The present study of the regional agricultural geography of Cuddapah district is conceptually designed in broad conformity with the view of Schaefer that "regional geography must become the laboratory side of an essentially theoretical subject" and the view of Bunge that "systematic geography must move into the theoretical spares and regional geography into a search for generic and not unique studies" (Haggett, 1965, p. 4). Thus the present study examines the regional character of agriculture with a view to provoking more detailed and in-depth consideration of optimum utilisation of agricultural resource base for overall development of the district.

The present study area, Cuddapah district is situated in the southern part of Andhra Pradesh State. It is identified as
draught prone area as well as one of the agricultural backward regions of the State. The economy of the district is predominantly agricultural and the cornerstone of the socio-economic development of the district lies in the development of its agricultural economy. The district represents poorer agrarian conditions but with its varied agricultural phenomena and diversified agro-climatic and socio-economic set up has indeed provided an appropriate setting for this study.

Objective of the Study:

The main objective of the present study is to bring out a synthesized account of the regional geography of agriculture of Cuddapah district for comprehensive understanding of the main problems and constraints that hinder the development of agriculture in this drought prone district. A detailed study of agricultural phenomena namely climate, water, soil, landuse, cropping, crop productivity and animal husbandry may certainly help to gain insights into the problem and disign the framework of agricultural planning and development.

The spatial distributional analysis is made at 'mandal' level for the triennium 1986-89, while the changes and trends are examined at 'taluk' level from 1862-65 to 1982-85. The primary data for the sample villages were generated through field work.
The Spatial Analysis of Rainfall:

In dry areas rainfall is an important ecological parameter to agriculture. A careful analysis of this parameter is utmost important for water resource planning as well as crop and land management. The average annual rainfall of the district is 647.6 mm. The rainfall distribution has revealed that the rainfall decreases from east to west with the significant decrease in number of rainy days. The western and north-western parts are identified as the low rainfall areas in the district. The rainfall intensity is high in the eastern part of the district due to the influence of cyclonic depressions. The variability values have not shown much variations in the annual pattern. The ratio values showed that there is low to moderate stability. The frequency of rainfall occurrence also however not shown much variations in the occurrence of rainfall and the departure from normal is very low.

The analysis of seasonal rainfall has revealed that the amount of rainfall is high in south-west monsoon (392 mm.) followed by north-east (230 mm). Owing to geographical location of the district under the rain-shadow region of the western and Eastern Ghats, the total rainfall received during south-west monsoon is not fairly sufficient to meet the agricultural demand. However, the rainfall variability and ratio values indicated that during south-west and nort-east monsoons there is more stability in rainfall distribution which is conducive to growing rain fed crops in Kharif. Rainfall frequency has also indicated that during monsoon periods there is not much variation from normal rainfall. The September month of south-west monsoon is important as it
brings the highest (134 mm.) rainfall in the district followed by October (122 mm.), August (102 mm.), July (93 mm.) and November (86 mm.). Therefore, the agricultural activities could more or less successfully be carried out in the months of August, September, October and November. The number of rainy days are more in these months due to the influence of monsoonal depressions and cyclonic storms. And also in these months, the rainfall variation from normal is low and rainfall variability has revealed that there is greater stability in the rainfall occurrence. The study has also revealed that in majority of the decades, there has been a greater stability in the distribution of rainfall in the district.

**Spatial Spread, Intensity and Frequency of Drought:**

Droughts are the frequent occurrences in the district but they have been localised in some years and quite widespread in other years. In this district no decade is seen to be entirely free from the drought whatever its intensity and spread. The total number of drought years and intensity of drought had been worked out on monthly, seasonal and annual basis. The droughts have been classified into disastrous severe, moderate and low types on the basis of rainfall.

The monthly distribution of the drought years revealed that the number of drought years are very low in the months of August, September and October since they are the crucial months for higher amounts of rainfall in the district. The seasonal analysis of the drought years indicated that during winter period the number of drought years are very high (ranging from 60 to 70 years out of 88 total years) followed by summer period (45 to 50 years), south-west
monsoon (30 to 40 years) and north-east monsoon (20-40 years). The spatial
distribution has shown that the number of drought years are low in
south-eastern, central and north-eastern parts of the district because these
areas receive substantial amount of rainfall both from south-west and north-east
monsoons than the other areas of the district.

The intensity of drought is moderate to low in the monsoonal
months than the rest of the months in a year. Very low intensity of drought
ranging between a minimum of 39.8 per cent and maximum of 47.7 per cent is
registered in the month of September. The seasonal analysis of drought
intensity indicated that during south-west and north-east monsoons, the drought
intensity is moderate to low. The intensity of drought is low in the
north-eastern, central and southern parts of the district. The occurrence of
disastrous drought is low in the months of June, July, September and October.
The frequency of disastrous drought years are low in monsoonal periods.

The trend analysis of the decadal variation of drought intensity
revealed that the trend of increase in drought intensity is found from 1910 to
1920; and a trend of decrease from 1920 to 1930; and again an increasing trend
from 1931 to 1940; and decreasing trend from 1941 to 1980. However, a steep
increase in drought intensity is recorded during 1981-88. The number of
drought years were high in Pulivendula in many of the decades followed by
Rayachoty, Jammalamadugu, Proddatur and Rajampet. Low number of drought
years in many of the decades were found in Badvel, but moderate in Cuddapah,
Sidhout and Kamalapuram.

