DECLINING SEX RATIO OF POPULATION IN TAMIL NADU 1977

ISSUED BY
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PREFACE

Sex ratio denotes the number of females per 1000 males. In Tamil Nadu the sex ratio was in favour of females from 1901 to 1951. There after a reverse trend has been observed. In this report the reasons for such a reversal change have been examined. It is hoped that the information furnished in this report will be useful to the administrators, research scholars, demographers etc.

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Suggestions for improvement are welcome.

Madras,
Dated: Jan.'77

R.PADMAVALLI,
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CHAPTER I

INTRODUCTION

1.1 The term sex ratio of population is used to denote the number of females per 1000 males in the relevant population. The sex ratio of a closed population is a function, only of the sex ratios of births, deaths or the sex specific balance of the influx into and efflux from the reservoir ofh human life. A slight excess of males over females at birth has been observed in almost all countries having reliable vital registration.

1.2 In most human population, there is a rough balance of sexes. But there are countries in Asia (Ceylon, India, Pakistan, Iran and Malaysia) where the populations account for higher masculinity in their numbers, while a number of European countries account for low masculinity in their population content.

1.3 In India some authors have suggested (i) a genetically based propensity for a higher sex ratio of male to female births and (ii) a greater rate of omission of women from Indian censuses to be the cause for such imbalance in sex ratios. But these do not appear to be plausible main explanations for the excess of the male.

1.4 The unusual sex differential in mortality appear to be the explanation for the high masculinity of the Indian population as a whole. Male predominance in numbers in India prevailed even since the turn of this century, with a steady decline in female populations. In Tamil Nadu the sex ratio was in favour of females from 1901 to 1951. This was the case in respect of Bihar, Kerala and Orissa States also. But in respect of other states, the sex ratio was just the opposite. But from 1961 census there was a reverse in Tamil Nadu when masculine composition of the population increased. Even though the above phenomenon seems to be a strange one in respect of Tamil Nadu, in fact it is not so when the data are compared with the all India figures and those of other States. In general sex ratio (females per 1000 males) has been decreasing ever since 1901, both in India as a whole and in respect of individual States.

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1.5 The sex ratio (females per 1000 males) in Tamil Nadu has decreased from 1044 to 978 from the year 1901 to 1971. This gradual change over in sex ratio requires an investigation of the census data for the decline in the number of females in the Tamil Nadu population as a whole in particular, based on the factors which would give rise to such a change over in the sex ratio.

1.6 The hypothesis seeking to explain the increase in the number of males over females may be examined in the light of the following aspects.

1) Omission of females in census enumeration

2) Sex ratio at birth which is favourable to males.

3) Pattern of sex differentials in mortality and

4) Inter state (internal) migration which is sex selective.

1.7 In the following chapters the above hypotheses have been discussed in detail and they lead us to the conclusion that declining trend in sex ratio of females to males is not a new phenomenon to Tamil Nadu, as this is the case in respect of India as a whole and that the increasing trend in sex ratio of females to males at death in Tamil Nadu alongwith natural increase in population having been favourable for males over females have been mainly responsible for the declining trend in sex ratio of females to males.

1.8 In addition, while the increase in expectation of life over the decades has benefited both males and female populations, the side effect of it has been responsible for the declining trend in the percentage of widows from 61.0% in the year 1901 to 49.4% in the year 1961, and there by caused an illusion upon the sex ratio (females to males) as if it is decreasing of its own accord.

CHAPTER II

REGIONAL VARIATION IN THE SEX RATIOS OF POPULATION OF TAMIL NADU.

2.1 The trends in the sex ratios of Tamil Nadu in comparison with the all India figures and the differentials according to districts, each constituting a separate region and religion are examined in this chapter. The series of

decennial censuses provide the basic data. In comparison with the world as a whole, the Indian data are considered above average and the picture emerging from census data can be termed as reasonably reliable.

2.2 The effect of boundary changes needs careful attention in studying the demographic a characteristics of population in different territorial units. Since the range of variation in sex ratios, is ordinarily more restricted than in some other characteristics, such as the occupational linguistic or religious distribution of the population in different areas, changes in territorial bouddaries are less likely to affect the sex ratios substantially. Efforts of the census authorities to adjust the earlier statistics for various administrative changes during the preceding decade are quite adequate for studying the trends in sex ratios over time. The following Table No.1 given sex ratio of India and Tamil Nadu.

TABLE: 1 : SEX RATIOS (FEMALES PER 1000 MALES) OF THE ENUMERATED POPULATION OF INDIA TAMIL NADU AND VARIOUS DISTRICTS OF TAMIL NADU (1901 to 1971)

	Census Year							
	1901	11	21	31	41	51	61	71
	2.	3	4	5	6	7	8	9
India	972	963	955	950	945	946	941	930
Tamil Nadu	1044	1042	1029	1028	1012	1007	992	978
Madras	983	947	911	899	910	921	901	9[illegible]
Chengalpattu	986	994	986	980	970	972	960	94[illegible]
North Arcot	1024	1022	1013	1003	992	1003	989	971
South Arcot	1014	1014	1013	1004	992	997	984	96[illegible]
Dharmapuri	1016	1014	1008	994	982	979	968	961
Salem	1037	1023	1013	1007	1001	1001	982	96[illegible]
Coimbatore	1030	1027	1007	1007	994	993	966	957
Nilgiris	840	868	888	842	858	902	914	94[illegible]

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1.	2.	3.	4.	5.	6.	7.	8.	9.
Madurai	1046	1042	1033	1030	1019	1009	998	986
Tiruchirapalli	1063	1067	1049	1055	1081	1017	1008	992
Thanjavur	1105	1104	1083	1086	1056	1032	1016	994
amnad	1117	1109	1108	1108	1087	1090	1060	1042
Tirunelveli	1061	1067	1050	1072	1056	1057	1053	1042
anniyakumari	996	990	981	993	992	980	979	972

2.3 The following facts are seen from the figures in the above table No.1.

1) The masculinity of the enumerated population has been rising steadily since 1901 in India as well as in Tamil Nadu as a whole and in most of the districts of Tamil nadu.

2) Among all the districts in Tamil Nadu, Nilgiris is the only district, which shows upward trend in sex ratio from 840 to 944 since 1901 to 1971. This increasing trend exceptionally in this district requires a special study.

3) According to the latest 1971 census Ramanathapuram and Tirunelveli are the only two districts in Tamil Nadu in which the sex ratio is above 1000 (i.e. There are more number of females than males) Madras district is having the least sex ratio (i.e.) 904.

4) Moreover the correlation coefficient between the sex ratio of India and Tamil Nadu worked out for data in Table 1 indicates that a very high correlation (r=0.944) exists between them.

2.4 The following Table No.2 explains the extent of percentage decrease over a period of 70 years since 1901 to 1971 in the sex ratio in Tamil Nadu as well as in each district. In all districts the percentage decrease is more in urban areas than in rural areas. Considering rural areas the percentage decrease is maximum in Salem district (6.48) while it is minimum in Tirunelveli district (0.85). In urban areas, the maximum and minimum decreases are found in North Arcot (11.07) and Dharmapuri (2.50) respectively.

TABLE 2: PERCENTAGE DECREASEIN SEX RATIO IN TAMILNADU DISTRICTWISE (TOTAL, RURAL AND URBAN) BETWEEN 1901 and 1971.

State/ District	Total Rural Urban	(Sex ratio females per 1000 males) in 1901	1971	% decrease in sex ratio
Tamil nadu	T	1044	978	6.32
	R	1043	990	5.08
	U	1047	951	9.17
Madras	T	983	904	8.04
	U	983	904	8.04
Chingleput	T	986	948	3.85
	R	983	965	1.83
	U	1006	946	5.96
North Arcot	T	1024	971	5.18
	R	1017	972	4.42
	U	1093	972	11.07
South Arcot	T	1014	971	4.24
	R	1012	972	3.95
	U	1040	954	8.27
Dharmapuri	T	1016	961	5.41
	R	1013	970	4.24
	U	1088	952	2.50

1.	2.	3.	4.	5.
Salem	T	1037	968	6.65
	R	1034	967	6.48
	U	1063	983	7.53
Coimbatore	T	1030	957	7.09
	R	1029	974	5.34
	U	1041	926	11.05
Nilgiris	T	840	944	12.38
~~Madurai~~	R	1047	998	4.68
	U	1037	964	7.04
Madurai	T	1046	986	5.74
	R	1063	1000	5.93
	U	1037	964	7.04
Tiruchirapalli	T	1063	992	6.68
	R	1063	1000	5.93
Thanjavur	T	1105	994	10.05
	R	1005	994	1.10
	U	1108	993	10.38
~~Ramnadvur~~	T	1117	1042	6.71
	R	1121	1053	6.07
	U	1096	1011	7.76
Tirunelveli	T	1061	1042	1.79
	R	1060	1051	0.85
	U	1065	1023	3.94
Kanniyakumari	T	996	972	2.61
	R	992	969	2.32
	U	1059	990	6.52

T: Total R: Rural U: Urban

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CHAPTER III

THE DIRECTO EVIDENCE ON UNDER ENUMERATION OF FEMALE POPULATION

3.1 The direct evidence bearing on the hypothesis of sex selective enumeration in the Indian censuses as an explanation of the excess of males is examined in this chapter. This discussion is based mainly on the sample verification of the 1951 census in India.

3.2 In view of the almost continuous increase in masculinity of population, shown by censuses after 1901, it has often been argued that the hypothesis of greater under enumeration of females has been refuted by facts. Such an ~~arg~~ argument assumes, not unreasonably, perhaps, that successive censuses have improved in quality and completeness of coverage so that the increasing numerical imbalance of the sexes could not be due merely to the omission of females. The sample verification for India as a whole was taken after 1951 census was completed, covering 81.2 percent of the population of the censused area in the country. The following data relating to South India, consisting Madras, Mysore and Coorg as sub zones, indicate that eventhough there had been more of undercount of women than men, the sex ratio of population without adjustment and with adjustment for estimated undercount, dont make any significant difference to the observed masculinity of population.

(Zone: South India: (Containing Madras, Mysore and Coorg)

Sample verification of the 1951 census data)

Percentage Net under count		Sex ratios (Males per 1000 females)	
Males	Females	With adjustment for estimated undercount	Without adjustment for estimated under count
0.82	0.92	1000	1001

3.3 The net undercount in censuses is found for both men and women,. Eventhough the percentage is more for females than for men, the difference ~~between~~ is not significant so as to explain the reasons for masculinity in Tamil Nadu and for the declining trend in sex ratio in this state. Hence the hypothesis is rejected.

CHAPTER IV

INDIRECT EVIDENCE OF UNDER ENUMERATION OF FEMALE POPULATION

4.1 The indirect evidence on the hypothesis of omission of females from censuses, examined in this chapter, consists of an analysis of the age distributions and the marital status data from the 1951 and 1961 census in particular in respect of Tamil Nadu. It has been argued generally that the dips at ages 15-19 for females and 15-24 for males are due to their omission from censuses. It is impossible to distinguish the effect of underenumeration from those of age misreporting. In fact, error in age reporting by the informant or enforced guess work, regarding the age of the informant(when the informant is unable to give a definite answer) by the enumerator in the Indian censuses seem to be a probable major cause, if not complete, explanation of the dips and humps appearing in the Indian age distributions.

4.2 The hypothesis of substantial under enumeration of females in Tamil Nadu can be analysed with reference to the marital status data from the 1951 and 1961 census of the State, as furnished in following table No.3.

TABLE NO.3

Sex Ratios (Males per 1000 females) of the Total and specified Age and Marital Status groups of population in Tamil Nadu according to 1951 (10% sample) and 1961 Censuses.

	SEX RATIO				
Census Year	Sample total population	Currently married	Widowed and divorced	Persons aged 0-34	Persons aged 34 +
1.	2.	3.	4.	5.	6.
1951	999	959	300	988	1025
1961	1008	960	265	986	1064

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i) The currently Married:

In the absence of migration, polyandry or polgamy and under renumeration of either sex the sex ratio of the currently married must be unity, which is very nearly so if not equal in respect of Tamil Nadu. The data for the currently married don't suggest and undercount of females as far as Tamil Nadu is concerned.

ii) The widowed and divorced:

The sex ratio of the widowed and divorced is a composite result of the differential rates of marital dissolution, mortality and re-marriage. In India the percentage of divorced persons seems to be very low. A majority of the divorced, particularly males, probably remarry very soon. According to the mortality prevalent in the west, the chances of a woman becoming a widow are higher than of a man becoming a widower. But in India, it is not so.

The widowed and divorced never show a balance or an excess of males is probably due to the sentiment against widow remarriage, particularly after a certain number of children. Probably because of the large number of factors at work, the range of variation is wide.

4.3 The sex ratio in respect of age group 0-34 doe not support the hypothesis of under-enumeration of women. The sex ratio ofpersons aged 35 +, is consistent with the hypothesis of excess female mortality in the productive age group which will be confirmed in the subsequent chapter, rather than supporting the hypothesis of under enumeration of women. In the light of the direct and indirect evidences discussed above and in the previous chapter, the postulated undercount of females from censuses does not appear to be a plausible main explanation for the excess of males.

CHAPTER V

SEX RATIO AT BIRTH

5.1 The hypothesis that the declining trend of sex ratio of females to males in each consecutive census since 1901, in Tamil Nadu is due to a sex ratio at birth to be favourable to males is examined in this chapter. As the inter mixture of different racial strains over the centuries has left no pure races in India, the theory that the race is an important factor in determining the relative degree of masculanity at birth, is now believed to be based on unsatisfactory procedures and questionable as far as racial classification of Indian population is concerned. A statistical study of sex ratios of births registered in

75 territories with a relatively complete vital registration has confirmed the widely held belief that the masculinity ratio at birth varies generally between 104 and 107. The sex determination of a human fetus also seems to depend on the chromosomal characteristics of the male sperm uniting with the female ovum. Of course besides race, differences in climate, habits and customs of people also seem to influence several human characteristics in different areas and one cannot rule out the possible influence of these factors on the sex ratio at birth.

5.2 In the following table No.4 sex ratios in British India and Madras Province are given from the period 1891 to 1946.

Table No.4: Sex Ratios at birth according to registered live births.
(females per 1000 males)

Province	1891-1900	1901-10	1911-20	1921-30	1931-40	1941-46
British India	932	936	932	926	923	912
Madras	959	958	956	959	954	952
Tamil Nadu	x	x	x	957	952	947 937 (41-50) (51-

5.3 Analysing the above table, it is seen that the sex ratio at birth has been declining both for British India and Madras province. As far as Tamil Nadu is considered, the trend for it is also the same. The sex ratios at birth of both Madras Province and Tamil Nadu have been more than that of British India in all decades since 1891. There has been a steady rise in the masculinity of the population of Tamil Nadu as well as India as a whole, which may be attributed to higher sex ratio at birth for males, being one among other factors responsible.

5.4 Eventhough it is questionable to accept this as a conclusive evidence of the reliability of the reported sex ratio at birth in India as a whole due to errors arising in registration of vital events, such as sex selective registration and registration of still births, reputation maintained by Tamil Nadu for its efficient system of registration of vital events, stands on the way to reject

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the hypothesis that there is higher sex ratio of males over females at birth in Tamil Nadu. Yet to come to any conclusive decision, an analysis of data on proportion of sex selective registration, registration of still births etc. are required for which it is very difficult to get such data from the records. Special sample surveys are needed to study this aspect.

