MICRO LEVEL PLANNING IN

DROUGHT PRONE AREAS OF ANDHRA PRADESH

Dissertation submitted to Jawaharlal Nehru University
in partial fulfilment of the requirements
for the award of Degree of the

MASTER OF PHILOSOPHY

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Certificate

This is to certify that the dissertation entitled : **MICRO LEVEL PLANNING IN THE DROUGHT PRONE AREAS OF ANDHRA PRADESH** submitted by **Y. VINODH KUMAR** in partial fulfilment of the Degree of Master of Philosophy (M. Phil) of the University is his original work according to the best of our knowledge and may be placed before the examiners for evaluation.

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My Dear
Nannagaru

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Any untoward mistakes committed in the work is the sole responsibility of mine.

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INTRODUCTION

Drought and famine are the natural disasters that limit the Human endeavours for the attainment of just and decent living. It breeds poverty and provides meagre means of livelihood. Many parts of the earth are not adequately endowed with natural resources. Some parts have poor and degraded topsoil. Some have scanty rainfall with wide fluctuation. Still many parts of the ecumene suffer from the unscientific farming practices. On the other hand population is demanding much more from the nature. The end result being ecological imbalance leading to famine and poverty. In order to ameliorate the lot of the poor people eking out livelihood in the drought-stricken regions and improve the ecological conditions, the drought has to be understood in geographical and technical.perspectives.

Drought, especially prolonged drought is considered as one of the major natural hazards affecting the human society. By observing the increasing level of disasters over the globe, the U.N. General Assembly adopted a resolution in December 1989 proclaiming the 1990's as the **International Decade for Natural Disaster Reduction** and designated the **Second Wednesday of October** every year as the **International day for Natural Disaster Reduction**. Nowadays various Governmental organizations and non-governmental organizations are engaged in various kinds of programmes at macro-level to micro-level, to minimize the effect of disaster.

Other natural hazards alike, drought is important in its impact on human population and agricultural economy. It is an invisible phenomenon which sets on by slow process.

Although meteorologists have not been able to find any evidence on the periodicity of drought, but there is some feeling of regular periodicity, however irregular. The most disastrous droughts come at irregular intervals.

It is important to note that the large size and varying altitudes of India do not allow drought to occur over the whole of the country in one year. As Loveday says "History gives no example of a drought extending over the whole of India; and meteorologists declare such events are impossible". Drought is a persistent but very uncertain phenomenon which effects our national economy off and on.

Drought has been a recurring feature of Indian agriculture. Drought occurs due to severe deficiency of rainfall which destabilises productivity of land, livestock and water resources. While technically all areas have, sometime or the other suffered crop losses and distress on account of drought, some clearly identifiable areas have been subject to frequent droughts. The subsistent economy in these areas is unable to absorb a particularly severe drought and the distress assumes the characteristics of a famine before long. This necessitates state intervention through protective and preventive measures against recurrence of such natural calamities in the future.

The United Nations Food and Agricultural Organisation (FAO) pointed out in its study of "Carrying Capacity" in 1982 that the country can, with proper management of its land and water resources, feed two and half times its population of one billion in the year 2000. Efficient water management should aim at better use of land and water resources to achieve high levels of agricultural production.

REVIEW OF STUDIES ON DROUGHT

No part of India is free from drought. Every year some part or other experiences drought. Widespread droughts in the years 1918-19, 1965-66 and in 1987 affected 73 percent, 66 percent and 63 percent of the area of the country. These droughts adversely affected the economy of the country. Many studies on the drought have been done on the nature, magnitude and the impact of drought on economy and dry farming techniques.

The occurrence of drought in India is not a recent phenomenon. Regular Monitoring of rainfall in India started in 1875 with the establishment of India Meteorological Department. Reliable information sources (Satish Chandra, 1992)[1] reveal that since 1800, there have been 40 drought years in the country (See Table below). Intensity-wise the drought of 1987 ranked third in the 20th century, the first one being in 1918 and the second 1965-66.

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[1] Satish Chandra, "Water Conservation and Management" in Sustainable Management of Natural Resources, (Ed.) T.N. Khoshoo and Manju Sharma, Malhotra Publishing House, New Delhi, 1992.

FREQUENCY OF DROUGHT YEARS SINCE 1800

Quarter	Frequency of Drought Years	Years
1801-25	6	1801,04,06,12,19,25
1826-50	3	1832,33,37
1851-75	6	1853,60,62,66,68,73
1876-1900	5	1877,83,91,97,99
1901-25	7	1901,04,05,07,11,18,20
1926-50	2	1939,41
1951-75	6	1951,65,66,71,72,74
1976-87	5	1979,82,85,86,87

Source: Updated Figures Given by Upadhyay & Gupta (1989).

Statistics on areal coverage indicate that out of the country's geographical area of 328 million hectares, 107 million hectares or about one-third of the area (29 percent of the population) is affected by drought. The Central Water Commission studied 99 districts spread in 13 states in 1982. The National Institute of Hydrology has made efforts to study hydrological aspects of drought.

Several studies deal with the definition of droughts. They can be broadly grouped under meteorological drought, hydrological drought and agricultural drought. Generally drought is meteorologically defined as significant negative departure of rainfall from the normal of annual, seasonal, monthly and weekly rainfalls. The India Meteorological Department uses two measures, one to describe rainfall condition and another to describe the drought as moderate or severe if the seasonal rainfall deficiency (in most cases south-west monsoon season) of 26 to 50 percent or more than 50 percent of the normal[2]. Climatological drought conditions in rainfed regions have been described by Chowdhry, A.K., and Banerjee and K.M.S.S. Gokhale (1980) and B.M. Virmani and M.V.K.Siva Kumar (1979).

V.P. Subramanyam (1965) in a study of rainfall for the past hundred years or more over the Indian region showed no significant trend in annual rainfall. On the contrary there has been an increase in this rainfall in which region from the beginning of this century till 1960 after which a downward trend is indicated.

DROUGHT PREDICTION

Attempts have been made to predict drought. But there is no breakthrough in the prediction of long range and short range drought. However several studies have been made in order to establish relationship between certain important circulation features about monsoon and monsoonal rainfall. Important among these are Ramaswamy (1972), Jayaram (1972) Banerjee et al (1976) and Raja Rao and Lakhole (1978). All these studies indicated certain

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[2] Tapeshwar Singh, Drought Prone Areas in India, Peoples Publishing House, New Delhi, October 1978, p.27.

associations between the components of atmospheric circulation features and the monsoon activity but are not adequate for predicting precisely monsoon activity. Similarly, several studies we are undertaken to correlate the suns activity in the occurrence of drought over India. Choudhary et al (1978) examined the linkage between sunspots and drought over India. Besides attempts have been made to analyze long series of rainfall data in order to find out the periodicity and trend of droughts. But it could not prove fruitful. Among such studies, important are Raghavendra (1976), Parthasarathy and Dhar (1974) made analysis of 31 meteorological sub-divisions based on data for 60 years. S.K. Banerjee (1979) explained the occurrence of rainfall and assessed the drought prone areas in India.

AGRICULTURAL DROUGHT

It deals with insufficient soil moisture to support the proper growth of plants and crops to maturity. In this connection, agricultural drought definitions link various characteristics of meteorological drought from the viewpoint of agricultural impacts, focussing on precipitation shortages (Humphereys, 1931, Rosenberg, 1980), departures from normal (World Book Encyclopedia, 1992) or numerous meteorological factors such as evapotranspiration (Laikhtman and Rusin, 1957).

A number of drought indices have been developed in addition to the areas ones of agricultural drought. They are really indices of the degree to which the weather has been abnormally dry. They do not attempt to include the biological and engineering uncertainties which arise when one tries to derive an index which relates to the specific agricultural and hydrological effects of a period of abnormally dry weather. Even so, a general drought index, properly interpreted, can be very useful for agricultural purposes.

One of the most important agricultural drought index is the one developed by W.C. Palmer (1965). Results from analysis of a long record provide a series of monthly drought index values which in general, range from +6 to -6. The positive values are more or less identical but they do provide realistic measures of the degree of unusualness of extended periods of either drought, abnormally wet or near normal. The following table lists the descriptive terms which have been assigned to describe the character of the weather represented by various intervals of the index.

PALMER'S DROUGHT SEVERITY INDEX (PDSI)

INDEX	CHARACTER OF RECENT WEATHER
4.00 or more	Very much wetter than normal
3.00 to 3.99	Much wetter than normal
2.00 to 2.99	Moderately wetter than normal
1.00 to 1.99	Slightly wetter than normal
0.50 to 0.99	Incipient wet spell
0.49 to 0.49	Near normal
-0.50 to -0.99	Incipient drought
-1.00 to - 1.99	Mild Drought
-2.00 to -2.99	Moderate drought
-3.00 to -3.99	Severe drought
-4.00 or less	Extreme drought.

Results are reported as being realistic in all areas. The procedure is mathematically simple, but it is involved and tedious. When done by hand, it is slow and time-consuming, but where computers are available, results can be attained quickly. The method is better suited for climatological analysis than for operational use. During periods when a major drought is developing and spreading it affords a useful means for routinely assessing the areal distribution of the various degrees of drought severity. In the USA this is done on weekly basis during critical situations (Palmer, 1968).

HYDROLOGIC DROUGHT

It is the consequence of prolonged meteorological drought. Linsley et al (1975) considered hydrologic drought a period "During which stream flows are inadequate to supply established uses under a given water management system". Whipple (1966) defined a drought year as one in which the aggregate run off is less than the long term average run off. If the actual flow for a selected period of time falls below a certain threshold, then hydrologic drought is considered to be in progress. However, the number of days and the level of probability that must be exceeded to define a hydrologic drought is arbitrary. (Matthai, H.F. 1979)

Other measures of drought have also been proposed. For example Subrahmanyam (1964) defined drought intensity by using standard Deviation of the Aridity Index, while Krishnan and Thanvi (1971) used the aridity index of the kharif cropping season to describe drought intensity.

There are number of studies related to socio-economic conditions to drought. D.C. Mishra (1987), R.P. Singh (1976), B.S. Kathakali (1991) have discussed the occurrence of drought in the drought prone districts of India.

M.V. Nadkarni has done a benchmark study of drought prone districts of Andhra Pradesh, Karnataka and Tamil Nadu.[3] His study is an investigation into how and to what extent drought proneness affects socio-economic conditions and levels of development, and how they are altered by the introduction of irrigation and other strategies like animal husbandry and rural industry. The study probes into the factors that lie behind differential levels of development and sees whether higher levels of development have contributed towards lowering poverty and inequality and improving socio-economic conditions of particularly the rural poor. He was assisted by R.S. Deshpande, M. Nageswara Rao and Charles Nelson.

R.P. Singh (1976), C. Kalyan (1993) assessed the drought condition in Palamau district of Bihar. The latter's article assessed the severity of drought in the starving state in the grip of worst famine".

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[3] Nadkarni M.V., Socio-Economic Conditions in Drought Prone Areas, A Benchmark sutdy of Andhra Pradesh, Karnataka and Tamil Nadu, Concept Publishing Company, New Delhi, 1985.

J. Venkateswarlu (1987, 1992) has highlighted the choice of suitable crops in a certain region in accordance with soil moisture and water availability as well as alternate crop strategies to meet weather aberrations. Another paper deals with the effect of drought of food, fodder and relief efforts to ease the severity of drought. Suresh K Singha, K Kailasanathan and A K Vasistha (1987) focussed attention on the "Drought Management in India Steps towards eliminating famine" in which authors have come across with defining drought and its magnitude, impact of droughts and post independence experience.

K. Sinha (1993) throws light on the importance of food security for the present and future scenario.

V. Ramakrishnan (1993) has explained the drought hitten area of Madhya Pradesh where government has failed to dispel the crisis. T. Ray (1993) has highlighted the problem, occurring in the recent drought hit area of Orissa, with special reference to socio political aspects.

D.A. Mooley (1979) examined the importance of climatological data for bumper agricultural production in the Indian context. R.P. Singh (1990) wrote on water management as a crucial factor for sustainable agriculture.

Sarkar (1990) focussed attention on the dry farming in drought prone areas. Samui R P and A L Jog (1986) assessed dry land farming under limited water resources.

A S R A S Sastri, M R H Siddiqui, J.S. Urkurkar (1990) examined the new measures for drought management of rainfed rice in central India.

G.G.S, N.Y.S. Ramakrishna, B.V Ramana Rao and R.S. Purohit highlighted the role of rainfall in the production of pearl millets. Some possibilities are also focussed to improve yield under mild drought condition through better management practices. Patel, S.R. A. S Sastri, V.K. Gupta and B.R. Chandravanshi (1986) dealt with the agricultural drought at various growth stages of different dry farming crops during 1981-82 based on the deviation of weekly values of AE / PE from the optimal required values of the same. Merita, R.S., M.M. Bhandari (1980) focussed on the role of vegetations to dispel the dry period and to gain moisture. Daulay, H.S. (1982) highlighted intercropping system in deficient rainfall areas. Rao, P. Vijay Kumar (1980) attempted to define the experiments of various winter season crops under dryland conditions.

CLIMATOLOGICAL DROUGHT

Some scientists are critical of climatically defined drought because it is expressed in terms of a thirty year precipitation. Same meteorological definitions of drought also encompass atmospheric parameters other than precipitation but they are less common. Popov (1948), Levitt (1958), Condra (1944), J.L. Lambert, B.N. Gurung and V. Khadka (1981) et al. defined drought under atmospheric parameters. The Indian Meteorological Department

(1974) has defined drought as a situation occurring in any area when the annual rainfall is less than 75 percent of the normal. Further it has defined "moderate drought" as obtaining when rainfall deficit between 25 percent to 50 percent of the normal and "severe" drought when the deficiency is above 50 percent of the normal (Tapeshwar Singh, 1978).

Thorntwaite (1947) in his paper 'Climate and Moisture Conservation identified three kinds of drought.

1. Permanent drought of the driest climate.
2. Seasonal droughts prevalent in regions with marked wet and dry reasons.
3. Contingent drought which results from the fact that rainfall is irregular and variable everywhere.

Chowdhary, A.K. Banerjee and KMSS Gokhale (1980) have discussed the general climatological aspects of rainfall including rainydays, maximum and minimum temperatures, annual evaporation, droughts and floods, water surplus, water deficit over arid and semiarid regions of the country.

S.M. Virmani and M.V.K. Sivakumar (1979) assessed the drought hazard in semi-arid tropical India.

The impact of the 1987 / 88 drought in India on food-grain production is analysed by Bhatty, I J, Sarkar H, Vashishtha, P. Panda, M, Bhide S, Pal .P. (1988). Despite the drought it was possible in 1987/88 to maintain a regular flow of food supplies that successfully prevented the occurrence of shortages in any region. The regional disparity in the agricultural production of the year is examined.

Andhra Pradesh Agricultural University - International Crops Research Institute for Semi-Arid Tropics (APAU-ICRISAT) cooperative drought research, 1989 highlights the field experiments conducted by them on drought resistance / tolerance of groundnut, pigeonpea, sorghum, pearl millet (variety trials were carried out at Agricultural Research Station, Anantpur).

Analysis of all the drought-prone district of India, their problems and perspectives was done by Bagchi K S (1991). Based on data generated at the Tehsil / Taluk level, it provides information encompassing geographical location, physical features agricultural production, livestock, landuse and wateruse, highlighting the problems of a given area and potentials of degraded and underutilised low productive soils.

Garrity, D.P., Sullivan, C.Y., Ross, W.M. (1982) emphasized on the alternate approaches to improve sorghum grain productivity under drought stress, like (i) The physiological approach that involves introduction of specific traits into superior genetic backgrounds, and (ii) the performance approach involving direct selection under water stress environments.

Unstable Agriculture and Droughts by Rao CH.H, Ray, S.K., Subba Rao, K. (1991) examines the consequences of droughts, particularly on the vulnerable sections of the population and works out the needed policy interventions for providing employment, food and other essential commodities to the rural poor and to the weaker sections of the society.

The dynamics and trends of crop-land use patterns in Anantpur district was examined by Reddy, N.B.K., Ramanaiah, Y.V. (1992). It considered the mutual transference of land between Net Sown Area and fallowland, the distribution of high yielding seed varieties (HYV's) and the efficiency and variation of land use. All crops except groundnut has shown a declining trend.

Matthews, R.B., Harris, D., Williams J.H., Rao, R.C.N. (1988) studied the physiological basis for yield differences between four genotypes of groundnut with the limited irrigation during post-rainy season in medium depth Alfisols of Telangana in Andhra Pradesh.

Bailey, E., Boisvert, R.N. (1989) studied the effects of drought, timing, duration and intensity of water stress on groundnut productivity and the extent of genetic variability in Hyderabad and Anantpur. The response of groundnut cultivar Robut 33-1 to the lack of soil water (Sarma, P.S., Siva Kumar, M.V.K. 1989) and its influence on growth, wateruse and seed production was studied.

Rao, R.C.N., Wadia, K.D.R., Williams J.H (1990) compared the productivity of intercropping short and long duration varieties in drought environments.

Wheatley A.R.D., Weightman, J.A. et al (1989) determined the influence of drought stress on the distribution of insect pests like Aproaerema, Empoasca Keri, Scirtothryes, etc.

Dhopte, A.M., Ramteke S D., Thote, S.G. (1991) related drought tolerance efficiency to leaf area and canopy growth. JL24 was found the most tolerant. Its root growth was 2-3 times greater than the other cultivars. Dwivedi, R.S., Joshi, Y.V. , Nautiyal, P.C., Singh, A.L., Ravindra V., Thakkar, Koradia, V.G., Dhapwal G.S and others have also worked on the detection of drought resistance on Arachis Hypogaea, L.

Nageswara Rao, R.C.; Williams J.H., Singh, M. (1989) studied the genotype drought pattern to develop managerial and breeding strategies for improvement and stabilizing of groundnut yields. Rao, R.C.N., Wadi K.D.R., Gayatri Devi (1990) screened the genotypes for drought tolerance and post-rainy season. More than 150 genotypes of varieties fastigata, vulgaris are screened.

Gallo, P.B., Mascarrenhas, H.A.A, Bataglia, O.C., Uaggio, J.A (1986) studied the interaction of time and nitrogen fertilizer on sorghum yield under drought conditions in rotation with soyabeans.

Mattews, R.B., Reddy, D.M., Rani, A.U. (1990) represented the response of sorghum to midseason drought. Craufurd, P.Q., Peakcock, J.M. (1993) studied the effect of heat and drought stress on Sorghum bicolor.

Blum, A., Golan, G., Mayer, J., Sinmena B, Obilana T (1992) worked on the comparative productivity and drought response on sub-tropical hybrids and open-pollinated varieties of sorghum. Seetharama, N., Mahalakshmi, V., Bidinger, F.R., Sardar Singh 1984 studied the response of sorghum and pearl millet to drought stress. The alternate approaches to improving grain sorghum productivity in drought environment are given by Garrity, D.P., Sullivan, C.Y., Ross, W.M. (1982) and Nimbalkar, V.S., Bharud, R.W., Jadhav, P.B. (1983) evolved an advanced winter sorghum for drought prone conditions. The inheritance of drought tolerance is studied by Hou H.T., Zhang, S.Y., Zhao, G.D. (1987). They worked a path coefficient analysis and showed that drought tolerance was associated with increased numbers of green leaves and increased chlorophyll content.

Burton G.W., Kvien, C.S., Maw, B.W. (1988) studied the effect of drought stress on productivity of trichomeless pearl millet penninsetum glacicum. the crop yields on loamy sand soils of foxtail millet (setoria italica) and proso-millet (panicum meliaceum) were studied by Joshi, N.L. (1988). Studies of drought tolerance and resistance on millets were done by Ibrahim, Y.M., Marcarian, V., Dobrenz A.K. (1986), Ali, M., Patil, B.D., Sinha, N.C., Rawat, C.R. (1986). Sagar, P., Kapoor, R.L. (1983) studied the genetics of grain yield and drought index under different levels of moisture stress.

Sastri, A.S. R.A.S, Rao, B.V.R., Ramakrishna, Y.S., Rao, G.G.S.N. (1982) studied agricultural droughts and crop production of pearlmillet and kharif pulses.

Venkateswarlu, J. (1984) studied the drought problems on productivity of Rice.

The works cited above provides a good account of the magnitude and frequency of droughts in India, the different alternatives available in crop planning and management for improving production in dry farming areas and the impact of droughts on the economy and life of the people.

GOVERNMENTAL PLANS FOR THE DEVELOPMENT OF DROUGHT PRONE AREAS

It was only after Independence that a long term view was taken of the problem for evolving a strategy for development of the drought affected areas. But there was no appropriate recognition of the problem of these areas in the initial years of the planning era in India. The first five year plan provided assistance to the scarcity affected areas, but there was no mention of these areas in Second and Third plans. The first and Second plans however emphasised the problems of dryland farming had to be given more attention than before. During the second five year plan, 45 dry farming projects were initiated covering an area of about 400 hactares, each in different states to demonstrate the benefits of dryfarming practices in low and erratic rainfall regions.

It was only in 1961, that a slightly wider connotation was given to famine by bringing in the concept of chronically drought affected areas which covered not only those areas where famine was endemic but also certain other areas where rainfall was low, and the general geographical, climatic and agronomic conditions were such that any slightest unfavourable tilt in these areas in the natural balance would push these areas in the direction of famine. However it was only after the very prolonged wide spread droughts of 1965-67 that there was a real awakening at the national level and the importance of evolving a long term strategy for development of drought prone areas was felt. With a concern at the deteriorating situation, the Fourth plan laid considerable emphasis on research into improved dry farming technologies and application of the breakthrough's in drought prone areas. All India Coordinated Research Project for dryland Agriculture was initiated in 1970-71 during this plan period with 24 pilot projects, for testing the applicability of a package of dryland practices.

The Rural Works Programme was formulated during 1970-71 54 districts (along with some contiguous areas of another 18 districts) in 13 states which were identified as chronically drought affected, with the primary objective of employment generation so as to mitigate the effects of drought. The districts selected in Andhra Pradesh are Anantapur, Kurnool, Cuddapah and Chittoor.

The districts include those recommended by the Gidwani Sub-Committee to the initial 23 districts under Rural Works Programme. The sub-committee recommended Mahbubnagar among 20 other districts in India. Following the fourth plan mid-term appraisal in 1971, the programme was reoriented from mainly employment generation to drought proofing of the areas covered. It was renamed as Drought Prone Area Programme (DPAP) with effect from January 1973.

The DPAP in the initial stages was restricted to schemes of minor and medium irrigation, afforestation and soil conservation, roads and drinking water supply. It was later appreciated that the development of cattle and dairying as well as sheep was highly relevant to the land and water resources situation in most of the drought prone areas and pasture and animal husbandary development would be more effective in utilising the resource potential of the areas concerned. The need for this programme was emphasised in the Fifth Five Year Plan also. Some of the important components of the programme are:

1. Development and management of water resources
2. Soil and moisture conservation measures
3. Afforestation, with special emphasis on social forestry and farm forestry
4. Development of pasturelands and range management in conjunction with development of sheep industry

5. Livestock and dairy development
6. Restructuring of cropping pattern and changes in agronomic practices.
7. Development of subsidiary occupations.

Several research and development works have been continuing by various institutions, a few of these organisations are named below:

IARI	-	Indian Agricultural Research Institute
ICAR	-	Indian Council of Agricultural Research
ICRISAT	-	International Crops Research Institute for Semi-Arid Tropics

In 1985, All India Coordinated Research Project for Dryland Agriculture (AICRPDA) was renamed as Central Research Institute after upgradation to institutional status. All India Coordinated Research Project on Agrometeorology (AICRPAM) was founded in 1983 to provide fillip in conducting basic and applied research for improving the productivity of dryland crops. The same year CRIDA was entrusted with the responsibility of giving technical backup to 31 of the 47 ICAR Model Watersheds spread over 31 districts in 13 states. These watersheds are distributed in different agro-climatic zones with varying topography and soil types. This provides appropriate conditions for evaluating the performance of dryland technology.

In Andhra Pradesh there are two of the model water sheds. They are as follows:

Watershed	Watershed Area Hactares	Cultivated Area, Hactares	Non-Arable Land, Hactares.
Yerracheruvu	567	445	122
Chevella	673	635	38

The main thrust of the watershed programme is to conserve the rainwater resource to an eco-zone through appropriate technology development. On an overall basis, integrated watershed development approach is advanced in that proven crop management technologies optimizing resource utilisation are superimposed for stable and sustainable rainfed agriculture.

The Irrigation Commission of 1972 identified 326 Tehsils /blocks in 67 districts of 8 states as drought prone which were followed by National Commission on Agriculture in 1976 to take up developmental measures according to the recommendations of DPAP. Since water is the most scarce commodity in drought prone areas, development and management of irrigation works to utilize surface and groundwater were given higher priority.

The National Committee on the Development of Backward Areas headed by Dr. M.S. Swaminathan submitted its Report on Development of Drought Prone Areas in 1981. The report identified 557 Community Development

Blocks out of the total of 5011 such blocks in India in 74 districts of 13 states as drought prone. The total area of these drought prone areas was 580,000 sq kms with a population of 600 lakhs. The programme thus covers about 12 percent of the total population and 19 percent of the total area of the country.