From the analysis of drought intensity and spread, it may be
stated that the frequent occurrence of droughts and prolonged dry spells have
had a devastating effect on agricultural economy of the district. To mitigate the problem of drought in the district, Drought Prone Area Programme (DPAP) was introduced during 1974-75 in which major emphasis has been given to irrigation projects, animal husbandry, dairy development, afforestation, soil conservation and watershed management. But however, several decades' efforts to find permanent solutions to the droughts have been unsuccessful and some of the irrigation schemes for this region are locked-up in controversies, paradoxically enough it is to state that the people of this region are also not aware of unscientific methods of drought watch and management. In other words they have been trying to adjust with the drought situation. To overcome this problem, the machinery of Government or voluntary should take concerted efforts to diffuse the scientific methods of farming like conjunctive utilisation of water through watershed management, soil conservation, dryland farming technology, diversified farming practices etc., through extension and training programmes.

Types and Distribution of Soil Resources:

The soil is a dynamic layer, in which many complex physical and chemical activities are going on simultaneously. From the genetic point of view soils are the function of factors like parent materials, climate, vegetation, soil biota, relief and time. Modification of any of these factors results in the change of soil characteristics. The present study is mainly based on the soil analysis data collected from the soil testing laboratory, Cuddapah and on the field observations of the author.

The District is covered by about 55 per cent of red soils and about 45 per cent of the black soils. The soil forming environment of the
district with its low rainfall, high temperatures, sparse vegetation and rugged terrain, is not congenial for development of fertile soils.

**Nutrient Status of the Soils:** Plants take several elements like phosphorus, potassium, sulphur, Calcium, Iron, magnesium, boron, manganese, copper, zinc, molybdenum and nitrogen. Of this nitrogen, phosphorus and potassium are described as 'big three'. Nitrogen is estimated indirectly through organic matter.

**Organic matter:** It makes an essential difference in the fertility of the soil. Practically all the nitrogen and sulphur of the soils are held in organic combinations. Organic matter promotes the granulation of the soil and increase its moisture retentive capacity. In the study region 82.5 per cent of the soils are poor (<1.0%) 12.5 per cent of the soils are moderate (1.2%) and only about 5.0 per cent of the soils are rich (>2.0%) in organic matter content.

**Phosphorus:** There are a few minerals containing $P_2O_5$. Igneous rocks are poor in phosphorus minerals. The phosphorus content of the soils of the region is low in 80 per cent of the soils, moderate in about 12% of the soils and high in only about 9% of the soils.

**Potassium:** The parent materials of the region are rich in potassium minerals. Due to this about 65 per cent of the soils have high potassium content. In only about 12 per cent of the soils potassium content is low.

**Agricultural Suitability of the Soils:** Assuming that the physical properties are suitable for plant growth, the chemical properties which retard plant growth and yield are soil acidity, alkalinity and salinity. In the study region more than 95 per cent of the soils are neutral or weakly alkaline and only in less than 5 per
cent of the soils salinity and alkalinity problems are noticed.

**Soil Management:** The soil management programme in a semi-arid region like Cuddapah district should be comprehensive and integrated one encompassing three different objectives (1) improvement of soil forming environment particularly the vegetation cover, thereby improving the fertility of the soil (2) improvement of the suitability of the soil with proper measures to prevent soil alkalinity and salinity and also reclamation of soils already affected and (3) prevention of soil erosion and reclamation of erosion affected areas through agronomic and engineering measures. What is required is a careful handling of the soil resources to preserve the good qualities and improve upon the bad qualities.

**Potential and Development of Water Resources:**

The importance of water is universal, probably only next in importance to air. Due to rapid population growth the available resources of water are being developed and used very rapidly. There is an urgent need for integrated plans for water conservation and rational utilisation particularly in a drought-prone area like Cuddapah District.

In the present study an attempt is made to assess the surface and subsurface water resources, to study the utilisation pattern and to suggest suitable strategy to get maximum yield per unit volume of water. Taluk is taken as the basic unit of study. As sufficient data on surface runoff is not available, the surface water resources are assessed theoretically using Barlow’s tables are Khosla’s formula and an average of the two values is taken as the surface runoff of each taluk. For the assessment of groundwater resources the
study mainly depends on the secondary data like the works of State and Central Ground Water Departments and the data collected from the D.P.A.P. Data is collected on utilisation pattern of both surface and ground water resources and a balance sheet of water resources is prepared.

**Surface Water Resources:** The surface run-off is 2370.5 mcum. and 4087.1 mcum. according to Barlow's and Khosla's methods respectively and the average is 3228.8 mcum. The 75 per cent dependable yield comes to 2421.6 mcum. and of this the utilisable resources is 1695.1 mcum. This is the available water resources in the district. The utilisable resources spatially varies from 7.8 mcum/100 km² in Pulivendla taluk to 15.2 mcum/100 km² in the Badvel taluk, while the district average is 11.0 mcum./100 km².

Apart from this the district gets about 1238 mcum. of water from outside the district through some major irrigation projects. On the other hand about 360 mcum. water as committed outside the district. Finally the available surface water resources comes to 2573.1 m cum.

**Ground Water Resources:** The district has 1182.0 mcum. of ground water resources with an average of 18.7 mcum./100 km². The potential varies from as low as 14.7 mcum./100 km² in Jammalamadugu taluk to as high as 25.0 mcum./100 km² in Cuddapah taluk. The high potentiality in taluks like Cuddapah, Badvel and Proddatur is due to substantial plain area and alluvial tracts and comparatively higher rainfall.

**Water Requirements for Domestic and Industrial Sectors:** The water requirements in the domestic and industrial sectors are calculated as per the norms laid down by the Ministry of Works and Housing. Water requirements of
125 litres per day per capita for urban population and 70 litres per day per capita for rural population and 40 litres per day per capita for livestock population is suggested by the ministry. Ten per cent of the domestic requirement (human + livestock) is the suggested requirement for the industrial sector. Based on these the estimated requirements in the domestic and industrial sectors are about 91.35 mcum in 1981 and about 114.19 mcum in 1991.