5.5 The following table illustrates the trend of sex ratio at birth in different districts of Tamil Nadu since 1921 to 1960.

Table 5.1: Districtwise sex ratio at birth from 1921 to 1960.

District	Sex ratio at birth (females per 1000 males), average for the decade.				
	1921-30	31-40	41-50	51-60	61-70
Tamil Nadu	957	952	947	937	929
Madras	950	952	949	958	N.A
Chingleput	956	952	949	945	N.A
North Arcot	957	958	948	941	N.A
South Arcot	965	937	939	927	N.A
Salem	957	958	939	932	N.A
Coimbatore	960	951	943	932	N.A
Nilgiris	964	960	965	960	N.A
Madurai	959	952	946	933	N.A
Tiruchirapalli	964	956	955	939	N.A
Tanjore	947	948	951	939	N.A
Ramnad	955	956	953	925	N.A
Tirunelveli	963	958	951	941	N.A
Kanniyakumari	914	919	935	927	N.A

N.A.: Not Available.

5.6 On an analysis of the above table is seen that the sex ratio at birth was declining in Tamil Nadu as a whole. The sex ratio was increasing in Madras district while it was osillating in Kanniyakumari District. In all other districts, it was decreasing.

5.7 In the following table sex ratio (females per 1000 males) at birth since 1921 to 1974 in Tamil Nadu is given.

Table 5.2: Sex ratio at birth in Tamil Nadu from 1921 to 1974.

Year	Sex ratio at birth (females per 1000 males)
1921	952
1931	948
1941	959
1951	939
1961	928
1962	931
1963	925
1964	925
1965	927
1966	925
1967	926
1968	931
1969	931
1970	936
1971	934
1972	936
1973	933
1974	931

The data furnished in the above table indicates that there is more of male births than female births in Tamil Nadu. Yet let us test statistically whether it is so.

Considering the sex ratios (females per 1000 males) for a series of continuous years, from 1961 to 1974 (table 5.2) can test a null hypothesis that there is no difference in the number of male and female births in Tamil Nadu

We can test the hypothesis with the help of "students" t distribution

formula in which $t = \frac{\bar{x} - M}{s} \sqrt{n-1}$

Where $\bar{x}$ is the mean of the sample,

M is the mean of the population,

s is the standard deviation of the sample and n is the size of the sample.

Under our null hypothesis, if the number of male and female births are equal, M = 1000. We have to test our null hypothesis that there is no difference in the number of male and female births in Tamil Nadu.

$\bar{x} = 929.93$

$s = 3.815$

$t = \frac{929.93 - 1000.00}{3.815} \times \sqrt{14-1}$

$= 66.231$

Referring to t table, we find the values 3.012 & 2.160 for 1 and 5 percent level of significance respectively for 13 degrees of freedom. As the value obtained (66.231) is much more than the above values, we have to reject our null hypothesis at both 5% and 1% level of significance. Hence we conclude that there is evidence which proves statistically that the male births are more than female births in Tamil Nadu.

CHAPTER VI

SEX DIFFERENTIALS IN MORTALITY

6.1 The excess of female mortality is the main factor, responsible for the imbalance of the sexes in Indian sub-continent as well as in Tamil Nadu. All discussions of the numerical imbalance of the sexes in India allude to the excess of female mortality over the male, particularly during reproductive ages as well. The stress and strain of frequent child bearing, with poor and in adequate medical care and the low value attached to female offspring, as a result of strong preference for male issues are both considered responsible for this anomalous situation.

6.2 It is a fact that as in other states, in Tamil Nadu also, there is excess of female mortality over the male, during reproductive ages. Eventhough this is also one of the factors for the declining trend in sex ratio of females to male population, it canbt be a conclusive evidence bearing on the hypothesis that excess female mortality is the main factor for the imbalance of the sex in Tamil Nadu.

6.3 The following may illustrate the point discussed above.

Table 6.1: Sex ratio at death (females per 1000 males) age group wise.

Age group	Year 1956	1958	1960
0	869	866	871
1-4	1041	1049	1071
5-9	985	992	1011
10-14	1078	1072	1056
15-19	1274	1345	1275
20-29	1529	1546	1483
30-39	1205	1220	1220
40-49	850	851	834
50-59	849	814	809
60 +	992	982	976
All ages	993	995	992

Sex ratio (at death) above 1000 in the age groups 10-14, 15-19, 20-29 and 30-39 indicating that more female deaths occur during reproductive period. This is true in respect of all states of India. But this is not a sufficient and exhaustive evidence for declining trend in sex ratio (female per 1000 males) in Tamil Nadu.

6.4 The sex ratio (females per 1000 males) (at death) since 1921 to 1974 in respect of Tamil Nadu is given in the following table.

Table 6.2 Sex Ratio (at death) from 1921 to 1974

Year	Sex ratio (females per 1000 males) at death
1921	977
1931	981
1941	990
1951	959
1956	993
1957	996
1958	995
1959	988
1960	992
1961	1021
1962	1006
1963	1004
1964	986
1965	971
1966	969
1967	952
1968	957
1969	962
1970	945
1971	931
1972	931
1973	911
1974	897

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6.5 The sex ratio at death (females per 1000 males) was increasing from 977 to 1021 since 1921 to 1961, and subsequently it is gradually falling down. This increase in sex ratio at death has been responsible for the fall in sex ratio (females per 1000 males) of the population of Tamil Nadu from 1029 to 992 from the year 1921 to 1961.

6.6 The natural increase has been always favourable for male over female and hence there is gradual decrease in sex ratio (females per 1000 males) in Tamil Nadu. Table 3 illustrates the above point clearly. This table number 6.3 illustrates how year after year the natural increase in birth over death is favourable to male population over female population and thereby being responsible for decrease in sex ratio (females per 1000 males) in Tamil Nadu over decades.

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TABLE 6.3: SEX RATIO IN THE NATION AT BIRTH From 1921 to 1974.

(Note: Birth and Death rates worked out for 1000 persons, sexwise)

Year	MALE			FEMALE			Males population in 000	Females population in 000	Natural increases in male population	Natural increases in female population	Increase in Male population over female population in a year
	Birth rate	Death rate	Natural increase rate	Birth rate	Death rate	Natural increase rate					
1	2	3	4	5	6	7	8	9	10	11	12
1921	26.0332	19.0039	7.0293	24.0837	18.0411	6.0426	10659	10969	74925	66281	8644
1931	33.9078	23.7040	10.2038	31.2927	22.6369	8.6558	11578	11894	129250	102952	26298
1941	34.9686	21.7524	13.2162	33.1540	21.2763	11.8777	13057	13211	172564	156916	15648
1951	26.4620	17.4628	8.9992	24.6639	16.6325	8.0314	15004	15115	135024	121395	13629
1961	27.6747	13.0990	14.5757	25.8969	13.4908	12.4061	16911	16776	246490	208125	38365
1971	25.9405	8.8997	17.0408	24.7658	8.4702	16.2956	20828	20371	354926	331958	22968
1972	25.1637	8.7675	16.3962	24.0895	8.1582	15.9313	21269	20814	346039	328438	17601
1973	24.1007	8.4331	15.6676	23.0308	7.8556	15.1752	21765	21298	336774	317996	18778
1974	22.7598	8.1074	14.6524	21.7303	7.4333	14.2970	22258	21779	320671	304531	16140

6.7 The generally improved health records, as indicated by the trend in death rates, reflects the rapid scientific and economic progress of Tamil Nadu. There has been a great development of public health facilities a widening spread of medical care services, and a unique record of advance on all fronts in medicine. Mention may be made of such specific factors as, water, food sanitation, immunization, particularly against childhood diseases and new surgical procedures. More food, more education, a greater appreciation of personal cleanliness and more time for recreation and leisure have also been responsible for reduction in mortality rates both for men and women.

6.8 It is important to note how the reduction in mortality rate of men has been responsible for decreasing sex ratio of women per 1000 men, in the course of the past decades. The following table illustrates how the percentage of widows among women aged 40 years and above has decreased over the decade since 1901 to 1961.

Table 6.4 : Percentage of widows among women aged 40 years and above.

Year	Percentage of widows among women aged 40 years and above
1901	61.0
1911	58.0
1921	57.4
1931	59.4
1941	N.A.
1951	48.9
1961	49.4

6.9 The percentage of widows among women aged 40 years and above has decreased from 61.0 percent in 1901 to 49.4 in 1961. (the figure for 1971 is not yet published) This decrease is mainly due to reduction in mortality rate of men which in turn is due to increase in expectation of life. The rates of remarriage after widowhood are, of course, an important determinant of the sex ratio of the widowed. As a result of social reforms, nowadays, widow re-marriages are encouraged and they are taking place at an increasing rate. This factor also contributes to the fall in the percentage of widows among women.

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6.10. To conclude, eventhough there is evidence on excess female mortality particulars in the age groups of 15-19, 20-29 and 30-39 reason for which is generally attributable to stress and strain of frequent child bearing during reproductive periods, this can't be the main reason for declining trend in sex ratio as far as Tamil Nadu is concerned as the sex ratio at death (females per 100 males) has never been above 1000, except during the years, 1961, 62 and 63. The increasing trend in sex ratio at death in general has been one of the reason for declining trend in sex ratio of Tamil Nadu and it took a turn from 1007 in 1951 to 992 in 1961. Natural increase of male population over female population and fall in percentage of widows among women aged 40 years and above, from 61.0 in 1901 to 49.4 in 1961 have been mainly responsible for the declining trend in sex ratio in Tamil Nadu.

CHAPTER VII

INTERSTATE MIGRATION

7.1 The hypothesis that migration is the factor responsible for the imbalance in the sexes in Tamil Nadu is examined in this chapter. Next to fertility and mortality, migration is an important factor contributing to the growth of population of a country. Economic development and industrialisation of several areas have brought about a shift in population from one area to another and a study of such shifts is an essential requirement of proper planning. The point for consideration is how far the net migration of female population in Tamil Nadu has affected sex ratio in this State.

7.2 In India, unlike in countries like Japan and Spain, the movement of population is not registered and therefore, one has to rely on census and vital registration data. Table No.7, given below, furnishes the total number of migrants males and females who were born in other states and migrated into Tamil Nadu, according to census 1961. This table illustrates that according to 1961 census there were more of male in migration than female, both from other States of India and abroad into Tamil Nadu and the difference between them was very small compared to the total male and female population in Tamil Nadu in 1961. It has therefore not contributed anything substantial to the declining sex ratio in Tamil Nadu.

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TABLE 7: TOTAL NO. OF MIGRANTS, MALES AND FEMALES WHO WERE BORN IN OTHER STATES AND MIGRATED INTO TAMIL NADU (Census 1961)

State/Union	Place of enumeration	Total No. of migrants	
		Male	Female
1	2	3	4
1. Andhra Pradesh	Rural	12169	27259
	Urban	43297	42892
2. Assam	Rural	41	14
	Urban	124	90
3. Bihar	Rural	162	176
	Urban	393	333
4. Gujarat	Rural	190	84
	Urban	4059	3118
5. Jammu and Kashmir	Rural	101	29
	Urban	191	99
6. Kerala	Rural	37342	29205
	Urban	124989	84982
7. Madhya Pradesh	Rural	292	221
	Urban	890	1146
8. Maharashtra	Rural	1354	967
	Urban	5057	4625
9. Mysore	Rural	13885	21820
	Urban	26419	26588
10. Orissa	Rural	82	38
	Urban	326	338
11. Punjab	Rural	735	192
	Urban	1284	801
12. Rajasthan	Rural	291	146
	Urban	5973	3488
13. Uttar Pradesh	Rural	805	326
	Urban	1775	1173

contd..21..

1	2	3	4
14. West Bengal	Rural	427	297
	Urban	1756	1509
Total (All States)	Rural	75348	96867
	Urban	228736	186704
Total (Rural + Urban)		304174	283571
Countries in Asia beyond India (including U.S.S.R.)	Rural	20475	19881
	Urban	18441	16848
	Total	38916	36729
Countries in Europe (excluding U.S.S.R.)	Rural	168	181
	Urban	1349	1025
	Total	1517	1206

7.3 When migration factor is analysed, it is necessary to consider both in and out migration and to take up net migration into consideration, to draw any conclusion regarding sex ratio. The following data show the migration estimates based on the survival ratio method and net inter-censal migration rate for Tamil Nadu.

Table 7.1 Migration estimates based on the Survival Ratio Method and Net Inter-Censal Migration rate for Tamil Nadu.

(i) Net Migration

1921-31		1931-41		1951-61		1941-51	
M	F	M	F	M	F	M	F
-229214	-48047	-243980	-247753	-708503	-513066	+317672	+236174

(ii) Net Migration Rate

1921-30		1931-40		1941-50		1951-60	
M	F	M	F	M	F	M	F
-22	-4	-21	-21	+24	+18	-47	-34

..22...

7.4 It is evident from the above table that there has been net out migration in all the decades, except in 41-51. The reasons for this change in the decade, 41-51 are not difficult to understand it we realise the difficult conditions underwhich Tamilians had to live in other countries as a result of the Second World War. Added to this, the post war spirit of nationalism in those countries made the local population to look at Indians as others and several economic disabilities have been placed on them. It is, therefore not surprising that there was a net in migration of 553,846 in the 1941-51 decade or 21 per 1000 of the 1941 population. In 1951-61, the position seems to have changed people of Tamil Nadu again and the mobility seem to have asserted itself with greater vigour and over 12 lakhs of persons migrated to other States in India. The net out migration during this decade works out to 4.06% of the 1951 population.

7.5 There was more male net out migration than female in all decades except in 1931 - 41 and 1941-51. If we consider all the 4 decades together there was net out migration of 864025 males and 562686 females. Hence this difference in net male out migration over female out migration can't contribute anything for the declining sex ratio in Tamil Nadu; in contrast it can contribute to reverse the situation. As the differences between the male and female net out-migration is small compared to the total population of Tamil Nadu, even the contribution made to reverse the declining trend is negligible. Hence, it is evident that migration can't be a factor responsible for the declining trend in sex-ratio of Tamil Nadu.

CHAPTER VIII

Summary and Conclusion

8.1 The results of the study are summarised in this chapter. The excess of males in India has persisted in all censuses and in fact male population was rising decade after decade. In respect of Tamil Nadu, there has been excess of females upto the end of the decade 1941-51 and subsequently reverse in sex ratio was observed according to the census 1961. The same trend in found in the 1971 census also and it is expected to be maintained in future years also.

8.2 The four hypothesis seeking to explain the reverse in sex ratio in Tamil Nadu in favour of male population since 1961 has been examined. The first hypothesis that the decreasing trend in the sex ratio of female to male population of Tamil Nadu is due to substantial omission of females from censuses is rejected as discussed in chapters III and IV, as the available direct and indirect evidences on the subject indicate that the estimated sex differentials in under enumeration cannot explain more than a very small amount of the inbalance of the sexes.

8.3 The next evidence bearing on the hypothesis that the masculinity at birth is higher in Tamil Nadu so as to be responsible, as one of the factors for declining trend in sex ratio of females to males has been examined in Chapter V. In all the previous decades the sex ratio at birth has been favourable to males and it seems to be declining so as to be favourable for masculinity in future and there is no evidence to reject the hypothesis. Hence it is accepted that sex ratio at birth being favourable to and it is one of the factors responsible for the declining trend in sex ratio of females to males in Tamil Nadu.