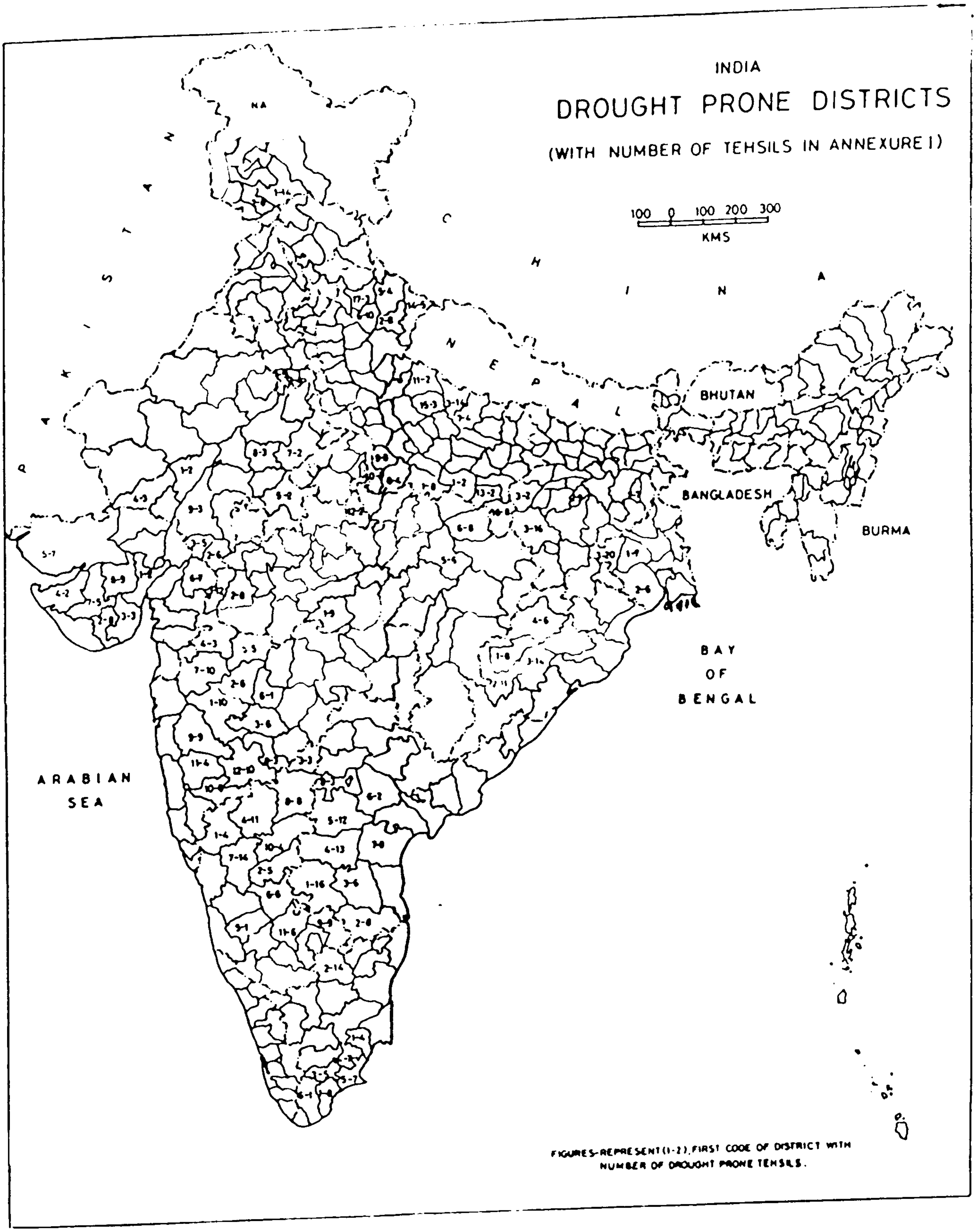
The area treated so far upto Sept 1993 under the DPAP comes to about million hectares which constitutes only 10 percent of the geographical area of the selected blocks under the programme.

Physical Achievements of DPAP, since inception upto Sept 93:

Sl.No.	Core Activity	Physical Achievement ('000 hectares)
1.	Land Development & Soil Conservation	2740
2.	Water Resources Development	902
3.	Afforestation and Pasture Development	1647
	Total	5289

Despite the fact that DPAP has been in operation for two decades, no substantial impact has been made. It is widely believed that drought conditions are increasing and ecological degradation proceeding unabated in these areas.

With regard to agriculture, the Seventh Five Year Plan's emphasis was on area development approach taking watershed as a unit of development.


INDIA
DROUGHT PRONE DISTRICTS
(WITH NUMBER OF TEHSILS IN ANNEXURE I)
100 0 100 200 300
KMS
BHUTAN
BANGLADESH
BURMA
BAY OF BENGAL
ARABIAN SEA
FIGURES-REPRESENT (1-2), FIRST CODE OF DISTRICT WITH NUMBER OF DROUGHT PRONE TEHSILS.

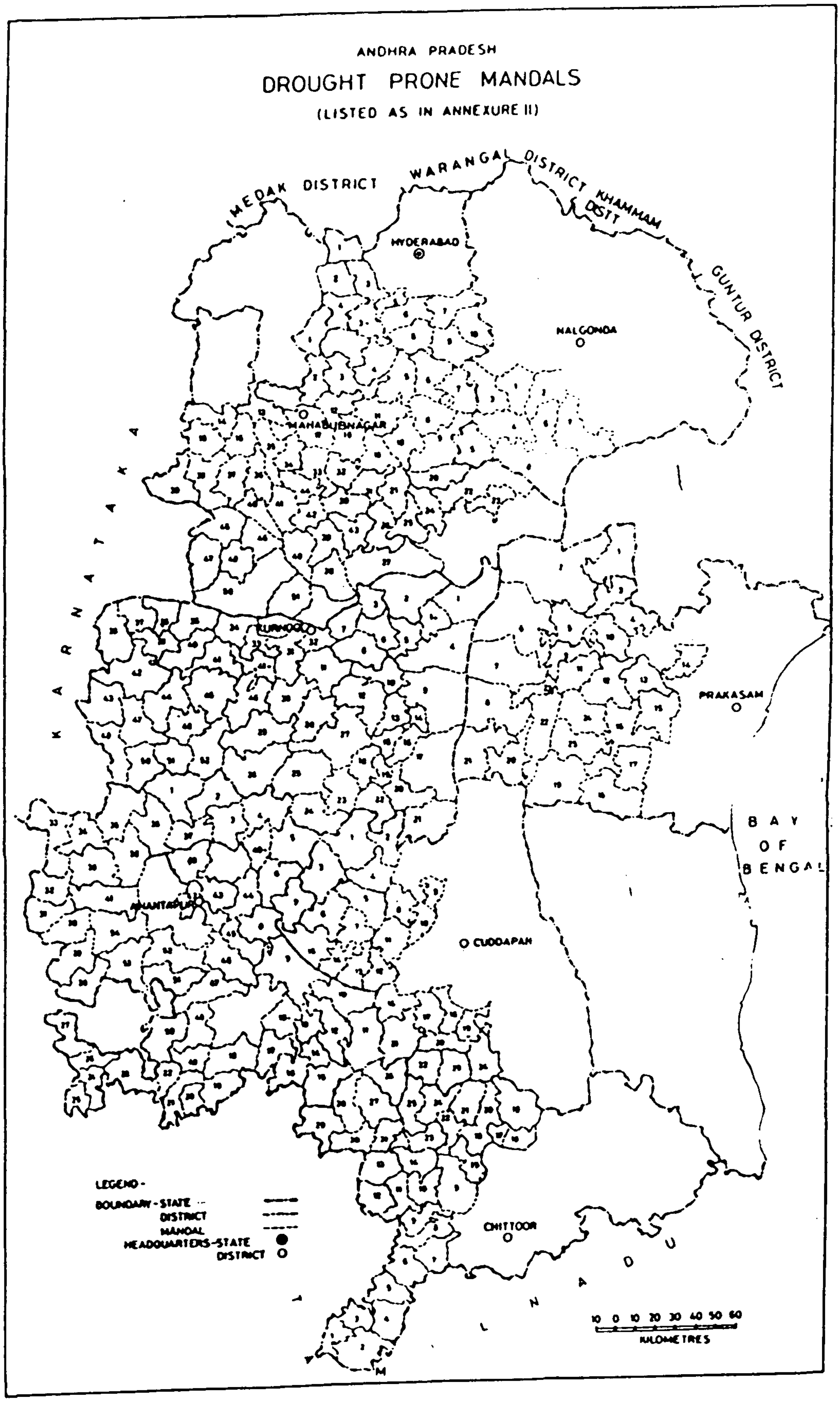
MAP NO. 1

The Technical Committee on DPAP headed by Sri CH. Hanumantha Rao submitted its report in April 1994. It recommended 619 blocks in 91 districts of 13 states as drought prone areas. This is a significant increase since the earlier report of NCDBA of Dr. M.S. Swaminathan. This requires serious concern from both Scientists and Government. Despite the fact that nearly 2,000 crores of rupees have been spent since its initiation, the unsatisfactory performance of the programme should be noted. A wide range of activities not necessarily related to the core objectives were taken up in the past by spreading them thinly over a widely dispersed area. The attempt of mitigating the sufferings of the people were aimed at the provision of ad hoc relief without integrating them for land and water conservation.

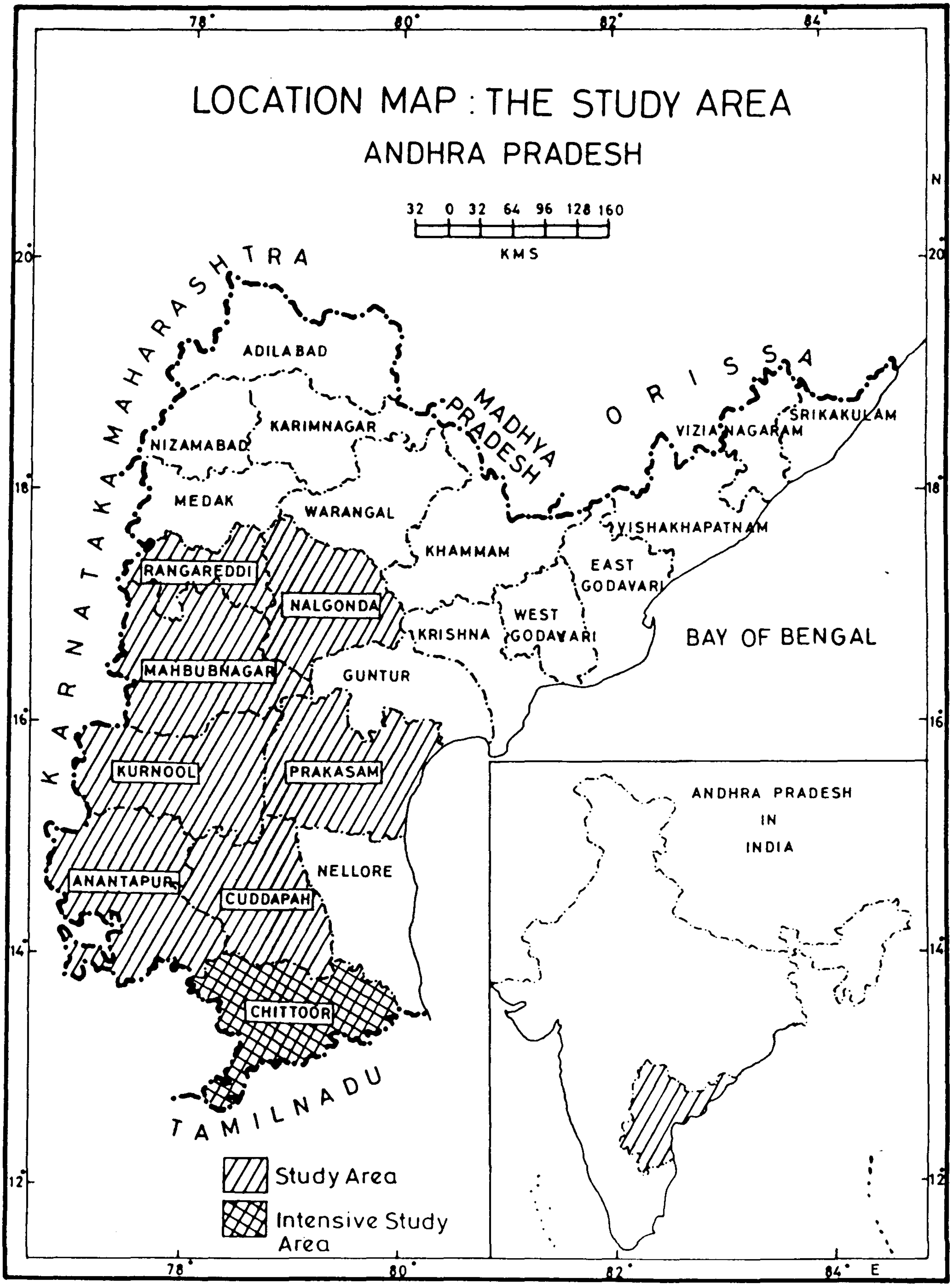
As a follow-up action to the Hanumantha Rao Committee Report, the Ministry of Rural development has come out with specific guidelines for watershed development. As on 17 October, 1994 Drought Prone Areas Programme covers 627 Blocks in 96 districts of 13 States. (See Map-1 and Annexure-I).

"It is an earnest desire and hope that these guidelines be adopted and implemented as soon as possible, creating a movement for a splendidly benefitful and beautiful environment in our motherland, especially in the drought prone and dry areas" (B.N. Yugandhar)[4] .

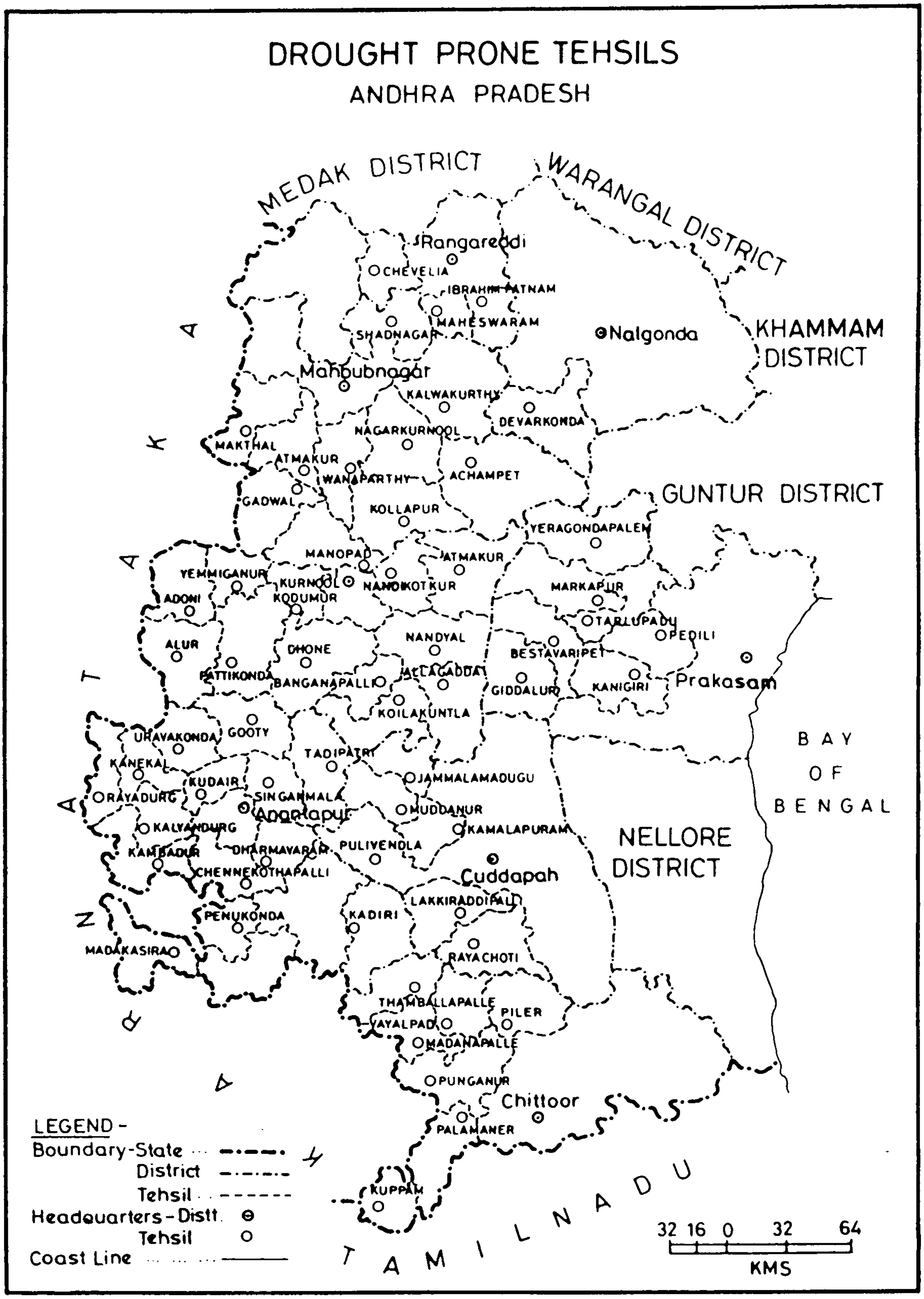
[4] Yugandhar. B.N., Secretary, Ministry of Rural Development, Government of India.


ANDHRA PRADESH
DROUGHT PRONE MANDALS
(LISTED AS IN ANNEXURE II)
MEDAK DISTRICT
WARANGAL DISTRICT
KHAMMAM DISTT
GUNTUR DISTRICT
HYDERABAD
NALGONDA
MAHABUBNAGAR
KURNOOL
PRAKASAM
ANANTAPUR
CUDDAPAH
CHITTOOR
KARNATAKA
TAMIL NADU
BAY OF BENGAL
LEGEND -
BOUNDARY - STATE
DISTRICT
MANDAL
HEADQUARTERS - STATE
DISTRICT
10 0 10 20 30 40 50 60
KILOMETRES

MAP NO. 2


LOCATION MAP : THE STUDY AREA
ANDHRA PRADESH
32 0 32 64 96 128 160
KMS
MAHARASHTRA
ORISSA
MADHYA PRADESH
KARNATAKA
TAMILNADU
BAY OF BENGAL
ADILABAD
NIZAMABAD
KARIMNAGAR
MEDAK
WARANGAL
KHAMMAM
SRIKAKULAM
VIZIANAGARAM
VISHAKHAPATNAM
EAST GODAVARI
WEST GODAVARI
KRISHNA
RANGAREDDI
NALGONDA
MAHBUBNAGAR
GUNTUR
KURNOOL
PRAKASAM
NELLORE
ANANTAPUR
CUDDAPAH
CHITTOOR
Study Area
Intensive Study Area
ANDHRA PRADESH IN INDIA
N
E
78°
80°
82°
84°
20°
18°
16°
14°
12°

MAP NO. 3


DROUGHT PRONE TEHSILS
ANDHRA PRADESH
MEDAK DISTRICT
WARANGAL DISTRICT
KHAMMAM DISTRICT
GUNTUR DISTRICT
NELLORE DISTRICT
BAY OF BENGAL
KARNATAKA
TAMILNADU
Rangareddi
CHEVELIA
IBRAHIMPATNAM
MAHESWARAM
SHADNAGAR
Nalgonda
Mahbubnagar
KALWAKURTHY
DEVARKONDA
NAGARKURNOOL
MAKTHAL
ATMAKUR
WANAPARTHY
ACHAMPET
GADWAL
KOLLAPUR
YERAGONDAPALEM
MANOPAD
ATMAKUR
YEMMIGANUR
KURNOOL
NANDIKOTKUR
MARKAPUR
ADONI
KODUMUR
TARLUPADU
PEDILI
NANDYAL
ALUR
DHONE
BESTAVARIPET
PATTIKONDA
BANGANAPALLI
ALLAGADDA
GIDDALUR
KANIGIRI
Prakasam
KOILAKUNTLA
URAVAKONDA
GOOTY
KANEKAL
TADIPATRI
JAMMALAMADUGU
KUDAIR
RAYADURG
SINGANAMALA
Anantapur
MUDDANUR
KALYANDURG
KAMALAPURAM
KAMBADUR
DHARMAVARAM
PULIVENDLA
CHENNEKOTHAPALLI
Cuddapah
LAKKIRADDIPALLI
PENUKONDA
KADIRI
MADAKASIRA
RAYACHOTI
THAMBALLAPALLE
PILER
VAYALPAD
MADANAPALLE
PUNGANUR
Chittoor
PALAMANER
KUPPAM
LEGEND -
Boundary-State
District
Tehsil
Headquarters - Distt.
Tehsil
Coast Line
32 16 0 32 64
KMS

MAP NO. 4

In Andhra Pradesh the DPAP is in operation in 69 blocks of 8 Districts. There are 262 drought prone mandals in the 69 tehsils (See Map Number 2 and Annexure - II). There are 76 micro watersheds which are identified in these drought prone areas of the state. (See Annexure-IX).

Map Number 3 shows the location of the study area. Map Number 4 shows the drought Tehsils of the study areas.

OBJECTIVES OF THE PRESENT STUDY

The present study attempts at

1. Studying the magnitude and frequency of occurrence of droughts in drought prone area in Andhra Pradesh.
2. Studying the effect of rainfall deficiency on the agricultural production.
3. To study the district-wise and mandal-wise cropped area and production of all Food and Non-food crops in drought prone areas.
4. To study the inter annual variability of Rainfall over Irrigation Source-wise, Irrigated Area, Cropped Area, Production of Different Crops.
5. Critically evaluating the various programmes for the development of drought prone areas in Andhra Pradesh.
6. Analysing the need for micro-level planning for the welfare of the people in Drought Prone Areas in Andhra Pradesh.

DATABASE

The present study is based on the analysis of secondary sources of data and important Government of India and Andhra Pradesh reports.

1. Indian Meteorological Department's Monthly and Annual Rainfall and Number of Days.
2. Directorate of Economics and Statistics, Andhra Pradesh
3. District Planning Officer, Chittoor.
4. Statistical Abstracts of Andhra Pradesh.
5. Outline of Agricultural Situation, Andhra Pradesh.
6. Season and Crop Report, Andhra Pradesh.
7. Indian Agricultural Statistics.
8. Livestock Census.

PRIMARY SOURCES

1. National Committee on Irrigation, Min. of Agriculture, 1972.
2. National Committee on Agriculture, Min. of Agriculture, 1976.
3. National Committee on Development of Backward Areas, Department of Rural Development, Min. of Agriculture, January 1981.
4. Report of Technical Committee on Drought Prone Areas Programme, Min. of Rural Development. April 1994.
5. Guidelines for Watershed Development, Min. of Rural Development, October 1994.

METHODOLOGY

The drought prone area in Andhra Pradesh has been demarcated based on the criteria laid down by the Irrigation Commission 1972 and as modified by the Technical Committee on Drought Prone Areas Programme. It is based on the percentage deviation of actual rainfall from the normal annual rainfall and the extent of irrigation at the mandal level.

Standard statistical frequency analysis is used for analysing the magnitude and frequency of occurrence of drought. The percentage deviations of rainfall from the previous year is correlated with the corresponding deviation in the major landuse classes and agricultural production. Cumulative Rank Method is used for identifying the Levels of Development in the Drought Prone Mandals of Chittoor - A District taken for an intensive study.

CHAPTERISATION

The Chapter One on Drought Prone Areas in Andhra Pradesh discusses the criteria of various state governments and committees for delineating the drought prone areas and looks at the various approaches to monitor drought. It gives a brief profile of the eight drought prone districts of the state with their taluks and mandals.

Chapter Two looks at the Spatial and Temporal Distribution of Rainfall in the drought prone tehsils and mandals. The frequency and intensity of the annual rainfall data over the last 30 years i.e. from 1961 to 1993 have been utilised for the study.

Chapter Three evaluates the Irrigation scenario in the drought prone areas of Andhra Pradesh. It gives special importance to the Irrigation during Kharif and Rabi seasons in the drought mandals of Chittoor.

Chapter Four examines the agricultural aspects of the drought prone areas. It looks into the cropping pattern and the agricultural yield of different food and non-food crops in the drought districts, especially in the drought prone mandals of Chittoor. It also studies livestock scenario in the tehsils and mandals of the study area.

The affect of Rainfall variability over the source-wise irrigation, cropped area, agricultural crop production in the drought prone areas of Andhra Pradesh has been discussed in Chapter Five of the study.

Chapter Six gives an Agricultural Contingency Plan for the drought prone areas of Andhra Pradesh. The plan forms of part of the Drought Management. The Watershed Approach is discussed in detail in this chapter.

Chapter Seven looks at the relevance of Micro Level Planning and the Welfare Approach for the drought prone areas in Andhra Pradesh. The Micro Level Planning attempts to measure the Levels of Development the Drought Prone Mandals in Chittoor.

Drought Prone Areas in Andhra Pradesh

CHAPTER ONE

Drought is normally defined by a large deficiency of rainfall which affects the plant and life of the people. If an area is occasionally affected by drought, it cannot be classified as drought prone area. Similarly an area which does experience large departure in its seasonal rainfall from the normal, but has adequate drought protection infrastructure, such an area cannot be called as drought prone area. Since government relief comes in a big way in drought affected area, there is a tendency to include as much area as possible as drought prone areas. In this chapter a review is done on the various approaches to delimit drought prone areas in India, the drought prone area in Andhra Pradesh is demarcated and geographical account of the drought prone districts is given.

1.1 CRITERIA OF DROUGHT DELIMITING DROUGHT PRONE AREAS

The States follows different criteria for identifying drought prone area.

CRITERIA FOLLOWED BY THE STATES

The Government of Tamil Nadu identified such taluks where the rainfall was less than 900 millimeters or less than 35 percent of the cultivated area was irrigated as drought areas.

The Government of Rajasthan identified such area as drought areas where the ratio of good crop year to scarcity year was 2:1 or less and where 15 percent of the villages of the areas were affected by drought.

The Government of Karnataka considered such areas as drought areas which received rainfall less than 400 millimeters during Kharif and less than

150 millimeters during Rabi with variability of more than 30 percent during each crop season and rainfall deficiency of more than 20 percent during the crucial stage of crop growth.

