD	83
10. MALAPPURAM	87
11. KOZHIKODE	97
12. WAYANAD	265
13. KANNUR	175
14. KASARGOD	164

Table.6.6. WEIGHTED COMPOSITE LEVEL OF AGRICULTURAL EFFICIENCY IN KERALA 1981-1991

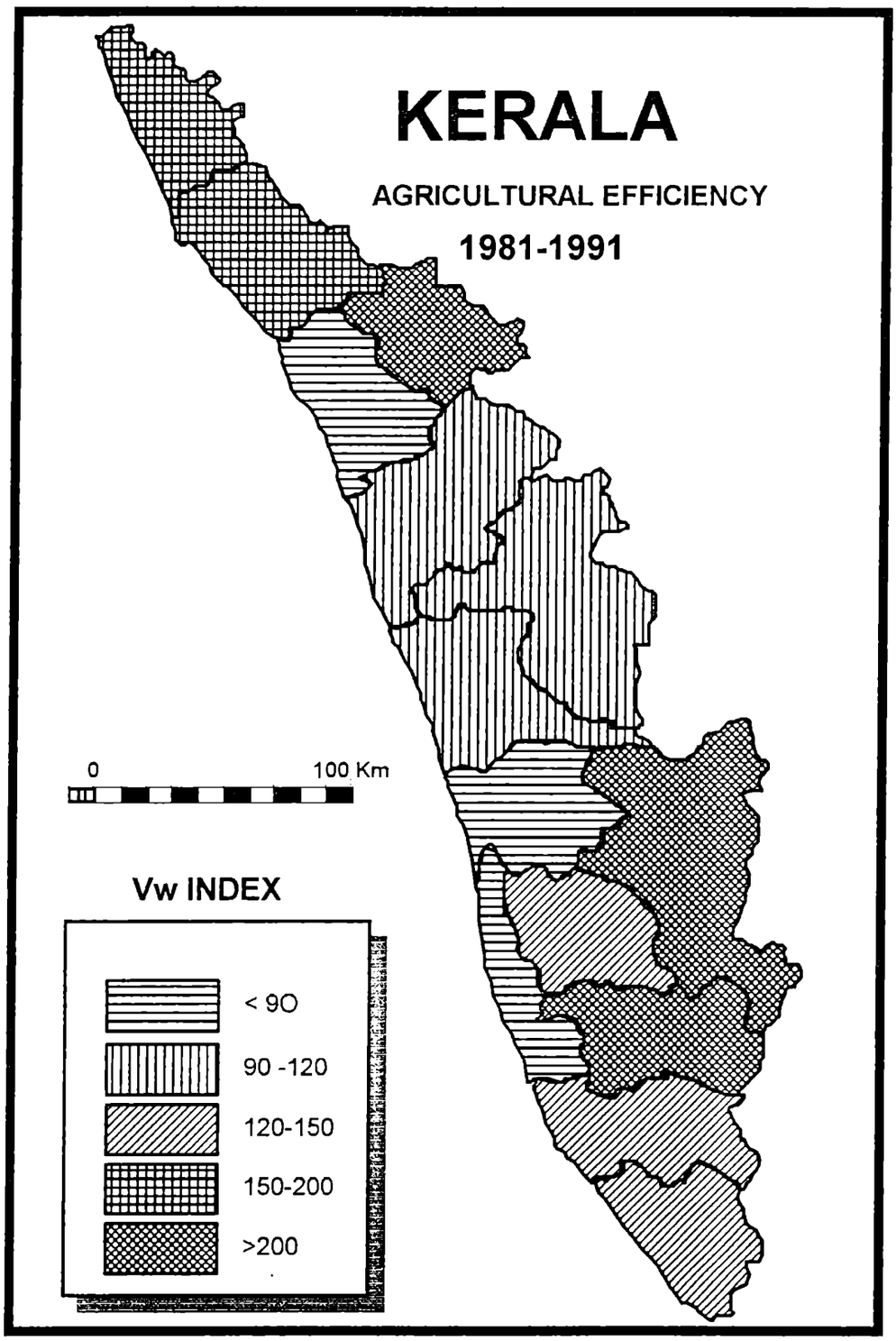

Fig. 6.14. KERALA - AGRICULTURAL EFFICIENCY

The efficiency level could be increased through intensive cultivation by way of multiple cropping, areal extension of crops to places where they can be suitably cultivated and through proper scientific agricultural practices.