8.4 The hypothesis that sex differentials in mortality has been responsible for declining trend in females to males sex ratio of the population of Tamil Nadu has been discussed in Chapter VI. It is found out that there has been excess of female mortality in the reproductive age groups. But this can't be the main reason for the declining trend in sex ratio, as the sex ratio at death (females per 1000 males) has never been above 1000 except during the years 1961, 62 & 63. However the increasing trend, in general, in sex ratio at death from 977 in the year 1921 to 1021 in 1961 has been responsible as one of the reasons for the gradual decrease in the sex ratio of the females to males in Tamil Nadu, the ratio being 1044 and 978 in the years 1901 and 1971 respectively.

8.5 In addition, it has been discussed in detail that the natural increase of male population over female population and fall in percentage of widow among women aged 40 years and above have been mainly responsible for the declining trend in sex ratio in Tamil Nadu.

8.6 The hypothesis that migration has been responsible for the declining trend in sex ratio of Tamil Nadu has been analysed in Chapter VII. Migration estimates based on the survival ratio method and net Intercensal Migration rates proved that there has been generally more of male

net out migration that women and as such this can't be responsible for declining trend in sex ratio of Tamil Nadu.

8.7 The fall in sex ratio (females/1000 males) in Tamil Nadu has been discussed in the light of the above four aspect individually. Now we can analyse the combined effect of them upon fall in sex ratio in Tamil Nadu.

Of the four aspects analysed, with reference to fall in sex ratio, the first aspect namely, omission of females in census enumeration, has to be discarded when the combined effect is analysedas the data relating to that aspect is incomplete and insufficient in the sense, that it is available only for the whole of southeren zone comprising Andhra Pradesh, Tamil Nadu, Mysore and Coorg and added to that it is available for 1951 alone. As such we shall have to consider the other three namely, bith, death and migration.

In table No.3, the combined effect of birth and death has been indicated. It is seen that the natural increase of birth over death has always been favourable to male population. In table No. 7.1 the extent to which migrations can affect sex-ratio has been discussed. Now the combined effect of birth, death and migration on sex ratio can be analysed.

During the decade 1921-30, there was net out migration of both men and women and men exceeded women by 1,81,167. But during the above decade the excess of males over females due to natural increase had increased from 8644 in 1921 to 26,298 in 1931. The total excess of female net natural increase over male works out to 9,21,129. (Worked out from the published records in census book). Deducting the net excess male out migration of 1,81,167 from the above net natural increase of male over female, we get the net increase in male population over female population during the decade 21-30, which works out to 7,39,962.

Similarly the net increase of male population over female population increased by 1,34,353, 252,838 and 28,708 in the decades 31-40, 41-50 & 51-60 respectively. These consecutive increases in male population with cumulative effect from one decade to another has been the main cause for the gradual decrease in the fall of sex ratio (females/1000 males) in Tamil Nadu.

8.8 Sex ratio at birth varies from one country to another. The data published in United Nations, Demographic year Book 1959, reveal that it varies from 90.2 to 116.2. But in majority of the countries the ratio exceeds 100 and centred between 105 and 107. Birth and dea th rates in a country are likely to be affected by so many factors such as socio-economic, cultural and racial differences, food habits, varittions in climate etc. A research on variations in birth and death rates among male and females, in different regions of the world, based on the above mentioned factors, will be worth attempting by any scholar, which will be helpful to throw more light on the different factors responsible for sex differences and their trends in future in different parts of the world, which will be very useful for the human, Society as a whole in the world.

MADRAS : 600 006
DATED : 21st March '77.

R. PADMAVALLI,
DIRECTOR OF STATISTICS.

SPECIAL TESTS—*cont.*

THE ACCOUNT TEST FOR SUBORDINATE OFFICERS, PART I—NOVEMBER 1980—*cont.*

Second Class—*cont.*

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SPECIAL TESTS—*cont.*

THE ACCOUNT TEST FOR SUBORDINATE OFFICERS PART I—NOVEMBER 1980—*cont.*

Second Class—*cont.*

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SPECIAL TESTS—*cont.*

THE ACCOUNT TEST FOR SUBORDINATE OFFICERS, PART I—NOVEMBER 1980—*cont.*

Second Class—*cont.*

MADRAS—*cont.*

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7029 Pushpavalli, K., Junior Assistant, A.A.O./Ambattur/MES (D) North, Tamil Nadu Electricity Board.
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SPECIAL TESTS—*cont.*

THE ACCOUNT TEST FOR SUBORDINATE OFFICERS, PART I—NOVEMBER 1980.—*cont.*

Second Class—*cont.*

MADRAS—*cont.*

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7073 Rajamohan, A., Junior Assistant, Government Central Press, Madras-1.
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RAINFALL AND CROPPING PATTERNS

Volume VIII

KERALA

GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
NEW DELHI

RAINFALL AND CROPPING PATTERNS—STATE SERIES

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RAINFALL AND CROPPING PATTERNS

KERALA

INTRODUCTION

1·1 The human population of the country is estimated to rise from the 1971 Census figures of 548 million to 935 million in 2000 AD. This rise calls for increased production. Land resources being limited emphasis has to be placed on increasing productivity per unit area. Temperature and other climatic conditions being favourable for crop production throughout the year over most parts of the country, it is possible to grow more than one crop in a year provided water, the most important input, is available. In some parts of the country, the rainy season is long enough to provide scope for double cropping. This potential is yet to be fully exploited. There is scope for increasing irrigation resources in the country, but our estimates show that the area under irrigation is not expected to be more than 42 per cent of the total cropped area even in 2000 AD. as against 22 per cent in 1970-71. Therefore, judicious utilisation of direct rainfall and irrigation water, singly and in combination, will have to be thought of for increasing production.

1·2 Farming technology has so advanced that it is possible to increase crop yields even under rainfed conditions, but the choice of crops would have to depend upon the amount and distribution of the prevailing rainfall. Additionally, it will be necessary that the maximum possible quantity of rain water is conserved in ponds and pools situated either within the farm area or elsewhere, in soil profiles and underground storages so that the same could be readily used to save crops in times of water stress. Not only in rainfed farming but even under irrigated conditions, one will have to plan for the most economic and efficient use of water so as to derive maximum possible benefit from rainfall and reduce dependence on irrigation. This necessitates a close study of the existing cropping patterns *vis-a-vis* rainfall patterns aimed at determining the nature of changes needed in the former. The cropping patterns depend primarily on the soil and climatic factors but the evolution of a cropping pattern in course of time is the combined effect of soil, climate, food habits and requirements and economic factors. In the context of increasing production, it is necessary to examine the cropping patterns from a scientific angle and find out possible alternative patterns having higher potential. Accordingly, the Commission undertook a comprehensive study of the rainfall and cropping patterns of the country using taluk or tehsil as unit of area. It covered several other relevant factors such as orography, land use data, human and livestock populations, soil and climate, the object being to make, as far as possible, an integrated assessment.

1·3 Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report presents a consolidated account of the data collected together with analysis of their inter-relationships on all-India basis. In this analysis the Commission has been greatly benefited by the discussions with the concerned officers of State Governments. It was realised that by condensing the vast amount of information collected from each State into the small space of a chapter, many important and peculiar features of individual States were likely to be missed and hence the data and analysis of each State have been presented in separate volumes. The manner of presentation is similar to Chapter 14. It has also been considered desirable to include in each State volume the methodology and suggestions for future cropping patterns, which are practically the same as given in Chapter 14.

2 METHODOLOGY

2·1 The chief features of the study are (a) use of taluk or tehsil as unit of area for all basic data and analysis; (b) introduction of coded numerical forms to express patterns of distribution of monthly rainfall throughout the year, crop and livestock; (c) inclusion of information on orography, temperature, evapotranspiration, rainfall, soil, irrigation, land use, human and livestock populations and yield performance of crops, all of which influence in different ways and degrees the cropping patterns of a place and (d) presentation of coded information on rainfall, crops and livestock on 1 : 1 million scale maps.

Rainfall Patterns

2·2 A major feature of Indian rainfall is that the southwest monsoon season (June to September) accounts for 70 to 95 per cent of the annual rainfall throughout the country except in the south east peninsula and Kashmir and adjoining hill areas. The monsoon as well as the annual rainfall show large fluctuations from year to year but, as stated in Chapter 13 on Climate and Agriculture, there is, no significant evidence of any trend or periodicity in either of them. Considered in relation to crop production, the total

anfiual or seasonal rainfall does not have much significance and what is important is its distribution during the period of growth of different crops. A relevant question, therefore, is whether rainfall should be examined on a weekly, fortnightly or monthly basis. The coefficient of variation (CV) of monthly rainfall is as high as 40-50 per cent even in the rainiest month of July over most of the central, northern and eastern India In the south, excluding the west coast, CV is higher and varies from 60 to 100 per cent. The variability of weekly or fortnightly rain fall being still greater, makes the use of either of them undependable as indicators of rainfall distribuition. For a macro-study like the present, monthly rainfall data which are more dependable and also the most convenient to handle have been used.

2.3 In order to relate crop production with rainfall, certain norms have to be assumed depending on the duration of the crops and their water requirements. On the basis of available information and the fact that most crops mature in about 90 days, the following broad norms have been drawn up :

(i) Rainfall greater than 30 cm per month (cm pm) for at least three consecutive months would be suitable for a crop like paddy whose water need is very high.

(ii) 20-30 cm pm for not less than three consecutive months would be suitable for crops whose water need is high but less than that of paddy, for example, maize and black gram.

(iii) 10-20 cm pm for at least three consecutive months would be suitable for crops requiring much less water, e.g., bajra and small millets

(iv) 5-10 cm pm for three consecutive months would be just sufficient for crops which have low water requirements. e.g., *moth* (*P. aconitifolius*) and ephemeral grasses.

(v) Rainfall less than 5 cm pm for three consecutive months is not of much significance for crop production.

2·4 For denoting the year's rainfall distribution using monthly, totals, a convenient code in letter symbols with numerical subscripts explained below, has been evolved. The letters A to E in Table 1 indicate the ranges of monthly rainfall and the subscripts to these refer to the number of months having these ranges of rainfall e.g., A_2 indicates two months with rainfall greater than 30 cm pm. The ranges correspond to those stated in the preceding paragraph.

TABLE 1

Code for Rainfall Data

Symbol	Monthly rainfall cm pm
A+	Greater than 30
B	20—30
C	10—20
D*	5—10
E*	Less than 5

+An examination of monthly rainfall in the country shows that except for areas in the west coast and some hill stations in extreme north-east, normal monthly rainfall seldom exceeds 40 cm.

*In distributions containing ranges of rainfall covered by A or B termed briefly as A & B types amounts less than 10 cm are not so significant and their frequency is generally small. To reduce the number of combinations, D is omitted in A or B type distributions; instead E is used to denote less than 10 cm pm. Thus B_2 E_2 would denote two months of 20-30 cm pm and two months less than 10 cm pm rainfall.

The southwest monsoon months of June to September being the principal rainy season dominate the rainfall distributions of the country. To indicate the season's importance monthly rainfall distribution during June to September is shown in brackets in tha annual patterns. To the right of the bracket is the distribution for the post-monsoon month, namely, October to January and to the left that for the pre-monsoon months, namely February to May. In order to explain how such a coded rainfall distribution written in symbols with numerical subscripts has to be interpreted, a hypothetical example may be considered. D_1 E_3 (A_2 B_1 C_1) C_1 D_3, in which for each of the three periods, the symbols are in order of decreasing rainfall which is not necessarily the calendar sequence, can be explained as under :

(i) D_1 E_3 represents the period February to May in which one month's rainfall (usually May) is in the range of 5-10 cm and the remaining three months get less than 5 cm pm.

(ii) A_2 B_1 C_1 represents the period June to September, in which two months (usually July and August) get more than 30 cm pm rainfall, one month (September) gets 20-30 cm and the remaining month, i.e. June gets 10-20 cm.

(iii) C_1 D_3 represents the period October to January in which October gets 10-20 cm rainfall and the rest 5-10 cm pm.

Boundaries of Rainfall Zones

2·5 Since the differences in monthly, seasonal and annual rainfall are not large within short distances, linear interpolation of rainfall data is permissible. Rainfall data being point measurements, isolines for the same or nearly the same type of distribution of monthly rainfall can, therefore, be drawn. These isolines may not necessarily follow the boundaries of taluks which are taken to be unit of area in this

study and hence for delineation of boundaries the following procedure has been adopted :

(i) Where variations are small, isolines follow the taluk boundaries;

(ii) where variations are large, isolines delineate the zone boundaries; and

(iii) any taluk, more than three quarters of which lies outside of a zone is not considered a part of that zone.

2·6 If an identical distribution is observed over two or more adjacent taluks a pattern is said to have evolved and the area covered by it is distinguished as a zone and indicated suitably by a Roman numeral. Rainfall patterns have been identified for the whole country using the methodology described above. The data used for the analysis are the monthly normals of rainfall (1901 to 1950)[1] and the patterns and zones are depicted on all-India map which forms part of Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report.

Cropping Patterns

2.7 The basic data for the study of cropping patterns of the country are the areas under different crops in each of the taluks. A large number of crops are grown in a taluk but most of them occupy small areas, often less than one per cent of the total cropped areas of the taluk. With a view to limiting the number of crops constituting a pattern only those crops are considered which individually occupy 10 per cent or more of the gross cropped area of the taluk. In this process, several crops have to be excluded, even though they may be otherwise important. The minimum limit has been fixed at 70 per cent, so that the number of crops, which together cover at least 70 per cent of the gross cropped area, and in which none occupies less than 10 per cent, is not large. Trial computations have shown that in such distributions any crop occupying more than 10 per cent area is rarely omitted and the number of crops hardly exceeds five. When the same distribution holds good for two or more adjacent taluks, a pattern is obtained.

2.8 As in the case of rainfall, percentage area coverage by crops is expressed by means of numerical subscripts affixed to crop symbols shown in Table 2. The list of crops given below is comprehensive and will hold good for all the States.

TABLE 2

Crop Symbols and Area Intervals

Crop	Symbol
1 rice	Pd
2 wheat	W
3 jowar (kharif)	Jk
4 jowar (rabi)	Jr
5 bajra	B
6 maize	M
7 ragi	R
8 small millets	Mt
9 barley	Ba
10 Oats	Oa
11 gram	G
12 pigeonpea (tur)	T
13 pulses other than pigeonpea and gram	Pu
14 groundnut	Gn
15 oilseeds other than groundnut	O
16 cotton	C
17 jute	Ju
18 other fibres	Fb
19 sugarcane	S
20 potato	Pt
21 vegetables	V
22 fruits	Fr
23 tapioca	Ta
24 plantations	L
25 fodder	F
26 chillies	Ch
27 tobacco	To

TABLE 2 (*Contd.*)

Area interval (per cent)	*Subscript*
70 or more	1
50—70	2
30—50	3
10—30	4
less than 10	5

The crop code contains the crop symbol and the appropriate subscript. In writing crop distribution, the first crop has always the highest area but the rest may not necessarily follow the order of decreasing areas. For example, crop distribution, C_3 Jr_4 Mt_4, means that cotton area is 30-50 per cent, and jowar rabi and millets each occupies 10-30 per cent of the gross cropped area, the total being 70 per cent or more. Two or more taluks having the same distribution of crops constitute a pattern. Cropping patterns so derived have been indicated on maps of 1 : 1 million size.

Relative Yield Index of Crops

2.9 Besides the absolute figures the yield of a crop has also been expressed as per cent of all-India average which is called Relative Yield Index (RYI). Relative Yield Index values have been computed for the principal crops on the basis of (1968-69 to 1970-71) data available in the records of the Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation.