Most of the other states follow the criteria of 'Annawary' estimate and revenue remission.

Annawary is a system to estimate the conditions of crop by visual assessment . This is assessed in terms of yield in the ratios of annas in a rupee.

The assessment of annawary is normally done by the village officers / karnams. Some times the subjective element in the assessment of Annawary by a village officer is large enough to vitiate any delineation of drought.

The Orissa Relief Code (Revenue Department Resolution No. 66555R, dated 5.9.1977) defined a procedure for measuring the extent of crop loss depending on the rain water for assessing the winter paddy and Ragi crops, which shows the effect of drought.

i) Firstly, a little earlier to the harvest (nearly November), an eye estimation survey is undertaken in the villages where 50 percent or more crop loss is anticipated due to inadequate rainfall or other reasons.

ii) The normal yield per acre is ordinarily determined on basis of the average yield of previous years except the drought years. In case of non-availability of information over 5 years, the average yield of the last 3 years may be taken.

iii) No crop cutting is usually undertaken in the irrigated lands unless there is any specific instruction for this.

No percentage of the yield is usually measured by the formula given below:

$$\frac{\text{Average present yield x 100}}{\text{Normal yield}} = \text{Normal Yield}$$

The crop sample is threshed the paddy separated and the weight recorded. One tenth of the weight is usually reduced towards humidity. Thus a register of crop cutting is maintained by the Revenue Inspector and in case one village in a Gram Panchayat experiences crop loss of 50 per cent or more, the entire Gram Panchayat is also covered for the purpose.

In Andhra Pradesh, the declaration of drought in the affected areas was based on the following considerations.

1. Significant deficiency in rainfall, gross uneven spread of rain and very much prolonged dry spells.
2. Steep reduction in the areas sown and also heavy damage to standing crops.
3. Fall in estimated yeilds of crops.
4. Considerable fall in extent of grain and fodder supply with abnormal increase in prices.
5. A trend of falling current agriculture and non-agriculture wages as compared with normal times.

6. Extent of unemployment position with reference to agricultural operations and on going works of Government, local bodies and big employers, and
7. Unusual movement of labour in search of employment.

The proposals for declaring scarcity were processed in the State Revenue Department for seeking Central assistance for emergency relief.

Though the identification during the cropping season was generally done only by visual inspection, at the end of cropping season, however, crop cutting experiments were done and the yield compared to the normal yield which is the average of the last five to ten years.

1.2 MONITORING DROUGHT

Of the various criteria for identifying drought prone areas in India, the criteria of Indian Meteorological Department is the one which is most prevalent and commonly practised. Therefore, Irrigation Commission in 1972 adopted these criteria for defining drought. IMD defined drought as a situation occurring in an area in a year when rainfall is less than 75 percent of the normal. Whenever 75 percent of the normal rainfall is not received in 20 percent or more of the years the area is said to be a drought prone area. Whenever this probability exceeds 40 percent of the area is said to be a chronically drought prone area. And with the rainfall deficiency above 50 percent of the normal, it is said to be severe drought. The Irrigation Commission (1972) recommended to exclude taluks where 30 percent or more

DROUGHT PRONE TEHSILS IN ANDHRA PRADESH

(BASED ON IRRIGATION COMMISSION REPORT, 1972)

MAP NO. 6

of the cultivated area is irrigated (See Map Number 6). Relying on the statistics of famine scarcity and revenue remissions, the Irrigation commission observed that the area experiencing famine scarcity more frequently could be classified as a drought area.

While this criteria indicates variation of annual rainfall, it does not give any indication whatsoever of the evenness or unevenness of distribution of rainfall. This criteria does not enable the analysis of rainfall with respect to the crop requirement. It also does not provide any indication of late onset of monsoon, early withdrawal or interspell duration so vital for crop maturity. Even for hydrological drought this criteria does not provide any means to calculate the dependable run off, since it does not take into consideration the intensity of rainfall and evaporation losses.

Nevertheless, this criteria gives a general indication of the excess or deficiency in rainfall when compared to the normal. Even the normal rainfall which has been used so extensively has not been defined (although in practice mean of 30 years or more of rainfall has been considered as normal rainfall) with the result that 30 years normal rainfall varies with 30 years average rainfall.

Moreover since the Indian Meteorological Department criteria defines the drought in terms of percentage of deficiency of rainfall from Normal the regions with substantial deficiency may not be drought affected. therefore this does not provide a scientific guide to identify agricultural drought.

In this report of National Commission on Agriculture (1976), drought has been defined taking an occasion when the rainfall in a week is half of the normal or less when the normal, weekly rainfall is 5 millimeters or more. The agricultural drought is a period of four such consecutive weeks in the period from middle of May to middle of October or six such consecutive weeks during the rest of the year.

The normal date of onset of monsoon is in the fourth week of June or first week of July. Under such conditions, this criteria would be difficult to apply.

According to the Commission, drought can occur in two ways.

A. Due to rainfall less than 10 millimeters in a month.

B. Due to absence of rainfall or zero rainfall in a period of four consecutive weeks.

In the meteorological terms a day upto 2.5 millimeters of rainfall is not considered a rainy day. Therefore if 15 millimeters or even 20 millimeters rainfall takes place distributed over a period of 10 days in a period of four weeks the same would not be considered as effective rainfall at all. Under the circumstances, effectiveness of 10 millimeters of rainfall in a period of four weeks appears doubtful.


DROUGHT PRONE TEHSILS IN ANDHRA PRADESH
BASED ON NATIONAL COMMISSION ON DEVELOPMENT OF BACKWARD AREAS, 1981
SHADNAGAR
KALWAKURTHY
DEVARKONDA
MAKTHAL
NAGARKURNOOL
ATMAKUR
WANAPARTHY
ACHAMPET
GADWAL
KOLLAPUR
VERAGONDAPALEM
MANOPAD
ATMAKUR
YEMMIGANUR
NANDIKOTKUR
MARKAPUR
ADONI
KURNOOL
KODUMUR
ALUR
NANDYAL
DHONE
BESTAVARIPET
PATTIKONDA
BANGANPALLI
ALLAGADDA
GIDDALUR
KANIGIRI
KOILAKUNTLA
URAVAKONDA
GOOTY
TADPATRI
KANEKAL
JAMMALAMADUGU
KUDAIR
BADVEL
RAYADURG
SINGANMALA
MUDDANUR
PRADDATUR
KAMALAPURAM
KAMBADUR
DHARAMAVARAM
PULIVENDLA
CHINNAKOTHAPALLI
CUDDAPAH
LAKKIREDDIPALLI
RAJAMPET
PENUKONDA
KADIRI
MADAKASIRA
RAYACHOTI
KODUR
HINDUPUR
THAMBALLAPALLE
VAYALPAD
CHINNAGOTHIGALLU
MADANAPALLE
PUNGANUR
CHITTOOR
PALAMANER
KUPPAM

MAP NO. 7

In addition this criteria does not take into account the crop requirement with respect to evaporation losses and the moisture stresses developed in the soil for the maturity of the crop.

The National Committee on the Development of Backward Areas (NCDBA, 1981) headed by M.S. Swaminathan was of view that the Water Balance technique may be an ideal approach for delineation of Drought Prone Areas. If experimental data on evapo-transpiration soilmoisture & area specific agro-climatic models are available the result may be accurate. However, since the committee was considering drought proneness as the fundamental backwardness which need amelioration neither considered the above approach nor it had the irrigation other opportunities as criteria for drought proneness (See Map Number 7).

NCDBA followed a synoptic definition that "a block can be defined as drought affected if the pattern and quantum of rainfall during the main crop season of the area makes the traditional cultivation of the main crop of the area hazardous in three years or more out of every 10 years". It allowed for the soil and wind factor which had been emphasized by Irrigation Commission in its stress on evapotranspiration. Its objective was to find means of increasing and stabilising productivity in the backward areas.

The Swaminathan Committee therefore followed the recommendations of National Commission on Agriculture and carried out the same delineated blocks. However, it emphasised that a scientific delineation of the areas is required if a scientific answer is to be found for the amelioration of the defect.

A methodology for computation of water balance by Thorntwaite & Mather (1955) is book keeping technique. Classification of drought by considering Audity Index has been done by a number of authors.

Drought is the balance between soil moisture and crop requirements. Assured moisture availability is the major constraint in the areas. Thus the crop and livestock production systems are frequently affected rainfall and percentage inflation for identification are only broad parameters. There is a need for refinement of the criteria based on the latest technological advancement in Data collection and the Remote Sensing applications which would help in focussing our efforts on a more scientific basis.

The Report of the Technical Committee on Drought Prone Areas Programme and Desert Development Programme (Hanumantha Rao Committee Report) used Moisture Index (MI) and the level of irrigation development for identifying drought prone areas. The recommendation is given in the Table below.

Moisture. Index (MI)	Permissible Programme	Eco System	Percentage of Irrigated Area
< -66.7	DDP	Arid	50 Percent
-66.7 to -33.3	DPAP	Semi-arid	40 Percent
-33.2 to 0	DPAP	Dry Subhumid	30 Percent

DROUGHT PRONE TEHSILS IN ANDHRA PRADESH

(BASED ON HANUMANTHA RAO COMMITTEE, 1994)

MAP NO. 8

Map Number 8 shows the drought prone tehsils delineated as per criteria of Hanumantha Rao Committee Report.

Annexure-III gives the comparative list of Tehsils identified according to the three important Committees discussed above.

Since a large part of Andhra Pradesh is coming under Dry sub-humid and semi-arid region the irrigation level of 40 percent is taken for identifying the drought prone areas. The same criteria was adopted at mandal basis in Chittoor District. The districts thus identified are Prakasam, Kurnool, Anantpur, Cuddapah, Chittoor, Rangareddy, Mahbubnagar and Nalgonda.

DROUGHT MONITORING THROUGH REMOTE SENSING TECHNIQUES

The advent of Remote Sensing has revolutionised the development and Management of Drought Prone Areas in India. Detailed drought impact assessments in terms of smaller areal units and impact on surface and sub-surface storages and crop specific production were identified as some of the key requirements. Such details require fine spatial and spectral resolution provided by earth resources satellites such as IRS IA and its followers.

Drought and Vegetation Response

The effect of drought is to cause recognisable structural changes in vegetation, which in turn cause changes in spectral reflectance. The structural changes include morphological changes such as leaf appearance (colour and shape) and stature of the plant. Phenology is and other structural characteristic, and changes could result from drought episodes. Repetitive satellite coverage provide the capability to temporarily monitor spectral changes resulting from drought. The National Agricultural Drought Assessment and Monitoring System (NADAMS) developed at DOS / NRSA uses the Vegetation Index (VI) as a convenient parameter for expressing the multispectral response of vegetation. Though many vegetation indices have been used by various investigators, this discussion will focus on the normalised difference Vegetation Index which is defined as follows:

NDVI = NIR - VIS / NIR + VIS

Where NIR and VIS are reflectances in near infrared and visible (chlorophyll absorption) bands. The normalisation minimises the effect of illumination geometry as well as surface topography. However, the rationing does not eliminate additive effects due to atmospheric attenuation. Currently data from NOAA-11 (National Oceanic and Atmospheric Administration) satellite is used from its AVHRR sensor system. The data has sizeable land areas under cloud cover on any particular day and hence not usable directly for operational drought monitoring. NADAMS covers 246 districts in 10 states. The NDVI shows a lag correlation upto 4 weeks with rainfall and aridity anomaly. "The Rainfall use efficiency" varies both in time and space making direct satellite monitoring of vegetation development essential for reliable and objective monitoring of drought conditions.

Remote Sensing Technology (RST) integrated with conventional techniques is emerging as an efficient, speedy cost effective and important tool for the management of natural resources. K.S.S. Prasad, S. Gopi and R.S. Rao have done watershed prioritisation using the RST of the Mahbubnagar District, Andhra Pradesh. The demarcation of priority macro-watersheds on the scale 1:250,000. Out of the total 49 watersheds in the district, 35 have been identified as very high and high priority categories. Further one very high priority macro-watershed has been analysed on the scale 1:50,000 and priority micro-watersheds have been demarcated showing the areas for immediate conservation measures. The data utilised includes IRS-1A LISS-1 FCC, LANDSAT-TM FCC. The priority demarcation methodology developed by All India Soil and Land Use Survey Organisation has been slightly modified by introducing rainfall phenomenon (Prasad et al 1992).

Sediment Yield Index (SYI) - [AE x G x D) / AW] x 100

Where, AE = Area of the erosion intensity unit in watershed

AG = Weightage value of erosion intensity unit

D = Delivery ratio

AW = Total area of watershed

100 = Uniform area base.

This has been suitably modified using rainfall data as follows:

Priority expressed in Percentage =

SYI percent	+ Rainfall Variation percent	+ Rainfall Deviation percent
(70% weightage)	(10% weightage)	(10% weightage)

Similar prioritization exercises were done for Chittoor district.

The important factors which effect watershed behaviour (Sharma and Kalia 1987) which need to be studied are:

1. The size and shape of the watershed
2. Topography / slope
3. Soil and its characteristics
4. Precipitation
5. Landuse
6. Vegetation cover.

The role of Remote Sensing in Watershed Management is concentrated on the supply of data and information for the planning and operation of the infrastructure (Meijerink, 1988).

At the XIII INCA Congress at Bangalore in November 1994, B.Ch. Chenniah et al presented a paper on Thematic Mapping and its role in sustainable development. A case study using IRSIA LISS II FCC imagery.

Remote Sensing Techniques have been used to aid natural resource mapping and hazards management. The use of thematic maps for development planning (Dr. R.S. Rao, Aug 1994) presents a detailed micro-level planning for natural resources management more scientifically for combating drought on long-term basis using RST at time and cost effective basis. The basic information derived from remotely sensed data and conventional techniques about land and water resources on 1:50,000 scale have been integrated and "Basic Integrated Land and Water Resource Units" (BILWRU) have been mapped. Basing on the BILWRU's and keeping in view the present day cropping patterns and the needs of the people, 'Recommended Optimal Landuse and Farming Systems" (ROLUFS) were arrived at. Keeping in view the severe drought situation and paucity of water resources optimal in Situ soil and moisture conservation measures such as rain water harvesting structures, soil and water Conservation measures, fodder fuel wood and permanent tree cover development zones, etc. were recommended. The Planning Commission proposed to implement the above recommendations in a model watershed in Anantpur district. The "Integration study to Combat drought on sustainable basis through space Applications" is a pilot project in Vanjuvanka watershed in Atmakuru and Kuderu Mandals of the district.

The integrated Remote Sensing based natural resources survey of Tettuvanka (Bahuda) watershed in Kurabalakota and Madanapalli Mandals of

Chittoor district, Andhra Pradesh used the Landsat T.M. and Spot-HRV data to prepare the multithematic maps on 1:25,000 scale as listed below:

1. Surface watershed resources and watershed delineation.
2. Landuse / Land Cover
3. Ground water prospect zones (Hydrogeomorphology)
4. Soils
5. Slope Map
6. Status of Groundwater development and recommended artificial recharge structures.

Information derived using remote sensing includes drainage, surface water resource, hydrogeomorphology, groundwater irrigated areas and tank spreads (Baldev Sahai, 1989). Rainfall, population, well census etc., collected from conventional data have been integrated to estimate ground water draft and recharge to arrive at the status of ground water development at village level.

The Role of Geographical Information Systems (GIS)

Geographical Information Systems have been born out to interrelate data sets to carryout spatial analysis and to present result. It is mainly the reduction of many layers of data into a new layer of information, in cartographic format. GIS is very much applicable in watershed management which requires an integrated development of an area through soil and water conservation proper cropping system, agronomic practices and rehabilitating degraded lands (Smita Sengupta, 1992).

Data from thematic maps, topographic maps, remote sensing imageries and statistical data of the study area on a geodetic grid can be compared and combined only with the help of a proper GIS. (David J Maguire, Michael F Goodchild and David W Rhind, 1992).

DROUGHT-PRONE AREAS OF ANDHRA PRADESH - A PROFILE

In Andhra Pradesh out of the total of 23 districts, 8 districts (a part or whole of district) have been identified as drought prone (See Map Number 3 for the location and Map Number 4 for drought prone tehsils in the study area). These districts are :

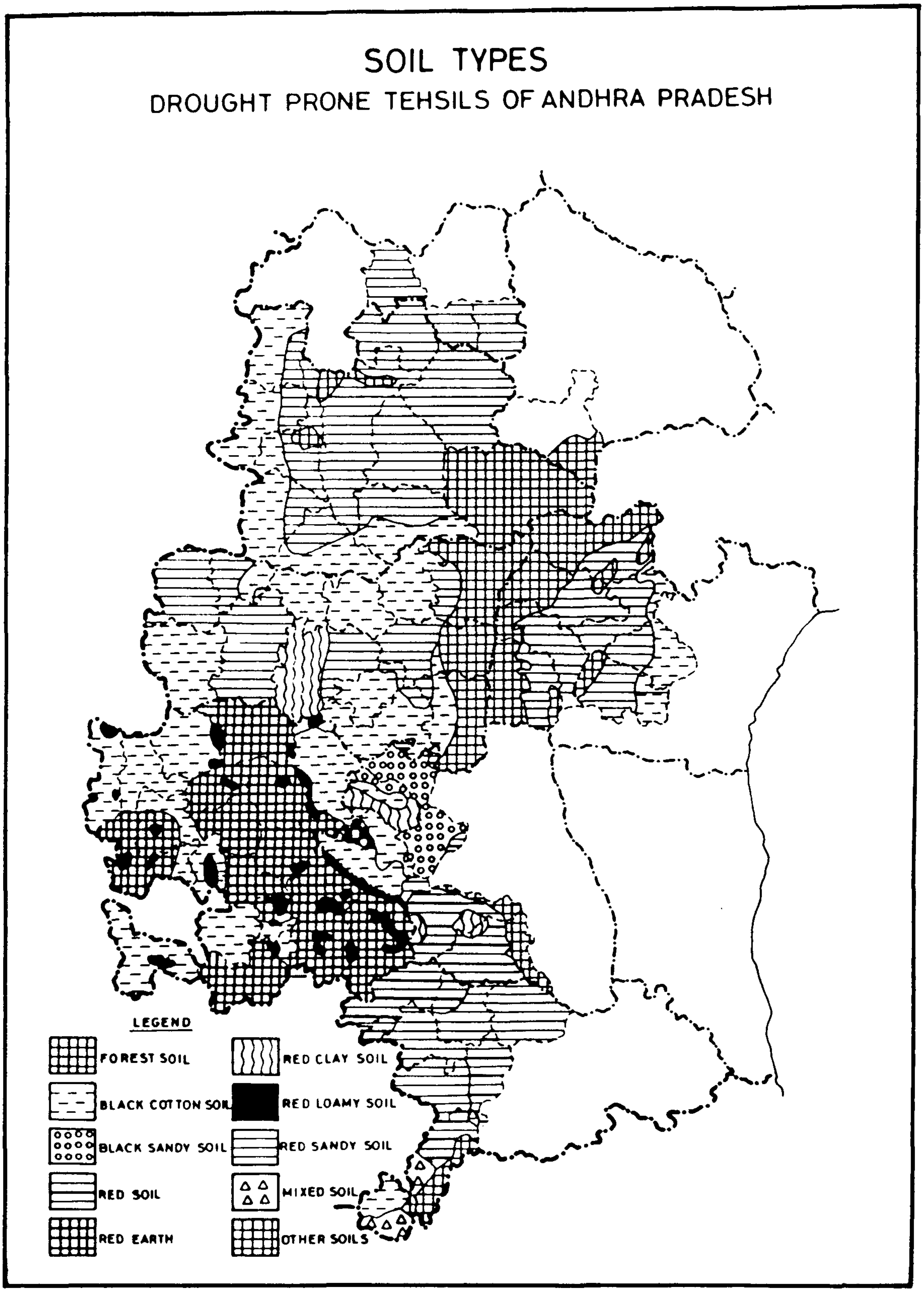
- Chittoor, Cuddapah, Anantpur, Kurnool - the four ceded districts of Rayalaseema Region
- Mahbubnagar, Nalgonda, Rangareddy of Telangana region and
- Prakasam of the Coastal Andhra region

1. CHITTOOR

Chittoor lies in the southern most part of Andhra Pradesh, it is located at 12^0 37' to 14^0 08' N latitude and 78^0 03' to 79^0 55' E longitude. Nellore (of Andhra Pradesh) and Chengleput (of Tamil Nadu) districts border its eastern limit; Kolar (of Karnataka) borders the western limit; Cuddapah is on the northern limit, whereas North Arcot (T.N.) and Dharmapuri (T.N.) districts are lying on its southern border.

Chittoor (area 15152 square kilometers.) has 11 taluks out of which 7 taluks (**Palamner, Punganur, Kuppam, Madanapalli, Thamballapalli, Vayalpadu, Chinagottigallu**) are designated as totally drought prone (31 mandals out of the total 66 mandals) by the state government. (See Map Number 2 and refer Annexure-II for Drought Prone Mandals in Andhra Pradesh) An area of 5575 sq km. is classified as drought prone in the district. The western taluks i.e. Madanapalli, Kuppam, Punganur and Vayalpad are subjected to drought conditions whenever rainfall fails. This part covers 9.05 lakh people (about 1/3 of the total district population).

The famous eastern ghat range stretches across this region; it enters this district first through Kuppam taluk, then runs northwards through Palamaner and Punganur taluks bending towards the east as far as the hills of Tirupati. It has a mean height of 762.5 m in this region while that of the plains vary from 305 meters to 457.4 meters Monsoon (June-Sept) breaks in by the 1st week of June. The normal rainfall of this district is 864.62 millimeters. which declines sharply one are approaches the hilly western side from the eastern plains. South-west monsoon contributes about 45 percent of the total normal annual rainfall (375 mm) while the north-east accounts for 35 percent (310 mm). The district receives its highest rainfall in the month of October amounting to over


SOIL TYPES
DROUGHT PRONE TEHSILS OF ANDHRA PRADESH
LEGEND
FOREST SOIL
BLACK COTTON SOIL
BLACK SANDY SOIL
RED SOIL
RED EARTH
RED CLAY SOIL
RED LOAMY SOIL
RED SANDY SOIL
MIXED SOIL
OTHER SOILS

MAP NO. 5

15 percent of the annual rainfall. The 20 percent rainfall occurs in hot weather season.

According to the Andhra Pradesh State Ground Water Board, Chittoor has a ground water potential of 1595.49 m. cum; surface sources contribute around 3629.94 m cum of water.

Soil are predominantly red sands and red loams (See Map Number 5). In the drought prone taluks the soils are distributed as follows:

	Percentage of Soil Type				
Taluk	Black-clay	Black-loam	Black-sandy	Red-loam	Red-sandy
Kuppam	57	-	-	14	29
Madanapalli	-	2	3	50	45
Palamaner	-	-	-	67	33
Punganur	-	6	-	41	53
Vayalapadu	-	-	-	90	10
District Total	3	2	1	57	34

Red soils need adequate surface drainage facility for paddy cultivation. All types of dry crops could be successfully grown here. Some patches of black clay, loamy and sandy soils are also found in the district predominantly in Kuppam. This soil has higher water holding capacity and is suitable for paddy, sugarcane and other wet crops cultivation. Small patches of laterite soil are suitable for cash crops - potato, turmeric, ginger, tobacco, mangoes and cashewnut.

Hilly terrain, undulating features render this district prone to soil erosion which becomes acute whenever there is heavy rain.

2. CUDDAPAH

It is located at 13^0 14' N to 15^0 16' longitude and 77^0 55' to 79^0 29' E latitude. Cuddapah has a geographical area of 15359 sq km. Kurnool district forms its northern border, eastern part is guarded by Nellore, southern part by Chittoor. Anantpur lies on its western side.

Cuddapah has 12 taluks out of which 6 taluks **(Rayachoti, Lakkireddipalli, Pulivendla, Jammalamadugu, Muddanur, Kamalapuram)** are drought prone (24 Mandals out of the 50 Mandals). Jammalamadugu, Muddanur, Kamalapuram and Pulivendla are in the western plains while Lakkireddipalli and Rayachoti are entirely on the southern plateau.

The annual rainfall of Cuddapah is 696.6 millimeters about 86 percent of which is contributed by the south-west monsoon. Ground water potential is around 1182 m cum. Surface sources contribute about 1713 m cum.

The soil nature in the district is quiet remarkable. Black clay constitutes 31 percent of the total district area and is distributed throughout Jammalamadugu, Pulivendla and Kamalapuram. It has good retention capacity and is rich in lime. The soil is particularly suited for rabi crops (cotton, groundnut and wet crops like paddy betelvine turmeric). Red sandy soils are predominant over Rayachoti taluk and cover 13 percent of the total area. They are the least productive soils stretching over 22 percent of the cultivable area. Due to its soil type Rayachoti taluk is the agriculturally most backward. It renders the area very prone to famine, drought, etc. Low lying parts of this taluk practice a little bit of paddy and ragi cultivation. Wells and Tanks are used for subsequent irrigation purposes. The taluk is the worst affected from water erosion.

3. ANANTPUR

Anantpur is situated in the dry Rayalaseema part of Andhra Pradesh. It is located at 13^0 41' N to 15^0 41' N latitudes and 76^0 47' E to 78^0 26' E longitudes. Karnataka state and Kurnool district (of Andhra Pradesh) border its northern limit, Cuddapah district guards its east. Its southern boundary is demarcated by the Chittoor district (of Andhra Pradesh) and Karnataka state. Out of the 17 taluks, 14 taluks (**Gooty, Tadapatri, Dharmavaram, Kadiri, Hindupur, Madakasira, Kambadur, Rayadurg, Kanekal, Uravakonda, Singanamala, Chennakothapalli, Kalyandurg, Penukonda**) of Anantpur are drought prone (53 out of the total 63 mandals). The other three taluks being Anantpur, Srisatya Sai and Nallamada taluks.