6.2. INFLUENCE OF SHORT-TERM RAINFALL FLUCTUATIONS ON THE AGRICULTURAL LAND USE.

The relationship between climate and agriculture is a well studied subject. It is a known fact that each crop or plant species requires a specific set of climatic conditions for its growth and production. Since there are spatial and temporal variations in the climate of the Earth, the agricultural systems also vary accordingly. Even in regions which experience uniform climatic conditions, the seasonal variation of climatic elements often will have adverse effects on the agriculture of that region. In the temperate regions of the Earth, the diurnal and seasonal ranges of temperature are the limiting factor in agriculture. In the tropical regions, on the other hand, the seasonal range of temperature is less important for crops and hence the amount and distribution of rainfall plays a dominant role in controlling the agriculture. It should be mentioned here, that these are general conditions and may vary according to the local circumstances even within one climatic region.

Indian agriculture still depends heavily on the monsoons. The link between the vagaries of monsoons and its effect on the agriculture is a well known fact. The rainfall deficits often lead to drought conditions and excess of rainfall may result in

flooding - both these can cause crop failure and consequent stress on the economy.

In this section the influence of inter-annual variations of rainfall on the agricultural landuse and crop production of Kerala is studied. Since the seasonal and annual variations of temperature in Kerala is minimum, only annual rainfall variations are considered in this analysis.

Like in many other States of the country, Kerala's agriculture also depends heavily on the monsoon rainfall. Even though the mean annual rainfall of Kerala is much higher than the national average, the inter-annual variations often affect the agricultural production. One way of combating this is by providing adequate irrigation facilities and proper water management practices.

Of the total 3021116 hectares of total cropped area in the State, only 387411 hectares are irrigated which accounts for 12.8%. This clearly indicates the degree of dependence of the State's agriculture on rainfall. The regional variations in the gross area irrigated reflect the influence of rainfall on agriculture in the individual districts.(Table.6.7.).

Only two districts, Ernakulam and Thrissur, have more than 25% of total cropped area under irrigation. Six districts have only less than 5%. This emphasises that the cultivation in these districts are practically rainfed.

AREA IN HECTARES

DISTRICTS	GROSS IRRIGATED AREA	TOTAL CROPPED AREA
1. THIRUVANANTHAPURAM	7896	202255
2. KOLLAM	4964	218267
3. PATHANAMTHITTA	8243	127563
4. ALAPPUZHA	31208	165993
5. KOTTAYAM	9978	235741
6. IDUKKI	3620	204999
7. ERNAKULAM	63756	246720
8. THRISSUR	79672	211646
9. PALAKKAD	82239	343372
10. MALAPPURAM	34769	268971
11. KOZHOKODE	5664	213179
12. WAYANAD	5536	176095
13. KANNUR	18392	265558
14. KASARGOD	33942	140757
STATE	**387411**	**3021116**

Table.6.7. GROSS AREA UNDER IRRIGATION AND TOTAL CROPPED AREA IN KERALA : 1991-1992

6.2.1.VARIATION OF CROP AREA, PRODUCTION AND YIELD DUE TO INTER-ANNUAL FLUCTUATION OF RAINFALL.

The technological advancements and socio-economic changes often result in the increase in crop production and yield. But the annual variations of area, production, and yield of a

particular crop may be attributed to the fluctuation of rainfall and its distribution.

In this study simple linear regression analysis is done for the set of data on area, production and yield of selected crops with annual rainfall of selected stations. These stations are assumed to be the representative of the respective districts in which they are located. The coefficient of determination (R^2) values obtained through regression analysis gives the degree of dependence of these parameters on rainfall

6.2.1a. ATTINGAL.

Attingal, located in Thiruvananthapuram district, receives nearly 80% of its annual rainfall during the SW monsoon season. Since Thiruvananthapuram district has got only 3.9% of total cropped area under irrigation, the agriculture in the district is predominantly dependent on rainfall.

Coefficient of variability of area, production and yield of paddy, tapioca and coconut are comparatively less. On the other hand, rubber has very high variability of 53%,71.3% and 37% respectively in its area, production and yield. (Table.6.8.).

41.5% of variation in area and 54.6% of variation in production of paddy is determined by the variation in annual rainfall. This explains the high dependability of paddy crop on rainfall, in the absence proper irrigation facilities in the district. The R^2 value for area and production of rubber is also quite high. 34.5% of variations in area and 29.8% of variations in production of rubber, is determined by variations in the annual rainfall. The dependability on rainfall for the area and production of tapioca and coconut are comparatively less. But tapioca and coconut yield shows high R^2 values.