A Strategy for the Management of Water Resources: From the present study of the water resources of Cuddapah district it is obvious that the existing schemes are committed for nearly 92 per cent of the surface water resources and about 33.8 per cent of the ground water resources for irrigation purpose. The present demand of the Domestic and industrial sectors is about 114.95 mcum. This leaves a total of about 810 mcum of water for further exploitation apart from the water brought from outside the district. So proper measures are to be taken to exploit the remaining water resources.

In spite of this unutilised water, still water is a limiting factor for crop production in this semi-arid region. Hence proper development and management of irrigation resources is a must for the development of this drought prone area. First it involves increasing the available water resources through various measures. The available water resources can be judiciously managed through water supply augmentation, protective irrigation, water harvesting and proper ground water exploitation methods.

The other and most important step involves the most economic use of available water so as to maximise the area under irrigation and to get maximum returns per unit of water. It could be achieved by adopting a
cropping pattern which would provide maximum coverage of crop per unit of water, adoption of watersaving methods of irrigation like sprinkler and drip irrigation and lining of canals to minimise water losses during transmission.

Spatial Pattern and Dynamics of Landuse and Arble Landuse Efficiency:

A study of landuse of any region provides a good amount of information on different types of landuse and such information is essential to the scientific and rational landuse planning with in the framework of ecological balance. The ever-increasing pressure of population and decreasing man-land ratio on one hand and the main problems of landuse include under-utilisation, over-utilisation and mis-utilisation on the other hand are posing challenging problems to the planners and academicians. To circumvent some of these problems, an indepth study of changing landuse patterns, efficiency and problems is of paramount importance.

The present study of landuse classification in Cuddapah district is accomplished on the basis of the standard landuse classification designed by the Department of Agricultural Statistics, Government of India in 1950 suggested nine-fold classification. For the purpose of analysis in the present study these nine categories of landuse have regrouped into five major landuse types namely, (i) forest cover, (ii) non-agricultural land, (iii) other uncultivated land, (iv) fallow land and (v) net area sown.

Forest Land: Cuddapah is one of the important districts in the State in respect of forest resources. In 1986-89, it accounted for 32.3 per cent of the total geographical area of the district. Vast stretches of forest cover are noticed on the hill ranges in the north-eastern, eastern, Southern and south eastern parts.
of the district. The chief distinction of the forests of Cuddapah district lies in the fact that there is an important plant species called red sanders. It has high commercial value and it is seldom found in the country.

In the 20 year period between 1962-65 and 1982-85 the proportion of forest land has increased by 2 per cent. A trend of increase is noticed in 6 taluks while the trend of decrease in 3 taluks. Due to large scale exploitation of economically valuable plants like red sander and bamboo, burning of forest cover for char-coal production and uncontrolled grazing of livestock are the serious problems but for which the quality of the forest cover of the district has been losing its significance in the regional ecosystem and economy. The need for proper conservation and management of forest cannot be over-emphasized in order to bring former richness of forest.

Non-Cultivable Land: The non-agricultural land in the district accounted for 29.6 per cent of the total Geographica area of the district. The high and very high concentrations of non-agricultural land are found in 54 per cent of the total mandals in the district. They are situated in eastern and south-eastern parts of the district. This high special spread of non-agricultural land is due to extensive mining activities of barytes and asbestos minerals. A comparison of the proportion of non-agricultural land between 1962-65 and 1982-85 has indicated an increase of 11.4 per cent and this is a significant increase indeed. The trend of increase of non-cultivable land is found in 7 taluks. It is observed that there has been a perpetual increase in the area under non-agricultural uses. The constructive use of this category of land is found more under mining activities. But what is noticed that there has not been a systematic and rational use of this land for exploitation of mineral resources. In view of
decreasing man-land ratio and shortage of agricultural land, it is necessary to have a proper check over the expansion and irrational use of non-cultivable land through various measures.

Other Uncultivated Land: The proportion of other uncultivated land accounted for 8.1 per cent of the total geographical area of the district. The high concentration of this landuse type is found in western plains and south-eastern valley. In these areas there is a great scope for agricultural colonisation. Between 1962-65 and 1982-85 the percentage of other uncultivated land has decreased by 9.2 per cent. This trend of decrease is found in all the taluks except Proddatur. Here it is perplexing to state that the decrease in other uncultivated land has not been accounted at the cost of agricultural colonisation, since the cropland is in declining trend. Much of this category of land has been brought under non-agricultural uses.

Fallow Land: The proportion of fallow land was accounted for 9.9 per cent of the total geographical area of the district. The high concentration of fallow land is found in central and north-western parts of the district. In the 20 year period the proportion of fallow land has decreased by 0.6 per cent. But the regression analysis has indicated the positive trend of fallow land with 2 per cent coefficient of determination. It shows that the increase is marginal but not constant from year to year. The trend of increase in the area under fallows is found in seven taluks while the decrease in two taluks. The highly fluctuating distribution of fallow land is noticed in rainshadow areas of the district. Since the district has limited land under cropping and large number of livestock population, these fallow lands especially in the western plains and other river valleys can be utilised effectively with the help of dry farming technology.
Net Area Sown: The area under cropping in 1986-89 accounted for 32.1 per cent of the total geographical area of the district. Obviously it is a low proportion of land under cropping in contrast to the average proportion of 43 per cent cropped area in the State. A significant proportion of net area sown is found in 25 mandals distributed in southern plateau and western plains. Extensive forest cover and presence of hill ranges in the eastern valley have restricted the area under plough. The development of agriculture in the entire eastern valley is hopeful only through the intensification of crop farming. A comparison of the proportion of net sown area between the first and the last trienniums indicated a decline of 3.6 per cent. The decrease in net area sown is found in all taluks of the district except Pulivendula and Rayachoty. The regression trend has also shown the decrease in the area under cropping. This constant decrease in the area under plough may be due to identification of mineral reserves and the extension of mining activities to the arable fields. Normally more than 40 per cent of area under plough has been considered as the basic requirement. But the present area under plough is too short to fulfil the above condition. But there is every possibility to achieve this minimum requirement through effective utilisation and scientific reclamation of fallow lands and other wastelands, besides the intensification and modernisation of agricultural processes.