Livestock Patterns

2.10 The livestock patterns are relevant only insofar as these are related to production of fodder and feeds. As talukwise data were not available for the livestock Census, 1972, those of 1966 Census as published by the States have been used. The animals considered for livestock analysis are shown in Table 3 together with their symbols.

1 Memoirs of India Meteorological Department, Volume XXXI, Part 3, 1962.

TABLE 3

Livestock Symbols

Category	Symbol
cattle :	
male	
(over 3 years)	Cm
female	
(over 3 years.	Cf
young stock	
(under 3 years)	Cy
buffaloes :	
male	
(over 3 years)	Bm
female	
(over 3 years)	Bf
young stock	
(under 3 years)	By
sheep	S
goats	G
horses, mules and ponies	H
donkeys	D
camels	Ca
pigs	P

The livestock patterns are expressed in coded form in the same manner as the cropping patterns.

Soils

2·11 Soil data on a taluk basis are not a vailable for all the areas of the country. As such, soils have been discussed in a general manner using the traditional nomenclature in describing their characteristics.

Other Data

2.12 The sources of other data featuring in the study are given below :

item	*source*
taluk area	States' Census Reports 1971. or from the data furnished by the States in their land-use returns.
orography	Maps of the Survey of India and National Atlas Organisation
temperature	Climatological Tables of Observatories in India, India Meteorological Department, 1931—1960 normals
•vapotranspiration	Scientific Report No. 136 of the India Meteorological Department, 1971
human population	Census of India, 1971
irrigation and land use statistics	Basic data pertaining to la d utilisation statistics obtaine d from the States and refer mostly to 1969-70.

Presentation of Information

2·13 The tables required for following the text are given in the text itself at appropriate places, whereas the basic data are appended as follows :

APPENDIX 1	Land Use (1970-71) and Population Statistics.
APPENDIX 2	Districtwise Livestock Population—1966.
APPENDIX 3	Zonewise Information on Rainfall, Rainy days and Cropping Patterns
APPENDIX 4	Districtwise Area under Principal Crops

2.14 Rainfall, cropping and livestock patterns of each State are indicated on maps in the 1:1 million scale and given in Appendices 5, 6, 7 respectively. In the case of rainfall patterns, the zonal numbers in State maps have been given in Roman numerals and their all-India equivalents as used in Chapter 14 of the Commission's Report have been shown in three digit Arabic numerals within brackets.

Variation in Methodology in the case of Kerala

2.15 In the case of Kerala, land-use, crop and livestock statistics are available at the district level only. Data for the newly constituted district of Malappuram have been furnished by the State Government for 1970-71 only. It is also noted that the variations from 1969-70 for the other districts are negligible. Hence, the data analysed in this report relate to 1970-71 covering all the ten districts of the State. Livestock Statistics used, however, relate to the 1966 Census.

2.16 For the study of the orographical features, maps on the scale of 1:1 million were utilised. As a number of districts extend to the western Ghats, the height variations in the eastern taluks are very considerable from near sea-level to 1000-2000 masl. or higher. Such variations affect significantly the rainfall and temperature distributions and consequently the cropping patterns too. The areas of the districts have been taken from the Census Report for 1971. These differ slightly from the figures received from the State. In regard to soils, the latest soil map of Kerala State on a scale of 1:1 million, as prepared by the All-India Soil Survey Organisation has been used.

3 GENERAL FEATURES

Area

3.1. The area of Kerala State is 38,864 sq km. There were 10 districts in 1969-70 with areas ranging between 1,884 sq km and 6,389 sq km. Alleppey is the smallest and Kottayam the largest district in the State with 1,884 and 6,389 sq km area respectively.

3.2 There were 56 taluks in the State in 1969-70, their areas varying widely from 73 sq km (Kodungallur-Trichur districts) to 2,262 sq km (Ernakulam-Malappuram district). Fifty per cent of the taluks have areas less than 550 sq km and nearly one-third between 400 and 600 sq km. The width of the State ranges from 11 to 120 km.

Elevation

3.3 The principal orographic feature of the State of Kerala is the western ghats, running almost from north to south and having an elevation of 1,500 masl. (metres above sea level). The ghats are interspread by passes, the most well known being Palghat gap. Nearly 50 per cent of the area has an elevation of over 75 masl and the remaining 50 per cent is between sea level and 75 masl. Peak heights in the taluks close to the ghats range between 1,000 and 2,000 masl. Devikolam taluk has a peak higher than 2,700 masl.

Population

3.4 The population of the State is 21.35 million, corresponding to a density of 550 per sq km (three times higher than the all-India average). Kottayam district has the lowest density of 326 in the State, since 40 per cent of the geographical area of this district is under forests. Population density in other districts varies from 326 in Kottayam to 1,128 in Alleppey. According to 1971 Census, rural population of each district exceeds 70 per cent, the average for the whole State being 84 per cent. Districtwise population density and rural population per sq km is given in Table 4.

TABLE 4

Districtwise Density of Population and Rural Population in Kerala

District	Area sq km	Population density per sq km	Rural population per sq km	Rural population as percent of population
Cannanore	5706	415	358	86
Kozhikode	3729	565	414	73
Malappuram	3638	510	476	93
Palghat	4400	383	334	87
Trichur	3032	702	620	88
Ernakulam	3271	729	528	72
Kottayam	6389	326	293	90
Alleppey	1884	1128	958	83
Quilon	4623	522	481	92
Trivandrum	2192	1003	742	74

3.5 Distribution of taluks according to the population density per sq km is indicated below :

population density (per sq km)	51—100	101—200	201—300	301—400	401—500	501—600
number of taluks	1	3	8	1	5	4
population density (per oq km)	601—800	801—1000	1001—1200	1201—1400	1401—1600	
number of taluks	7	9	6	1	6	
population density (per sq km)	1601—2000		2001—2500		2501—3000	
number of taluks	3		1		1	

About seventy per cent of the taluks have density exceeding 500 and about thirty per cent have a density of more than 1,000. Cochin has the highest density of 2,775 followed by Trivandrum with 2,428. The lowest population density of 76 is in the taluk of Devikolam.

Land use

3.6 Twenty seven per cent of the total geographical area of the State is under forests. Kottayam, Quilon and Trichur districts have 40—45 per cent forest area followed by Kozhikode (35 per cent) and Malappuram (27 per cent). The remaining districts have below 20 per cent area under forests. Alleppey has practically no forests. Fallow lands and pasture lands are negligible. Barren uncultivable land is hardly 2 per cent. Land under non-agricultural use is 7 per cent. The net sown area is highest in Alleppey (87 per cent of total reporting area) followed by Trivandrum, Ernakulam and Palghat (65 to 70 per cent), Malappuram (58 per cent) and Cannanore, Kottayam, Quilon, Trichur and Kozhikode (around 40 to 50 per cent). The State average for net sown area is 56 per cent of reporting area. This is one of the few States where area sown more than once is as high as nearly a third of the net sown area. Land utilisation statistics for the State during 1970-71 is furnished in Table 5.

TABLE 5

Land Use Statistics—1971-72

KERALA

	Area ('000 ha)	Per cent of reporting area
geographical area	3859	
reporting area	3859	
forests	1055	27·3
land not available for cultivation :		
(*a*) area put to non-agricultural use	275	7·3
(*b*) barren and uncultivated land	72	1·9
(*c*) total	347	9·0
other uncultivated land excluding fallow land :		
(*a*) permanent pastures	28	0·7

TABLE 5 (*Contd*

	Area (1000ha)	Per cent of reporting area
(*b*) land under misc. trees, crops and groves not included in sown area	132	3·4
(*c*) cultivable waste land	80	2·0
(*d*) total	240	5·4
fallow lands		
(*a*) fallow lands other than current fallows	23	0·6
(*b*) current fallows	24	0·6
(*c*) total	47	1.2
net sown area	2172	56·2
total gross cropped area	2933	
area sown more than once	761	

	Jan	*Feb*	*Mar*	*Apr*	*May*	*June*
monthly rainfall	2	3	5	11	25	67
per cent	1	1	2	4	8	22

3.9 The average annual rainfall increases from about 150 cm in the extreme south to 300 cm along the coast near Alleppey and Cochin and is generally 300 cm or higher in the rest of the coastal belt. There are two pockets of low rainfall in Kottayam district, viz., Chinnar in Udumbanchola taluk (60 cm) and Marayur in Devikolam taluk (136 cm). The rainiest areas are Pirmed-Kottayam district (516 cm), and Neriamangalam—Ernakulam district (558 cm).

3.10 The nature of variability (coefficient of variation—CV) of monthly, seasonal and annual rainfall is given in Table 6.

TABLE 6

Variability of Monthly, Seasonal and Annual Rainfall in Kerala

Monthly rainfall :

January, February	CV exceeds 100 per cent
March	only in south of Cochin, CV is lower than 100 per cent.
April	in south of Cochin CV is 50—60 per cent and in the rest of the area CV is 60—80 per cent
May	coast—less than 80 per cent; rest including Trivandrum area 80—100 per cent
June	narrow coastal area 30 per cent; rest excepting Trivandrum area 30—40 per cent.; Trivandrum greater than 40 per cent
July	30—40 per cent
August	50—60 per cent excepting in Trivandrum area where CV is higher at 60—80 per cent
September	60—80 per cent
October	40 per cent or less in the central areas of the State & 40—50 per cent in the rest of the State
November	in south of Cochin CV is less than 60 per cent and 60—80 per cent elsewhere
December	in north of Cochin CV is greater than 100 per cent & in the rest of the State less than 100 per cent

3.7 The net irrigated area increased from 411 thousand ha (19.3 per cent) of the net sown area in 1967-68 o 423 thousand ha (19.5 per cent) by 1969-70. Fifty per cent of area is irrigated by canals and tanks account for 17 per cent. Eighty one per cent of the total irrigated area is under rice. Fiftyfive per cent each of the total areas under rice and sugarcane are irrigated.

3.8 Kerala State receives heavy rainall not only in terms of annual total but also in its distribution throughout the year. In fact, there is hardly a month of the year when some part or other of the State does not receive rainfall. The average annual rainfall of Kerala State is 300 cm distributed as follows :

July	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*	*Annual*
68	42	24	31	9	5	292
23	14	8	10	3	2	—

Seasonal variability :

January-February
in south of Cochin CV is greater than 100 per cent
and is below 100 per cent elsewhere

March—May
south of Cochin, 40—50 per cent
elsewhere 50—60 per cent rising to 80 per cent in a small coastal area in the extreme north

June—September
north of 11 °N Lat, CV is less than 20 per cent
rest 20—30 per cent

October—December
less than 40 per cent

Annual :

CV is less than 20 per cent in general but less than 15 per cent in a small area in the extreme north

Temperatures

3.11 The climate in the State is of the coastal type with small order of variations in temperatures (less than 5°C along coast and 10°C in the interior) during the year. The maximum and minimum monthly normals are as follows :

Station	*Range of normal monthly temperature* (°C)		
	maximum	*minimum*	*mean daily*
Calicut	28·2—32·9	22·0—25·8	26·2—29·4
Cochin	28·1—31·4	23·2—26·0	25·9—28·3
Trivandrum	29·2—32·7	22·3—25·1	26·2—28·8

3.12 The highest temperatures on any individual day have not exceeded 37.5°C in the coastal belt but in the interior, temperatures exceeding 40°C have been recorded. The lowest minimum temperatures have generally been between 15 and 20°C. Normals of daily maximum, daily minimum and daily mean temperatures for five observatory stations in Kerala are given in Table 7—9.

Potential Evapotranspiration (PE)

3.13 The annual values of PE range between 140 to 150 cm along the coast and 160-170 cm in the interior, but rainfall is very much higher over most of the area. For example, annual PE of Cochin is 142 cm but rainfall is more than twice (310 cm). Normal PE values for the observatory stations are given in Table 10. The climate is generally very humid.

TABLE 7

Normals of Daily Maximum Temperature (°C)

Satiton	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Annual
Calicut	31·7	31·9	32·6	32·9	32·5	29·5	28·2	28·7	29·5	30·4	31·1	31·6	30·9
Palghat	33·5	35·7	37·4	36·0	33·4	29·3	28·1	28·8	30·3	30·7	31·8	32·1	32·3
Cochin	30·6	30·7	31·3	31·4	30·9	29·0	28·1	28·1	28·3	29·2	29·8	30·3	29·8
Alleppey	31·9	31·9	32·6	32·7	31·6	29·5	28·8	28·8	29·4	29·7	30·3	31·4	30·7
Trivandrum	30·7	31·3	32·4	32·7	31·4	29·7	29·2	29·2	29·6	29·8	30·1	30·5	30·7

TABLE 8

Normals of Daily Minimum Temperature (°C)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Calicut	22·0	23·1	24·7	25·8	25·6	23·8	23·3	23·6	23·7	23·8	23·4	22·2	23·8
Palghat	22·3	23·0	24·5	25·3	24·8	23·3	22·6	23·1	23·1	23·4	23·0	22·2	23·4
Cochin	23·2	24·3	25·8	26·0	25·7	24·1	23·7	24·0	24·2	24·2	24·1	23·5	24·4
Alleppy	22·6	23·6	24·9	25·5	25·3	23·9	23·3	23·5	23·7	23·8	23·7	22·8	23·9
Trivandrum	22·3	22·9	24·2	25·1	25·0	23·6	23·2	23·3	23·3	23·4	23·1	22·5	23·5

TABLE 9

Normals of Daily Mean Temperature (°C)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Calicut	26·9	27·5	28·7	29·4	29·1	26·7	25·8	26·2	26·6	27·1	27·3	26·9	27·4
Palghat	27·9	29·4	31·0	30·7	29·1	26·3	25·4	26·0	26·7	27·1	27·4	27·2	27·9
Cochin	26·9	27·5	28·6	28·7	28·3	26·6	25·9	26·1	26·3	26·7	27·0	27·1	27·2
Alleppey	27·3	28·8	28·8	29·1	28·5	26·7	26·1	26·2	26·6	26·8	27·0	27·1	27·3
Trivandrum	26·8	27·3	28·4	28·8	28·3	26·5	26·2	26·4	26·6	26·7	26·6	26·7	27·1

TABLE 10

Normal Monthly and Annual Potential Evapotranspiration (PE)

(mm)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Calicut	138·9	141·8	170·2	153·8	139·2	99·2	92·9	102·3	111·2	113·2	115·0	127·5	1505·7
Palghat	165·7	162·2	192·0	162·5	151·3	108·2	100·3	111·7	123·2	114·7	121·9	149·0	1663·1
Cochin	136·8	135·0	159·2	138·0	122·5	94·5	95·6	100·6	106·1	106·3	107·4	121·8	1424·1
Alleppey	133·4	131·7	156·7	136·1	123·6	98·3	99.7	104·2	106·9	107·6	106·9	124·9	1430·3
Trivandrum	132·0	134·1	156·1	140·0	129·6	102·7	107·2	120·2	124·2	112·2	105·7	119·8	1484·4

4 RAINFALL ZONES TOGETHER WITH THEIR CROPPING AND LIVESTOCK PATTERNS

4.1 The State is divided into 9 rainfall zones, which are given below :

Rainfall Zone	*Rainfall Pattern*
I	$C_1 D_1 E_2 (B_1 C_3) B_2 E_2$
II	$B_1 C_1 E_2 (A_1 B_1 C_2) B_1 C_1 E_2$
III	$B_1 C_1 E_2 (A_2 B_1 C_1) B_1 C_1 E_2$
IV	$B_1 C_1 E_2 (A_3 B_1) A_1 B_1 E_2$
V	$A_1 C_1 E_2 (A_4) A_1 B_1 E_2$
VI	$C_1 D_1 E_2 (A_3 C_1) B_1 C_1 E_2$
VII	$B_1 E_3 (A_3 B_1) B_1 C_1 E_2$
VIII	$C_2 D_1 E_1 (B_2 C_2) B_1 C_1 E_2$
IX	$D_2 E_2 (C_4) B_2 C_1 D_1$

4.2 Zones VIII and IX are very small, even less than a taluk. These have been demarcated separately merely to indicate the difference in the distribution of rainfall compared to the neighbouring areas. The remaining seven zones are discussed in this section. These seven zones can be grouped in to the following three categories depending upon the dominance of a particular type of rainfall in the four months of SW monsoon :

Category of rainfall	*Rainfall zone*
BC	I
AB	II, III,
A	IV to VII

Rainfall zone I—$C_1D_1E_2(B_1C_3)B_2E_2$

4.3 Only one taluk, Neyyattinkara of Trivandrum district is in this zone, the remaining three taluks of this district being in zone II. The cropping pattern of the zone is : L_3 Ta_4 (Pd_4).