IN PERCENTAGE

COEFFICIENT OF VARIABILITY				COEFFICIENT OF DETERMINATION		
CROP	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	18.9	15.3	9.3	41.5	54.6	0
Tapioca	20.5	26.5	20.1	12.3	4.8	37.9
Coconut	12.2	15.8	14.2	10.1	6.0	28.6
Rubber	53.0	71.3	37.0	34.5	28.8	15.2

Table.6.8. COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION IN AREA, PRODUCTION AND YIELD OF MAJOR CROPS : ATTINGAL

6.2.1b. CHERTHALA.

Comparatively low coefficient of variabilities in area, production and yield of paddy and coconut, and high variability of tapioca and rubber are the marked features in Cherthala. (Table.6.9).

Relatively high R^2 values can be noticed in the area under coconut and production and yield of rubber. This indicates the changes in these elements are highly influenced by the annual rainfall of the station.

In Alappuzha district, paddy is mainly cultivated in the Kuttanad region, which is a low lying land. The Kayal lands are usually utilised for this purpose, after draining out the excess impounded water. During the punja season, if sufficient water is not available, other seasonal crops are cultivated. Hence the rainfall dependency of paddy in this region is considerably less, which is reflected in the low R^2 values.

IN PERCENTAGE

COEFFICIENT OF VARIATION				COEFFICIENT OF DETFRMINATION		
CROP	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	13.1	13.3	15.3	10.7	0.5	10.4
Tapioca	34.3	36.2	27.5	18.0	0.1	18.9
Coconut	16.6	26.0	22.6	39.0	15.0	1.6
Rubber	20.7	58.0	60.7	17.8	30.0	24.9

Table.6.9. COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION IN AREA, PRODUCTION AND YIELD OF MAJOR CROPS : CHERTHALA

6.2.1c. KOTTAYAM.

Kottayam district has only 4.23% of total cropped area under irrigation. A high variability in area, production and yield of tapioca and rubber is observed in Kottayam (Table.6.10.).

IN PERCENTAGE

COEFFICIENT OF VARIABILITY				COEFFICIENT OF DETERMINATION		
CROP	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	17.7	17.2	19.4	3.7	2.9	13.0
Tapioca	33.6	35.9	24.9	5.0	9.8	26.0
Coconut	16.5	27.8	18.7	0.1	3.1	11.2
Rubber	31.6	52.6	31.0	8.8	10.0	3.0

Table.6.10.COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION IN AREA, PRODUCTION AND YIELD OF MAJOR CROPS : KOTTAYAM.

It is evident from Table 6.10 that only a few changes in area, production and yield can be attributed to the fluctuations in rainfall in Kottayam district. For example, even though there is

52.6% variability in the production and 31% in yield of rubber, only 10 % of fluctuations of production and 3% fluctuations in yield are influenced by the changes in annual rainfall.

Similarly, only 3.7% of changes in area, 2.9% of production and 13 % of yield of paddy are determined by the fluctuations of rainfall, while the coefficient variability of area, production and are 17.7%, 17.2% and 19.4% respectively. Hence it can be stated that the majority of inter-annual fluctuations of agriculture in Kottayam are due to other factors.

6.2.1d. MALAYATTOOR

Ernakulam district, where the station Malayattoor is located, has 25.84% of total cropped area under irrigation. Of this about 74% is used for irrigating paddy. This indicates that the dependability of paddy on rainfall in the district is comparatively less. (Table 6.11.).

IN PERCENTAGES

	COEFFICIENT OF VARIABILTY			COEFFICIENT OF DETERMINATION		
CROPS	**AREA**	**PRODUCTION**	**YIELD**	**AREA**	**PRODUCTION**	**YIELD**
Paddy	11.3	13.9	11.1	13.2	16.9	7.0
Tapioca	25.5	28.0	28.9	0.2	30.5	30.1
Coconut	12.6	14.4	8.4	1.8	3.2	46.1
Rubber	43.3	60.6	37.2	3.2	34.2	41.2

Table.6.11.COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION OF AREA, PRODUCTION AND YIELD OF MAJOR CROPS : MALAYATTOOR

Rubber had a high variability in area, production and yield in Ernakulam district, followed by tapioca. From the R^2 values it becomes clear that only 13.2% of changes in area, 16.9% in

of other crops on rainfall can be explained as due the fairly good irrigation facilities available in the district.

