8. SUMMARY AND CONCLUSIONS

The present study has indicated several determinants of landuse in general and agriculture in particular. The major factors concerning the physical aspects are physiography, geomorphology, geology, soils and climate. These factors have been modified to a great extent by human intervention in the form of provision of irrigation facilities in the water scarce areas, reclamation of lowlying and backwater areas into cultivable paddy fields, terracing of the slope for cultivation, introduction of plantation crops in the deforested areas and a host of other deeds. These modifications to the original factors have further been subjected to change due to the market mechanism, technology in getting higher yields, the structural changes in the society and the governmental policies and programmes.

The State of Kerala, though an example of political ferment and change has not shown drastic changes in the age old agricultural practices. This is seen when the statistical analysis is made of the agricultural practices and patterns for different time periods. Similarly the constraints of physiography and drainage pattern coupled with soil and climatic characteristics still govern the landuse and agricultural pattern at macro-level. But when similar analysis was made for smaller spatial units such as village and individual holdings, the impact of man is more visible. The study shows that there are some differences in the results for the macro, meso and micro-level spatial units; but they are essentially concerned with details and not generalities. Now and then some uniqueness has emerged at village level analysis but they do not in any way vitiate the general pattern.

The Kerala State, which has 560 km length, 70 km average width and 38,864 sq km area is classified into three major physiographical zones, namely, the eastern highland (above 75 m MSL), the western lowland (7.6 m above MSL and MSL) and the midland in between the highland and the lowland. Each of these
zones has certain peculiar features which distinguishes them considerably from the other zones of the State. The highland has a number of peaks, the Anamudi being the highest (2695 m height) and few gaps and passes, the Palghat gap being the widest (30 km width). The midland zone is characterised by a number of small cultivated watersheds with areas generally ranging from 1 sq km to 10 sq km. The lowland zone has several estuaries and backwaters, lagoons, waterways, marshes and lowlying cultivated areas.

Each of the three physiographic zones of Kerala has certain peculiar features with regard to geology, landforms, soils and climate. All these factors ultimately have an impact on the water resources of these zones. Since the landuse and cropping pattern depend considerably on these physical features, each physiographic zone is bound to have its own characteristics in agricultural system. Geologically, the highland generally has charnockites, khondalite, and granitic gneiss rocks of Archean age, the midland has laterites capping the crystallines and sedimentary rocks of Miocene age and the lowland has recent and sub-recent deposits (Quaternary Sediment) of Cenozoic age. The landform of highland is considerably undulating and with steep slopes and that of the midland is a chain of hills and valleys forming well defined watersheds and that of the lowland is gently sloping topography with isolated hills and depressions. The soils of highland are generally characterised by forest loam, that of the midland by lateritic soils with alluviam in the valley fills and that of the lowland by alluviam and sandy soils. The situation of Kerala State in the humid tropics has influenced the climate to a great extent. It is further influenced by the south-west (June-september) and the north-east (October-December) monsoons. The annual average rainfall in the highland ranges from 2,500 mm in south to 5,000 mm in the north, followed by that of the midland varies from 1,800 mm in the south to 4,000 mm in the north, and in lowland ranges from 1,400 mm in the south to 3,500 mm in the north. Not only the physical characteristics, but also the socio-economic factors are different in each of the physiographic zones. There is a gradual decrease in population
density from the coastal plains (1,000/sq km) to the eastern highlands (less than 200/sq km). All the three Corporations, namely, Calicut, Cochin and Trivandrum, and also important towns are situated in the lowlands. The agricultural workers in the lowland and the midland are considerably small in numbers in comparison with that of the highland. More than 80 per cent of cultivators have landholding below 1 ha size class and more than 46 per cent of the total holdings belong to the lowest size class (0.04 - 0.25 ha). High concentration of smaller size holding is found in Alleppey district (lowland) and high concentration of large size holdings in the Idukki district (highland). Around 86 per cent of the total operated area is cultivated by the owner. Since Independence the State has established a number of agricultural credit societies and marketing facilities.