Near to the Cuddapah region and other eastern parts of Anantpur, the terrain is hilly. Erramala or Errakonda hill range runs across the northern frontier. Five hill ranges (Mutchukota, Nagasamudra, etc.) criss cross the district.

The total annual rainfall is 564.16 millimeters mostly contributed by the south-west monsoon. Anantpur has a total useable surface water source of 1192.87 m cum. (50 percent dependable value Dr. Khosla formula). Its ground water potential is 736 m cum. An additional 817 m. cum. of water is available from the surrounding districts. Three types of soil are found in Anantpur:

Soil Type	Taluk
Black Cotton Soil	Gooty, Tadapatri & Uravakonda
Arid, unfertile,	Anantpur, Kalyandurg, Dharmavaram
Red soil	Kadiri, Rayadurg, Penukonda
Red, Fertile soil	Hindupur, Madakasira

Red (82%) and black (18%) are characteristic features of this drought prone region. Black cotton soils are good and productive which are distributed in the northern parts. Stony and with poor humus content, arid red soil stretches over the central part. This is the least productive and highly erodable. Southern parts of the district have productive red soil.

Anantpur suffers from an acute soil erosion problem caused by rain. Sheet and gully erosion result in the loss of a good amount of fertile soil which calls for the bunding methods for soil conservation in fields.

4. KURNOOL

Kurnool is located between 14^0 54' and 16^0 7'N latitudes and 76^0 58' E and 78^0 56' E longitudes. Kurnool's northern boundary is formed by the river Tungabhadra and Krishna alongwith the Mahbubnagar district eastern side by the Prakasam and Guntur districts, western side by the Bellary district (of Karnataka). Anantpur and Cuddapah border its southern part. All of its 13 taluks (**Kurnool, Kodumur, Nandikotkur, Atmakur, Nandyal, Allagadda, Koilkuntla, Banganapalli, Dhone, Pathikonda, Alur, Adoni, Yemmiganur)** are identified as drought-prone (All the 54 Mandals) which cover the total district area of 17,658 sq km.

A large portion of the district lies between two big hill ranges - The Nallamalai Range and Erramalai Range. The former stretches for 113 km. with a mean height of around 606 meters The latter is a series of low, plateau topped hills which extend over a 40 km. stretch towards southern region of Kurnool.

The mean annual rainfall of Kurnool district is 658.65 millimeters. The total ground water potential is 1370 m cum. and about 2367 m cum of water is gained from the surface sources.

Kurnool has regur and red soils in general. Regur soil (black cotton soil) cover the taluks of Koilkuntla, Nandyal, Allagadda, Kurnool, Nandikotkur, Alur and Adoni which is 60 percent of the total area of the district. Red soils make-up the remaining 40 percent of the area covering Dhone and Pattikonda taluks. While the former can support two-time crops, the latter which supports one time kharif crop with good rainfall, needs manuring, irrigation etc. to develop 2 time crops on it.

Among others wind erosion is a challenging problem in the district.

5. MAHBUBNAGAR

It is the largest district of Telangana region located between 16^0 and 17^0 N latitudes and 77^0 and 79^0 E longitudes. Its northern boundary is demarcated by Rangareddy and Nalgonda districts, southern parts by the rivers Krishna and Tungabhadra, eastern part by Nalgonda and Guntur districts and the western part by Raichur and Gulbarga districts of Karnataka.

Mahbubnagar has an area of 18432 sq.kms divided into 13 taluks. Except Kodangal, Jadcherla and Mahbubnagar, the rest of the ten taluks (**Makthal, Gadwal, Atmakur, Alampur, Wanaparthi, Kollapur, Achampet, Nagarkurnool, Kalwakurthi, Shadnagar**) are drought prone (53 mandals out of the total 64 mandals).

In general Mahbubnagar has an elevation of 300-600 meters from mean sea level. The annual rainfall of this district is 746.9 millimeters with the south-west monsoon contributing 80 percent of the total annual rain. Ground water potential is 2038 m cum about 3013 m cum water is available from the surface sources.

S.No.	Soil Type	Percent Distribution	Taluks Covered
1.	Red Soil (CHALKA)	67 percent of total area i.e. 1237.24 sq km	Mahbubnagar, Atmakur Wanaparthy, Kalwakurthy, Kolhapur, Nagarkurnool, Shadnagar, Achampet
2.	Black soil (REGUR)	20 percent of Total area 3694.40 sq km.	Alampur
3.	Mixed soil (DUBBA)	13 percent of total area 2401.36 sq.km.	Kodangal, Makthal Gadwal

On the Chalka soils, all types of crops can be grown provided irrigation and manures are available. Whereas, on regur soils, crops like cotton and tobacco do well even with one or two subsequent drought years.

6. NALGONDA

Nalgonda is located at 16^0 25' to 17^0 50' N latitudes and 78^0 40' to 80^0 5' E longitudes. It has a total land area of 14223 square kilometers. Medak and Warangal form its northern boundary, Khammam and Krishna stand on its eastern side, Guntur and Mahbubnagar districts form its southern limit, whereas Mahbubnagar and Rangareddy keep vigil on its west.

Nalgonda has 15 taluks out of which **Deverakonda** taluk is delineated as a drought prone area (9 mandals out of the total 59 mandals). A range of hills cut across the taluk in south-west direction. The total available water from the surface sources figure around 2545 m. cum. Ground water potential is 2087.76 m. cum. About 1762 m cum. of surplus water is available from other districts. The annual average rainfall is 753.89 millimeters about 80 percent of which occurs during the period of southwest monsoon.

The red soil of Devarakonda is very porous incapable of holding water of nutrients. The hill slopes are barren and much prone to soil erosion.

7. RANGAREDDY

Rangareddy is located at 16^0 50' N to 17^0 45' N latitudes and 77^0 30' N to 78^0 E longitude. It is bounded by Medak on the north, Nalgonda on the east, Mahbubnagar on the south and Gulbarga (of Karnataka) on the west. The district was formed on 15th August 1978. Its 7493 sq km. area is divided into 11 taluks out of which three taluks **Chevella, Maheswaram and Ibrahimpatnam** are drought prone (10 mandals out of 37 mandals). Rangareddy has a groundwater potential of 517 m cum. surface water comes to around 1979 m. cum.

Red soils cover 70 percent of total area in which while Red loamy sand occur on the sloping terrains of Ibrahimpatnam the Red sandy clay covers part of Chevella taluk. The former is shallow to moderate deep, coarse textured soil whereas the latter is a moderate to good depth. Nutrient holding capacity is high due to higher clay content.

8. PRAKASAM

Prakasam is situated between the latitudes of 14^0 57' N 16^0 15' N and longitudes of 78^0 04' and 80^0 50' E. Guntur districts borders the northern entry while Nellore and Cuddapah are lying on the south Kurnool district demarcates the western part. Bay of Bengal guards its eastern border. Prakasam (formerly known as Ongole) was readjusted in the 1980's out of its own 9 taluks, 17 taluks are formed in 17626 square kilometers area.

Velikonda is the major hill range stretching between Giddalur taluk to the Kanigiri and Podili taluks. Nallamalai range continues from Kurnool and adorns Markapur and Giddalur taluks. A great plain Cumbam valley lies between these two ranges. Kanigiri is itself a hill tract often interspersed with large barren tracts. Thus the district has a much undulated and un-even topography.

South-west monsoon breaks in by the beginning of June this exerts considerable influence over the inhospitable summer weather. The total annual rainfall is 757.08 mm, 88 percent of the rain is received during this south-west monsoon season which ceases by September end while north-east monsoon (October-December) begins.

In the 17 taluks (erstwhile 9 taluks) out of which seven taluks **(Yerragondapalem, Markapur, Bestavaripet, Giddalur, Tardapadu, Podili, Kanigiri)** are drought prone (25 mandals out of the total of 56 mandals) predominantly dry farming / rainfed farming is in vogue.

Taluk	Percentage of soil type		
	Black cotton	Red loam	Sandy loam
Giddalur	60.50	39.50	-
Kanigiri	10.50	76.00	13.50
Markapur	5.50	94.50	-
Podili	9.00	88.00	3.00

Giddalur taluk has the productive black cotton soil over which the high priced Tobocco is grown. Kanigiri, Markapur and Podili have predominantly red loamy soils. Kanigiri is situated on a hilly track thus having largely barren uncultivated land area. Markapur and Giddalur are covered with forests of the Nallamalai range.

Drought prone area development activities are under progress in different taluks and Mandals. Arid environment, high wind velocity, scanty rainy season, all have collectively put them into a worse situation.

Spatial and Temporal Distribution of Rainfall in Drought Prone Areas in Andhra Pradesh

CHAPTER TWO

Andhra Pradesh covering a land area of 2,74,400 sq kms with a population of over 6.34 crores (1991) is the fifth largest state in India, accounting for 8.4 percent of the country's area. It is located at 12^0 37' to 19^0 54' N latitudes and 76^0 46' to 81^0 51' E longitude. It is bound on the north by Maharashtra, on the northeast by Orissa and Madhya Pradesh, on the south by Tamil Nadu, on the east by Bay of Bengal and on the west by Karnataka. It consists of 23 districts, 316 taluks (erstwhile samithis), 74 Divisions, 1110 revenue mandals, 234 towns, 2724 villages. The state comprises of three geographical regions, namely the coastal Andhra covering nine districts. Rayalaseema consisting of the four districts and Telangana region which includes the remaining 10 districts.

Approximately 77 percent of the states population is dependent on Agriculture (including allied sectors) which contributes over 60 percent of the state's income Cultivated crops occupy about 40-42 percent of the geographical area. Thus, Andhra Pradesh is agrarian in character and it is considered as one of the most progressive states with respect to agricultural development, maintaining high levels of crop production compared to several other states.

The state can be divided into three physical regions namely

1. Coastal plains
2. Peninsular plateau
3. Eastern Ghats

The 150 meter contour separates the coastal plain from the peninsular plateau. The area above 600 meters contour is considered as Eastern Ghats. The coastal plains, covering 35 percent of the area of the state have rich agricultural lands.

The peninsular plateau, also called the Deccan Plateau, corresponding to 150-600 meters contours, covers Rayalaseema and most parts of Telangana regions. This region covers more than half the geographical area of the state. The plateau is characterised by levelled uplands with red sandy soil and numerous hills and outcrops.

Andhra Pradesh has around 42 percent of its geographical area under drought-prone condition which affects more than 35 percent of the total population of the state (Central Water Commission 1980)

Towards the end of 80's, Out of the 23 districts, 8 have been identified as drought prone districts. In fact 76 taluks covering about 47.5 percent of the total geographical area of Andhra Pradesh gets frequently affected by drought affecting 34.7 percent of the total population of the state (Drat 8th Five Year Plan 1990-95).

CLIMATE

By virtue of its location and climate, Andhra Pradesh presents a transition from tropical to sub-tropical India. In the coastal belt, humid to sub-humid climatic conditions prevail, while in the rest of the state the climate is semi-arid to arid.

The seasons in Andhra Pradesh are

1.	Hot weather (summer)	-	March to May
2.	South-west Monsoon	-	June to September
			(Sometimes extending upto October)
3.	North-east Monsoon	-	October to December
4.	Winter	-	January to February

Andhra Pradesh is dependent largely on south-west and north-east monsoons for its rainfall. The average annual rainfall of the state is 890 millimeters. Annual rainfall varies from 500 millimeters in south-west to 1400 millimeters in the north-eastern parts. The distribution as a whole is about 67 percent during south-west monsoon, 23 percent during north-east monsoon and 10 percent during winter and hot weather periods.

Considering different regions, 81 percent of the annual rainfall is received during south-west monsoon in Telangana region as against 55-57 percent in Coastal and Rayalaseema regions. The north-east monsoon contributes only 11 percent in the Telangana area while the Coastal and Rayalaseema areas receive over 30 percent of their annual rainfall during this period. The distribution of annual rainfall differs widely when considered by district and time periods, giving rise to specific rainfall patterns.

Of the 31 rainfall patterns identified in the state, 4 have rainfall regime 300 millimeters in one or two months, 6 have 200-300 millimeters in one or two months, 20 have 100-200 millimeters in one or two months and the rest has 50-100 millimeters in one or two months. This indicates the need for supplemental irrigation to support good crop growth.

The present rainfall study of the drought prone areas of Andhra Pradesh confines to the regions Rayalaseema and Telangana.

The normal annual rainfall in the western parts of Rayalaseema is less than 600 millimeters being as low as (507.1 millimeters in Uravakonda of Anantpur) 550 millimeters in Anantpur and adjoining parts of Kurnool district. This is the driest part of Andhra Pradesh (See Annexure-IV for the list of Mandals in Scarce Rainfall zones of the Drought Prone Area of Andhra Pradesh). The annual rainfall in Rayalaseema varies between 400 to 750 millimeters. Most of Rayalaseema gets 311 to 425 millimeters of the rain during the south-west monsoon season, June to September accounting for 46 to 63 percent of the annual total. September is the rainiest month except in the Chittoor district where it is October.

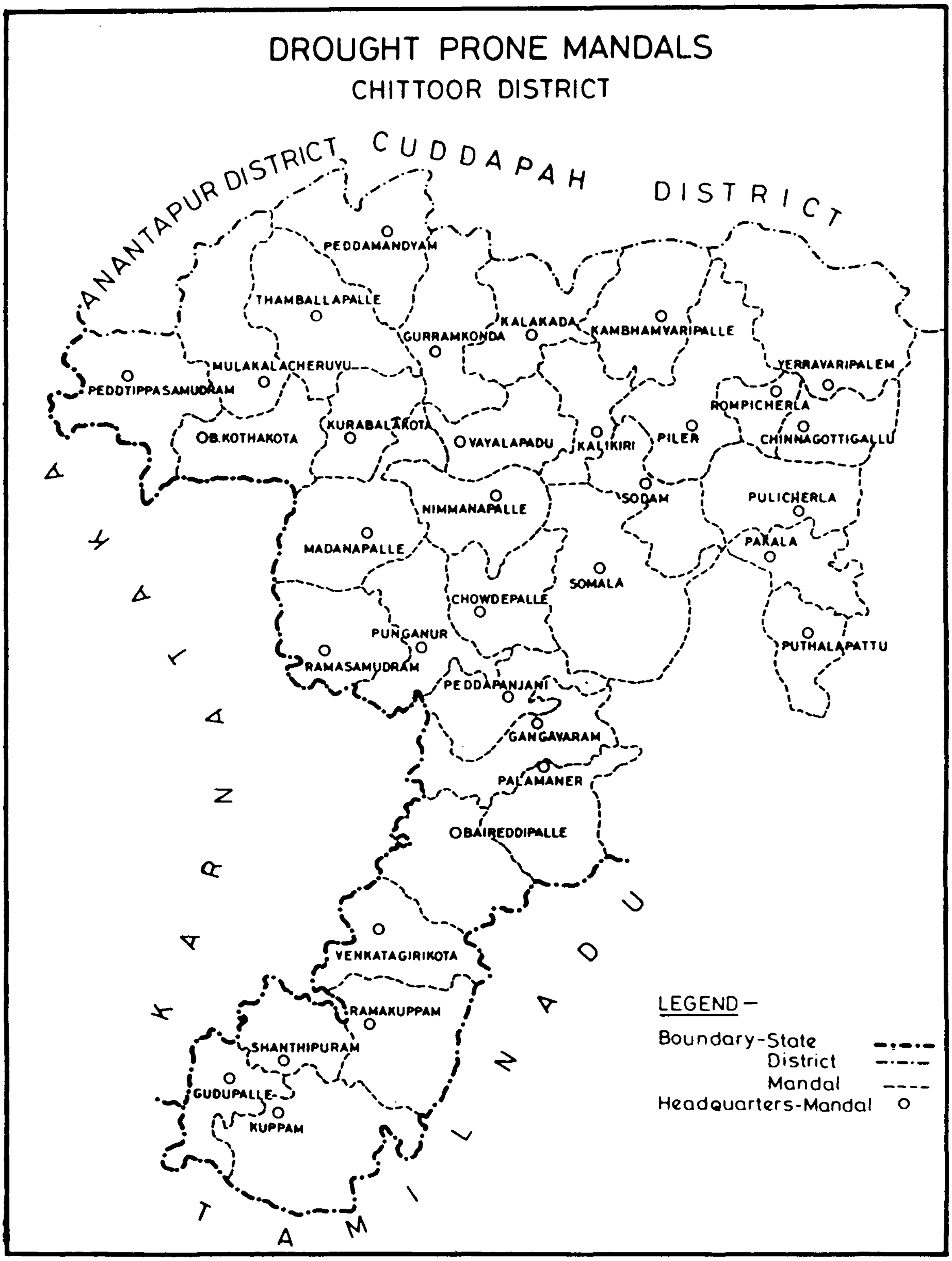
In Telangana about 81 percent of rain is received during the south-west monsoon season. July is the rainiest month in the region except in the districts of Nalgonda, Hyderabad, Rangareddy and Mahbubnagar where September is the rainiest month. The annual rainfall varies between 550 to 800 millimeters.

Drought - the term may be explained as 'scarcity situation'. It indicates non-availability of necessary water or moisture in a particular area for agricultural and minimal domestic needs, for animal and humans, crops, vegetation, etc. This water scarcity is largely the phenomenal outcome of scanty, erratic, untimely and unevenly distributed rainfall. Any one of these factors, singly or in combination with others may result in drought like conditions.

2.1 SPATIAL DISTRIBUTION OF NORMAL RAINFALL

In the eight Drought Prone Districts of Andhra Pradesh under the present study rainfall data of over 70 rain guage stations have been considered from 1961 to 1993. The data of the rainfall includes the available recorded rainfall of the drought prone taluk, district headquarters and of Begumpet in Hyderabad the state capital. Non availability of a few years in the data series is to be noted.

The normal rainfall in the drought prone Andhra Pradesh shows an increasing trend from the western side to the eastern coastal areas. This is primarily due to the rainfall that is brought by the southwest monsoon. In the southern part of the state i.e. over a large part of Chittoor there is higher rainfall due to the double advantage of the north-east monsoon in addition to the south-west monsoon.


DROUGHT PRONE MANDALS
CHITTOOR DISTRICT
ANANTAPUR DISTRICT
CUDDAPAH DISTRICT
KARNATAKA
TAMIL NADU
PEDDAMANDYAM
THAMBALLAPALLE
GURRAMKONDA
KALAKADA
KAMBHAMVARIPALLE
YERRAVARIPALEM
MULAKALACHERUVU
PEDDTIPPASAMUDRAM
ROMPICHERLA
KURABALAKOTA
OB.KOTHAKOTA
VAYALAPADU
KALIKIRI
PILER
CHINNAGOTTIGALLU
SODAM
PULICHERLA
NIMMANAPALLE
MADANAPALLE
PAKALA
SOMALA
CHOWDEPALLE
PUTHALAPATTU
PUNGANUR
RAMASAMUDRAM
PEDDAPANJANI
GANGAVARAM
PALAMANER
BAIREDDIPALLE
VENKATAGIRIKOTA
RAMAKUPPAM
SHANTHIPURAM
GUDUPALLE
KUPPAM
LEGEND -
Boundary-State
District
Mandal
Headquarters-Mandal

MAP NO. 9

The normal rainfall in the eight drought districts generally vary between 400 millimeters to 800 millimeters range. The only exception is of Palamaner which has a rainfall of 851.7 millimeters due to its location on the windward side of the famous eastern ghats whose mean height is 762 meters in this taluk.

The lowest of the normal rainfall is over the only arid patch of area in the western part of Anantpur. They are on the ubac / schattenseite of the Mutchukota and Nagasamudra hill ranges in the southern part of Anantpur which have an elevation of 670 meters Kanekal with 443.7 millimeters is the tehsil with the lowest rainfall among all the drought prone areas in Andhra Pradesh.

Sixty stations are taken for the present study (See Appendix 6a) the Rain guage stations and their normal annual rainfall. The rainfall of all the drought prone mandals of Chittoor (See Map No.9) have been considered in the present study.

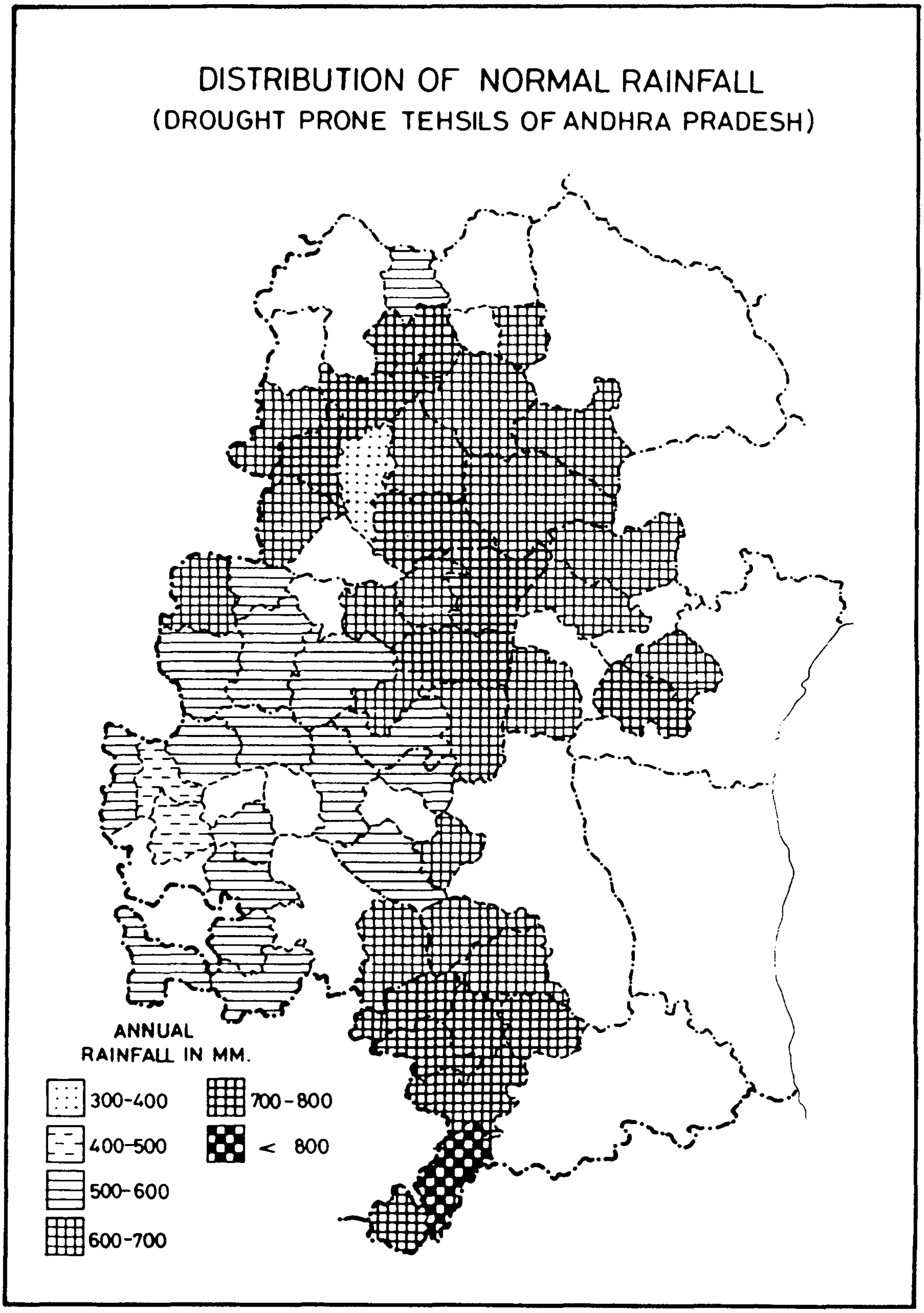
The percentage of number of tehsils in the eight drought prone districts of Telangana and Rayalaseema which fall under the difference ranges of normal rainfall among the 52 rain guage stations which are of the drought prone taluks are given in Table 2.01 in the next page.