Intensity of Cropping: As expected, the intensity of cropping in this drought district is low and accounted for 105 per cent in 1986-89. A high intensity of cropping is found in 11 mandals only located in the south-eastern valley. Here the development of irrigation and limited availability of agricultural land have called for intensification of agriculture. The low intensity of cropping is found in the rain-shadow area of western plains and southern plateau. The intensity
cropping is highly fluctuating in the district and this is due to fluctuating in the rainfall and irrigation discharges. A decreasing trend is noticed in the area sown more than once and this negative trend is registered in all taluks except Rajampet and Sidhout. It is confirmed that the change in the intensity of cropping is highly subjected to a similar change in the intensity of irrigation as the correlation coefficient value is 0.9.

**Landuse Orientation:** The study of landuse orientation is based on the Kostrowicki's method. On the whole there are about 27 different landuse combinations identified in 1986-89. The general landuse orientation of the district is accompanying agriculture with non-cultivable land and forest cover \((A_1+B_1+F_1)\). The spatial pattern of landuse orientation ranges from a predominant agriculture \((A_3)\), forest cover \((F_3)\) and non-cultivable land \((B_3)\) to a mixed base of different types of landuse \((D_1+C_1+A_1+B_1)\). The interaction of physical and socio-economic environment have a profound bearing on the emergence of diversified pattern of landuse orientation without giving undue importance to any one landuse type over the others.

**Agricultural Landuse Efficiency:** Agricultural landuse efficiency is a complex and dynamic attribute of land which provides a conceptual framework to understand the agricultural landuse and assess its overall performance. It is the combined product of natural and socio-economic factors. In the present study the agricultural landuse efficiency in measured with the help of 'mean per cent coefficient' method and it involves the grouping and averaging the related positive variables.

The degree of agricultural landuse efficiency in the district is ranged between a maximum of 51.9 per cent in Pullampet mandal to a minimum
of 19.2 per cent in Narasapuram mandal in 1986-89. High agricultural landuse efficiency of more than 50 per cent is found in six mandals and moderate agricultural landuse efficiency of 40.1-50 per cent in twenty five mandals. They are located in south-eastern valley, southern plateau and K.C. Canal irrigated area. Low agricultural landuse efficiency is observed in western plains and in hilly tracts of north-eastern region. On an average, the degree of agricultural landuse efficiency has been increased from 34.4 per cent in 1962-65 to 39.8 per cent in 1982-85, which is a marginal improvement in the last 20 year period. The increase in the level of agricultural landuse efficiency is recorded in 6 taluks while the decrease in 3 taluks. It is inferred that the achievements made in hybridisation, irrigation, better cropping systems and intensification of crop landuse through 'Green Revolution' have not brought about any radical change in the levels of agricultural landuse efficiency. The modern agro-technology could not overcome the severity of drought impact on agriculture in many areas of the district. At this end much could be done to improve the performance of agricultural land for optimum use through conjunctive utilisation of surface and groundwater resources, diffusion of dry farming practices and improvement of the socio-economic conditions of the farmers.

Changing Distributional Pattern of Crop Farming:

In the recent times, cropping patterns and cropping structures have undergone radical transformation resulting in agricultural production. A systematic study of cropping pattern helps to regionalise agriculture which in turn forms the scientific basis for rational land resources allocation to various crops and planning for maximum productivity. For the purpose of the present analysis, 12 crops which account for 96 per cent of the total cropped area of
the district are considered. Food grain crops are less important in Cuddapah district which accounted for 43 per cent of the gross sown area. This proportion is too short of the state’s average value of 70 per cent. The low concentration of food grain crops is due to low development of irrigation and heavy competition from more remunerative dry crops like oil seeds.

**Paddy:** Paddy is the most important and widely grown crop in the irrigated areas of the district, accounted for 12.7 per cent of the total cropped area. High concentration of more than 20 per cent is found in 16 mandals distributed over central and south-eastern parts. The crop is grown both in kharif and rabi seasons under irrigation. Its concentration is more under K.C. Canal irrigation. The proportion of paddy cultivation has registered a decrease of 1.5 per cent in the last 20 year period. This decrease is found in 6 taluks while the increase in three taluks. The regression trend has also revealed that there has been a negative trend in the area under paddy cultivation. It is noticed that the paddy cultivation is gradually losing its spatial ground but confining its concentration to the canal and tank irrigated areas. Paddy cultivation is not economically valuable or viable under well irrigation sources. It would be more prudent if the per hectare yield are improved rather than spatial expansion of paddy cultivation in this drought district.