4.4 Area of the zone is 571 sq. km. and its population density 980.

4.5 The elevations range between sea-level and 300 masl. The soils are coastal alluvium, laterite, gravelly and red loamy.

4.6 The annual rainfall is a little over 150 cm. There are two months of heavy rainfall—June and October. June rainfall average is 29 cm (19 per cent) and that of October 26 cm (16 per cent of annual). The months of April to November receive about 10 cm pm rainfall. May accounts for about 10 per cent of annual rainfall. The zone is under the influence of both the south west monsoon (June to September) and north-east monsoon (October—December). Rainfall during June to September is 43 per cent and that dulring October-November 30 per cent of annual. The two seasons together (June to December) account for about 80 per cent of the annual rainfall. The zone has a long rainy season though in none of the months does average rainfall exceeds 30 cm pm. Rainfall rapidly rises in May and June and diminishes to 40 per cent of June in August and September. With the advent of October, rain increases to about twice that of September which level is maintained in November. There is a substantial reduction in rainfall in December to less than a third of November and it is negligible in January to March (2-3 cm pm.),

Rainfall Zone II—B_1 C_2 E_2 (A_1 B_1 C_3) B_1 C_1 E_2

4.7 There are only 3 taluks, namely, Chirayinkil, Nedumangad and Trivandrum of Trivandrum district in this zone and the cropping pattern is : L_3 Ta_4 (Pd_4).

4.8 The area of the zone is 1,616 sq km and population density, 1,003. According to 1971 Census-three-fourths of the population of the district is rural, and density of population 742. Talukwise, the population density of Trivandrum is 2,428 followed by Chirayinkil 1,209 and Nedumangad 465.

4.9 The heights vary from sea-level to 170 masl except in Nedumangad taluk where they vary from 100 and 1,900 masl. Laterite is the main soil of the district except for coastal sand or alluvium and red loamy soils in the eastern portion of Nedumangad taluk.

4.10 Twenty per cent area is under forests and 8 per cent land is put to non-agricultural use. Fallow lands and pastures are negligible, leaving a net sown area of 70 per cent, the intensity of cropping is high.

411 The annual rainfall of the zone is 200 cm in 105 days of rain. June is the month of maximum rainfall, receiving about 40 cm rain in 18 days and accounting for 20 per cent of annual average. Trivandrum gets 48 per cent and Attingal 52 per cent of annual rainfall during south west monsoon. October to December season gets 25 to 30 per cent of annual rainfall. April receives about 10 cm and May 21 cm. June gets 40 cm and July 26 cm rainfall but it diminishes rapidly to about 15 cm in September. There is marked rise in October to nearly double that of Sepetember. Nedumangad receives 34 cm rainfall (16 per cent of annual). The district (zones I and II) has a long rainy season with two periods of two consecutive months June-July and October-November having more than 20 cm pm.

4.12 Plantation crops occupy about 43 per cent of the cropped area, out of which, area of coconut is 32.5 per cent and of tapioca 27 per cent. Other plantation crops are pepper, rubber, arecanut and cashewnut. Area under rice is 39 thousand ha (16 per cent of the cropped area), the cropping pattern of the district is : L_3 Ta_4 (Pd_4).

4.13 Tapioca yield is only 86 per cent of all-India average. Coconut, which occupies a third of the gross cropped area of the district, has 108 per cent yield index (about the same as all-India). The yield of arecanut is only 92 per cent and less than all-India average, but significantly better than the rest of the State excepting Quilon district. Relative Yield Index of rice in the district is given below :

	Autumn	*Winter*	*Summer*	*Total*
area in '000 ha	18·6	20·2	0·8	39·6
R. Y. Index	130	139	61	131

Rice yields of autumn and winter crops are well above all-India averages.

4.14 Thirty-nine per cent of the total livestock of the district are goats and 47 per cent are cattle; females over 3 years being 21 and young stock 20 per cent. Male and Female buffaloes above 3 years account for 5 per cent each and pigs 1 per cent of the total. The number of sheep in the area is negligible.

Rainfall Zone III—B_1 C_1 E_2 (A_2 B_1 C_1) B_1 C_1 E_2

4.15 The taluks included in this zone are Karunagapally and Quilon of Quilon district.

4.16 The area of the zone is only 592 sq km and the population density of Quilon district is 522. Rural population is 92 per cent of the total and the average density for rural areas is over 480.

4.17 The zone is practically at sea-level, the maximum elevation being 100 masl. The soils are coastal alluvium. A detailed discussion of crops, land use etc. will be given under zone IV as most of the taluks are included in that zone and the variations in rainfall are not very large.

4.18 The annual rainfall is about 240 cm in 115-120 rainy days. Like zones I and II, the month of maximum rainfall is June with an average of 54 cm in 22 days accounts for 22 per cent of annual precipitation. All the months from April to November have more than 10 cm pm rainfall. April rainfall in 12-14 cm. Rainfall in May is double of April in 12 rainy days and accounts for 12 per cent of the annual average. July rainfall is 40 cm. August 25 cm and September about 20 cm. The other month of heavy rainfall is October with about 27 cm in 12-13 days followed by November (21 cm) in 10 days. December rainfall is 5 cm. May to August rainfall is 25 cm pm or higher. This pattern of rainfall is suitable for paddy. All the months from May to November get 20 cm or higher rainfall.

Rainfall Zone IV—B_1 C_1 E_2 (A_3 B_1) A_1 B_1 E_2

4.19 The districts and taluks included in the zone and their cropping patterns are as follows :—

Cropping Pattern	*Taluks*	*District*
L_3 Ta_4 (Pd_4)	Pathanapuram	Quilon
	Kottarakkara	,,
	Kunnathur	,,
	Pathanamthitta	,,
L_3 Ta_4 (Pd_4)	Maudikkara	Alleppey
	Chengannur	,,
	Karthigappally	,,
	Tiruvalla	,,
	Kuttanad	,,
	Ambalapuzha	,,
	Shertalai	,,
L_2 Pd_4	Vaikom	Kottayam
	Devikulam (3/4 W)	,,
L_3 Pd_3	Kunnathunad	Enrakulam
	Kanayannur	,,
	Cochin	,,

4.20 The area of the zone consisting of 16 taluks is over 9300 sq km. Most of the taluks are below 800 sq km in area. Pathanamthitta (1976 sq km) is the largest taluka in the zone.

4.21 In Quilon district, height variations are from 50 to 150 masl in Kottarakka and Kunnathur taluks and in Pathanapuram and Pathanamthitta from 100 to 1,900 masl. In the taluks of Alleppey district, there are practically no variations from near sea-level except in Chengannur where the maximum height is 161 masl. In Vaikom, maximum height is only 50 masl, but in Devikolam elevation ranges from 600 to 2700 masl. Cochin and Kanayannur are practically at sea-level, but in Kunnathandu, the heights increase to 450 masl from sea-level.

4.22 Forty-five per cent area of Quilon district is under forests and 6 per cent under non-agricultural use. Fallow lands are practically nil leaving 49 per cent net sown area. In Alleppey district, area under forests is almost nil. Seven per cent of land is used for non-agricultural purposes and 4 per cent is under tree crops. Net sown area is 87 per cent. In Ernakulam district, 17 per cent of the total area is under forests and 10 per cent is under non-agricultural use. Net sown area is 69 per cent. In Kottayam district, 40 per cent, of the area is under forests and four per cent is for non-agricultural use. Net sown area is 51 per cent.

4.23 Soils in coastal strip are coastal alluvium in the southern and peat and saline peaty soils in the northern parts. The soils of Quilon district are mostly red loamy or laterite. Elsewhere, soils are mainly laterite or laterite gravelly.

4.24 This is a zone of very heavy rainfall, the annual average being 300 cm in 135 rainy days. Excepting in Devikulam and Kunnathunad areas, June is the month of maximum rainfall. In the latter, July is the month of maximum rainfall. The total of June and July rainfall is more than 40 per cent of annual average in 45—50 rainy days. Generally, during April to November, the monthly average exceeds 10 cm pm the total rainfall exceeding 90 per cent of annual precipitation.

4.25 The principal crops of the zone are plantations, tapioca and paddy. Plantations dominate in this zone. Area under cardamom is maximum in Kottayam district with 12 per cent of the cropped area, which is also the highest in the State. Rubber occupies a significant area in this zone being 15 per cent in Kottayam and 9 per cent in Ernakulam. Coconut covers 20 per cent area in Kottayam and Ernakulam and 35 per cent in Alleppey. Coconut dominates and covers more than a third of the cropped area in Alleppey. The other crops hardly account for 1-2 per cent and the total is about 5 per cent only. The area under pepper is not large, being 22,600 ha only. In Quilon, rubber occupies 9 per cent of the area. The total area under plantations in Alleppey,

Quilon and Ernakulam is about the same being around 40 per cent. Tapioca is significant in Quilon with 27 per cent area. It is 5 to 10 per cent in the rest of the zone. Paddy occupies significant areas, being more than a third in Alleppey and Ernakulam districts and about 15 per cent alsewhere.

4.26 There are three paddy crops annually. The autumn (A) crop is sown in April-May and harvested in August-September the winter (W) crop is sown in August-September and harvested in January-February. The summer (S) crop is sown in November-December and harvested in February-March. The Relative Yield Index of these crops is given in Table 11. The yields of autumn crop are normal. Winter crop yields are better than the autumn crop, Quilon and Kottayam showing about 50 per cent higher than all-India average. Alleppey yields are lowest for autumn crop. Ernakulam has the highest area but the yield index is 125 only. Summer crop yields are lower than all-India in Quilon and Ernakulam. In Alleppey the yield index is 132. The lowest relative yield index is at 78 in Quilon. Alleppey yields are the highest for summer crop because of irrigation facilities. With good rainfall (30 cm pm) for 3 to 4 months, and irrigation covering 55 per cent of paddy area, the yields though above all-India average, cannot be regarded as very satisfactory. Arecanut yields are very low over the major portion of the zone. Coconut yields are also not high.

4.27 Of the total livestock, more than 60 per cent cattle are in Ernakulam, Kottayam and Quilon districts and as high as 77 per cent in Alleppey district. Goats account for about a quarter of the total livestock in this zone but there are no sheep. Male cattle population is small in Alleppey and Kottayam but is 10-17 per cent in Quilon and Ernakulam,. Quilon, Kottayam and Ernakulam have 7-10 per cent pigs. Female cattle on the whole dominate in Quilon, Alleppey and Ernakulam. The livestock patterns for the various districts in this Zone are :

Quilon	$\frac{C}{f_4}$	G_4	$\frac{C}{y_4}$	
Alleppey	$\frac{C}{f_3}$	$\frac{C}{y_3}$		
Kottayam	$\frac{C}{f_4}$	$\frac{C}{y_4}$	G_4	
Ernakulam	G_4	$\frac{C}{f_4}$	$\frac{C}{y_4}$	$\frac{C}{m_4}$

TABLE 11

Area and Relative Yield Index Values of Rice Crop in Zone IV

District	Area ('000 ha)				Relative yields index%			
	autumn	winter	summer	Total	autumn	winter	summer	Total
Quilon	21·3	29·3	1·3	31·9	115	152	78	134
Alleppey	21·0	22·0	41·7	85·7	92	109	132	144
Kottayam	7·0	24·6	17·5	50·0	122	145	106	145
Ernakulam	41·0	42·4	10·4	93·8	114	125	89	119

Rainfall Zone V—A_1 C_1 E_2 (A_4) A_1 B_1 E_2

4.28 The districts, taluks and their cropping patterns are given below :

Cropping Pattern	*Taluk*	*District*
L_2 Pd_4	Kottayam	Kottayam
	Meenachil	,,
	Changanacherry	,,
	Kanjirappally	,,
	Peermade	,,
L_3 Pd_3	Muvathpuzha	Ernakulam
	Thodupuzha	,,

4.29 The area of the Zone is 4,557 sq km. The areas of taluks vary from 262 to 1,308 sq km. The population density is 900-1000 in Kottayam, Changanacherry and Muvattupuzha followed by Mennachil and Kanjirapally (500), Thodpuzha (250) and Peermade (112).

4.30 The maximum elevation in Kottayam and Changanacherry is 100 m but it rises to 900 masl in Meenachil and 2,019 masl in Peermade.

4.31 Forest area is of the order of 40 per cent and net sown area about 50 per cent in Kottayam district.

4.32 Soils in the coastal taluks are coastal alluvium or peaty saline peaty soils in a narrow strip. Further to the east are laterite and gravelly soils and in the extreme east red sandy or loamy soils prevail.

4.33 This is a Zone of very heavy rainfall, exceeding 300 cm annually. Peermade gets about 500 cm of rainfall and Kanjirapally and Meenachil 400 cm. In the western half, June is the month of maximum rainfall and in the rest July. Rainfall of June and July accounts for 40 per cent of total rainfall in about 50 rainy days. All the months from April to November get more than 10 cm of rainfall and the total for these months is over 90 per cent of annual precipitation. During May to October more than 30 cm pm of rainfall is received. Rainfall in November is higher than 20 cm.

4.34 Crops of Kottayam and Ernakulam districts have already been discussed under previous zone. Yield of coconut in Kottayam district is 84 per cent and in Ernakulam 103 per cent of all-India average. The yields of arecanut in Ernakulam (RYI-37) and Kottayam (RYI-51) are very low. Yields of paddy in Kottayam are well above the all-India average. Ernakulam yield are lower than Kottayam but are above all-India average. RYI for Summer crop in Ernakulam is 89 only. This is low considering that rainfall distribution is not unsatisfactory.

4.35 An important feature of livestock population is the presence of pigs in Kottayam (10 per cent) and in Ernakulam (7 per cent). The pig population in all the other districts of the State is negligibe. Goats form more than a fourth of the total livestock. Next to goats, female cattle dominate in Ernakulam. The proportion of female cattle is more than that of goats in Kottayam.