TABLE 2.01

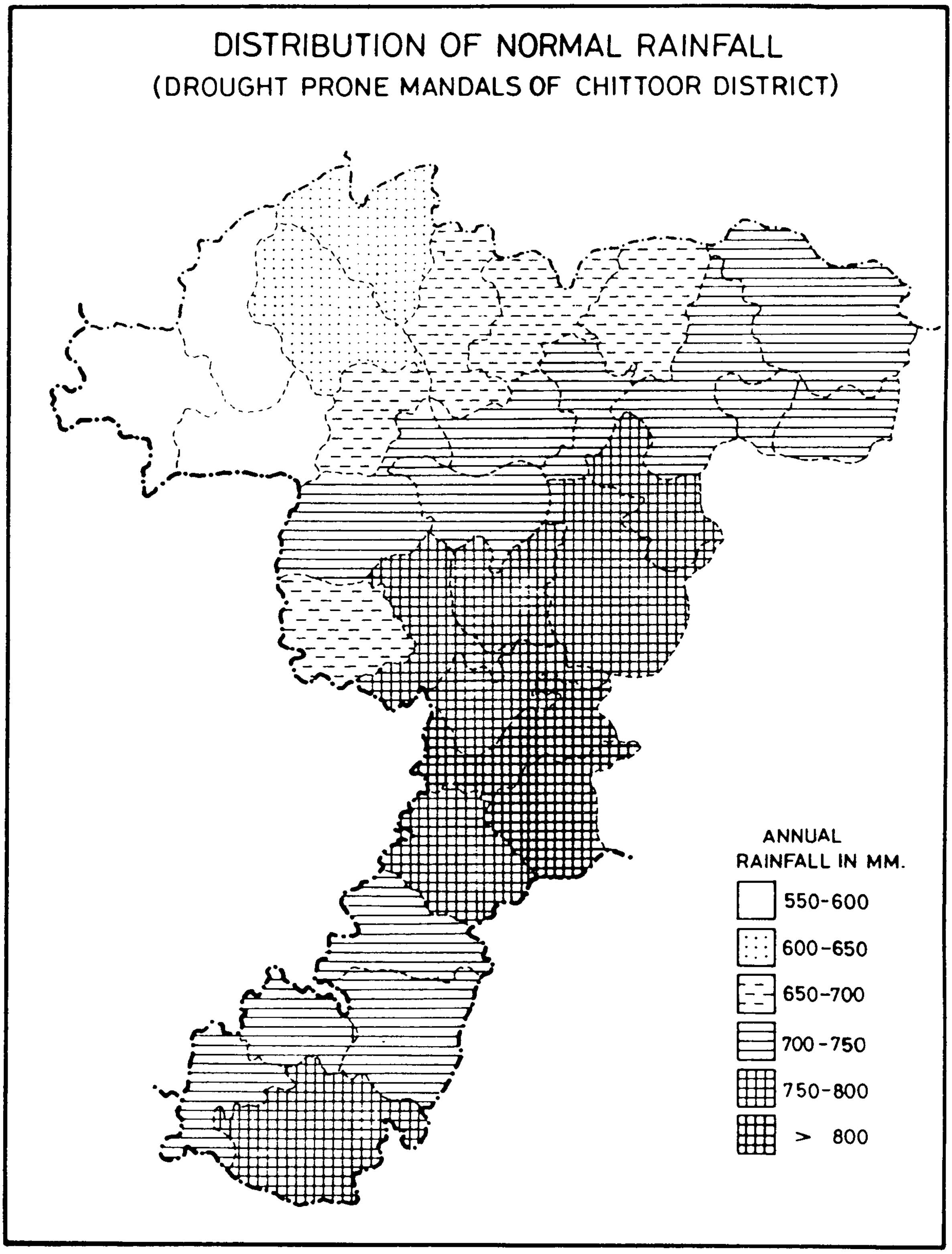
DISTRIBUTION OF NORMAL RAINFALL IN DROUGHT PRONE AREAS OF ANDHRA PRADESH

Range of Normal Rainfall	Percentage no. of taluks
400 - 500 mm	3.85
500 - 600 mm	34.62
600 - 700 mm	38.46
700 - 800 mm	21.15
800 - 900 mm	1.92

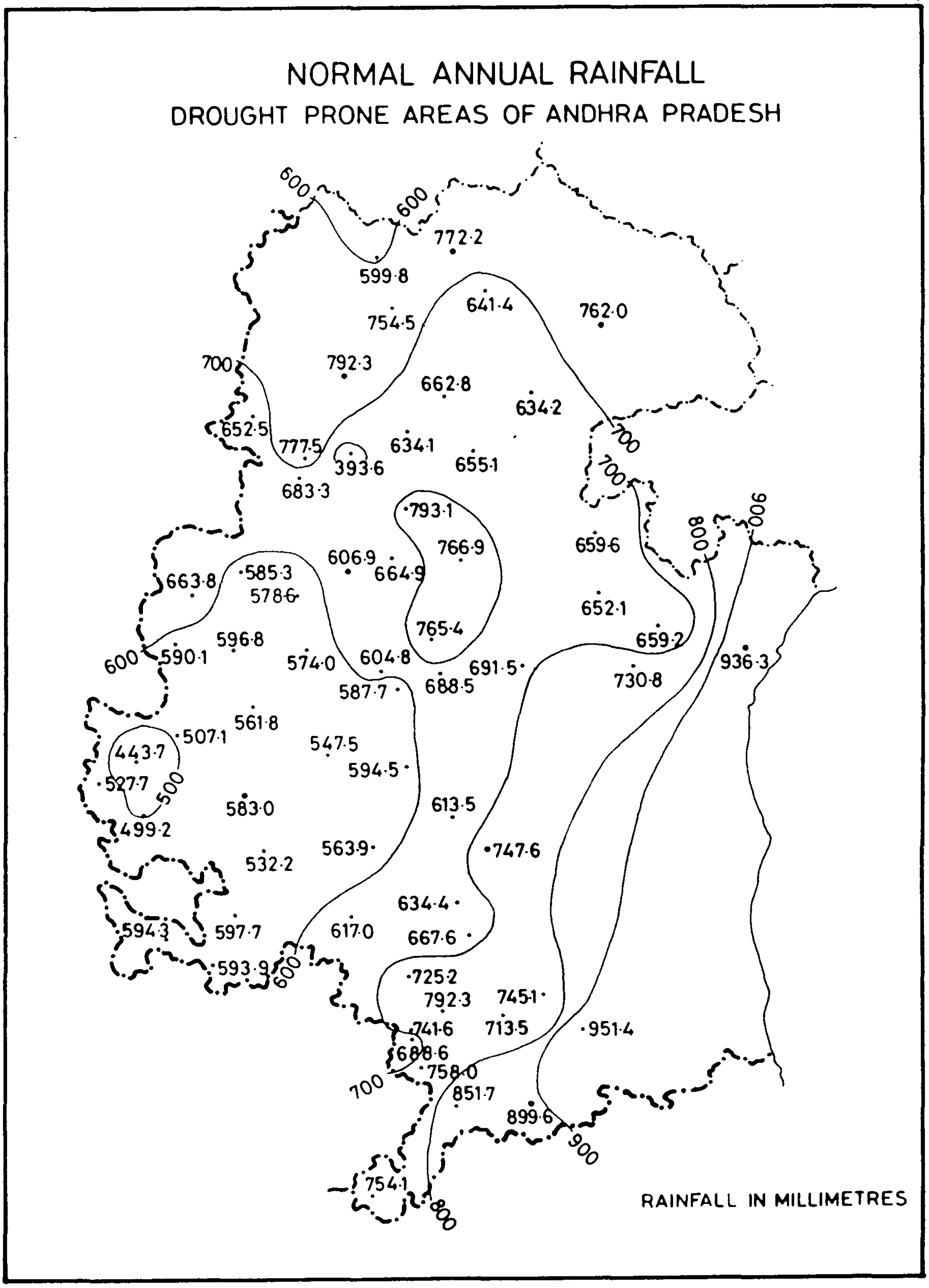
Kalyandurg and Kanekal fall in the range of 400-500 millimeters. Major areas of Anantpur (8 taluks) and Kurnool (6 taluks) fall in the 500-600 millimeters range of normal rainfall with two of Cuddapah and one each of Mahbubnagar and Rangareddy also under the same range but more closer to the 600 millimeters of normal rainfall. The highest being Chevella of Rangareddy with 599.8 millimeters. The lowest in the range is of Uravakonda of Anantpur with 507.1 millimeters. The maximum number of 20 taluks fall into the range of 600-700 millimeters normal with Kurnool and Mahbubnagar having five taluks each. Prakasam (4 taluks), Cuddapah (3 taluks) and one each of Anantpur, Nalgonda and Rangareddy. The lowest of the lot being Banganapalli


DISTRIBUTION OF NORMAL RAINFALL
(DROUGHT PRONE TEHSILS OF ANDHRA PRADESH)
ANNUAL
RAINFALL IN MM.
300-400
400-500
500-600
600-700
700-800
< 800

MAP NO. 10


DISTRIBUTION OF NORMAL RAINFALL
(DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT)
ANNUAL
RAINFALL IN MM.
550-600
600-650
650-700
700-750
750-800
> 800

MAP NO. 11


NORMAL ANNUAL RAINFALL
DROUGHT PRONE AREAS OF ANDHRA PRADESH
RAINFALL IN MILLIMETRES
600
700
800
900
500
772·2
599·8
641·4
762·0
754·5
792·3
662·8
634·2
652·5
777·5
393·6
634·1
655·1
683·3
793·1
766·9
659·6
606·9
664·9
663·8
585·3
578·6
652·1
765·4
596·8
659·2
590·1
574·0
604·8
691·5
730·8
936·3
587·7
688·5
561·8
507·1
443·7
547·5
594·5
527·7
583·0
613·5
499·2
563·9
747·6
532·2
634·4
594·3
597·7
617·0
667·6
593·9
725·2
792·3
745·1
741·6
713·5
951·4
688·6
758·0
851·7
899·6
754·1

MAP NO. 12

with 604.8 millimeters. The highest normal rainfall in the range is of Giddalur (Prakasam) with 691.5 millimeters due to its location on the rain side of Nallamalai range and Velikonda range major portions of Chittoor with 5 taluks[1], Mahbubnagar (3 taluks), Kurnool (2 taluks), Prakasam (1 taluk) fall in the 700-800 range of rainfall, while the high rainfall in Chittoor is reasoned earlier, the high rainfall of Atmakur and Kollapur can be explained by their presence on mesas and buttes which are scattered in Mahbubnagar district with an elevation of 600 meters above Mean Sea Level. See Map Number 10 and Map Number 11 for the distribution of Normal Annual rainfall in the Tehsils of Andhra Pradesh and Mandals of Chittoor.

In the Isohyetal map of the normal rainfall of Drought Prone Andhra Pradesh a low rainfall decreasing trend is shown around Wanaparthi which is explicited by its presence on the leeward, side of the Amrahbad-Farahbad range. The volcanic plateau of the Deccan west of the Hyderabad - Mahbubnagar explains the high range of rainfall in the northern portion of Drought Prone Andhra Pradesh. (See Map Number 12)

In general the drought prone areas of Andhra Pradesh fall towards the west of the 150 meters relief all along the coastal Andhra i.e. between 150-900 meters of height as per the physiography of the state.

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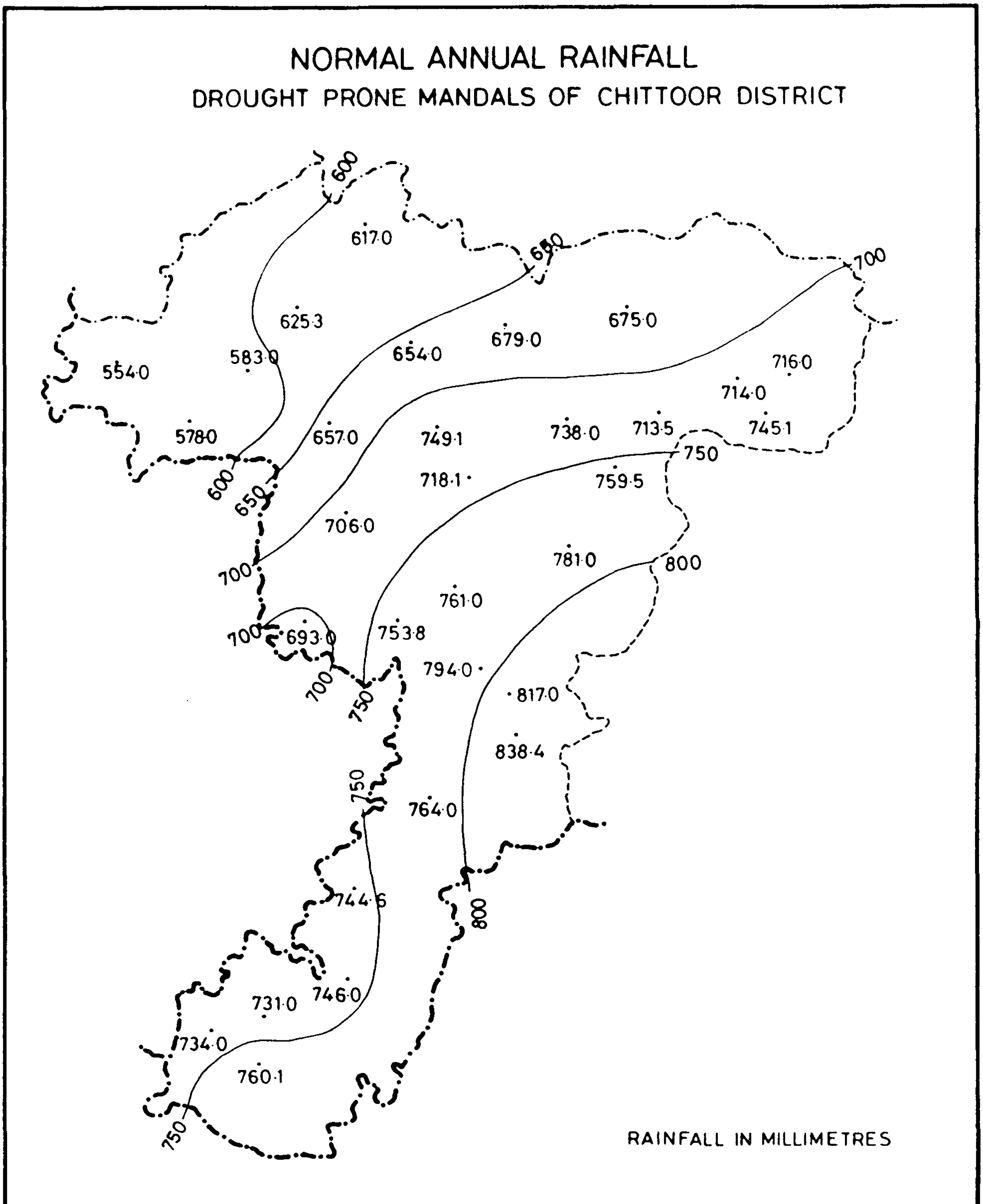
[1] CHITTOOR - Kuppam, Gudupalle, Shantipuram, Rama Kuppam, Venkatagiri Kota


NORMAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
600
617·0
650
700
625·3
675·0
679·0
583·0
654·0
716·0
554·0
714·0
578·0
657·0
749·1
738·0
713·5
745·1
750
718·1
759·5
600
650
706·0
781·0
800
700
761·0
700
693·0
753·8
794·0
700
750
817·0
838·4
750
764·0
800
744·6
731·0
746·0
734·0
760·1
750
RAINFALL IN MILLIMETRES

MAP NO. 13

The Normal Annual Rainfall of Drought Prone Mandals of Chattoor has been depicted as an Isohyetal Map (See Map Number 13).

By nature, monsoon rains are highly whimsical. The amount of rainfall received is highly variable. The coefficient of variation for the entire country for the south-west monsoon rainfall is 9.5 percent. However, the CV for annual rainfall ranges from 15 percent to 80 percent. The trend is similar to the rainfall pattern. High rainfall regions have lower CV while low rainfall regions have high CV (Mooley et al, 1984; Parthasarathy, 1984 and Parthasarathy et al, 1987).

COEFFICIENT OF VARIATION

This aspect of rainfall, i.e., its variability in time of commencement and length of season, quantum of rainfall received and its areal extent are the main factors leading to drought and floods, the nemesis of Indian agriculture and economy.

The coefficient of variation of the annual rainfall from the normal rainfall in the present study of the drought prone taluks of Andhra Pradesh have been tabulated below. Out of the total number of 60 stations, 52 stations for the study. The rest 8 are used as benchmarks. The normal rainfall is the assumed mean, while the average annual rainfall is the simple mean. Since both the means are almost equal, the CV from normal rainfall is analysed.

Percentage Coefficient of Variation = [Standard Deviation / Mean] x 100

TABLE 2.02

PERCENTAGE COEFFICIENT OF VARIATION OF RAINFALL OF DROUGHT PRONE TALUKS IN ANDHRA PRADESH

Percentage Coefficient of Variation.	Percentage No. of Taluks under rainfall
0-20	25.00
21-40	50.00
41-60	17.31
1-80	5.77
80 and above	1.92

As depicted in the table the range of percent Coefficient of Variation (21-40) which has the highest (50%) percentage number of taluks (26 taluks) under the rainfall covers the major portions of Anantpur (9 taluks), Kurnool (7 taluks) and Chittoor (4 taluks). The other districts having a similar variability are Prakasam (3 taluks), Mahbubnagar (2 taluks) and Nalgonda (1 taluk). Within the range Kuppam with 25 percent has the lowest Coefficient of Variation while the high variability of 39 percent is expressed by Anantpur's Dharmavaram, Uravakonda, Koilkuntla, Prakasams Kanigiri and Giddalur taluks.

TABLE 2.03 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

KURNOOL

	Allagadda	Koilkuntla	Atmakur	Nandikotkur	Dhone	Pattikonda	Adoni	Alur	Yammiganur	Banginagalli	Kurnool	Nandyal	Kodumur
1961	-9.31	-26.20	44.65	35.00	-26.43	-2.95	-9.79	-24.56	-29.63	-29.28	-57.87	-1.20	-5.55
1962	13.32	32.87	0.81	27.10	8.76	33.83	-11.65	-21.49	-91.63	60.73	0.05	8.34	105.70
1965	13.14	57.61	-9.60	4.69	-16.95	-6.43	-20.14	-27.39	-74.70	-6.75	10.74	-20.81	-9.87
1966	22.06	22.43	-0.09	-3.74	12.09	4.78	12.20	-31.66	16.54	-1.22	-14.99	-6.21	-19.29
1967	18.46	7.86	-14.63	-19.58	-22.23	-0.57	-32.04	-22.71	-21.77	-27.40	-33.35	-33.22	-66.11
1970	18.18	15.70	4.49	-0.87	70.23	-15.53	-10.26	-14.35	-10.44	0.29	-4.46	-9.52	-2.36
1971	11.82	N.A.	N.A.	-6.95	13.54	N.A.	N.A.	-42.25	N.A.	N.A.	-17.00	-38.99	N.A.
1972	-5.04	-14.53	N.A.	-32.28	39.29	-30.19	N.A.	-25.45	N.A.	-12.33	-27.91	-35.68	N.A.
1973	7.61	8.32	N.A.	1.86	60.80	-16.69	N.A.	-7.80	N.A.	5.14	-30.35	12.46	N.A.
1976	-15.18	-20.16	-5.37	-1.55	31.29	-49.93	-37.59	-49.89	-37.54	528.80	-18.64	-14.41	-38.13
1977	24.23	34.81	5.39	20.65	177.49	24.40	-24.74	-19.95	4.17	19.48	28.24	20.08	33.22
1978	60.42	73.03	30.93	1.28	82.37	15.68	27.06	43.60	4.15	25.69	28.44	-1.76	31.94
1979	14.32	12.71	3.96	10.86	86.86	-36.46	-5.78	1.29	-12.52	-5.06	6.05	-8.36	51.16
1980	-27.33	-23.40	-7.71	-22.73	31.43	-32.17	-6.91	-46.25	-9.99	-55.62	-22.67	-28.17	-42.34
1981	32.43	48.24	13.52	11.90	11.39	12.84	-6.91	1.83	7.26	38.33	0.43	N.A.	N.A.
1982	1.66	5.29	-9.70	16.83	18.85	8.45	5.83	4.36	19.22	9.82	18.77	-15.56	N.A.
1983	64.65	54.50	61.65	59.17	25.52	2.61	29.20	-27.47	37.35	25.50	53.78	66.37	N.A.
1984	-43.86	1.50	-40.17	8.51	-9.43	-31.80	-44.32	-25.28	15.58	-9.71	-25.92	-44.40	-3.72
1985	11.39	21.15	-19.45	-22.71	-19.06	18.20	1.43	-17.91	25.30	15.87	-1.35	-24.51	N.A.
1986	-20.20	-34.52	-3.40	-16.95	-26.78	-19.30	-50.21	5.58	-33.09	-27.66	N.A.	-22.08	N.A.
1987	3.69	21.61	10.20	89.14	0.42	17.66	38.20	17.20	58.62	17.46	62.73	-26.91	80.97

TABLE 2.04 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

ANANTPUR

	Madakasira	Hindupur	Penukonda	Dharmavaram	Kalyandurg	Uravakonda	Gooty	Tadapatri	Kadiri	Rayadurg	Kanekal	Anantpur
1961	-12.74	8.97	-21.67	-29.03	-32.47	-18.12	-16.93	-35.63	-16.65	-27.31	-52.38	-76.05
1962	-32.61	15.26	15.69	21.01	52.16	-16.11	47.31	33.63	30.00	2.90	-85.08	-43.95
1965	-31.21	-81.01	-56.06	-33.62	-22.14	-17.02	-5.36	-15.82	-43.52	-42.60	-50.03	-82.71
1966	22.46	5.94	24.76	52.46	15.00	27.51	-11.94	-34.94	5.58	-6.16	29.55	35.28
1967	-5.45	-8.81	1.57	24.97	-4.13	7.61	-15.95	-24.71	21.47	-1.42	2.28	-90.05
1970	-22.04	-14.60	-6.64	9.81	20.21	67.94	-1.80	-4.97	-5.74	-18.84	-11.40	N.A.
1971	-10.03	-18.30	N.A.	1.80	18.65	-13.33	N.A.	6.32	-1.54	-8.19	N.A.	N.A.
1972	28.98	34.79	30.00	4.42	-14.06	-29.24	-18.96	-21.74	-14.41	-32.20	N.A.	N.A.
1973	-1.77	5.24	10.26	42.43	26.00	4.79	N.A.	17.86	41.31	-16.05	N.A.	N.A.
1976	-45.20	-28.37	-16.80	-52.86	-49.80	-24.43	-27.48	-36.64	-17.13	-61.40	-46.77	N.A.
1977	34.41	44.74	N.A.	N.A.	49.52	29.17	38.91	36.66	11.91	25.32	51.39	N.A.
1978	9.44	-9.65	0.70	-19.67	-8.61	-12.74	2.17	27.34	-6.29	-12.68	12.55	N.A.
1979	9.98	29.43	-19.21	14.64	39.60	3.85	4.04	39.27	10.60	1.63	21.43	6.00
1980	6.11	14.31	2.98	-29.33	-17.75	-24.59	-29.30	-38.01	-34.39	-33.47	-20.96	-40.05
1981	41.34	30.48	20.48	31.19	19.13	95.60	9.97	38.72	61.10	-16.85	37.28	34.75
1982	-22.80	-26.17	6.94	3.18	-28.85	9.09	54.17	36.31	5.40	-4.81	35.72	-32.54
1983	9.99	-0.81	6.04	73.62	-5.09	-2.01	-9.65	11.45	-6.21	-16.35	-14.60	33.55
1984	-29.43	-28.61	-8.32	-39.97	-35.24	-0.69	-24.65	-17.24	6.55	-4.95	-24.68	-37.67
1985	-35.92	-48.98	-44.35	-33.48	N.A.	N.A.	N.A.	-33.74	-22.88	-49.06	-47.85	-90.60
1986	-23.10	-10.46	-12.20	-7.82	-31.35	-25.30	-24.42	-26.37	30.99	-24.54	6.47	-37.03
1987	14.13	-2.46	-12.13	-17.51	29.45	50.27	-11.75	3.51	-1.62	22.34	-10.64	-41.37

TABLE 2.05 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

CUDDAPAH

	Pulivendla	Jammala-madugu	Kamalapuram	Rayachoti	Lakkireddipalli	Cuddapah
1961	-34.14	-19.28	-0.46	-14.93	-18.02	1.39
1962	58.63	41.18	4.71	11.43	0.93	20.68
1965	-42.47	-6.11	-32.81	-29.42	-37.80	-27.82
1966	0.28	18.79	47.29	6.77	8.65	22.50
1967	-12.96	61.28	-9.99	36.44	69.51	29.96
1970	-20.18	10.80	-2.92	-6.74	30.61	8.77
1971	10.23	N.A.	-15.68	-31.73	N.A.	-22.87
1972	12.38	21.48	N.A.	14.98	50.11	9.87
1973	6.65	17.14	7.92	-2.82	66.82	N.A.
1976	49.03	-35.61	-22.20	33.24	18.87	N.A.
1977	128.16	25.92	1.19	15.43	24.87	N.A.
1978	104.29	42.56	29.60	-1.56	21.36	26.00
1979	46.89	13.98	7.48	-5.74	33.94	-10.58
1980	-40.20	-30.18	-6.23	-32.50	-32.88	-22.47
1981	-8.72	17.09	30.12	-9.00	16.39	-12.89
1982	-20.87	-2.94	-9.57	-20.24	-52.65	-22.15
1983	-195.94	51.59	56.23	-1.44	40.76	63.19
1984	-14.67	-11.54	-35.13	-11.38	-14.66	N.A.
1985	-24.03	-11.79	-21.96	N.A.	-26.48	-16.10
1986	0.23	-17.59	-34.72	-22.48	4.43	-27.47
1987	-34.78	8.53	-9.14	-23.22	2.11	-24.67