**Jowar:** Jowar is the second most important crop in the district accounted for 19.8 per cent of the total cropped area. It is cultivated in both the seasons as a rainfed crop. In contrast to paddy, jowar is basically a rainfed crop eminently suitable for cultivation in dry areas with black soils, low rainfall and drought prone conditions. High concentration of more than 20 per cent jowar cultivation is found in 18 mandals distributed over rainshadow area of western
plains. Jowar cultivation under irrigation is negligible as it accounts for 2.4 per cent to total jowar area. The proportion of jowar area in total cropped area has decreased by 0.8 per cent. However, the spatial spread of jowar area is also highly fluctuating and differing from year to year. It is observed that the area under jowar has shrunk with the increase of irrigation in central and eastern taluks. In this dry region particularly in the black soil zone of western plains, there is a greater scope for productive cultivation of jowar if it could overcome some of the constraints.

**Bajra:** Bajra is mainly cultivated as a kharif crop both under irrigation and rainfed conditions on poorer and light soils. Its cultivation accounts for only 2.2 per cent of the gross cropped area in the district. About 56 per cent of bajra cultivation is under irrigation and much of it belongs to high yielding varieties. Bajra cultivation has been confined to only certain pockets, out of which, south-eastern valley is significant for high concentration of bajra cultivation. A decreasing trend is noticed in the area under bajra cultivation. The proportion of bajra in the total cropped area has decreased by 2.5 per cent. This negative trend is found in all taluks of the district. A high trend of decrease is found in the high concentrated areas of south-eastern valley due to competition from more remunerative crops like groundnut, fruits, paddy etc.

**Ragi:** Ragi accounts for 1.2 per cent of the gross cropped area in the district. Although it is grow in kharif and rabi seasons but it is predominantly a rabi crop. The high concentration of its cultivation of more than 5 per cent is found in 8 mandals distributed over north-eastern valley region. The trend of the area under ragi is negative and its proportion has decreased by 0.3 per cent. It is noticed that the ragi as a supplementary foodgrain to paddy is gradually
losing its importance due to changes in the dietary habits of the people.

**Small Millets:** The cultivation of small millets accounted for 3.4 per cent of the total cropped area in the district. They are cultivated in Kharif season under rainfed conditions on poorer soils. The cultivation of small millets is confined to few areas (33 mandals) only. Of them, north-eastern and western parts of the district are important for moderate to high concentrations. There has been a decreasing trend in the area under small millets. The percentage difference is 4.6 per cent decrease in the 20 year period. It shows that small millets are unable to stand competition from other foodgrain crops due to changes in the dietary conditions of people.

**Pulses and Grams:** Pulses and Grams accounted for 3.4 per cent of the total cropped area in the district. They are grown both in Kharif and rabi season under rainfed conditions. The high concentration of pulses and grams is found in the millet and oil seeds dominated areas of western and northern parts of the district. Here they are cultivated as interculture crops with groundnut and jowar. This type of mixed cropping is a flourishing cropping system in the dry areas under rainfed conditions. There has been a decreasing trend in the area under pulses. The proportion of the area under pulses has decreased by 5 per cent. Concerted efforts must be made to increase the area under pulses as an interculture crop as they form an important part of the diet.

**Groundnut:** Groundnut is the leading crop in the cropping pattern of the district. It accounted for 42.2 per cent of the gross cropped area. Groundnut is grown both in Kharif and rabi under irrigation and rainfed conditions. But it is essentially a kharif crop in the sense that its main concentration is found in
kharif under rainfed conditions. Only 13 per cent of the area under groundnut is irrigated. High concentrations of its cultivation are found in many parts of southern plateau and Pulivendula basin. In the 20 year period the proportion of groundnut cultivation has increased by 7.7 per cent. The increase in its proportion is recorded in 7 taluks while the decrease 2 taluks. The positive trend to groundnut crop area is accounted by 7 per cent of coefficient of determination. It shows that the area under groundnut cultivation is highly fluctuating from year to year. The study has revealed that groundnut cultivation is highly favoured by the farmers of Cuddapah district because (i) it is a cash crop, (ii) it fetches good income, (iii) it is a short growing crop, (iv) the cost of its cultivation is moderate, (v) it has a good market, (vi) it requires less water than any other irrigated crop, (vii) its cultivation in easy, (viii) it is less disease prone, (ix) the red sandy and red and black soils are more suitable and (x) it can be cultivated under rainfed conditions. Groundnut cultivation has tended to replace millet crops and paddy and same of the minor millets are getting eliminated from the cropping pattern.

Cotton: The cultivation of cotton accounted for 0.3 per cent of the total cropped area of the district. Its cultivation is found in 17 mandals distributed over black soil zone of western plains. There has been a significant decrease of 3.3 per cent in the proportion of cotton cultivation. This is due to low per hectare yields and uneconomic cultivation of cotton as well as the competition from more remunerative crops like groundnut and jowar etc. But cotton cultivation has bright prospects in the black soil area of western plains if some of the following inhibiting factors are eliminated through dry farming technology, (i) low per hectare yields, (ii) moisture deficiency adverse effects
of prolonged dry spells and droughts (iii) lack of protective irrigation, and (iv) fluctuations in price structure and glut in the market conditions.

**Spices and Condiments:** The cultivation of spices and condiments as commercial crops is widespread in the district. The important spices cultivated in the district are turmeric, chillies and coriander. These crops together accounted for 5.4 per cent of the gross sown area. They are cultivated both in kharif and rabi under irrigation facilities. High concentration of spices cultivation are found in 12 mandals distributed over north-western and central parts of the district. In the 20 year period, the concentration of spices cultivation increased by 1.4 per cent. Since they are high value crops which fetch good income and thereby a significant increase is registered in their hectarage.