Rainfall Zone VI—C_1 D_1 E_2 (A_3 C_1) B_1 C_1 E_2

4.36 The districts and taluks included in the Zone and their cropping pattern are as follows :—

Cropping Pattern	*Taluk*	*District*
Pd_2 L_4	Chittur	Palghat
	Alathur	,,
	Palghat	,,
	Ottapalam	,,
L_2 Pd_4	North Wynad	Cannanore

4.37 The area of the Zone is 4,037 sq km. The areas of taluks in this Zone exceed 500 sq km, highest being Chittur (1,155 sq km). Population density is less than 300 in Chittur and North Wynad and 500 to 600 in the rest of the Zone.

4.38 Ottapalam is practically close to sea-level, the highest elevation being only 150 masl. In the other taluks, heights vary up to 2,000 masl. There is a small area of coastal alluvium soils in Ottapallam. Elsewhere, red loamy and sandy soils prevail.

4.39 Area under forests is 15 per cent and under non-agricultural use 14 per cent in Palghat district. The net sown area is 64 per cent and area sown more than once is only 17 per cent.

4.40 The annual rainfall of the zone is generally more than 200 cm (except in Chittur) in about 100 rainy days. July is the month of maximum rainfall and together with June accounts for between 40 to 50 per cent of the annual rainfall. May to November are months with more than 10 cm pm rainfall. The total rainfall from May to November is more than 90 per cent of the annual. June to August are the only months with more than 30 cm pm rainfall. Rainfall averages of May, June and July are 15, 45 & 60 cm respectively. Rainfall decreases rapidly to 15 cm in September. During October, rainfall is 20-25 cm and in November 12-13 cm. Rainfall in December is only 3 cm and in January negligible.

4.41 The cropping pattern in Palghat district is paddy and plantation crops, i.e., Pd_2 L_4. The main crops under plantations are coconut (7 per cent) and cashewnut (3 per cent). Paddy is grown 3 times in a year as autumn, winter and summer crops. Area under paddy is 1.8 lakh ha, which is the highest in the State (autumn crop more than 1 lakh ha, winter crop 0.8 lakh ha and summer crop less than 4,000 ha). The sowing period for paddy is May and June for autumn crop, September and October for winter crop and February-March for summer crop. Palghat district is more or less fully covered by irrigation projects, which is the main reason for paddy being grown three times in a year.

4.42 The Relative Yield Index for different rice crops are : autumn 164 winter 168 summer 93, total rice crop 161. The high yields are due to good irrigation facilities, but when compared to rice yields in Tamil Nadu, where RYI of upto 200 has been recorded, the rice yields cannot be considered to be high.

4.43 Palghat has the highest proportion of male buffaloes (18 per cent). in the State. Goats are the largest in number with 24 per cent, of the total. Female cattle of over 3 years is 19 per cent and young stock 18 per cent. Male cattle form 12 per cent of the livestock population. Male buffaloes are used for ploughing, which accounts for the high percentage of their population. The general livestock pattern is G_4 Cf_4 Cy_4 Bm_4 (Cm_4).

Rainfall Zone VII—B_1 E_3 (A_3 B_1) B_1 C_1 E_2

4.44 The districts, taluks and the cropping patterns included in the zone are :

Cropping Pattern	*Taluk*	*District*
L_2 P_4	Kasaragod	Cannanore
	Hosdurg	,,
	Taliparamba	,,
	Tellicherry	,,
	Cannanore	,,
	Badagara	Kozhikode
	Quilandy	,,
	South Wynad	,,
	Kozhikode	,,
L_3 Pd_3 (Ta_4)	Ernad	Malappuram
	Tirur	,,
	Perintalmanna	,,
	Ponnani	,,
Pd_2 L_4	Mannarghat	Palghat
d_3 L_3	Talappilly	Trichur
	Trichur	,,
	Chavakkad	,,
	Mukundapuram	,,
	Kodungallur	,,
L_3 Pd_3	Parur	Ernakulam
	Alwaye	,,

4.45 This is the biggest rainfall zone in the State with an area of 16,886 sq. km. It extends from Parur and Alwaye taluks of Ernakulam district in the south to Kasargod in the north. It includes 21 taluks in six districts. five of which are in Cannanore and the whole of Kozhikode, Malappuram and Trichur districts. The areas of the taluks vary very widely from 73 sq km (Kodungallur) to 2,262 sq km (Ernad). About half the number of taluks are between 300 and 1000 sq km and seven taluks exceed 1,000 sq km. Mannarghat and North Wynad have the lowest population density (170—180) in the zone. South Wynad has a population density of 200, North Cannanore 300 to 400 and most of the coastal belt a little more than 1,000.

4.46 The percentage area under different height ranges according to 1961 Census Report, is given in Table 12. In Mannarghat the heights vary from 50 to 2,383 masl and in Ernad from 50 to 2,554 masl. Kasargod, the northernmost taluk, has height variations from 80 to 2,000 masl.

TABLE 12

Elevations of Districts in Zone VII

(Per cent of total Area)

District	Elevation		
	76 m	7·6 m to 76 m	Less than 7·6 m
Cannanore	52·7	41·4	5·9
Kozhikode	44·2	49·1	6·7
Trichur	33·3	51·4	15·3
Palghat	54·1	44·5	
Ernakulam	30·0	52·7	17·3

4.47 In the coastal belt, coastal alluvium or sandy soils prevail. These are succeeded by laterites/gravelly soils, the extreme eastern part having red loamy or red sandy soils.

4.48 The area under forests exceeds four lakh ha. Trichur district has 44, Kozhikode 35 and Cannanore only 11 per cent of the area under forests.

4.49 Rainfall in Kozhikode and Cannanore is more than the southern portion, more than 300 cm., but the pattern of monthly distribution is the same all over the zone. In south of Trichur, June is the month of maximum rainfall but elsewhere, it is mostly July. June and July together account for 55 per cent of annual rainfall in the northern portion and 50 per cent in the rest of the zone. There are two peak rainfall periods. (i.e. June/July and October) in Cannanore and thereafter the rainfall recedes. The months June to August get more than 30 cm pm rainfall whereas rainfall averages are in September 24 cm, in October 30 cm upto Kozhikode decreasing to 20 cm in the north and in November, 15 cm. except in Cannanore, where it is about 11cm. The months May to November get more than 10 cm pm rainfall and the total precipitation for the months May to November exceeds 80 per cent of annual rainfall.

4·50 As the zone covers almost four districts and one or two taluks each in two other districts, there are some variations in the cropping patterns which are given below :

District	*Crop Distribution**
Trichur	Pd_{47} L_{35} Ta_3
Malappuram	Pd_{37} L_{42} Ta_9
Kozhikode	Pd_{24} L_{63} Ta_4
Cannanore	Pd_{27} L_{60}
Palghat	Pd_{55} L_{15} Ta_3
Ernakulam	Pd_{34} L_{42} Ta_5

4.51 Paddy is common throughout and the percentage varies from 24 to 55 of the respective cropped areas of the districts. Rainfall distribution is good for one crop with three consecutive months, getting more than 30 cm pm. It is, however, seen that three crops of Paddy are taken in a year. The acreage in the four main districts included in the zone is about a lakh ha except in Kozhikode, which has about 65,000 ha. Tapioca area is 9 per cent in Malappuram but elsewhere it is 5 per cent or below.

4.52 Percentage area under various plantation crops to total area is given in Table 13. Coconut is the dominant crop covering more than 25 per cent of area. In Kozhikode and Cannanore districts, plantation crops occupy above 60 per cent of the cropped area.

TABLE 13

Area Under Different Plantation Crops in Zone VII—1970-71

('000 ha)

	Pepper	Cardamum	Arecanut	Cashewnut	Coconut	Tea	Coffee	Rubber	Total
Trichur	0·3	—	5·4	3·3	32·3	0·2	—	3·4	34·9
Malappuram	1·3	—	5·7	5·6	25·4	0·1	—	3·8	41·9
Kozhikode	6·6	0·4	3·0	2·1	34·2	1·4	7·3	7·3	62·6
Cannanore	14·1	0·1	3·8	11·0	25·5	0·4	1·3	4·1	60·3

4.53 The area and Relative Yield Index of rice in different districts are given in Table 14. The yields of rice in the zone, except in Kozhikode district and of summer crop in the entire zone (except in Trichur Dist.), are significantly above all-India levels. The rainfall distribution is favourable for one crop since June to August receive more than 30 cm pm rainfall. As paddy is grown on large areas more than once in a year, irrigational facilities must be available to obtain even the present yields.

4.54 Goats account for more than a quarter of the total livestock except in Cannanore, where they are less than 20 per cent. Female cattle population increases from about 19 per cent in Trichur district to 25 per cent in Kozhikode and to 31 per cent in Cannanore. Male cattle population is about 15 per cent. Male buffaloes account for only 5 per cent in Kozhikode (old undivided) and 9 per cent in Trichur. The pattern in Cannanore is C_4 Cy_4 G_4 and in the rest of the zone G_4 Cf_4 Cy_4 Cm_4.

TABLE 14

Relative Yield Index of Rice of Zone VII

	Autumn	*Winter*	*Summer*	*Total*
Trichur	119	119	105	121
Malappuram	124	117	92	119
Kozhikode	84	105	87	94
Cannanore	132	113	93	122

*The subscripts to the crop codes represent the percentages to the gross cropped area.

5 FUTURE CROPPING PATTERNS—SOME OBSERVATIONS

General

5.1 In the foregoing sections, the existing rainfall zones, cropping and livestock patterns in the State have been discussed. Among other information that on soils, which ought to play an important role in determining cropping patterns, is lacking in such details as is required for this analysis. Data on orography and population density have featured in this analysis but their exact role on cropping and livestock patterns could not be brought out due to the lack of more detailed information. Studies and analysis indicated in the preceding sections are important for the guidance they may give in decisions regarding suitable cropping and livestock patterns *vis a vis* rainfall patterns. The greater the accuracy of the primary information, and the more detailed such information is, the more useful the data would be in drawing up the most efficient cropping and livestock patterns in an area or a zone. For this purpose the following procedure is suggested :

(i) Delineation of rainfall zones;

(ii) Identification of the existing cropping patterns;

(iii) Assessment of area needed for each crop and its ideal distribution.

(iv) Comparison of (iii) with (ii) in order to determine possible changes; and

(v) Consideration of other related factors like *soil, irrigation facilities,* density of population, livestock patterns and the arriving at the future cropping patterns.

5.2 The methods of delineating rainfall patterns or zones and cropping patterns have been fully discussed in Section 2. For the purpose of locating suitable areas for a crop, soil and topography of the land are important factors. The approximate area to be put under each crop will be decided by the demand for it at the State and national levels, both for internal consumption and export. The departments responsible for crop planning of a State should, therefore, be cognisant of the demand for a crop, so that production efforts are not rendered futile for lack of demand and marketing facilities. The part played by each of the factors mentioned in item (v) in paragraph 5.1 in deciding cropping patterns has already been discussed. For this purpose not only detailed data but also knowledge about the correlation between these factors and crop performance would be necessary. Knowledge gained, through long experience, by farmers would also be most helpful.

5.3 It may be mentioned that the rainfall intervals which form the basis of identifying rainfall patterns are subject to minor modifications. Thus, the condition that not less than 30 cm pm of rainfall for three consecutive months is good for paddy may not be rigorously adhered to. If the soil is favourable and has high water retention capacity or, what is more, important, water management is efficient and makes for economic water use, rainfall lower than 30 cm pm for three months may sustain a good crop of paddy.

5.4 The choice of a cropping pattern is not decided by the farmer only on technical grounds. He is also guided by the profitability of the crops or requirements for his household consumption. Farmers may not be inclined to accept a crop unless the necessary inputs and infrastructure are assured. Of all the inputs water is the most important as is made evident by the spread of groundnut in the country, sugarcane in Gujarat maize and cotton in Karnataka and recently of wheat in West Bengal. These are excellent instances of the manner of introduction of new crops in the cropping patterns of a State or a region.

Some observations pertaining to Kerala

5.5 In so far as cereal crops are concerned, rice fits in the agroclimatic conditions prevailing in Kerala and as many as 2 to 3 crops of rice can be taken in a year. The other starchy food crop which is a speciality of Kerala is tapioca. About half of the country's production of dry ginger also comes from this State. But for these field crops, Kerala's agriculture pertains mainly to plantation crops. The ridge of the western ghats which passes through this State provides enough area on slopes of hills for various kinds of plantation crops. More than 90 per cent of the area under and production of pepper and rubber in the country is accounted for by Kerala. The State is also important for arecanut, cardamom and coconut accounting for 50 to 70 per cent of the country's area under these crops. Area in the State under Coffee and cashewnut account for about 20 per cent of the country's area under these crops. About 10 per cent of the area under tea in the country also lies in this State.

5.6 An ideal distribution of different plantation crops over the hills should be coffee and tea at higher elevations followed in descending order of elevations by cashew, rubber, arecanut and coconut. Arecanut and coconut are taken near the foothills or even on flat lands. This order is scientifically not followed all over the state. It has been observed that the coffee species *arabica* and *robusta* which require different altitudes for best growth, are found wrongly planted with respect to elevation at some places. This applies equally to other plantation crops. There is need to systematise plantations over hill slopes and to this extent, cropping patterns in different places may undergo a change.

5.7 The new plantation crops for which potentialities exist in Kerala are oilpalm, clove, nutmeg and cocoa. Provision will have to be made for these crops in Kerala's future cropping patterns.

5.8 It has already been stated that three crops of rice are taken in this State in a year. A good amount of rainfall in this State is received during a period ranging from 5 to 9 months. It is felt that two rainfed crops of rice can be taken in this State. The third crop is invariably taken with the help of irrigation water. Improved technology will make it possible to get the desired level of production in future even from two crops. Therefore, if the third crop could be dispensed with, a good deal of irrigation water could be diverted for growing many other crops. In fact, the State needs the growing of various vegetable

and fodder crops. This requires to be considered by the agricultural scientists while planning the future cropping patterns. Possibilities of fitting in various crops before and after rice need examination.

5.9 Fooder needs are likely to increase in future with livestock development and, therefore, all possible areas should be explored for growing fodder crops. In this connection, it is worth considering how for grasses could be grown in the areas where no tree can grow. In so far as the lower slopes are concerned, tapioca is already being grown. However, this is done without adopting adequate soil conservation methods, in the absence of which soil is likely to be worked out. Cultivation of tapioca needs to be encouraged in order to supplement the country's increasing cereal needs. The State already accounts for about 85 to 90 per cent of the all-India area and production of the crop. Further increase in area under this crop and improvement in the yield standards have to be attempted. The area under this crop in Kerala is also likely to increase and to that extent cropping patterns would have to be adjusted. When this is done, soil conservation aspect should also be kept in view. Various kinds of yams and other tuber crops are also of promise for this State and should be encouraged.

5.10 Recent experiments are leading to trends in favour of mixed cropping of various plantation crops. In places, a combination of crops like banana, cardamom, pepper, arecanut and cocoa has been found to be quite efficacious and profitable. It is desirable that the future cropping patterns should reflect such combinations.