IN PERCENTAGES

	COEFFICIENT OF VARIABILITY			COEFFICIENT OF DETERMINATION		
CROPS	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	12.2	9.3	11.2	7.1	0.4	6.5
Tapioca	29.2	32.6	27.7	2.0	2.0	12.0
Coconut	24.2	23.3	8.7	11.0	9.6	31.0
Rubber	13.1	34.1	36.2	21.2	14.6	19.6

Table.6.12.COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION IN AREA, PRODUCTION AND YIELD OF MAJOR CROPS : KODUNGALLOOR

6.2.1f. MANNARAKKAD.

Palakkad district, where this station is located, is popularly known as the 'Granary of Kerala', because it produces about 32.5 % of the total paddy output in Kerala. It has 27.2% of the total paddy area of the State. The district has also got a fairly good irrigation facility. 23.9% of total cropped area is irrigated. Among this a major share (82.1%) is used for irrigating paddy.

The district has low variability in area, production and yield of paddy. Other crops have a relatively high variability.(Table.6.13).The coefficient of determination shows that the influence of inter-annual variations of rainfall on the area, production and yield of many crops in the district is comparatively low.

production and 7% in yield of paddy are determined by the fluctuations in rainfall. As mentioned earlier, this is due to the reason that more paddy areas are irrigated in the district, than any other crop.

While the rainfall variations have little effect on area under tapioca, its production and yield are determined by rainfall to a large extent. The same pattern can be seen in the case of rubber and coconut. 46.1% of variations of coconut yield, 34.2% variations of production and 41.2% changes of yield of rubber, are influenced by the fluctuations of annual rainfall.

6.2.1e. KODUNGALLOOR.

Kodungalloor is located in the Thrissur district. The district has the highest area under irrigation- 37.64% of the total cropped area. Of the total 69065 hectares of paddy in the district, 44825 hectares have irrigation, which account for 64.4% of the total paddy area. Similarly 29015 hectares, out of the total 84789 hectares, of coconut area, have irrigation. This account for 34.2%.

The district has a low coefficient of variability in area, production and yield of paddy, while it is moderate in the case of other crops (Table 6.12). The coefficient of determination values show that the dependability of area, production and yield of many crops is comparatively of minimal significance. The inter-annual fluctuations of rainfall in the district have a fair amount of influence on the area and yield of rubber and on the yield of coconut. 31% of variations in the yield of coconut and 21.2% of area of rubber and 19.6% of rubber yield are determined by the fluctuations of rainfall. The low dependability

IN PERCENTAGES

	COEFFICIENT OF VARIABILITY			COEFFICIENT OF DETERMINATION		
CROPS	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	10.1	9.3	10.5	7.5	0.6	5.3
Tapioca	45.0	52.4	33.5	9.4	11.2	18.0
Coconut	25.0	27.9	31.7	15.2	2.1	10.5
Rubber	44.0	66.1	39.8	15.3	22.3	18.5

Table.6.13. COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION IN AREA, PRODUCTION AND YIELD OF MAJOR CROPS : MANNARAKKAD

6.2.1g. KANNUR.

Kannur district has 18932 hectares of gross irrigated area, which is 7.3% of the total cropped area of the district. Relatively high coefficient variability is found in all the crops, especially in the case of tapioca and rubber.(Table.6.14).

IN PERCENTAGES

	COEFFICIENT OF VARIABILITY			COEFFICIENT OF DETERMINATION		
CROPS	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
Paddy	38.1	35.2	10.8	6.0	21.0	0.4
Tapioca	52.8	61.8	31.0	14.0	0	19.0
Coconut	16.1	15.0	25.5	12.0	6.1	0.8
Rubber	26.6	64.3	55.9	0	0	0.3

Table.6.14. COEFFICIENT OF VARIABILITY AND COEFFICIENT OF DETERMINATION OF AREA, PRODUCTION AND YIELD OF MAJOR CROPS : KANNUR

It is obvious from Table.6.14. that the high variability of area, production and yield of many crops in Kannur is not because of the fluctuations in rainfall, except in the case of production of paddy and, area and yield of tapioca. 21 % of variations in paddy production, 14% variations of area and 19% changes of yield of tapioca are caused by the inter-annual variations of rainfall in the district.

From the above analysis, the following conclusions can be arrived at.

1. With the fluctuations in rainfall the agricultural landuse also changes. This is evident from the coefficient of determination obtained for area under different crops in various districts.

2. The production and yield of many crops are determined primarily by the amount of annual rainfall.

3. The degree of dependency of crops on rainfall varies from place to place and based on the availability of irrigation facilities.

4. The variability of area, production and yield of many crops in the State are not only because of the fluctuations in rainfall, but also because of other determinants of agricultural system of particular locality.