**Fruits:** Cultivation of fruits as commercial crops is significant in the district. The important fruit crops grown in the district are mangoes, plantains, oranges, lemons and other citrus crops. Except mangoes, the rest of fruit crops are intensively cultivated under well-irrigation. Recognisable concentration of fruit farming is found in south-eastern valley which is not only a significant fruit farming zone in the district but also in the State. The concentration of fruit farming has increased by 0.2 per cent. But the serious constraint that the fruit cultivation is facing here is instability of the market. If this constraint is overcome there is a great scope for the increase of area and production and establishment of industry in this district.

**High Yielding Varieties:** The cultivation of high yielding variety crops accounted for 9.3 per cent in the district which indicates the low proportion indeed. This low proportion of the cultivation of high yielding varieties is not uncommon phenomena in this drought district on account of scanty irrigation, precarious
rainfall condition and poor socio-economic conditions of the people. It is found that HYV cultivation is raised in all the taluks, but confined to only irrigated tracts. The concentration of HYV cultivation has increased by 1.7 per cent between 1974-75 and 1984-85. Since the cultivation of HYV crops requires heavy investment on technological input and need of irrigation, the farmers of this drought district have not taken the risk of HYV cultivation. But it is imperative to innovate and diffuse drought resistant high yielding varieties and dryland farming practices for achieving considerable degree of the modernisation of agriculture in the district.

**Crop Regionalisation And Crop Combination Types:**

Crops are generally grown in combination or association as a response to physical, socio-economic, demographic and technological factors. A study of crop combinations immensely helps to design agricultural planning and to optimise crop farming. In the present study the crop combination types are identified on Doi's method and crop diversification is measured with the help of Gibbs - Martin's statistical method. On the basis of hierarchical arrangements in the spatial distribution of crops, the crop regionalisation is made on an arbitrary scale. A careful analysis of the crop regions, the crop combinations and crop diversification has revealed the following:

1. It is indicated that the primary crop production is accounted both by dry crops and wet crops but dominated by dry crops especially groundnut and jowar.

2. Both rainfed crops and irrigated crops are the predominant in forming the crops regions, either by first-order, second-order or third-order regions. This is due to diversified agro-climatic and socio-economic conditions of the district.
3. The regional agriculture overwhelmingly characterised by an extensive cultivation of dry crops namely, groundnut and millets which together accounted for three-fourths of the cropland.

4. It is found that paddy, jowar and groundnut are the predominant crops to form different hierarchinal crop-order regions. Out of which, groundnut has gained the spatial extension of its cultivation.

5. The number and spatial extent of each one of the crop combinations has tended to decrease from 1962-65 to 1982-85 partly due to development of irrigation and modernisation and partly due to the preference of the farmers to cultivate market oriented more remunerative and superior variety of crops.

6. The tendency to specialise rather than diversify the cropping pattern is patently noticeable. For example, groundnut, paddy, fruit crops, jowar and spices have gradually tended to replace minor crops like small millets, ragi, cotton, bajra etc., Some of these crops are getting eliminated from the cropping pattern in the process of crop transformation from subsistensive to market oriented commercial farming.

7. Crop combinations with a fewer crops i.e. one-crop, two-crop and three-crop combinations are far more prevalent than hyper multiple crop combinations.

8. The crop combinations with a lesser number of crops are found in larger number of mandals as well as in areal contiguation. In contrast, the crop combinations with larger number of crops are limited in their spatial spread but contiguous in their areal distribution due to marked
geographical conditions of specific localities. The crop combinations with less number of crops as well as specialisation of crops are mostly confined to rain-shadow areas of extensive plains, dry upland areas, un-irrigated and scantily irrigated areas of the district. In contrast, high diversification and the crop combinations with more number of crops are mostly prevalent in the high rainfall areas, irrigated areas, river valleys and the regions with limited source of arable land.

9. In the process of crop transformation due to modernisation of crop farming, significant changes in the structure as well as number of crop combination types are conspicuously exhibited in the areas of rainfed farming.

10. The changing patterns of crop regions, crop combination types and crop diversification vividly revealed that the crop farming has been moving from subsistence farming (millets) to market oriented economy (groundnut, fruits, spices and paddy).

11. As the process of change in the cropping pattern has progressed, a greater degree of uniformity, stability and specialisation are brought in the cropping pattern of the district.

12. It is observed that, Kharif cropping is more specialised and mostly rainfed in contrast to rabi cropping which is highly diversified due to irrigated farming in the selected favourable areas.

13. Crop diversification and crop rotation in the rabi season seem to be increasing.
14. It is necessary to achieve high degree of modernisation and intensification of agriculture in the district especially in the areas of eastern valley where the available land is very limited, rainfall is more and scope for further development of irrigation is expected and possible.

15. In the rain-shadow areas of western plains and southern dry uplands there is a great scope for spatial expansion of agriculture as well as diversification of farming in different soil zones rather than intensification of cropping due to limited irrigation facilities.

16. In view of frequent drought occurrences and prolonged dry spells and low development of irrigation facilities in many areas of the district, especially in the western plains, it is essential to opt diversified cropping systems and also it is essential to bring more stability in the cropping pattern with the help of dry farming technology.

17. There is an ample scope for the strengthening of the existing cropping pattern and enhancement of crop production especially of oil seeds, spices, fruits, paddy, cotton and millets with the help of irrigation development, modernisation of agriculture and dry farming technology.

Changing Pattern of Crop Yield levels:

A detailed study of the changing trend of the yield levels helps to design crop planning and reduce the yield gaps as well as regional disparities in agricultural production. The analysis of changing trends in the crop yield levels is made at district level for a period of 18 years i.e., from 1967-68 to 1985-86. The correlation testing is made to assess the impact of
rainfall on the changing crop yield levels especially for the dry crops.