APPENDIX 1

Land Use (1970-71) and Population Statistics

KERALA

(Area thousand hectares)

district/taluk	population 1971		forests	nac	cw	pp & gl	mtc &g	fallow lands	net area sown
	total	per sq km							
Trivandrum			44	18	1	1	1	1	152
			(20)	(8)	(0·3)	(0·3)	(0·3)	0·3)	(70)
Neyyattinkara	559,488	980							
Chirayinkil	460,473	1,209							
Nedumangad	430,779	465							
Trivandrum	747,866	2,428							
Quilon			211	26	2	1	0·4	1	228
			(45)	(6)	(0·4)	(0·2)	(0·1)	(0·2)	(49)
Karunagappally	321,164	1,515							
Quilon	677,646	1,783							
Pathanapuram	310,659	252							
Kottarakkara	421,406	763							
Kunnathur	291,796	915							
Pathanamthitta	390,150	198							
Alleppey			1	13	1	0·2	8	2	163
			(0·3)	(7)	(0·5)	(0·1)	(4)	(1)	(87)
Mavelikkara	323,277	1,134							
Chengannur	232,218	1,155							
Karthigappally	330,506	1,469							
Thiruvalla	342,736	988							
Kuttanad	187,698	706							
Ambalapuzha	329,661	1,842							
Shertalai	379,626	1,186							
Kottayam			253	26	15	4	4	4	320
			(40)	(4)	(2)	(1)	(1)	(1)	(51)
Vaikom	252,288	791							
Devikolam	134,350	76							
Kottayam	497,156	921							
Meenachil	351,879	487							
Changanacherry	265,347	1,013							
Kanjirappally	172,360	491							
Peermade .	146,841	112							
Udumbanchola	264,913	247							

— = nil or negligible

nac = not available for cultivation

cw = culturable waste

pp & gl = permanent pastures and other grazing lands

mtc & g = miscellaneous tree crops and groves not included in net area sown

NOTE : Figures in brackets represent percentages to total reporting area.

APPENDIX 1 (*Contd.*)

district/taluk	population 1971		forests	nac	cw	pp & gl	mtc &g	fallow lands	net area sown
	total	per sq km							
Ernakulam			**55**	**32**	**4**	**2**	**0·3**	**6**	**219**
			(17)	(10)	(1)	(1)	(0·1)	(2)	(69)
Kunnathunad	292,113	431							
Kanayannur	498,884	1,545							
Cochin	396,849	2,775							
Mavattupuzha	370,534	929							
Thodupuzha	241,575	248							
Parur	281,047	1,464							
Alwaye	302,176	927							
Cannanore			**66**	**81**	**18**	**12**	**88**	**12**	**300**
			(11)	(15)	(3)	(3)	(15)	(2)	(52)
North Wynad	129,335	173							
Kasaragod	353,819	364							
Hosdrug	329,201	333							
Tellicherry	615,953	510							
Cannanore	501,766	1,164							
Talliparamba	435,090	327							
Palghat			**67**	**59**	**4**	**3**	**14**	**6**	**284**
			(15)	(14)	(1)	(1)	(3)	(1)	(65)
Chittur	313,973	272							
Alathur	295,762	520							
Palghat	369,001	513							
Ottapalam	522,027	617							
Mannarghat	184,579	168							
Trichur			**132**	**19**	**2**	**1**	**5**	**2**	**139**
			(44)	(7)	(·7)	(0·3)	(1·6)	(·7)	(46)
Talappilly	403,795	609							
Trichur	588,364	925							
Chavakkad	433,346	1,416							
Mukundapuram	590,317	449							
Kodungallur	112,975	1,548							
Malappuram			**98**	**18**	**24**	**2**	**8**	**1**	**209**
			(27)	(5)	(7)	(1)	(2)	(0·1)	(58)
Ernad	715,496	316							
Tirur	653,793	983							
Perintalmanna	273,101	540							
Ponnani	213,972	1,075							
Kozhikode			**129**	**55**	**10**	**3**	**5**	**7**	**159**
			(35)	(15)	(3)	(1)	(1)	(2)	(43)
Badagara	409,771	745							
Quilandy	468,714	619							
South Wynad	284,515	206							
Kozhikode	943,249	918							

APPENDIX 2

District-wise Livestock Population—1966

KERALA

(thousands)

district	cattle			buffaloes			sheep	goats	horses & ponies	mules	donkeys	camels	pigs	total livestock
	m	f	ys	m	f	ys								
Trivandrum	18	66	64	16	18	9	1	128	..	..	..	..	4	324
	(6)	(21)	(20)	(5)	(5)	(3)	(0·2)	(39)					(1)	
Quilon	52	160	149	12	10	5	3	137	..	..	..	..	1	528
	(10)	(30)	(28)	(2)	(2)	(1)	(1)	(26)					(0·1)	
Alleppey	18	167	141	8	5	2	1	80	..	..	..	..	..	423
	(4)	(40)	(33)	(2)	(1)	(1)	(0·2)	(19)	..	..				
Cannanore	74	172	154	19	18	9	1	102	..	..	..	..	3	552
	(13)	(31)	(28)	(3)	(3)	(2)	0·1)	(19)					(1)	
Palghat	83	124	116	116	28	25	5	158	..	..	..	..	0·4	655
	(12)	(19)	(18)	(18)	(4)	(4)	(1)	(24)					(0·1)	
Kozhikode	101	158	133	31	23	13	..	164	..	..	..	..	1	623
	(16)	(25)	(21)	(5)	(4)	(2)		(26)					(0·2)	
Malappuram	na													
Trichur	57	79	87	35	19	12	..	116	..	..	..	..	1	405
	(14)	(19)	(21)	(9)	(5)	(3)		(28·6)					(0·4)	
Kottayam	34	184	165	6	8	5	1	160	0·1	..	0·1	..	64	625
	(6)	(29)	(26)	(1)	(1)	(1)	(0·2)	(26)	(neg.)	(—)	(neg.)	(—)	(10)	
Ernakulam	83	110	110	11	7	3	1	143	..	..	..	..	37	506
	(17)	(22)	(22)	(2)	(1)	(1)	(0·2)	(28)					(7)	

m = male

f = female

ys = youngstock

— = nil or negligible

NOTE : Figures in brackets represent percentages to total livestock population.

APPENDIX 3

Rainfall and Cropping Patterns

KERALA

cropping patterns	district / taluk	geographical area (sq km)	elevation (masl) max	elevation (masl) min	annual rainfall total (cm)	annual rainfall rd	mmr	mr	md	*consecutive months a	*consecutive months b	*consecutive months c
	Rainfall Zone—I	..	..	..	..	..	.. *Rainfall Patterns—C_1 D_1 E_2 (B_1 C_3) B_2 E_2*					
L_3 Ta_4 (Pd_4)	**Trivandrum**											
	Neyyattinkara	571	300	S.L.	165	91	6	48	28	4—8	149	81
	Rainfall Zone—II	..	..	..	..	..	*Rainfall Pattern—B_1 C_1 E_2 (A_1 B_1 C_2) B_1 C_1 E_2*						
L_3 Ta_4 (Pd_4)	**Trivandrum**											
	Chirayinkil	381	150	S.L.	196	100	6	70	26	4—8	182	93
	Nedumangad	927	1869	100	224	112	6	69	34	4—8	205	101
	Trivandrum	308	167	S.L.	181	102	6	58	34	4—8	166	92
	Rainfall Zone—III	..	..	..	..	..	*Rainfall Pattern—B_1 C_1 E_2 (A_2 B_1 C_1) B_1 C_1 E_2*						
L_3 Ta_4 (Pd_4)	**Quilon**											
	Karunagapally	212	10	S.L.	246	115	6	96	41	4—8	232	107
	Quilon	380	100	S.L.	240	120	6	91	42	4—8	226	111
	Rainfall Zone—IV	..	..	..	..	..	*Rainfall Pattern—B_1 C_1 E_2 (A_3 B_1) A_1 B_1 E_2*						
L_3 Ta_4 (Pd_4)	**Quilon**											
	Pathanapuram	1234	1200	100	316	138	6	112	46	3—9	303	132
	Kottarakkara	552	150	50	266	134	6	97	45	4—8	266	123
	Kunnathur	390	150	27	294	141	6	106	45	3—9	282	134
	Pathanamthitta	1976	1922	100	331	143	6	111	45	3—9	314	135
	Alleppey											
	Maudikkara	285	100	10	319	141	6	128	48	4—8	300	131
	Chengannur	201	161	10	306	142	6	118	47	4—8	286	131
	Karthigapally	225	10	S.L.	285	130	6	115	44	4—8	267	120
	Thiruvalla	347	100	10	309	145	6	120	48	4—8	291	134
	Kuttanad	266	10	10	na							
	Ambalapuzha	179	10	S.L.	282	132	6	112	46	4—8	263	121
	Shertalai	320	10	S.L.	287	132	6	124	48	4—8	272	123
L_2 Pd_4	**Kottayam**											
	Vaikom	319	50	10	306	128	6	136	47	5—7	283	115
	Devikolam (3/4W)	1331	2695	600	292	150	7	124	49	4—8	277	139
L_3 Pd_3	**Ernakulam**											
	Kunnathunad	678	450	13	348	139	7	157	52	4—8	336	132
	Kanayannur	323	10	10	306	134	6	138	50	4—8	294	126
	Cochin	143	10	S.L.	305	132	6	135	49	4—8	290	124

masl = metres above sea level

rd = rainy days

mmr = month of maximum rainfall

mr = total rainfall of mmr plus that of preceding or following month, whichever is higher, in cm.

md = number of rainy days of mmr plus that of preceding or following month, whichever has higher rainfall.

*Consecutive months with rainfall of more than 10 cm per month

a = Initial month with more than 10 cm of rainfall and number of consecutive months with more than 10 cm/month, separated by hyphen.

b = Total rainfall of consecutive months under 'a' in cm.

c = Total number of rainy days of consecutive months under 'a'

na = not available.

NOTE :—Information on rainfall and rainy days are based on the Memoirs of India Meteorological Department, Vol. XXXI, Part III as on 12th May, 1961.

APPENDIX 3 (*Concld.*)

cropping patterns	district / taluk	geographical area (sq km)	elevation (masl) max	elevation (masl) min	annual rainfall total (cm)	annual rainfall rd	mmr	mr	md	*consecutive months a	b	c
	Rainfall Zone—V	..	..	..	..	..	..	*Rainfall Pattern—A_1 C_1 E_2 (A_4) A_1 B_1 E_2*				
L_2 Pd_4	**Kottayam**											
	Kottayam	540	100	10	326	137	6	136	48	4—8	308	127
	Meenachil	723	900	100	399	160	7	147	51	3—10	391	156
	Changanacherry	262	100	38	319	142	6	125	48	4—8	300	131
	Kanjirappally	351	450	100	416	162	6	145	49	3—9	398	154
	Peermade	1308	2019	300	516	167	7′	238	54	4—8	497	155
L_3 Pd_3	**Ernakulam**											
	Muvattupuzha	399	450	50	346	146	7′	147	50	4—8	331	137
	Thodupuzha	974	1194	50	na							
	Rainfall Zone—VI	..	..	..	..	..	..	*Rainfall Pattern—C_1 D_1 E_2 (A_3 C_1) B_1 C_1 E_2*				
L_2 Pd_4	**Cannanore**											
	Northwynad	747	2060	900	283	121	7′	158	48	5—6	262	105
Pd_2 L_4	**Palghat**											
	Chittur	1155	1527	150	179	93	7′	84	40	5—7	166	86
	Alathur	569	900	100	225	105	7′	109	45	5—7	210	97
	Palghat	720	1996	144	212	103	7′	103	44	5—7	198	96
	Ottapalam	846	150	50	260	114	7′	127	47	5—7	244	105
	Rainfall Zone—VII	..	..	..	..	..	..	*Rainfall Patterns—B_1 E_3 (A_3 B_1) B_1 C_1 E_2*				
L_2 Pd_4	**Cannanore**											
	Kasaragod	973	208	79	348	117	7′	203	52	5—7	338	113
	Hosdrug	989	900	150	356	117	7′	209	53	5—7	347	112
	Taliparamba	1330	1200	289	356	120	7′	210	53	5—7	347	114
	Tellicherry	1207	900	S.L.	330	116	7′	190	51	5—7	319	109
	Cannanore	431	50	S.L.	327	115	7′	191	51	5—7	319	110
	Kozhikode											
	Badagara	550	1368	S.L.	351	121	7′	196	52	5—7	338	113
	Quilandy	757	600	S.L.	336	119	7′	184	51	5—7	323	111
	Southwynad	1378	988	450	na							
	Kozhikode	1027	1200	150	318	117	7′	168	51	5—7	302	110
L_3 Pd_3 (Ta_4)	**Malappuram**											
	Ernad	2262	2554	50	299	117	7′	154	49	5—7	285	109
	Tirur	665	478	S.L.	291	118	7—6	153	50	5—7	278	110
	Perintalmanna	506	572	50	283	118	7′	141	48	5—7	268	109
	Ponnani	199	106	S.L.	296	119	6	147	49	4—8	289	115
Pd_2 L_4	**Palghat**											
	Mannarghat	1100	2383	50	289	122	7′	135	47	4—8	281	117
Pd_3 L_3	**Trichur**											
	Talapilly	663	300	150	309	119	7′	158	50	5—7	294	112
	Trichur	636	450	50	310	123	6	154	51	5—7	296	115
	Chavakkad	306	10	S.L.	314	121	6	152	50	4—8	306	118
	Mukundapuram	1316	900	10	330	125	6	161	50	4—8	321	121
	Kodungallur	73	10	S.L.	322	131	6	153	50	4—8	313	126
L_3 Pd_3	**Ernakulam**											
	Parur	192	10	10	270	112	6	130	46	5—7	255	104
	Alwaye	326	150	10	323	133	6	153	51	4—8	313	127
	Rainfall Zone—VIII	..	..	..	..	..	..	*Rainfall Patterns—C_2 D_1 E_1 (B_2 C_2) B_1 C_1 E_2*				
L_2 Pd_4	**Kottayam**											
	Udumbanchola	1071	1463	600	na							
	Rainfall Zone—IX	..	..	..	..	..	..	*Rainfall Pattern—D_2 E_2 (C_4) B_2 C_1 D_1*				
L_2 Pd_4	**Kottayam**											
	Devikolam (1/4 E)	443	2695	60	292	150	7	124	49	4—8	277	139

APPENDIX 4

Districtwise Area Under Principal Crops

KERALA

(Thousands hectares)

District	Gca	Paddy	Jowar Kharif	Jowar Rabi	Bajra	Maize	Ragi	Wheat	Barley	Millets	Grams	Tur	Pulses	Sugar cane	Groundnut	Oilseeds	Cotton	L	Ta	Mc
Trivandrum	243	39 (16)	..	..	..	..	..	..	..	..	..	..	3 (1)	1 (·5)	..	1 (·5)	..	104 (43)	70 (29)	25 (10)
Quilon	341	52 (15)	..	..	..	..	·4 (·1)	..	..	..	..	..	7 (2)	1 (·3)	..	4 (1)	..	138 (40)	91 (27)	48 (14)
Alleppy	232	85 (37)	..	..	..	..	..	..	..	..	..	..	1 (—)	4 (2)	..	4 (2)	..	95 (41)	20 (8)	23 (10)
Cannanore	366	99 (27)	..	..	..	..	1 (·3)	..	..	..	..	.2 (—)	3 (1)	·3 (—)	..	·4 (—)	..	219 (60)	7 (2)	34 (10)
Palghat	331	183 (55)	1 (1)	..	..	..	1 (·3)	..	..	4 (1)	..	5 (1)	7 (2)	5 (1)	15 (5)	1 (·3)	7 (2)	48 (15)	10 (3)	44 (13)
Kozhikode	271	65 (24)	..	..	..	..	·5 (.2)	..	..	..	..	..	·2 (·1)	0·1 (0·1)	..	·3 (·1)	..	171 (63)	11 (4)	23 (8)
Malappuram	253	93 (37)	..	..	..	..	1 (·4)	..	..	1 (·2)	..	·4 (·1)	4 (2)	0·3 (0·1)	..	1 (·4)	..	105 (42)	24 (9)	24 (9)
Trichur	246	115 (47)	..	..	..	..	1 (·4)	..	..	..	..	..	8 (3)	1 (·4)	..	1 (·4)	..	85 (35)	8 (3)	27 (11)
Kottayam	372	50 (13)	..	..	..	..	..	..	..	1 (·2)	..		·4 (·1)	1·6 (·4)	..	4 (1)	..	198 (53)	37 (10)	80 (22)
Ernakulam	277	94 (34)	..	..	..	..	..	..	..	..	..	..	2 (1)	1 (·4)	..	3 (1)	..	117 (42)	15 (5)	45 (16)

Gca = Gross cropped area Mc = miscellaneous crops. L = Plantation crops

NOTE : Figures in brackets represent percentages to gross cropped area.