The most important input to agriculture in the State is recognised as irrigation, since paddy and all the important garden crops require irrigation at least during the four dry months (January-April). Of the total cropped area of 21,80,355 ha only 2,65,536 ha (net) has been brought under irrigation. About 1,04,019 ha is irrigated by canals of major irrigation projects, 33,937 ha by minor and lift irrigation, 35,606 ha by tanks and ponds, 31,186 ha by wells, and 6,788 ha by other sources. A number of environmental problems associated with major/medium projects such as submergence, sedimentation, waterlogging, deforestation etc. have been identified. Therefore, it is suggested that the development of agriculture in Kerala in all physiographical zones depends to a great extent on the introduction of more minor irrigation schemes, the selection of which will have to be based on detailed scientific investigations. The cropping system of Kerala State has been studied using different statistical techniques to determine landuse orientation, crop ranking, crop concentration, crop diversification, crop combination, relationship among area, production and irrigation as well as for finding out relative spread and yield index of paddy and surplus/deficit of paddy and pulses with reference to different districts of Kerala. The following conclusions are drawn based on the districtwise studies
i Kerala is an agriculturally oriented State with one district classified as predominant, three districts as dominant and most of the other districts as semidominant from the point of agriculture;

ii Paddy and coconut have emerged as the first ranking crops in five districts each, while rubber, cardamom and coffee are the first ranking crops in one district each in 1984-'85;

iii Paddy has emerged as the first ranking crop with high percentage of area coverage mainly in districts with more area under the lowland and the midland, except in Palghat district;

iv Coconut has a tendency to emerge as the first ranking crop in more districts as time passes, based on the analysis of data for the past ten years;

v Rubber is the first ranking crop in Kottayam district with more area under midland and highland and this crop is spreading in the highland areas of other southern districts also;

vi Cardamom and coffee are the first ranking crops in Idukki and Wynad districts respectively, which have more area in the highland;

vii Paddy has very high concentration in Palghat district mainly due to extensive irrigation facilities and high concentration in Alleppey, Ernakulam and Trichur districts, the latter three having more area under the lowland and the midland and paddy has low or very low concentrations in districts with more area in the highland such as Idukki, Kozhikode, Wynad, Cannanore and Quilon;

viii Coconut shows moderately good concentrations in most of the districts of Kerala except in Wynad, Palghat and Idukki districts which have more area under the highland;

ix The concentration of rubber and pepper are mainly in
districts which have more area in the midland and highland;

x High diversification of crops is found in two highland districts namely Idukki and Wynad, four districts, namely, Quilon, Alleppey, Malapuram and Kozhikode which have more area either in the midland or in the lowland show low diversification and in the other districts medium diversification is observed;

xi Only one district, namely, Palghat has emerged under monoculture and the other districts come under two or three crop combinations based on Maximum Positive Deviation method (MPD);

xii The production of paddy depends not only on the area under the crop and irrigation facilities but also on the physical characteristics such as soil, slope etc;

xiii The maximum area and production of coconut is in Kozhikode district but minimum irrigation facilities are available for coconut crop in this district;

xiv The relative spread and yield index shows that paddy is best suited for Palghat and Alleppey districts;

xv It is found that only Palghat district is self sufficient from the point of view of paddy and no district is self sufficient with regard to pulses.

In order to further investigate on the cropping system of the State, a representative river basin has been taken up for detailed studies. A river basin is considered to be an ideal geographical and hydrologic unit for integrated planning, development and management. Since irrigation is a major input to agriculture, water resources development has a major role to play in the field of agriculture and in that sense, a river basin is an ideal unit for detailed study. The Kuttiyadi river basin has been selected since it is flowing through all the physiographical zones of the State and have representative physical and socio-economic characteristics of a west flowing river. The geomorphological studies indicate that paddy is mostly grown in valley fills and coconut in the riverine islands,
lower sloping part of the denudational hills and the isolated denudational hills. Coffee, tea and rubber are mainly found in the upper part of the denudational hills and piedmont zone. These features are in general in agreement with the results obtained from the State level study. The quantitative geomorphological studies show that, the laws of drainage basin development hold good for the highland and midland as has been found in the case of other west flowing river basins of the State. The highland is characterised by steep slopes, the midland by moderate slopes and the lowland by gentle slope. Geological formations and soil types in different physiographical zones also are more or less similar to the State. The basin has a medium irrigation project, presently catering to 14,566 ha and several minor irrigation projects catering to 600 ha of land. There is scope for developing more minor irrigation schemes in the basin. The crop water requirement of important crops has also been discussed. As in the case of the State, more agricultural workers are in the highland zone in comparison to the midland and lowland zones. The fragmentations of land holding is higher in the lowland than in the highland, the average size of holding in the basin being 0.19 ha in comparison to 0.14 ha of the State.