**Yield Level of Paddy:** On an average the per hectare yield level of paddy was increased by 686 Kgs. in 18 year period. The regression trend has also revealed that there has been a steep increase in the yield level of rabi paddy than Kharif paddy. The yield level of kharif paddy is highly fluctuating from year to year in contrast to the yield level of rabi paddy. The per hectare yield level of paddy in Cuddapah district is higher than the State's average and the yield gap is 0.9 per cent in the last triennium (1983-86). It is very clear to say that the agricultural modernisation has brought about a significant impact in the enhancement of paddy yield levels in the district.

**Yield Level of Jowar:** The current yield level of jowar is somewhat respectable (1017 Kgs./hectare is 1983-86) in Cuddapah district in contrast to the State (624 Kgs./hectare). There has been a striking increase in the yield levels of jowar both in kharif and rabi. The average yield of jowar was increased by 513 Kgs./hectare. But in kharif, the yield level is highly fluctuating. The impact of rainfall on the yield level of kharif jowar is very high with high coefficient of correlation value of 0.9. But in rabi season the impact of rainfall is very low as it is clear from the low coefficient of correlation value of 0.2. But what is more required at the present is to reduce the fluctuations in the yield levels of kharif jowar and it is possible through dry farming technology.

**Yield Levels of Bajra, Ragi and Korra:** The yield levels of bajra, ragi and korra are increased during the period of 1967-85. The bajra yield was increased by 422 kgs/hectare and it is higher than the State's average yield
level. But the problem is high fluctuations in the yield of bajra in the district. The relationship between rainfall and the yield of bajra is positive and the correlation coefficient value is 0.5. The yield level of ragi was increased by 364 Kgs./hectare as against 139 kgs./hectare increase in the State. The relationship between rainfall and yield level of ragi is positive with a correlation coefficient value of 0.5. The yield level of korra is very low which accounted 658 kgs./hectare when compared to the other millet crops. The annual compound growth rate has shown a high increase at the rate of 6.5 per cent but it suffers from high fluctuations. The correlation analysis has revealed that there is a high positive relationship between rainfall and the korra yield which is evident from the fact that the correlation value is 0.6.

**Yield Level of Pulses and Grams:** The present yield level of pulses and grams is not encouraging. Their current yield levels are low and they remain neglected in input application. The yield level of horsegram has increased by 129 kgs./hectare as against 140 kgs/hectare increase at the state level. The yield level of redgram has shown a decrease of 268 kgs/hectare in the district which is higher than the decrease of 133 kgs/hectare in the State. The yield level of green gram has increased by 259 kgs/hectare in the district compared to 267 kgs in the State. On the whole the current yield levels of pulses and grams are not significantly high. This is due to (i) rainfed cultivation of these crops incurred high fluctuations in the yield levels, (ii) lack of varietal programmes to boost up the production of grams, and (iii) attention and care given to the cultivation of these crops is comparatively less.
Yield Level of Groundnut: The level of agricultural productivity of the district heavily depends upon the contribution of groundnut yield and production. But it is very unfortunate to note that the yield level of groundnut in the district is very low (688 kgs/hectare in 1983-86) compared to the State (856 kgs/hectare). Another debilitating effect is the decline of 150 kgs/hectare in the 18 year period. The present negative trend is a marginal one on account of striking fluctuations in the yield level of groundnut. The regression trend of the yield of kharif groundnut is negative but it is positive in the case of rabi groundnut. The relationship between rainfall and the yield level of kharif groundnut is positive and the coefficient of correlation value is 0.7. Since the large area is under kharif groundnut and the yield gap is negative, it is imperative to improve the yield level of kharif groundnut with the help of suitable fertilizer responsive high yielding varieties for the low rainfall and low irrigation condition of the district.

From the study of changing trends in the yield levels of different crops in the district, it is inferred that the yields are moderate to high in the cereal crops but yields are deplorably poor in oilseeds and pulses crops. This situation mainly obtains due to disparity in the use of physical resource base and input application. Many parts of the district are plagued with problems of variability of rainfall with greater degree of uncertainty and drought, prolonged dry spells, scanty irrigation facilities, poor red soils and soil erosion in the valleys and upland areas. The technological input application is also very insignificant in the cultivation of dry crops. Consequently, the yield levels of many crops in the district have not been found with constant rise and the fluctuations are more vivid. This highly
fluctuating increase of the yield levels can not be shown the stable performance of agriculture. The first and foremost problem to be solved in this region is to bring reduction in the fluctuation of yield levels and so as to bring normalcy and stability in the production processes. Secondly, attempts are to be made to enhance the yield levels of important crops especially groundnut, jowar and paddy which accounted for three-fourths of area and production. Until and unless these crops are not raised with spectacular yield levels the overall productivity and prosperity of agriculture may not be achieved. This, however, is not easy but much greater efforts will have to be made than attempted so far. In this endeavour, the illiterate and orthodox farmers of this region are to be trained in the new methods of cultivation and modernisation of agriculture.