TABLE 2.06 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

CHITTOOR

	Tirupati	Kuppam	Palamaner	Punganur	Madanapalli	Voyalpadu	Tamballapalli	Arogyavaram
1961	10.34	-11.28	-22.11	-19.59	-17.99	-34.36	N.A.	-11.33
1962	-54.02	19.16	17.79	0.74	79.13	11.32	N.A.	3.08
1965	-16.23	-10.69	-21.32	-52.85	-31.77	-46.48	N.A.	-45.12
1966	13.10	33.60	18.65	26.36	39.15	18.89	N.A.	N.A.
1967	-25.07	-15.10	-13.40	-47.84	18.55	-1.68	N.A.	-26.17
1968	-41.39	-28.68	-3.13	-16.99	-28.30	-20.48	N.A.	-32.07
1969	-18.01	23.25	19.17	2.15	4.26	-4.43	N.A.	15.36
1970	-22.10	4.59	-8.52	-13.73	-11.06	-13.18	N.A.	35.74
1971	N.A.	6.15	-4.80	0.92	9.84	N.A.	N.A.	20.64
1972	11.41	31.52	34.24	19.47	41.05	12.34	N.A.	57.93
1973	-38.93	-14.12	-9.63	-28.94	8.31	-12.26	-6.70	N.A.
1976	5.09	-8.10	-3.55	N.A.	3.60	-19.39	N.A.	9.12
1977	42.12	14.55	18.45	5.96	27.93	0.59	-30.56	47.60
1978	3.48	46.55	3.60	27.63	32.85	14.68	11.71	44.79
1979	20.74	40.01	15.23	29.49	26.29	-8.25	-2.54	-96.89
1980	-22.93	-39.53	-40.05	-52.01	-39.56	-39.05	-50.79	-36.67
1981	-4.85	26.65	28.20	16.89	-8.68	-8.72	8.62	4.97
1982	-22.87	0.00	-15.60	1.45	-47.21	-39.16	-31.78	-29.77
1983	27.25	54.95	13.48	11.65	-8.04	-3.52	3.36	N.A.
1984	29.89	4.51	-9.59	-12.88	3.74	-5.00	-8.18	-1.73
1985	25.45	13.13	8.23	-6.87	-0.30	-25.68	-8.44	5.55
1986	-18.76	10.49	-8.92	-15.22	-24.30	-17.15	-10.25	N.A.
1987	-12.39	7.94	-28.12	10.37	-1.86	7.21	-15.44	12.27
1989	N.A.	12.60	-20.81	-4.31	-12.55	-2.79	-9.17	-14.64
1990	N.A.	-33.56	-40.82	-2.12	14.28	31.18	-10.87	35.59

TABLE 2.07 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

MAHBUBNAGAR

	Nagarkurnool	Wanaparthy	Atmakur	Matkhal	Shadnagar	Kalwakurthy	Gadwal	Achampet	Kollapur	Mahbubnagar
1961	67.28	107.06	29.17	-29.81	43.54	155.58	43.57	21.42	15.17	42.31
1962	7.19	28.94	-14.03	55.72	28.76	2.81	24.51	16.15	-19.77	45.01
1965	-11.07	-12.11	-25.75	-28.97	-6.97	4.41	-8.12	-15.77	19.91	-16.45
1966	N.A.	-36.96	-46.77	-0.14	-14.23	-16.48	-31.32	-13.49	-38.53	-4.59
1967	-9.18	9.77	-22.15	11.66	-19.84	-10.20	-27.43	-0.70	-25.52	21.37
1970	-6.50	-17.33	-15.14	11.03	-30.03	-18.47	-39.13	-53.05	-33.82	8.70
1971	-27.74	-17.84	-22.34	-37.23	-15.98	7.41	N.A.	N.A.	1.15	-22.77
1972	-31.60	-46.51	-58.30	-46.34	-41.37	-47.07	-29.56	-49.84	-48.51	-42.86
1973	-13.26	9.40	-28.26	-2.74	-11.53	15.74	31.03	-66.46	-39.24	5.52
1976	45.97	8.04	-12.68	-11.39	6.71	6.25	-23.99	20.88	-23.50	N.A.
1977	33.75	40.25	-8.14	0.29	-0.49	14.82	-13.00	10.00	16.62	N.A.
1978	46.40	60.46	6.17	19.20	52.87	73.99	-4.51	68.52	9.95	49.98
1979	51.76	102.12	20.87	8.86	8.31	19.16	-14.80	30.41	9.73	19.61
1980	-11.64	19.07	-17.79	-10.41	-22.68	-19.13	-21.98	-17.95	-36.77	-10.36
1981	54.31	29.33	10.74	20.09	42.05	15.00	-13.30	4.93	-13.01	N.A.
1982	18.25	57.35	0.54	12.00	-15.68	-7.00	3.67	12.36	-8.16	N.A.
1983	45.61	65.28	32.91	33.24	14.59	0.62	33.03	32.61	35.93	N.A.
1984	-12.29	-2.91	-45.18	-39.03	-26.31	-3.62	-32.97	-23.86	-47.93	N.A.
1985	-26.15	-0.29	-42.24	-13.61	-14.01	-9.20	-12.25	-20.50	-54.87	N.A.
1986	-25.55	-29.72	-47.58	-31.72	-26.30	-22.09	-50.89	-23.77	-31.12	N.A.
1987	30.26	-11.54	-10.69	-15.34	14.22	20.26	17.94	24.44	14.08	-97.10

TABLE 2.08 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

	NALGONDA		RANGAREDDY		HYDERABAD
	Deverakonda	Nalgonda	Chevella	Ibrahim-Patnam	Begumpet
1961	29.28	22.22	33.24	3.91	-4.16
1962	14.63	13.98	42.26	31.70	49.31
1965	-16.35	-37.59	-34.94	-56.58	-0.32
1966	24.98	-16.35	-2.68	8.06	-54.73
1967	-21.79	-7.19	-22.37	17.31	6.55
1970	1.67	-15.68	48.47	12.91	47.92
1971	-9.97	9.87	-33.33	N.A.	-13.86
1972	-83.25	-92.01	-92.86	-90.46	-83.92
1973	18.29	2.93	67.72	32.77	16.60
1976	19.19	15.14	10.54	12.25	78.90
1977	4.48	N.A.	11.84	-28.30	N.A.
1978	40.57	N.A.	-77.16	-84.24	-84.94
1979	-1.36	N.A.	-87.53	-91.67	-8.87
1980	-20.75	-28.79	16.29	-2.62	-34.32
1981	10.42	5.56	96.87	33.99	33.98
1982	6.12	N.A.	-5.72	-0.30	N.A.
1983	71.37	N.A.	72.97	37.04	19.14
1984	-19.03	N.A.	16.24	-18.68	1.18
1985	-36.85	N.A.	22.69	8.98	-34.74
1986	-32.75	N.A.	34.49	-13.63	N.A.
1987	-1.86	24.84	45.67	36.89	24.71

TABLE 2.09 : PERCENTAGE DEVIATION OF ACTUAL ANNUAL RAINFALL FROM NORMAL ANNUAL RAINFALL

PRAKASAM

	Kanigiri	Podili	Markapur	Giddalur	Yerragonda-palem	Ongole
1961	11.11	1.49	43.24	30.48	18.84	N.A.
1962	32.42	40.11	7.58	4.71	24.47	N.A.
1965	-31.42	-50.58	-44.24	-57.22	-50.15	N.A.
1966	9.20	69.17	256.34	32.75	35.39	N.A.
1967	-44.42	-24.62	-30.00	5.21	-12.52	N.A.
1970	-6.61	10.53	-9.52	-11.67	-38.52	N.A.
1971	-29.24	-4.51	N.A.	N.A.	N.A.	-16.12
1972	16.32	24.17	8.82	1.68	-2.24	952.97
1973	-11.96	-11.76	-12.85	N.A.	N.A.	N.A.
1976	6.62	6.71	12.67	-21.30	-26.20	22.33
1977	-21.24	-14.11	6.03	-0.64	N.A.	-18.07
1978	16.06	18.93	34.49	15.26	31.20	30.10
1979	93.40	40.46	68.66	-5.26	22.23	7.71
1980	-12.32	-26.18	-26.82	10.61	-52.97	16.92
1981	30.76	37.70	26.59	-11.97	15.90	-2.62
1982	-30.43	0.85	2.85	2.50	-7.40	-25.25
1983	38.81	67.07	2.71	43.62	-10.45	21.07
1984	-40.96	29.92	-30.55	-18.28	-25.64	-58.72
1985	-32.96	-14.91	-11.19	-41.23	12.93	-18.09
1986	N.A.	-2.78	-4.28	-35.55	-50.71	-41.32
1987	-6.32	47.57	34.86	-7.35	53.61	20.40

Majority of the taluks in Cuddapah (5 taluks) and Mahbubnagar (7 taluks) show a range of 0-20 percent of Coefficient of Variation with almost all the stations in Cuddapah showing a minimal variation of 0.1 percent to 7 percent. Kamalapuram has a percent Coefficient of Variation of 0.1 percent, the overall lowest in the drought prone Andhra Pradesh, Palamaner of Chittoor is the only taluk in the district with 20 percent Coefficient of Variation.

The Coefficient of variation percent range of 41-60 with 17.317 of spatial distribution is scattered into three patches over the districts of Kurnool (4 taluks) and Anantpur (2 taluks), Rangareddy (2 taluks) and Prakasam. Dhone in the heart of Kurnool's semi-arid land has a Coefficient of Variation of 54 percent.

The 61-80 percent Coefficient of Variation is expressed by the 3 taluks. Thamballapalli, Kodumur and Markapur. While Kurnool's Kodumur shows a high CV of 73 percent, Prakasams, Markapur has a low CV of 66 percent, with Thamballapalli showing 68 percent.

See Tables 2.03 to 2.09 which give the percentage deviation of actual rainfall from the normal rainfall of the drought prone Tehsils in each of the drought prone district of the Andhra Pradesh. The District Head Quarters and the Indian Meteorological Department's observatories have been also considered for benchmark study.

CLASSIFICATION OF RAINFALL PATTERNS

The incidence of rainfall at the time of agricultural operations and the distribution of rainfall during the growth of the crops plays an important role in food grain production. Even though the total rainfall is more, if it is not distributed during the period when crops require water, there will be no benefit from such rainfall. Thus the total rainfall is not of significance for the agricultural production. Rainfall pattern can be meaningfully described in relation to crop production (National Commission on Agriculture, 1976).

On the assumption that most of the crops mature in about 90 days, the following norms have been suggested:

i. Rainfall greater than 300 millimeters per month for at least three consecutive months would be suitable for a crop like paddy whose water need is very high.

ii. Rainfall between 200 to 300 millimeters per month 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 Blackgram.

iii. Rainfall between 100 to 200 millimeters per month for at least three consecutive months would be suitable for crops requiring much less water. Eg. Bajra and small millets.

iv. Rainfall between 50 to 100 millimeters per month for three consecutive months would be just sufficient for crops which have low water requirements. Eg - Ephemeral grasses.

v. Rainfall less than 50 millimeters per month for three consecutive months is not of much significance for crop production.

The southwest monsoon months of June to September being the principal rainy season dominate the rainfall distribution in the eight drought prone districts of Andhra Pradesh. The south eastern part of Chittoor is primarily affected by the post monsoon rains of the retreating monsoon i.e. north east monsoon between October and December. So the monthly rainfall regime of the seven months (June to December) is studied for their pattern. The month of May which is usually the premonsoon is also considered in the present study for the classification of rainfall patterns of the Tehsils of the districts and the Mandals of Chittoor which are drought prone.

The thirty years of monthly data which has been studied for all the drought prone tehsils of the eight districts have given a broad picture of the extent of rainfall over time and its intensity. In these districts of Andhra Pradesh the rainfall of over 150 millimeters commence with the month of June but the intensity and magnitude is never maintained though rainfall of over 300 millimeters is recorded in the month of November in Yerragondapalem of Prakasam district. This districts of coastal Andhra has rainfall of over 100 millimeters all through the months from July to October in the two tehsils of Kanigiri and Giddalur. In Telangana the rainfall regime is similar as the coastal districts. Kalwakurthy of Mahbubnagar and Ibrahimpatnam of Rangareddy show an anomaly of about 300 millimeters of rainfall during November. In Rayalaseema though high Rainfall of 300 millimeters is recorded periodically in July over Atmakur in Kurnool and Tamballapalli in Chittoor the minimum range of 100 to 200 millimeters is maintained during the three months of August, September and October. Spurts of about 200 millimeters rainfalls is also received by the Tehsils for one or two months. The maximum rainfall of 469.7 millimeters is recorded over Nandyal in Kurnool during the August of 1987, a rare 15 day spell of downpour. On the whole in the drought prone tehsils of Andhra Pradesh the rainfall can feed only the coarse grain crops, if the rainfed farming alone is taken up. But the amount of irrigation through the different sources allow these Tehsils to grow Paddy.

In Prakasam, Kanigiri and Giddalur are best suited for Bajra, Jowar and small millets. The tehsils of Podili, Markapur and Yerragondapalem can be utilized for the fodder crops development which is of tremendous boost to the districts growing livestock population and the improving Dairy farming.

In Rangareddy, Chevella and Ibrahimpatnam receive good rainfall during July to October, ideal for coarse grain cultivation, though wheat and Maize are grown here to cater to the demands of Hyderabad, Deverakonda of Nalgonda is just suitable for the Bajra and small millets if only rainfall is used during August to October. Mahbubnagar district has a wider magnitude of rainfall than compared to the other two drought districts of Telangana with Gadwal and Achampet receiving above 100 millimeters rainfall from July to November while Wanaparthy and Makthal receive the same rainfall during June to October. The other tehsils which receive the four month range of rainfall i.e. from July to October are Nagarkurnool and Kalwakurthy. Atmakur and Kollapur receive 100 millimeters of rainfall during July to September.

In Rayalaseema, while Anantapur and Cuddapah receive above 100 millimeters rainfall during August to September the similar regime in Kurnool starts a month early in July, while the same pattern extends during the month of November in Chittoor. A safe cropping time of fair months is available for the later two districts to chalk out their crop plan. Allagadda, Koilkuntla, Banganapalli and Nandyal are the four tehsils with four months of above 100 millimeters rainfall. Atmakur, Pathikonda, Adoni and Kurnool have the rainfall during the standard three months while Dhone receives above 100 millimeters rain during July, August and September. In Cuddapah, Jammalamadugu, Rayachoti, and Lakkhireddipalli and Kamalapuram have the standard months of rainfall above 100 millimeters. Pulivendla, and Muddamur rarely have two months of similar intensity of rainfall. The rainfall pattern in Anantpur is very sporadic with the western tehsils, in general getting less than 100 millimeters of rainfall. Madakasira, Gooty, Tadapatri, Kadiri and Kambadur receive above 100 millimeters of rainfall during the standard months. Chittoor which is affected by both the south west and north east monsoons receive over 100 millimeters of rainfall for four months, i.e. August to November. Kuppam and Palamner in the south east zone of the drought prone region in the district receive the monsoon rains of above 200 millimeters during July.

Vayalpadu receives rainfall of above 100 millimeters during August to November with periodic high intensities of over 300 millimeters during September or October. Punganur has the 100 millimeters rainfall during August to October while Thamballapalli hardly has two months of 100 millimeters rainfall though it abnormally received 349.2 millimeters of rainfall during July in 1989.

As a part of the present study, the monthly and annual normal rainfall of the Mandals of Chittoor has been analysed to arrive at a rainfall pattern to recommend the appropriate rainfed farming. In the eastern region of the district all the Mandals short receiving above 100 millimeters of rainfall in August, while a few show the figure even in July. The western region is the rain deficient area. Chinnagottigallu has the normal rainfall of above 100 millimeters from August to November while Kuppam records the above rainfall during August to September. The eastern half of the drought prone area is however consistent in receiving at least the required 100 millimeters of rainfall during September, October and November. While none of the mandals received above 200 millimeters those of the southern part of the half receives rainfall about 150 millimeters during October. They are Peddapanjani, Somala, Sodam, Palamaner, Gangavaram. In addition to the above mandals, Piler, Rampicharla, Chinnagottigallu, Yerravanipalem present the spatial distribution of over 100 millimeters rainfall during the standard three months to take up the rainfed cultivation of coarse grains without any irrigation.

2.2 FREQUENCY AND INTENSITY OF DROUGHT

The vital role of summer monsoon rainfall (mainly in the four months June to September) has been appreciated throughout history, and the primary focus of so much meteorological and climatological research on India has been to assess, evaluate and ultimately forecast the intensity of this Life Line to the Indian Agriculture. This has stimulated a vast literature over the years concerned with India in general. Most though not all the studies consider rainfall taking India as an integrated unit. On the other hand Parthasarathy et al (1987) studied the summer monsoon rainfall data for each of 29 meteorological subdivisions of India for the years 1871 to 1985. Whilst Gregory (1989) rescheduled such data into 10 macro-regions. Studies for individual areas of India have also been made, examples include Anantha Krishnan and Soman (1988) on Kerala and Pant and Hingane (1988) on Rajasthan desert. As for the time units under study, (daily frequencies and intensities have been examined

RAINFALL DEVIATION - ACTUAL ANNUAL RAINFALL DEVIATION FROM NORMAL ANNUAL RAINFALL

	61	62	65	66	67	68	69	70	71	72	73	76	77	78	79	80	81	82	83	84	85	86	87	88-89	89-90	90-91	91-92	92-93	* Deficient (-20% to -60%)	# Scanty (-60% & below)	Total No. of Years
CHITTOOR																															
TIRUPATI		*			*	*		*			*					*		*											7	-	7
KUPPAM						*										*		*								*			4	-	4
PALAMNER	*		*													*							*	*		*		*	7	-	7
PUNGANUR			*		*						*					*										*			5	-	5
MADANAPALLI			*			*										*		*				*							5	-	5
VAYALPADU	*		*			*										*		*			*							*	7	-	7
THAMBALLPALLI													*			*		*										*	4	-	4
AROGYAVARAM			*		*	*										*		*											5	-	5
CUDDAPAH																															
PULIVENDLA	*		*					*								*		*			*		*						7	-	7
JAMMALAMADUGU												*				*													2	-	2
KAMALAPURAM			*									*								*	*	*							5	-	5
RAYACHOTI			*						*							*		*				*	*						6	-	6
LAKKIREDDIPALLI			*													*		*			*								4	-	4
CUDDAPAH			*						*							*		*				*	*						6	-	6
ANANTPUR																															
MADAKASIRA		*	*					*				*						*		*	*	*							8	-	8
HINDUPUR			#									*						*		*	*								4	1	5
PENUKONDA	*		*																		*								3	-	3
DHARMAVARAM	*		*									*				*				*	*								6	-	6
KALYANDURG	*		*									*						*		*		*							6	-	6
URAVAKONDA										*		*				*						*							4	-	4
GOOTY												*				*				*		*							4	-	4
TADAPATRI	*			*	*					*		*				*					*	*							8	-	8
KADIRI			*													*					*								3	-	3
RAYADURG	*		*								*	#				*					*	*							6	1	7
KANEKAL	*	#			*							*				*				*	*								6	1	7
ANANTPUR	*		*						*			*				*		*				*							7	-	7
MEHBUBNAGAR																															
NAGARKURNOOL									*	*											*	*							4	-	4
WANAPARTHY				*						*												*							3	-	3
ATMAKUR			*	*	*				*	*	*									*	*	*							9	-	9
MAKTHAL	*		*						*	*										*		*							6	-	6
SHADNAGAR								*		*						*				*		*							5	-	5
KALWAKURTHY										*																			1	-	1
GADWAL				*	*			*		*		*				*				*		*							8	-	8
ACHAMPET								*		*	#									*	*	*							5	1	6
KOLLAPUR				*	*			*		*	*	*				*				*	*	*							10	-	10
MEHBUBNAGAR									*	*																			2	-	2

TABLE 2.10

RAINFALL DEVIATION - ACTUAL ANNUAL RAINFALL DEVIATION FROM NORMAL ANNUAL RAINFALL

	61	62	65	66	67	68	69	70	71	72	73	76	77	78	79	80	81	82	83	84	85	86	87	88-89	89-90	90-91	91-92	92-93	* Deficient (-20% to -60%)	# Scanty (-60% & below)	Total No. of Years
KURNOOL																															
ALLAGADDA																*				*		*							3	-	3
KOILKUNTLA	*											*				*						*							4	-	4
ATMAKUR																				*									1	-	1
NANDIKOTKUR										*						*					*								3	-	3
DHONE	*				*																	*							3	-	3
PATTIKONDA										*		*			*	*				*									5	-	5
ADONI			*		*							*	*							*		*							6	-	6
ALUR	*	*	*	*	*				*	*		*				*			*	*									11	-	11
YEMMIGNUR	*	#	#		*							*										*							4	2	6
BANGANAPALLI	*				*							*				*						*							5	-	5
KURNOOL	*				*					*	*					*				*									6	-	6
NANDYAL			*		*				*	*						*				*	*	*	*						9	-	9
KODUMUR					#							*				*													2	1	3
NALGONDA																															
DEVERAKONDA					*											*					*	*							4	-	4
NALGONDA			*													*													2	-	2
RANGAREDDI																															
CHEVELLA			*		*				*																				3	-	3
IBRAHIMPATNAM			*										*																2	-	2
HYDERABAD-BGPT				*												*					*								3	-	3
PRAKASAM																															
KANIGIRI			*		*				*				*					*		*	*								7	-	7
PODILI			*		*											*													3	-	3
MARKAPUR			*		*											*				*									4	-	4
GIDDALUR			*									*									*	*							4	-	4
YERRAGONDAPALEM			*					*				*				*				*		*							6	-	6
ONGOLE																		*		*		*							3	-	3
DEFICIENT * (-20% to - 60%)	17	3	30	7	20	5	-	8	11	18	5	22	4	-	1	39	-	16	1	24	22	30	5	1	-	3	-	3	295		
SCANTY # (-60% & below)	-	2	2	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		7	
Total No. of Tehsils	17	5	32	7	21	5	-	8	11	18	6	23	4	-	1	39	-	16	1	24	22	30	5	1	-	3	-	3			302

by Anantha Krishnan and Rajan (1987) and Singh and Kripalani (1986). Another difficulty is presented by changes in the space units considered, from individual stations of subdivisions, macro-regions or All India. The years 1877, 1899, 1911, 1918, 1920, 1941, 1951, 1965, 1666, 1972 and the recent 1987 are considered national droughts. In individual parts of the country, however other years also produced summer drought conditions as intense as or even more intense than those listed above.

In the present study the rainfall of over 60 drought prone tehsils of Andhra Pradesh utilised have been to study the frequency and intensity of drought. The years of study is 1961-1993. Monthly rainfall data has been used to study the variation of the rainfall during the seasons.

In order to identify the taluks which receive deficient and scanty rainfall, (See Table 2.10 for the frequency of the drought which is marked for each year over each rainfall station. The deficient and scanty rainfall is calculated according to the percentage deviation of the actual annual rainfall from the normal annual rainfall) the Indian Meteorological department gives a standard criteria (1987 Drought - Response and Management)

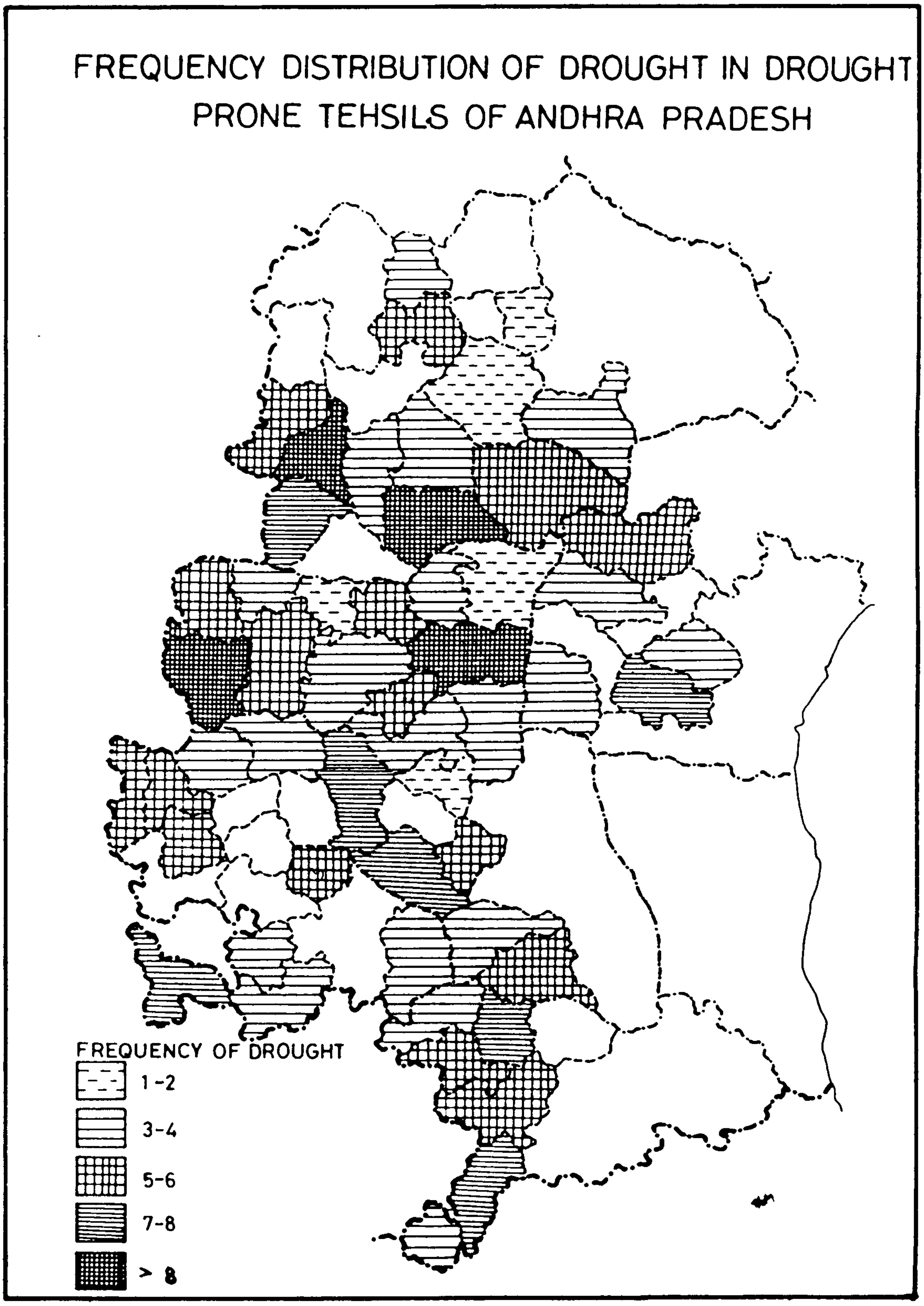
Criteria for Deficient and Scanty Rainfall

Percentage Deviation of Actual Annual Rainfall from Normal Annual Rainfall	Type
+19 to -19	Normal
-20 to -59	Deficient
-60 to -99	Scanty
-100	No rain

For the present study Annual Rainfall of the drought prone Tehsils of Andhra Pradesh and at an intensive level the Mandals of Andhra Pradesh have been utilised. The percentage deviation of the sixty (60) rain guage stations in the tehsils are calculated and as per the IMD criteria.