The data collected from the Kuttiyadi river basin has been subjected to detailed statistical analysis to determine the landuse orientation, crop ranking, crop concentration, crop diversification and crop combination.

The detailed investigations based on 1983-84 (Period 2) data throw light on the following:

i Most of the villages of the basin (87%) are agriculturally predominant and the landuse has not significantly changed during the past one decade;

ii Coconut is the first ranking crop in most of the villages (33) and rubber in one village while paddy emerged as the second ranking crop in 22 villages and rubber in 5 villages;
iii The concentration of paddy is more in the lowland and midland villages and irrigation in general has increased the area under paddy but in some cases it has resulted in water-logging which has in turn reduced the area under this crop;

iv The concentration of coconut is very high in 14 villages and most of them also have paddy as the next degree of concentration;

v The concentration of tapioca and rubber are more in highland villages;

vi High diversification of crops is found only in one village and most of the villages are under medium diversification;

vii Based on MPD method for crop combination analysis it is found that twelve villages are classified under monoculture with coconut, of which seven are in the lowland and four in the midland; this is in variance with the results of crop diversification for Kuttiyadi river basin based on Bhatia's (1965) method modified by Singh (1976);

viii Fourteen villages coming under two crop combination are having coconut-paddy combinations and among them 13 are situated either in the lowland or in the midland;

ix Four villages have coconut-rubber combinations, of which three are in the highland and one in the eastern fringes of the midland;

x Paddy and most of the garden crops of the basin, such as coconut, tapioca and banana require irrigation, and water-logging is harmful to most of these crops; and

xi Perennial crops such as coconut and arecanut require shade during the initial stages of their growth.

Three villages, representing one each of the highland, the midland and the lowland have been selected for micro-level studies. This study has helped considerably in understanding the factors influencing agriculture in different physiographical
zones of the basin as well as to enable a comparative study with the results obtained from State level and basin level studies. Some of the important physical features observed are furnished below:

i The drainage density is higher in the highland village;

ii The percentage of valley fills is maximum in the lowland followed by the midland village;

iii The lowland village does not have well defined watersheds;

iv The isolated lower denudational hills in all the physiographical zones are cultivated with mixed plantation crops, though the combination of crops change from zone to zone; and

v The annual average rainfall is maximum in the highland and minimum in the lowland.

Studies have been carried out with respect to selected three villages to determine crop ranking, crop concentration, crop diversification and crop combination. The salient results are furnished below:

i Coconut has emerged as the first ranking crop in all the three villages with percentage area ranging between 60 and 70;

ii Paddy has emerged as the second ranking crop in all the three villages, though percentage areas are just above 25 for the lowland and the midland villages and just below 10 for the highland village;

iii Tapioca has emerged as the third ranking crop in the highland village, arecanut in the midland village and cashew in the lowland village;

iv Coffee and tea are confined to only the highland village and rubber to the midland village;

v Coffee, tea, vegetables, turmeric, tapioca, arecanut, coconut, pepper, banana and pineapple have very high concentration in the highland village.
while paddy, rubber and ginger have low and very low concentrations; 

vi The crops like, rubber, ginger, paddy, coconut and pepper have very high concentration in the midland village while coffee, turmeric and pineapple have low or very low concentrations; 

vii The crops such as banana, paddy, coconut, pulses and pepper have very high concentrations in the lowland village while tapioca, rubber, coffee, tea, vegetables and turmeric have low or very low concentrations; 

viii The lowland village comes under low diversification, the midland village under high diversification and highland village under low diversification; and 

ix All the three villages selected come under two crop combination with coconut and paddy, based on MPD method.

Data collected from the farmers of three selected villages as a part of the present study have helped in arriving at the following inferences on the socio-economic aspects of the villages:

i The size of an average family is the largest in the lowland of Thurayur (6.6), followed by the midland village (5.46) and the highland village (3.3); 

ii The total working population is the highest in the highland village (51.5) followed by the lowland village (26.79), the minimum being in the midland village (24.44%); 

iii The agricultural workers form 87.92, 45.24, and 60.82 per cent of the total working population of the highland, the midland and the lowland villages respectively; and 

iv Irrigation facilities for paddy is minimum in the highland and garden crops receive minimum irrigation facilities in all the three villages.
As a part of the field investigations the farmers have been interviewed to understand the problems encountered by them in the field and certain general inferences are drawn from these interviews.