**Taxonomy and Spatial Distribution of Livestock and their Combinations**:

The importance of animal husbandry in the drought prone area of Cuddapah district are manifold. The small size of land holdings and precarious nature of crop farming due to drought conditions compel the small and marginal farmers to relay upon a secondary occupation to supplement their income. As an alternative enterprise next to crop husbandry, animal husbandry claims an unrivalled place in affording a fillip in the agrarian economy of this region. For the purpose of analysis various categories of livestock namely bovines, ovines, equistrains, poultry etc., have been converted into homogenous livestock units on the basis of ICAR conversion scale. To understand the specialisation of diversification in the pattern of livestock production, the livestock combinations are identified on the basis of Doi's method. The pressure of total livestock units is calculated to 100 hectares of arable land.
On an average there were 193 livestock units per 100 hectares of arable land in Cuddapah district. High concentrations of more than 200 livestock units per 100 hectares of arable land are found in 15 mandals distributed in the areas of eastern valley and northern part of the district. The total livestock units in the district have declined by 3.1 per cent or 21,677 livestock units over the period of 1972-87. The most striking changes over this period took place in the numbers of cattle, sheep, pigs and donkeys with a quite significant decline to be seen in those categories of livestock units while the numbers of buffaloes, poultry and goats showed a distinct raise of 3.1 per cent. The contrasting spatial distributions of the different types of livestock within the district have been exhibited that the district endowed with propitious environment for a plenitude of livestock resources especially cattle, buffaloes, sheep, goat and poultry. Because of the simulatory environment created by irrigation, fodder cultivation, transport accessibility, marketing compatibility and changing agro-technology, the role of cattle has diminished, while that of buffaloes enhanced spectacularly. It reveals that there has been a great impetus for the development of dairy farming as a subsidiary occupation of crop husbandry. The favourable agro-climatic and socio-economic conditions as well as large numbers of she-buffaloes in Cuddapah, Kamalapuram, Proddatur and Jammalamadugu taluks are conducive for the development of intensive dairying. With the help of modern innovations and diffusion methods, the white Revolution can be brought along with the Green Revolution in this region. Though there was a decline in sheep population during the study period, the place of ovine population consists sheep and goats is yet to play a significant role in the livestock economy of the district. Vast areas under forest, extensive grazing lands and semi-arid
climatic conditions are the most favourable factors for the development of sheep and goat rearing in the eastern and southern taluks namely, Rajampet, Sidhout, Badvel, Rayachoty and Pulivendula. In this region, the development of mutton breed is considered suitable. Especially for the development of commercial sheep ranching which is more profitable than goat, but which is very susceptible to disease, the intensive treatment and health care as well as breeding facilities must be rendered in all the interior places. The study has revealed that poultry farming has also a significant place to play in the livestock economy of the district. Requirements of small space, low capital, quick returns and well distributed turnover round the year make this enterprise lucrative in both rural and urban areas as well as small and large farmers. By paying proper attention to the management of this house-hold industry, it has become a dependable source of profit and has consequently attracted large investment, from entrepreneurs among whom are farmers, labourers, unemployed persons and big financiers.

On the whole the propitious environment and distribution of different types of livestock in the district may be considered for the development of diversified livestock farming on sound edifice by applying modern technology. Since crop husbandry is unstable, unprotective and unproductive in most of the rainshadow areas of the district, animal husbandry has to be excogitated as a subsidiary occupation to alleviate the economy of the peasant community. Here the diversification in the agriculture i.e., mixed farming must be brought to avoid the environmental and socio-economic problems created by monocultures and to make maximum use of available bio-diversity to adopt agriculture to changing environments and adverse
conditions. The concept of White Revolution is to be placed on an equal plane with Green Revolution and both these diversified farming activities must be made to travel together to achieve the noble destination of the rural economic uplift of this backward region.

**Landuse and Cropping Systems of Selected Villages:**

From the study of sample villages, it is found that the land is being used at optimum level for agriculture under canal irrigation of Mandlapalli village. Here, the cropping is specialised with superior crops indicated the stable and productive levels of agriculture. Under well irrigation, the cropping pattern is highly diversified and equal importance is being given to foodgrain, oilseed, fruits and spices. Intensification of crop farming is found as the chief characteristic of agriculture under well irrigation. Under tank irrigation, the cropping pattern just confined to less number of crops but the extension, stability and productivity of farming are based on the supply of water from the irrigation tank which is rainfed. The utilisation of land for agriculture, the successful cultivation of crops and the expected yield levels are highly precarious under rainfed conditions. Here the crop farming is extensive type with the cultivation of dry crops in the large size fields. On the whole there are conspicuous differences in the landuse pattern and cropping system from one sample village to another due to differences in the physico-socio-economic conditions.

In conclusion, it may be stated that the further success of agriculture in the drought prone area of Cuddapah district will depend upon (i) the intensification of crop farming due to limited proportion of arable land, (ii) extension of irrigation by conjunctive use of both surface and
subsurface water resources, (iii) stabilisation of the agricultural economy by the practice of dryland farming technology, (iv) optimisation of cropping pattern, (v) improvement in the yield levels especially of oil seeds and millets which are predominant in the district, (vi) rational and optimum utilisation of the land resources with the application of better soil and water conservation methods, (vii) modernisation of agriculture, (viii) strengthening of the diversification of agriculture by giving importance to dairy farming and livestock ranching on an equal plane with crop husbandry, and (ix) set up of agro-based industries to integrate the agricultural production and industry for overall development of the region.

Research programmes involving the participation and training of uneducated and orthodox farmers in practicing the dry farming technology, tackling and problems of soil erosion and moisture deficiency and convincing the need of diversified agriculture i.e. mixed farming, will immensely contribute to control the drought effect on agriculture and improve the productivity and potentiality of agriculture in this district. Recent advances made in the technology of remote sensing is likely to be of invaluable help to understand the ecological processes and changes that take place in the district. With the help of remote sensing data long term plans can be made to solve the problems of drought on permanent basis. Planning, monitoring and evaluation cells are to be set up to perform the functions and the activities of the concerned machinery for the development of agriculture on sound lines. And lastly it is clear that the development of agriculture in this dry region, is not the one which can be solved by mere technological processes but require lasting socio-economic and institutional changes too.