740 Agri./76—16-7-77—GIPF.

ERRATA

RAINFALL AND CROPPING PATTERNS

Volume VI

KERALA

Page No.	Paragraph/Table/ Appendix No.	Line	As printed	As desired
1	2	3	4	5
2	2·2	1	an fiual	annual
2	2·4	2	Monthly, totals	monthly totals
2	2·4	7 after Table 1	month	months
4	2·11	1	a vailable	available
5	3·2	3	(Ernakulam-	(Ernad-
5	3·3	4	interspread	interpersed
5	3·3	10	higher than	around
5	3·4	2	550	549
5	3·5	Against number of taluks under 101—200 201—300 301—400 1601—2000	 3 8 1 3	 4 5 4 2
5	3·5	15	Seventy	sixtysix
5	3·6	8	Barren	Barren and
5	Table 5	row 1	geographical area 3859	"delete"
5	Table 5	Col. 2 against reporting area	3,859	3,861
5	Table 5	Col. 3 against (c) total	9·0	9·2
6	3·7	3	0 423	to 423
6	Table 5 (contd.)	Col. 3 against (d) total	5·4	6·1
7	Table 7	Col. 1 Heading	satiton	station
8	4·6	11	dulring	during
8	Rainfall zone II	Rainfall pattern	$B_1 C_2E_2 (A_1 B_1 C_3)$ $B_1 C_1 E_2$	$B_1 C_2 E_2 (A_1 B_1 C_2)$ $B_1 C_1 E_2$
8	4·8	2	1,003	1,014
8	4·8	4	population	population for rural areas is
9	4·19	Against $L_2 Pd_4$ line 2	Devikulam	Devikolam
9	4·20	2	9300	8700
9	4·21	2	Kottarakka	Kottarakkara
9	4·21	10	Kunnathandu	Kunnathaunad
9	4·24	3	Devikulam	Devikolam
10	4·26	3	August-September	August-September and
10	4·27	8	Quilon, Kottayam	"Kottayam
10	4·27	13 against Alleppey	$Cf_3 Cy_3$	$Cf_3 Cy_3 G_4$
10	4·29	5	jirapally	jirappally
11	4·39	3	64	65
11	4·44	Cropping Pattern—Col. 1, line 4	$d_3 L_3$	$Pd_3 L_3$
11	4·44	Against $L_3 Pd_3$ Col. 2	Paru	Parur
11	4·46	5	Kasargod	Kasaragod
12	4·54	9	$C_4 Cy_4 G_4$	$Cf_4 Cy_4 G_4$
14	5·9	1	Fooder	Fodder
15	Appendix 1	Col. 1 below Alleppey	Mavelikkara	Maudikkara
18	Appendix 3	Rainfall Zone III—Pattern	$B_1C_1E_2(A_2B_1C_1)B_1C_1E$	$B_1C_1E_2 (A_2B_1C_1)$ $B_1C_1E_2$
18	Appendix 3	Below Alleppey Col. 2, line 3	Karthigapally	Karthigappally
19	Appendix 3 (Concld.)	Below Cannanore Col. 2, line 2	Hosdrug	Hosdurg
19	Do.	Below Cannanore Col. 2, line 3	Taliparamba	Talliparamba
19	Do.	Below Trichur Col. 2, line 1	Talapilly	Talappilly

APPENDIX V

KERALA

RAINFALL PATTERNS

MILES 10 5 0 10 20 30 40 50 60 70

10 0 10 30 50 70 90 110 KM

KARNATAKA

KASARAGOD

HOSDURG

TALIPPARAMBA

$C_1D_1E_2(A_3C_1)B_1C_1E_2$
(028)
VI

TELLICHERY

CANNANORE

NORTH WYNAD

MAHE (PY)

BADAGARA

SOUTH WYNAD

KOZHIKODE

QUILANDY

$B_1E_2(A_3B_1)B_1C_1E_2$
(020)
VII

CALICUT

MALAPPURAM

ERNAD

MANNARGHAT

TIRUR

PERINTALMANNA

OTTAPPALAM

PONNANI

PALAGHAT

$C_1D_1E_2(A_3C_1)B_1C_1E_2$
(028)
VI

CHITOOR

TALAPPALLI

ALATHUR

CHAVAKAD

TRICHUR

ARABIAN SEA

TAMILNADU

MUKUNDAPURAM

$D_2E_2(C_4)B_2C_1D_1$
(110)
IX

KODUNGALUR

ALWAYE

KUNNATHUNAD

PEROOR

DEVICOLAM

MUVATHUPUZHA

ERNAKULAM

UDUMBAN CHOLA

COCHIN

KANAYANNUR

THODUPUZHA

$C_2D_1E_1(B_2C_2)B_1C_1E_2$
(085)
VIII

(022)
IV

VAIKOM

SHERTALAI

MEENACHIL

$A_1C_1E_2(A_4)A_1B_1E_2$
(010)
V

$B_1C_1E_2(A_3B_1)A_1B_1E_2$

KOTTAYAM

KANJRAPALLY

PEERMADE

AMBALAPUZHA

CHANGANACHERRY

KUTTANAD

TIRUVALLA

ALLEPPEY

CHENGANNUR

KARTHIGAPALLY

PATHANAMTHITTA

MAVELIKKARA

$B_1C_1E_2(A_3B_1)A_1B_1E_2$
(022)
IV

KUNNATHUR

PATHANAPURAM

KARUNAGAPALLY

(044)
III

KOTTARAKARA

QUILON

$B_1C_1E_2(A_2B_1C_1)B_2C_1E_2$

CHIRAYINKIL

$B_1C_1E_2(A_1B_1C_2)B_1C_1E_2$
(068)
II

NEDUMANGAD

TRIVANDRUM

$C_1D_1E_2(B_1C_3)B_2E_2$
(098)
I

NEYYATTINKARA

5-APR1978

LEGEND

The rainfall pattern which describes the distribution of monthly rainfall throughout the year is expressed in coded form with letter symbols and numerical subscripts. A letter denotes a rainfall interval and the subscript to each letter the number of months in the interval.

Symbol	Rainfall interval centimetres per month
A	greater than 30
B	20-30
C	10-20
D	5-10
E	Less than 10 if the pattern begins with A or B Less than 5 if the pattern begins with C, D or E

The coded form of each pattern consists of three groups corresponding to the three seasons February to May, June to September and October to January. The central is entered in brackets.

The area covered by a rainfall pattern is termed a zone and the zones in the map are serially numbered.

Roman numbers indicate state rainfall zones
Three-digit figures in Arabic numerals within brackets give their corresponding all-India equivalents.

REFERENCE

—·—·—	BOUNDARY,	STATE
– – – – –	,,	DISTRICT
····· ·····	,,	TALUK
▬▬▬	,,	ZONE

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.

APPENDIX VI

KERALA

CROPPING PATTERNS

MILES 10 5 0 10 20 30 40 50 60 70

10 0 10 30 50 70 90 110 KM

KARNATAKA

KASARAGOD

HOSDRUG

TALIPARAMBA

TELLICHERRY

CANNANORE

L2 Pd4

CM

MAHE (PY)

BADAGARA

NORTH WYNAD

SOUTH WYNAD

KOZHIKODE

QUILANDY

CALICUT

L3 Pd3

MALAPPURAM

ERNAD

MANNARGHAT

TIRUR

PERINTAL

MANNA

Pd2 L4

PALAGHAT

OTTAPPALAM

PONNANI

TALAPPALLI

CHITOOR

ALATHUR

CHHAYAKAD

TRICHUR

Pd3 L3

MUKUNDAPURAM

KODUNGALUR

KUNNATHUNAD

ALWAYE

PERUR

DEVICOLAM

L3 Pd3

MUVATHUPUZHA

ERNAKULAM

COCHIN

KANAYANUR

THODUPUZHA

UDUMBANCHOLA

VAIKOM

MEENACHIL

SHERTALAI

L2 Pd4

KOTTAYAM

KANJRAPALLY

PEERMADE

AMBALAPUZHA

CHANGANCHERRY

KUTTANAD

TIRUVALLA

ALLEPPEY

CHENGANNUR

PATHANAMTHITTA

MAVELLIKARA

KUNNATHUR

KARUNAGAPALLI

PATHANAPURAM

KOTTARAKARA

QUILON

L3 TA4 (Pd4)

CHIRAYINKIL

NEDUMANGAD

TRIVANDRUM

NEYYATTINKAR

TAMILNADU

ARABIAN SEA

INDIAN OCEAN

LEGEND

Crops	Symbols
Paddy	Pd
Plantations	L
Fodder	F
Ragi	R
Bajra	B
Small Millets	Mt
Jowar (Kharif)	JK
Jowar (Rabi)	Jr
Maize	M
Wheat	W
Gram	G
Tur	T
Other Pulses	Pu
Cotton	C
Groundnut	Gn
Other oilseeds	O
Sugarcane	S
Barley	Ba
Oats	Oa
Tobacco	To
Fruits	Fr

A cropping pattern consists of one or more crops, each with a subscript which indicates the percentage area of the crop concerned.

Subscript	Percentage of gross cropped area
1.	greater than 70
2.	50-70
3.	30-50
4.	10-30
5	less than 10

Example:

(1) Pd I — Paddy covers more than 70 percent of gross cropped area of the taluk.

(2) R2 Pu 4 Pd4 — Ragi (50-70% area) Other pulses (10-30%) area Paddy (10-30%) area

REFERENCE

BOUNDARY, STATE

" DISTRICT

" TALUK

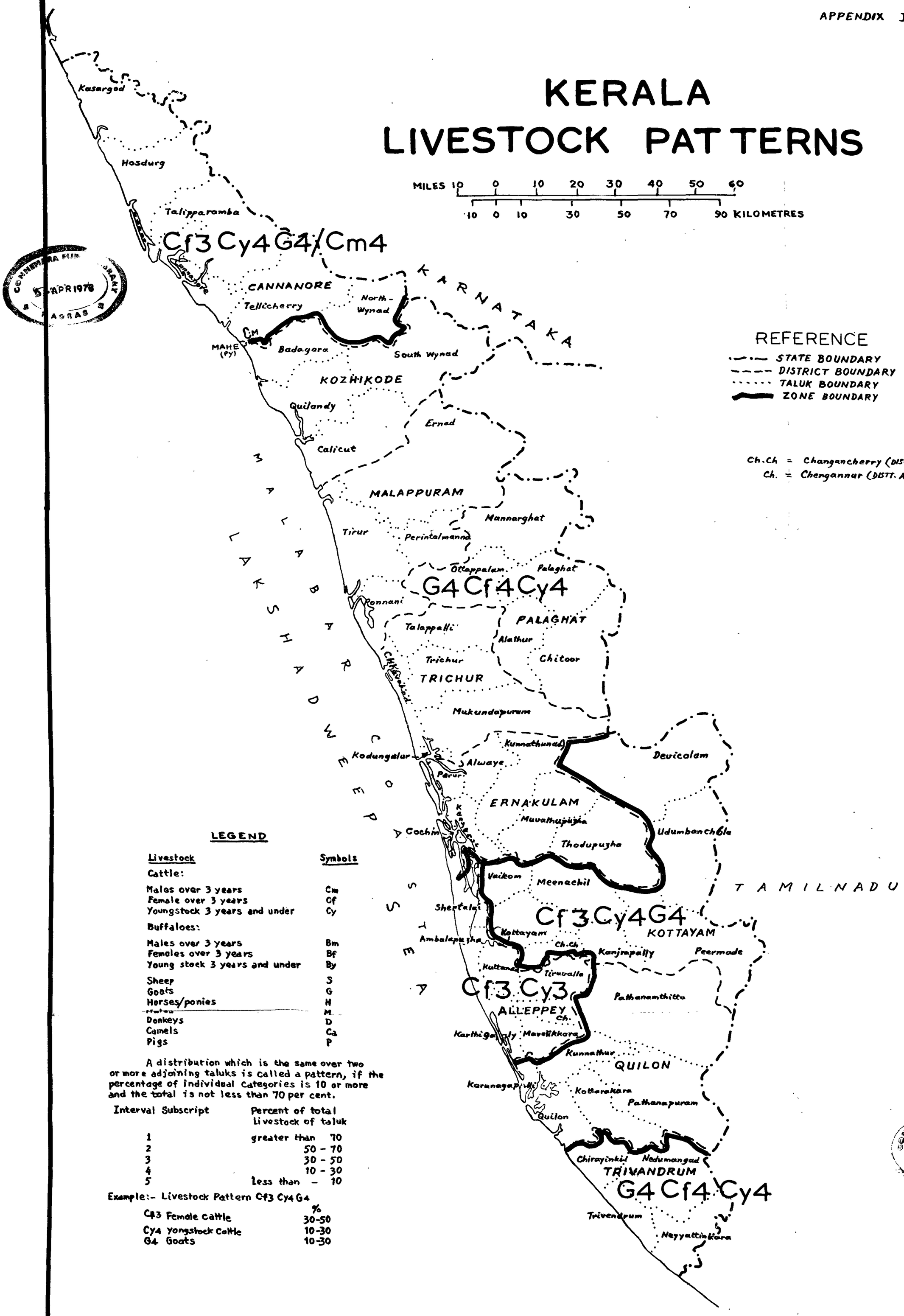
" ZONE

" SUB-ZONE

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.

KERALA
LIVESTOCK PATTERNS

MILES 10 0 10 20 30 40 50 60
10 0 10 30 50 70 90 KILOMETRES



REFERENCE

- STATE BOUNDARY
- DISTRICT BOUNDARY
- TALUK BOUNDARY
- ZONE BOUNDARY

Ch.Ch = Changancherry (DISTT. KOTAYAM)
Ch. = Chengannur (DISTT. ALLEPPEY)

LEGEND

Livestock	Symbols
Cattle:	
Males over 3 years	Cm
Female over 3 years	Cf
Youngstock 3 years and under	Cy
Buffaloes:	
Males over 3 years	Bm
Females over 3 years	Bf
Young stock 3 years and under	By
Sheep	S
Goats	G
Horses/ponies	H
Mules	M
Donkeys	D
Camels	Ca
Pigs	P

A distribution which is the same over two or more adjoining taluks is called a pattern, if the percentage of individual categories is 10 or more and the total is not less than 70 per cent.

Interval Subscript	Percent of total Livestock of taluk
1	greater than 70
2	50 - 70
3	30 - 50
4	10 - 30
5	less than - 10

Example:- Livestock Pattern Cf3 Cy4 G4

	%
Cf3 Female cattle	30-50
Cy4 Youngstock Cattle	10-30
G4 Goats	10-30

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.