IMPORTANT CONCLUSIONS

The studies have brought to light that physiography is an important factor deciding the cropping pattern and the agricultural system in general of the Kerala State. Most of the physical features of the State such as geology, land-forms, soils and rainfall are to a great extent closely interlinked with the physiographical configuration. Therefore, a study on cropping pattern and the major inputs to agriculture of the State has to be considered giving due weightage to the physiography. The socio-economic factors also show a marked variation from one physiographic zone to another. The studies with special reference to the meso-level in Kuttiyadi river basin and micro-level in three representative villages of the different physiographical zones also have shown that physiography is a major factor influencing the agricultural system.

It is found that Kerala is agriculturally oriented State and paddy and coconut are the major crops of the State. Paddy, which is a seasonal crop is mainly cultivated in the lowland and the midland zones and therefore, it is mainly concentrated in districts which have more area under the lowland and the midland. The physiography influence the slope characteristics and rainfall which in turn have a bearing on the spatial pattern of the crops that are grown in different physiographical zones of Kerala. The meso-level and micro-level studies also have shown that paddy is preferred in the lowland and midland zones. The alluvial plains of the lowland and valley fills of the midland are ideally suited for paddy. This becomes apparent when the analysis is made of the distributional pattern by maps, figures and tables relating to it. In some of the districts, paddy is even cultivated in areas lying below the mean sea level by dewatering and by adopting salt water exclusion measures. This shows that the
hypothesis postulated concerning the impact of socio-cultural factors is to a large extent substantiated. The Palghat district has emerged as an area with more coverage of paddy although it is situated mainly in the highland, this is attributed to the abundant irrigation facilities. The example of Palghat has to a large extent substantiated the number three hypothesis which states that the irrigation facilities are responsible for intensification of agriculture, higher yields and monoculture tendencies, the other factors being uniform.

Coconut is generally found in combination with paddy in the midland and the lowland zones, though there is a tendency to go in for coconut in all physiographical zones upto 1,000 m above MSL, altitude. There is even a tendency among farmers to reclaim the lowlying paddy fields for coconut cultivation. Coconut is found in all physiographical zones in the Kuttiyadi basin; coconut has emerged as the first ranking crop in the Kozhikode district in which Kuttiyadi basin is situated. The crop diversification is minimum in the lowland and the midland areas of the State and the basin where two crop combinations with coconut and paddy are identified.

Cardamom, coffee and tea are mainly confined to the highland zones as evidenced from macro-level, meso-level and micro-level studies. Rubber and pepper are preferred by the farmers of midland and highland. Rubber, coffee, tea and cardamom are mainly cultivated in large size holdings. The agricultural pattern in Idukki and Wynad districts are the example for the hypothesis postulated to find out the influence of size of landholdings as one of the factor which decide cropping pattern.

Tapioca is mainly concentrated in Trivandrum and Quilon districts where soil conditions are suited for this crop. However, it has been introduced even in the Kuttiyadi basin mainly by the settlers from the southern part of Kerala.

Paddy and all the important perennial crops of Kerala require irrigation, especially in the dry months. It is also
found that irrigation can enhance the yield of most of these crops. Therefore, irrigation is one of the major inputs to agriculture in all the physiographical zones of Kerala. The existing projects mainly cater to only paddy and the facility has to be extended to garden crops also. The present projects have a number of limitations from the point of view of water-logging, seepage, inadequacy of canals etc. These aspects also require to be looked into while developing the irrigation facility.

In developing the agricultural system of Kerala, a physiographic approach is very important. This is mainly because the physical, socio-economic and water resources of the region are highly interlinked with physiography. The water resources will have to be investigated with a view to provide irrigation in all physiographic zones of Kerala with stress on minor irrigation projects. One of the major constraints in developing agriculture in the region is the smallness in size of landholdings.

Most of the conclusions arrived at in this study are from the analysis of either the secondary data or from the primary data which were collected mainly for the purpose. The conclusions are also based on many other studies conducted independently for various projects but related to main theme.

The overall study indicates that the agricultural situation and development is a function of physiography, climate and the soil conditions which to some extent is modified by socio-cultural variables. This emphasises the role of environment in determining the development of a region particularly with reference to agricultural development in the context of regional planning. The present work cannot only become a benchmark study but also indicates how such empirical studies can be made use of in agricultural landuse planning.