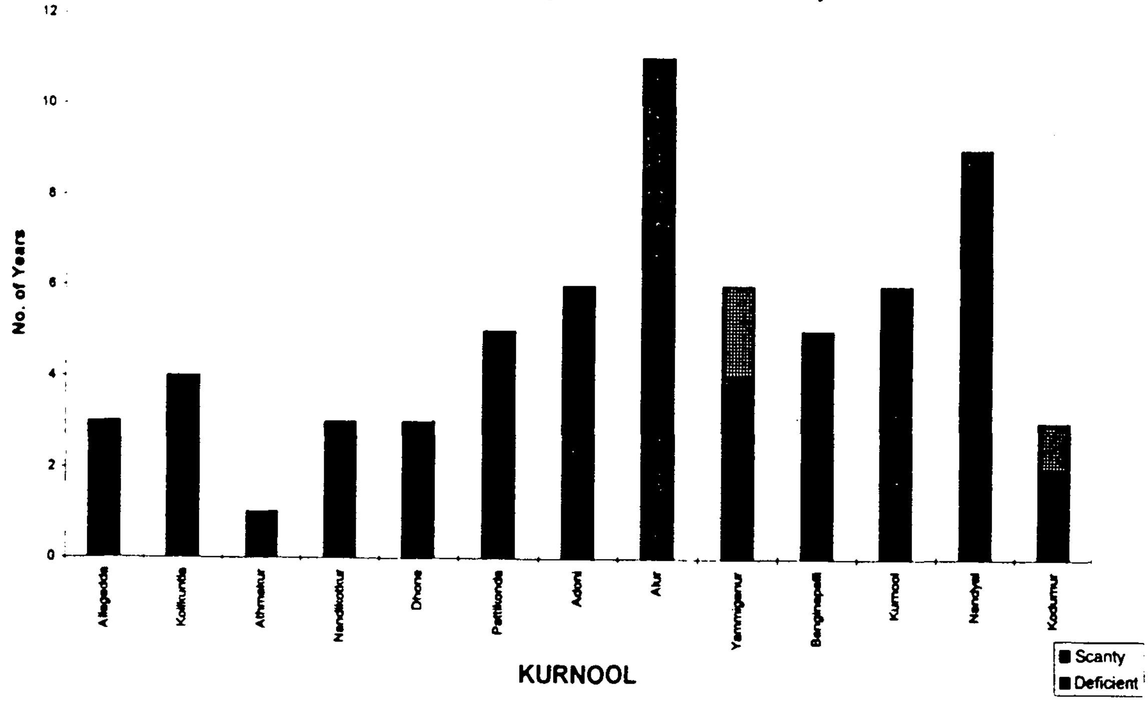
Rainfall deviation of each station has been identified in Table 2.03 to 2.09. The deficient and scanty rainfall of Taluks at the state level and Mandals at the district (Chittoor) level has been distributed in the Five frequency intervals as according to their frequency in each taluk.

Number of years of Drought	Drought Prone Taluks
One and two	Seven
Three and Four	Twenty Two
Five and Six	Eighteen
Seven and Eight	Nine
Nine and above	Four


FREQUENCY DISTRIBUTION OF DROUGHT IN DROUGHT PRONE TEHSILS OF ANDHRA PRADESH
FREQUENCY OF DROUGHT
1-2
3-4
5-6
7-8
> 8

MAP NO. 19

Frequency of Drought - Deficient and Scanty Rainfall



KURNOOL

Frequency of Drought - Deficient and Scanty Rainfall

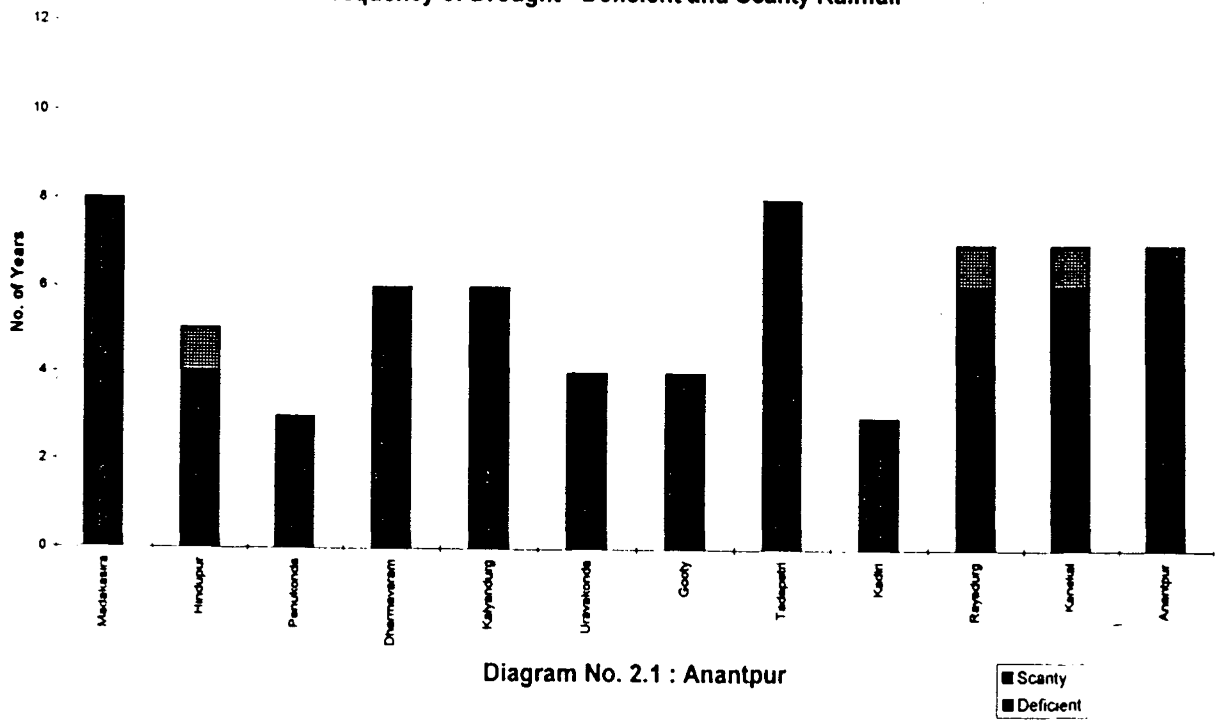
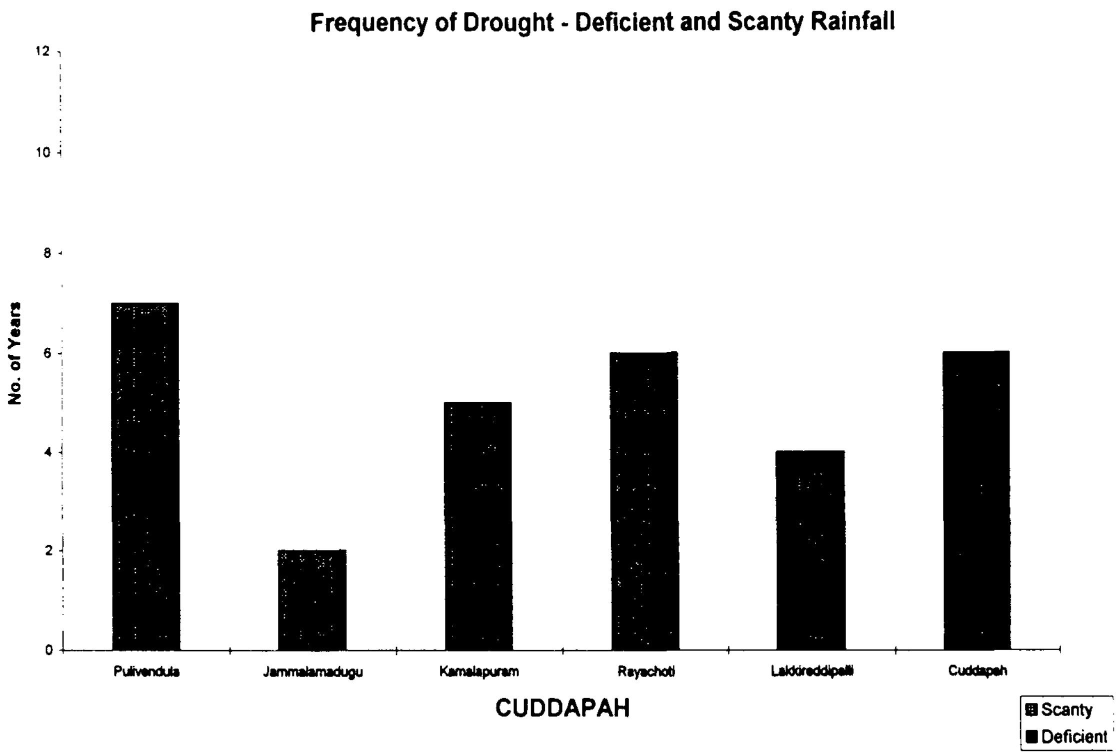


Diagram No. 2.1 : Anantpur



CUDDAPAH

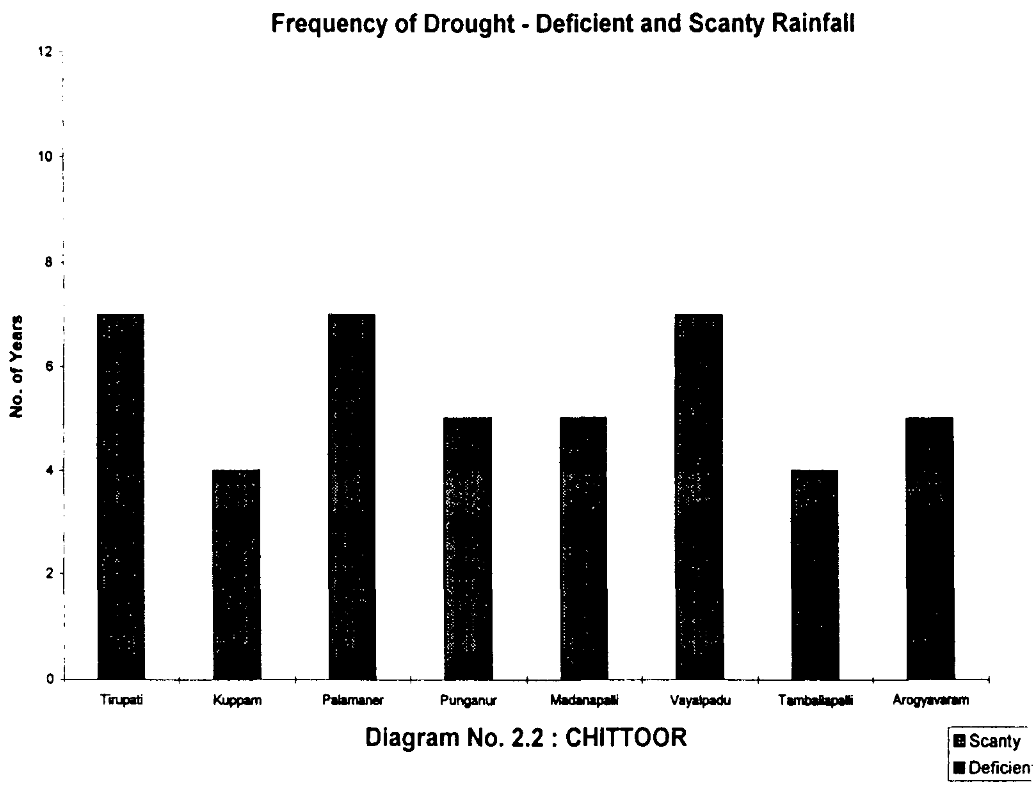
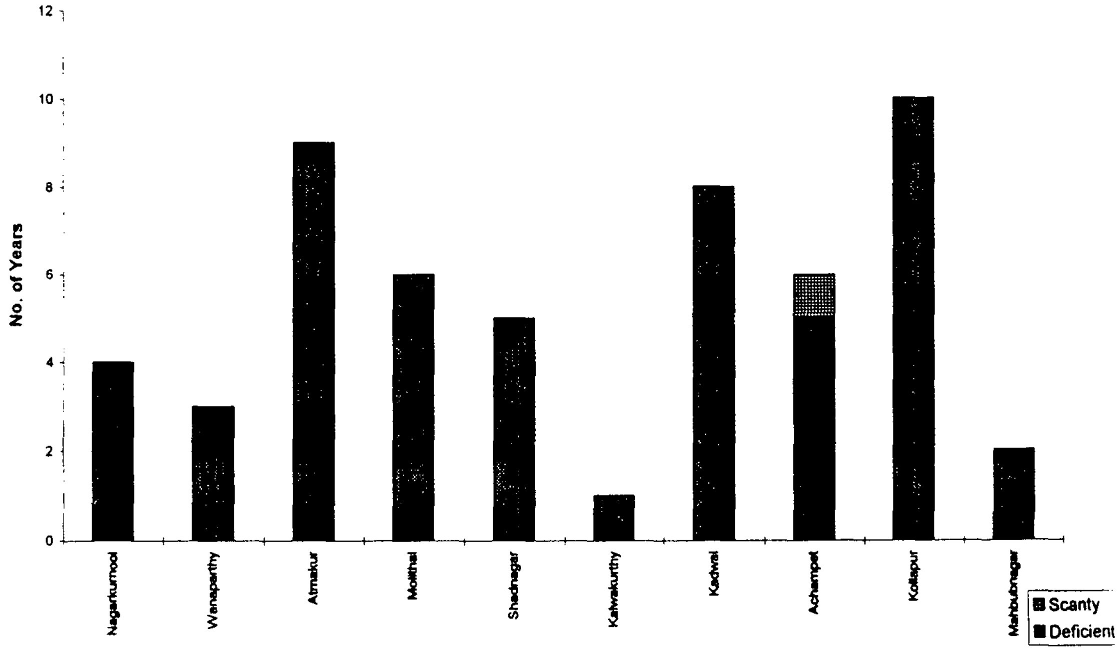


Diagram No. 2.2 : CHITTOOR

Frequency of Drought - Deficient and Scanty Rainfall



MAHBUBNAGAR

Frequency of Drought - Deficient and Scanty Rainfall

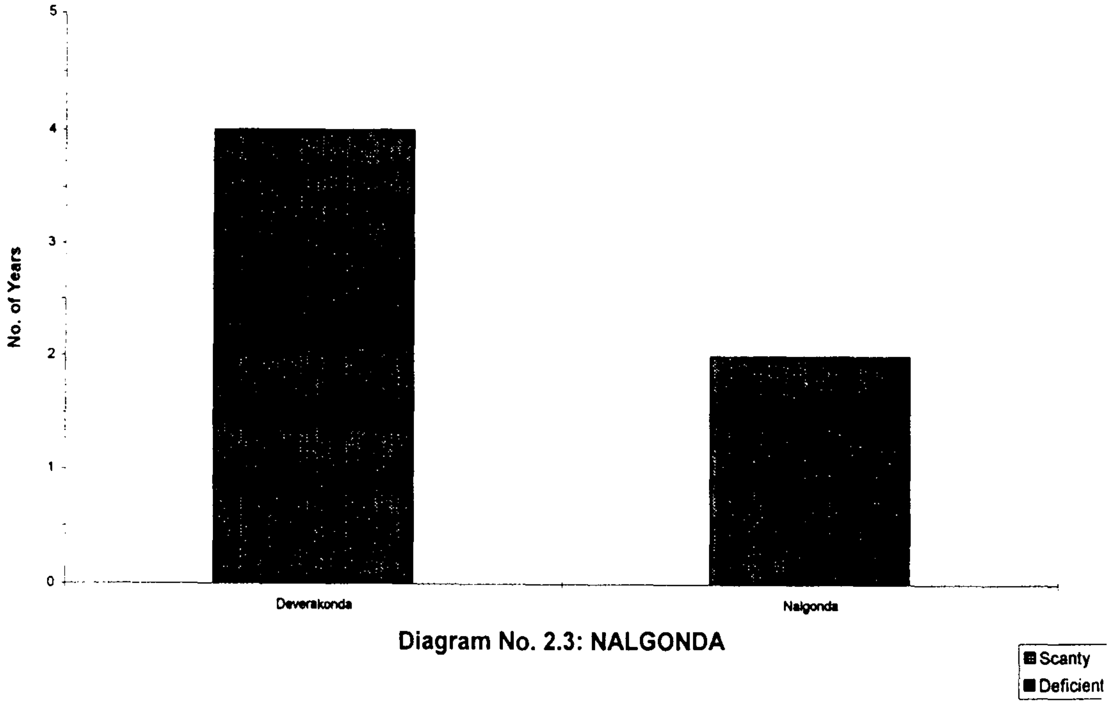
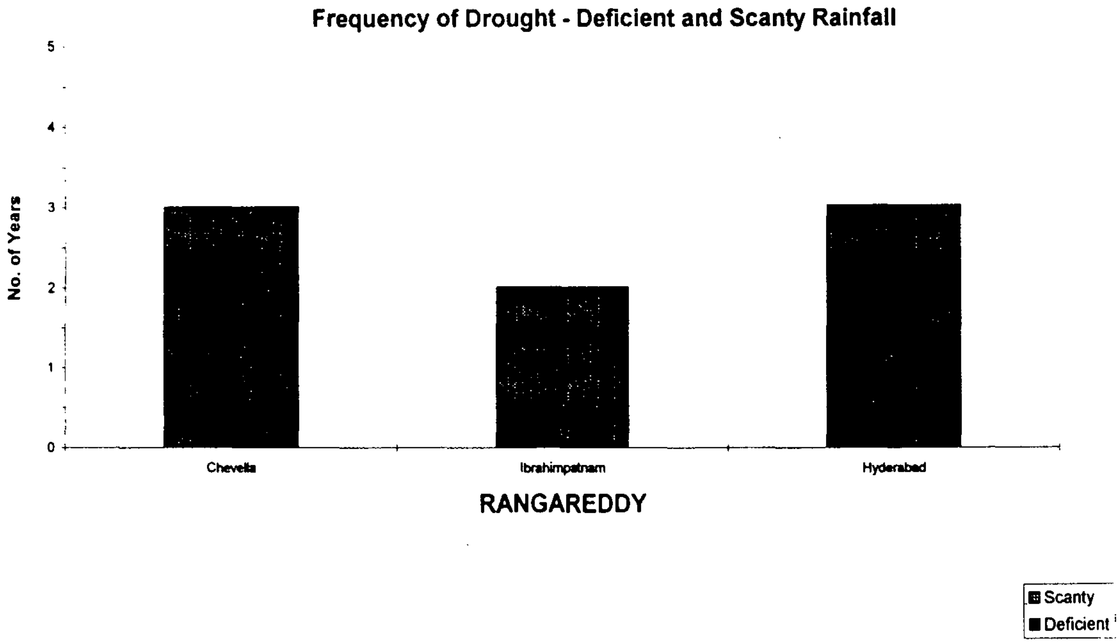


Diagram No. 2.3: NALGONDA



RANGAREDDY

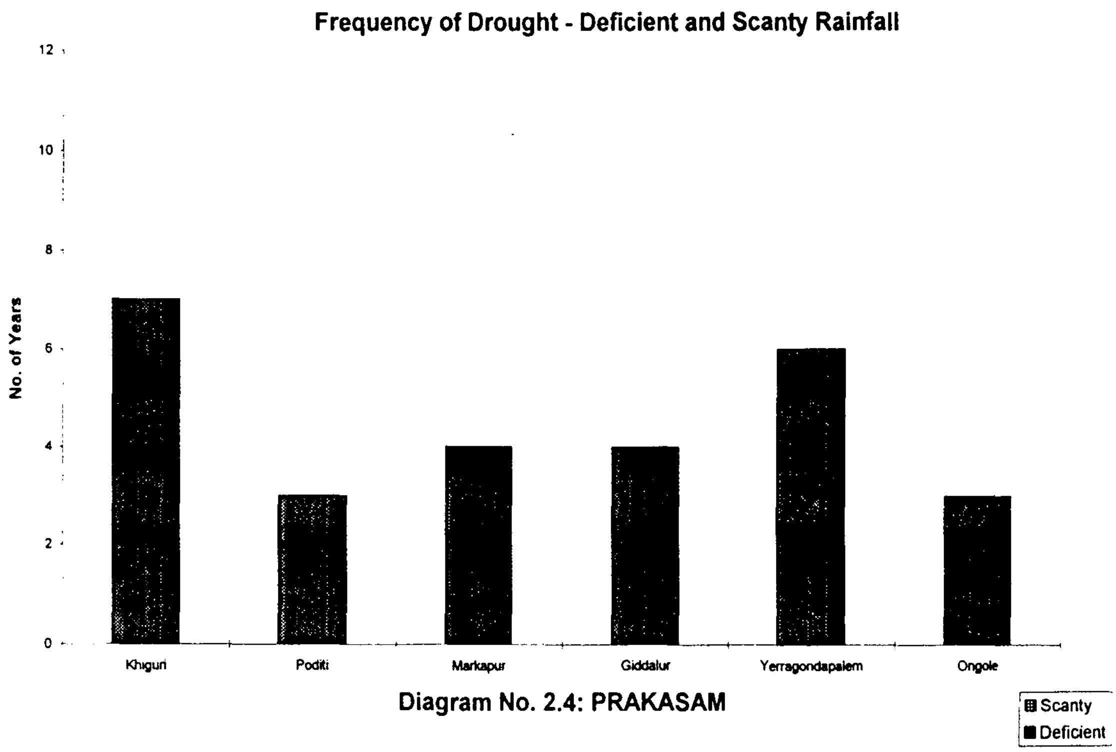


Diagram No. 2.4: PRAKASAM

The list of taluks which experienced deficit and scanty rainfall are given in the Annexure VI-b.

Out of the 52 drought prone tehsils, Anantpur and Kurnool are the districts where the maximum number of episodes of deficient rainfall conditions have been experienced.

Diagrams 2.1 to 2.4 shows the frequency of drought over drought prone tehsils of Andhra Pradesh according to deficient and scanty rainfall.

During the thirty years in the study area 12 taluks have been observed to have a frequency of 4 times of deficient rainfall. These taluks are present in all the districts which show that a regional rainfall deficiency is faced by these districts Rayalaseema and Telangana the maximum number of 11 times (during 1961-87) occurred in Alur of Kurnool, and 10 times in Kollapur of Mahbubnagar. Two taluks Kalwakurthy of Mahbubnagar and Atmakur of Kurnool, however experienced only one year of deficient rainfall.

The scanty rainfall condition is observed over six taluks one in Mahbubnagar and two each in Kurnool and Anantpur. (See Annexure VIa) Yemmiganur had two years of scantiness of rainfall which all the other five taluks experienced it once. See Map Number 19 for the distribution of rainfall frequency for the drought prone Tehsils of Andhra Pradesh.

It can be mentioned here that in Rayalaseema the western Anantpur and Kurnool as the regions of perpetual scarce rainfall which rarely goes above 500 millimeters (See Annexure IV) for the mandals which cover this zone. Kurnool has 54 mandals, Anantpur 53 mandals Cuddapah 22 mandals, Prakasam 12 mandals and Mahbubnagar 4 mandals.

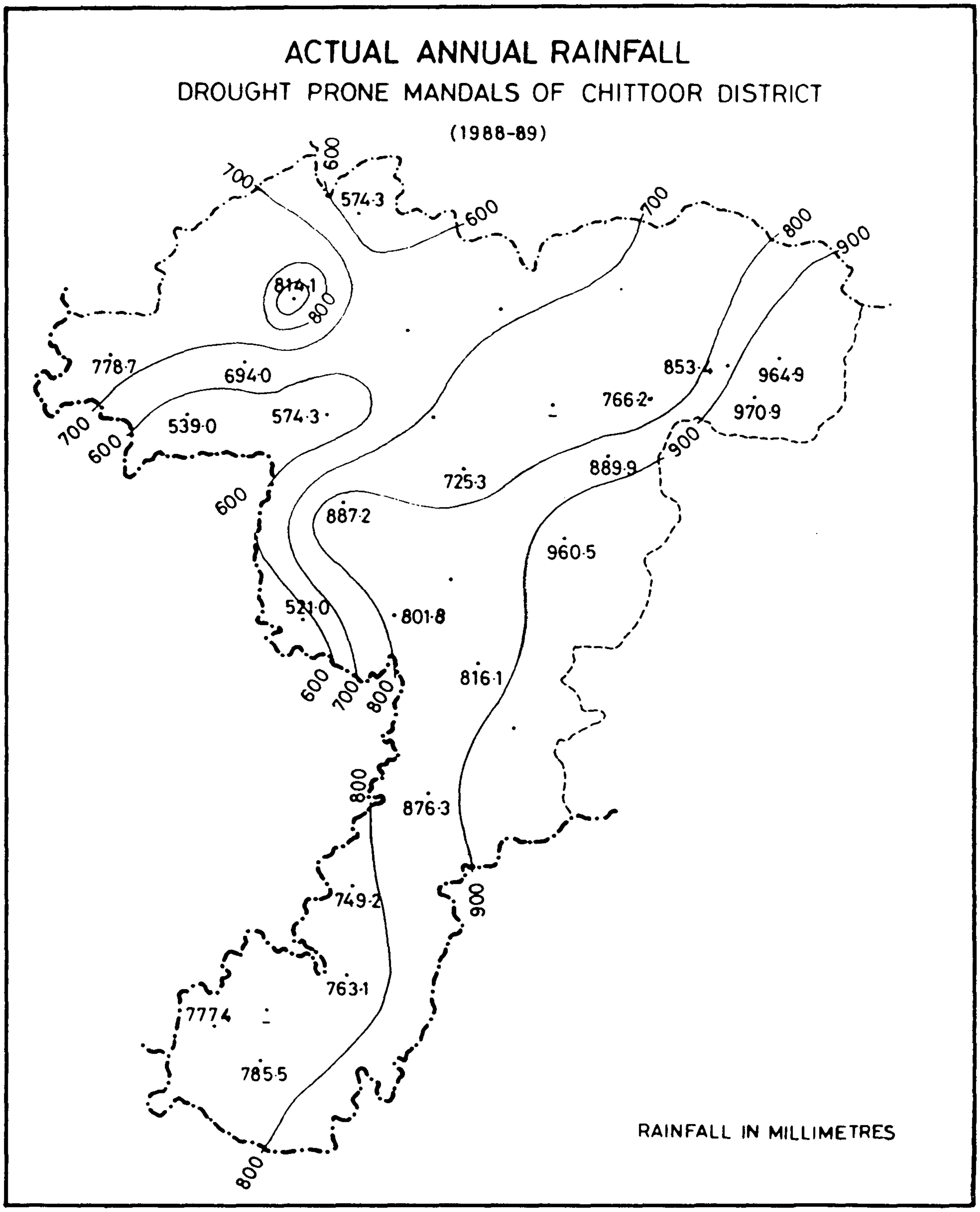
This zone thus consists of the entire district of Kurnool, most of Anantpur district except 10 mandals of Kadiri taluk and parts of three districts Cuddapah, Prakasam comprising 145 mandals, 38 towns and 2529 revenue villages. This zone supports a total population of 60.15 lakhs (1981) and the density of population per square kilometre is 127. This zone is mainly agrarian in character, with about 38 percent of its geographical area under cultivation with 3/4 of the population depending upon agriculture. This is the situation of man's ordeal against the severe testing conditions of NATURE.

There has been consecutive years of drought in the Drought Prone areas of Andhra Pradesh for atleast five times. They are 1961-62, 65-66, 71-72, 72-73, 84-85 and 85-86. While the severe drought of 1962 in Kanekal of Anantpur is followed moderate drought. Yemmiganur had a dosage of slight drought in 1961 prior to severe drought. Slight drought followed moderate drought in Atmakur and Kollapur of Anantpur during 1971-72 and 1985-86 respectively. Over the rest of the 21 cases there has been two consecutive years of slight drought over 12 taluks (20 percent area).

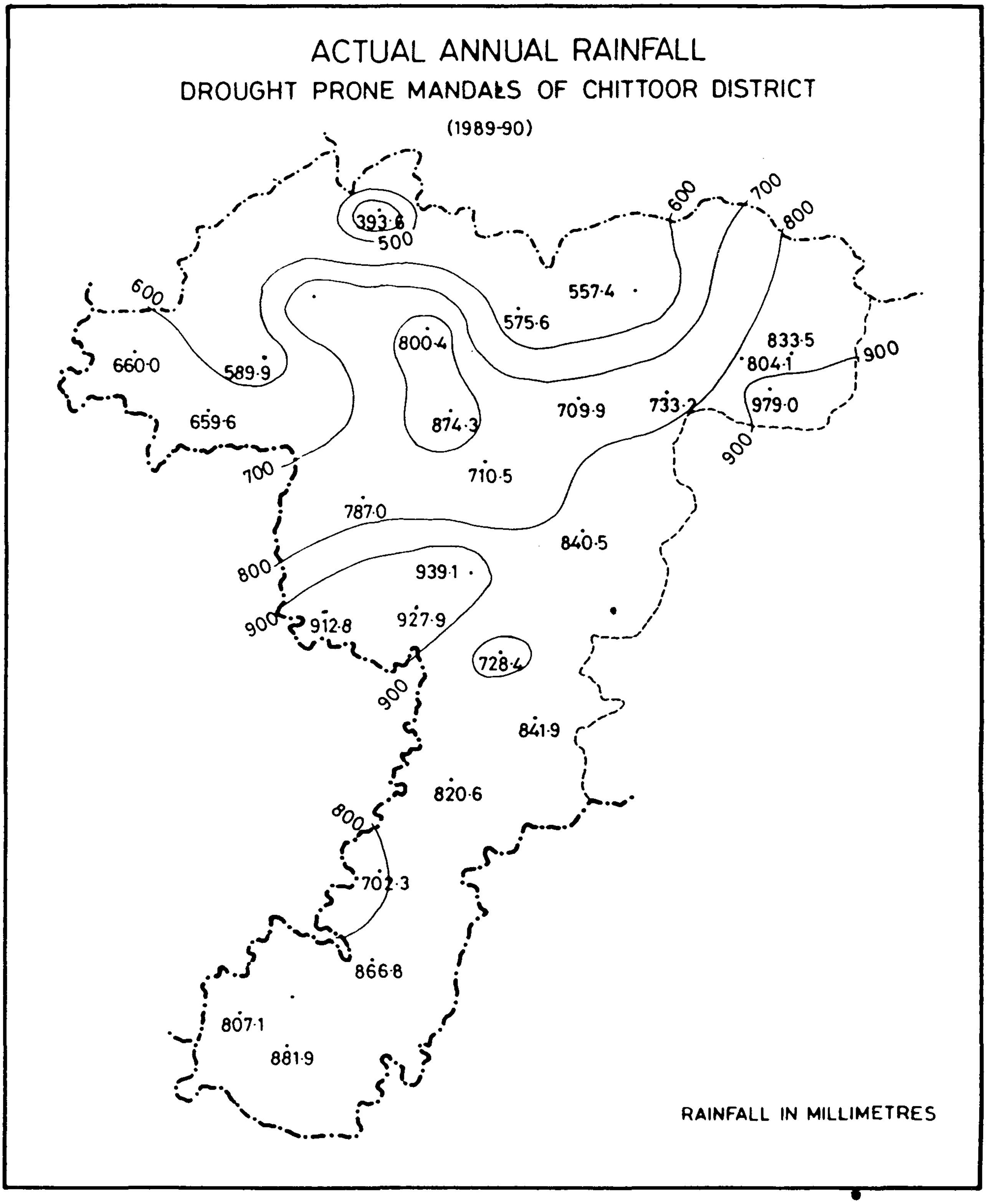
In the present study an intensive micro-level (Mandal) study of the rainfall scenario has been done for Chittoor district. Sixty six mandals which include 31 drought prone mandals have been selected for study of rainfall over the five years of 1988 to 1993 and a comparitive account has been made of the annual rainfall to the normal rainfall. For this Isohyet maps of the normal rainfall and the annual rainfall have been plotted. See Map Number 11 for the normal annual rainfall of the drought prone mandals of Chittoor.

The Drought Prone Mandals of Chittoor which lie on the entire western half of the district, experience slight drought conditions and deficient rainfall scenario. While south-west monsoon brought high rainfall during the three years of 1988 to 90, there has been a shift towards north-east monsoons quantum rainfall in the following, two years with a very heavy rainfall lashing the area during October & November months of 1991, thus leading to a high total annual rainfall of 1235.1 millimeters.

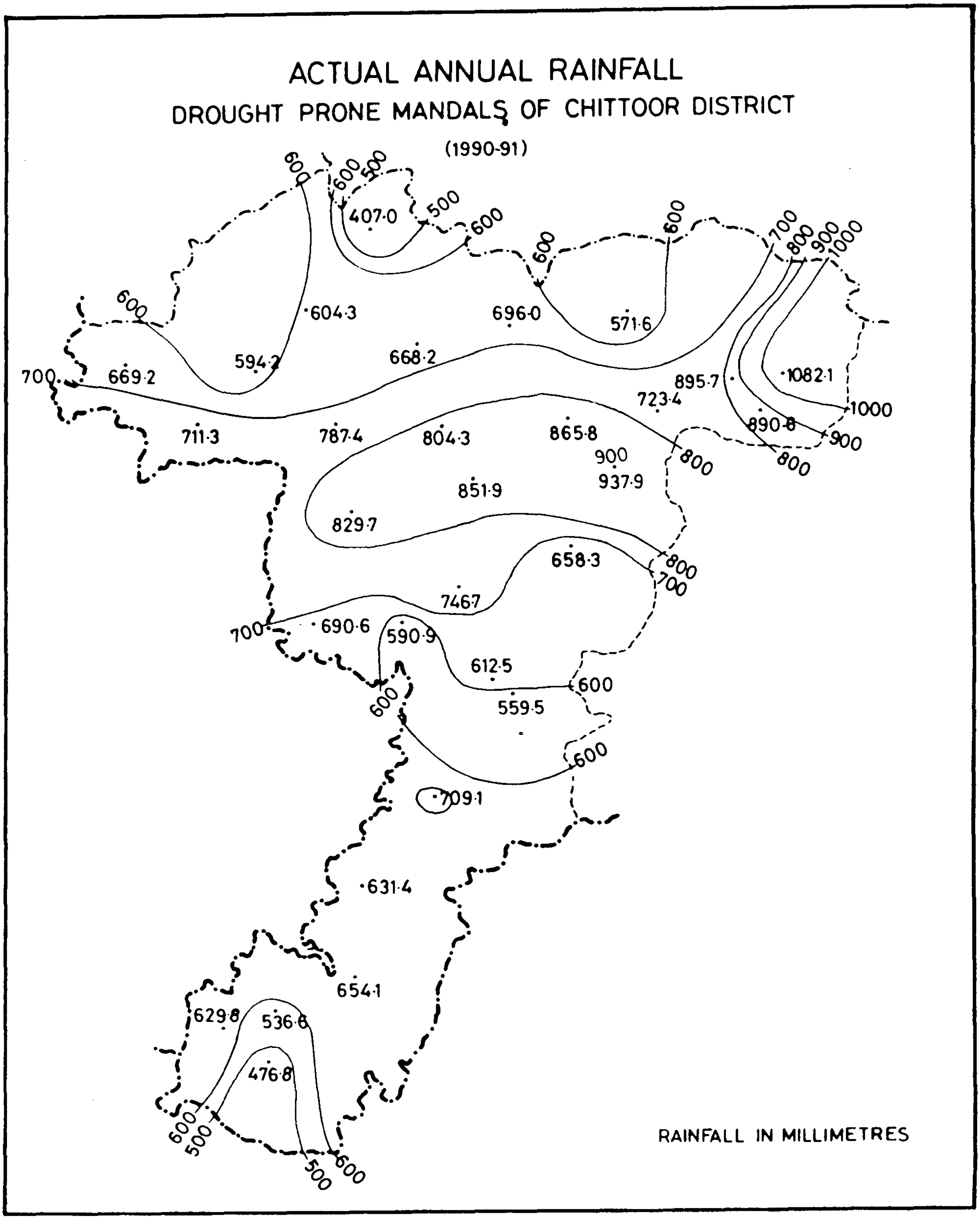
Over the drought prone mandals of Chittoor the normal annual rainfall varies between the lowest of 554 millimeters. at Pedatippasamudrum in the north-western corner of the district and the highest of 838.4 millimeters at Palamaner at east-southeast corner of the drought prone Chittoor. The normal rainfall shows a general increasing trend towards the north-west - south-east direction.


ACTUAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
(1988-89)
574·3
814·1
778·7
694·0
539·0
574·3
853·4
964·9
766·2
970·9
725·3
889·9
887·2
960·5
521·0
801·8
816·1
876·3
749·2
763·1
777·4
785·5
RAINFALL IN MILLIMETRES

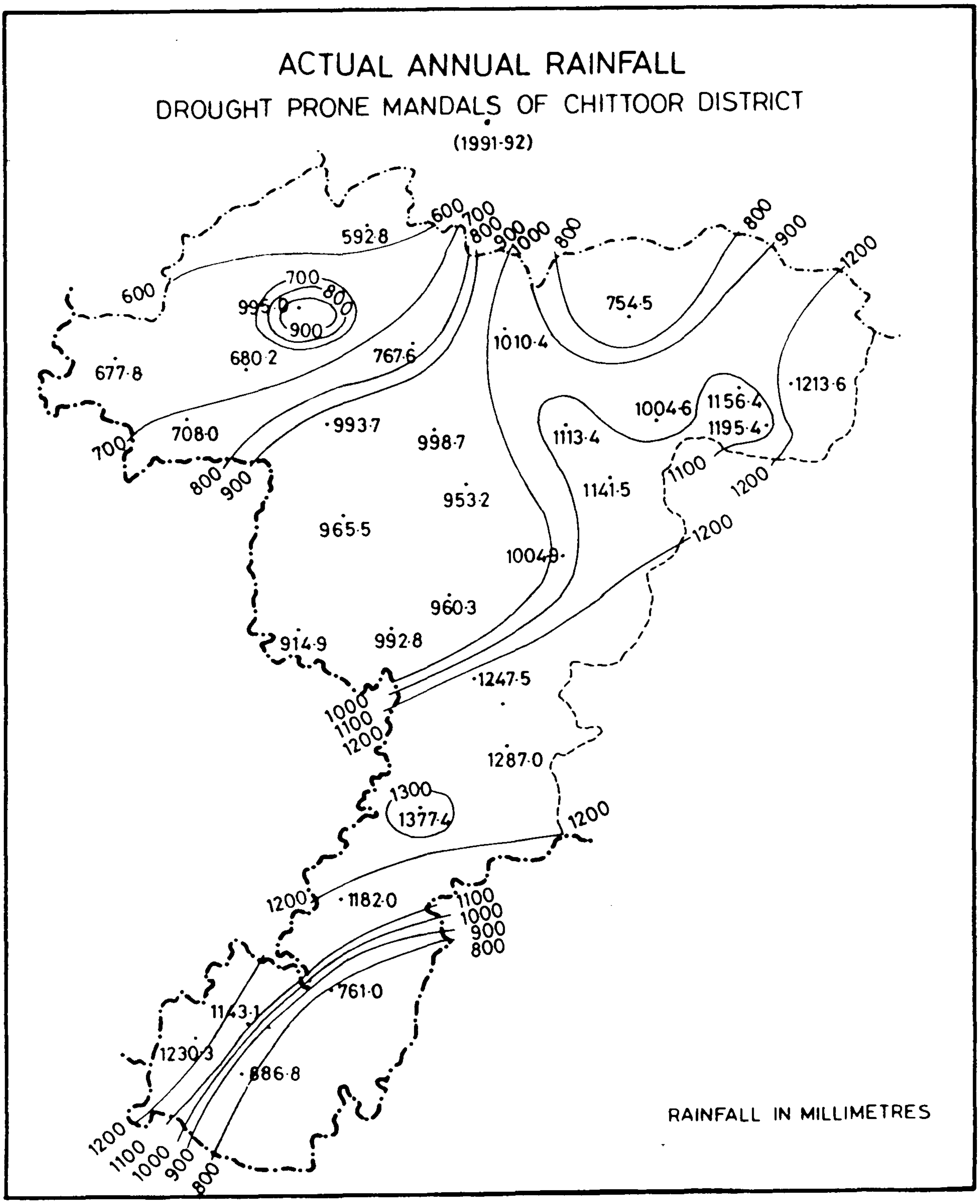
MAP NO. 14


ACTUAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
(1989-90)
393·6
500
600
700
800
557·4
575·6
600
660·0
589·9
659·6
800·4
874·3
709·9
733·2
833·5
804·1
979·0
900
900
700
710·5
787·0
840·5
800
939·1
900
912·8
927·9
728·4
900
841·9
820·6
800
702·3
866·8
807·1
881·9
RAINFALL IN MILLIMETRES

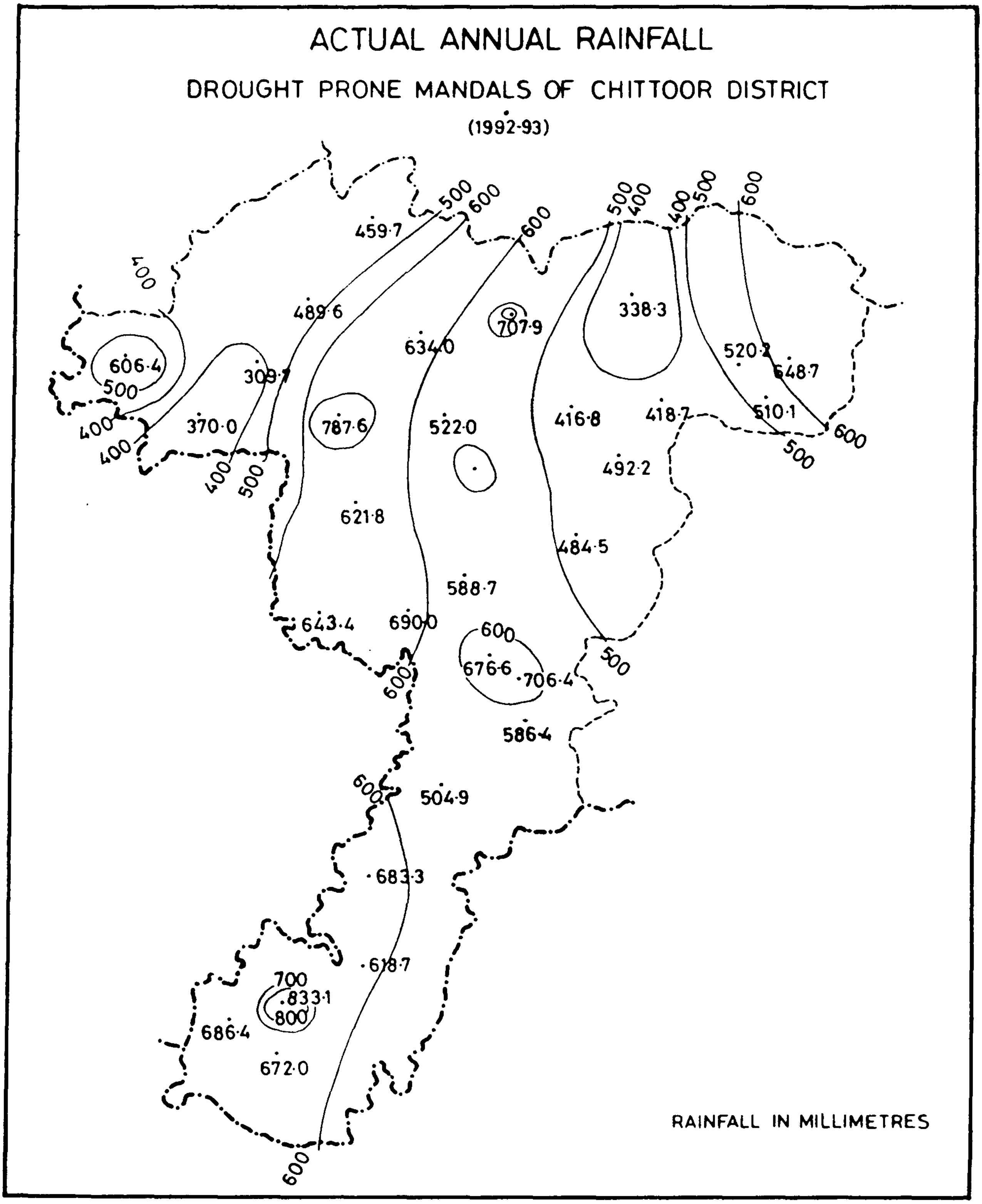
MAP NO. 15


ACTUAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
(1990-91)
407·0
604·3
696·0
571·6
594·2
668·2
669·2
895·7
1082·1
723·4
711·3
787·4
804·3
865·8
890·8
937·9
851·9
829·7
658·3
746·7
690·6
590·9
612·5
559·5
709·1
631·4
654·1
629·8
536·6
476·8
RAINFALL IN MILLIMETRES

MAP NO. 16


ACTUAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
(1991-92)
592·8
754·5
995·0
680·2
677·8
767·6
1010·4
1213·6
1004·6
1156·4
1195·4
708·0
993·7
998·7
1113·4
1141·5
953·2
965·5
1004·8
960·3
914·9
992·8
1247·5
1287·0
1377·4
1182·0
761·0
1143·1
1230·3
886·8
RAINFALL IN MILLIMETRES

MAP NO. 17


ACTUAL ANNUAL RAINFALL
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
(1992-93)
459·7
489·6
606·4
309·7
370·0
787·6
634·0
707·9
522·0
338·3
520·2
648·7
416·8
418·7
510·1
492·2
621·8
484·5
588·7
643·4
690·0
676·6
706·4
586·4
504·9
683·3
618·7
833·1
686·4
672·0
400
500
600
700
800
RAINFALL IN MILLIMETRES

MAP NO. 18

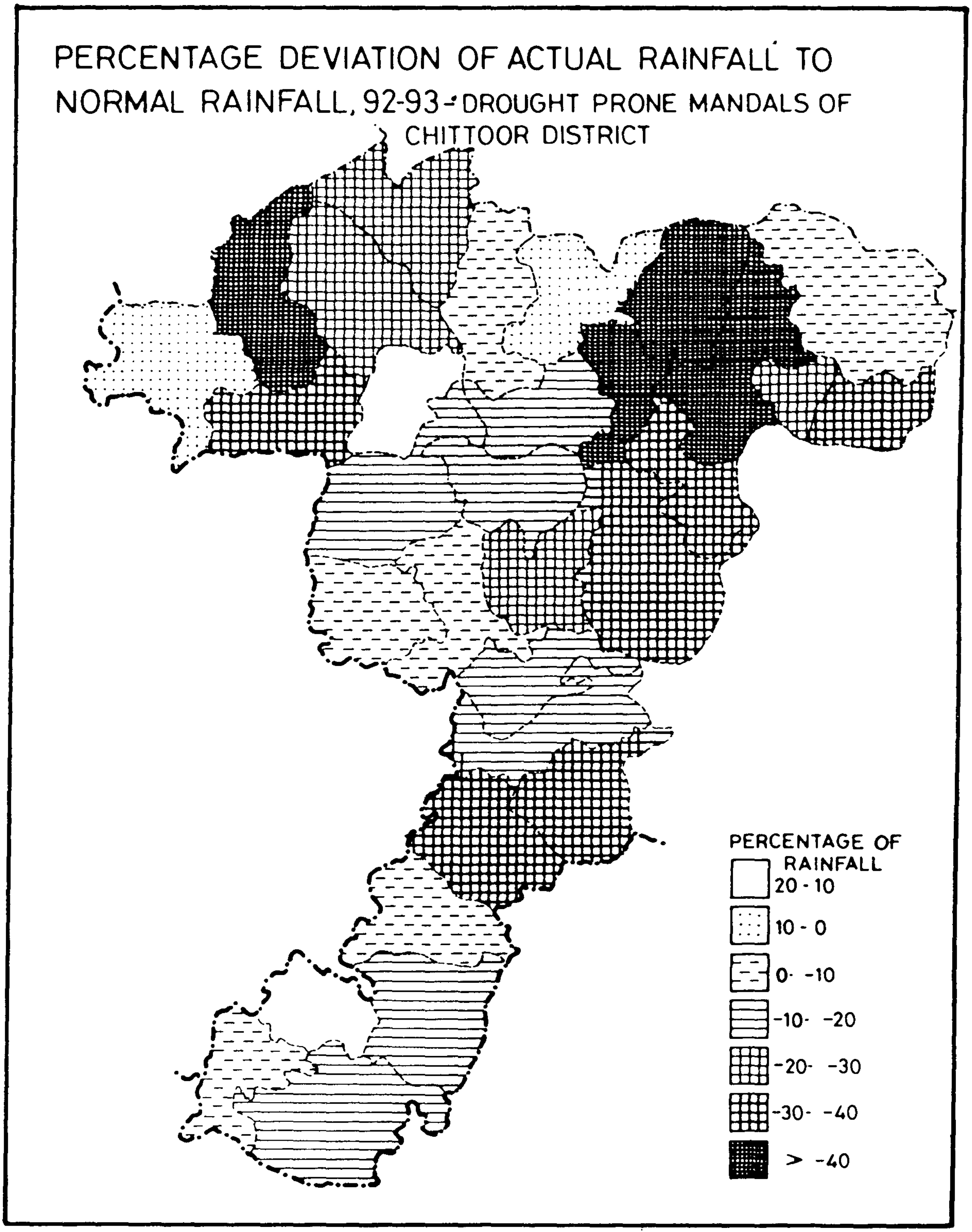
The probability distribution of annual rainfall is given in the following table.

Taluk	At 75 percent Probability & Above (Rainfall in millimeters.)
Kuppam	700-800
Madanapalli	600-700
Palamaner	700-800
Punganur	600-700
Vayalpad	600-800

Source: Rainfall, Chittoor District, Govt. of A.P., 1986

The actual annual rainfall of the five years isohyets (1988-93) has been studied for the spatial distribution of rainfall. (See Map Numbers 14, 15, 16, 17 and 18) In the history of Chittoor the maximum annual rainfall of 1331 millimeters was received in 1943 while a minimum of 380 millimeters is received in 1957. At least 50 years in the present century (1901-1993) had rainfall less than normal rainfall. While the coefficient of variation for annual rainfall is 22.18 percent.

As per the present study of the drought prone mandals of Chittoor, Peddamandyam at the northern most area of the district shows the lowest of annual rainfall for three consecutive, rainfall years from 1989 to 1992. In general low level of rainfall occurs in the north-western part with Molakalacheruvu getting the lowest rain 309.7 millimeters during the extensive drought year of 1992-93, while the westwardly located. Ramasamudrum got about of rainfall low (521.6 mm) in 1988-89. All these stations / mandals are in the rain shadow of eastern ghats. The eastern part of Chittoor obviously is endowed with very high rainfall gifted by the double advantage of south-west and north-east monsoonal rains. This explains the high rainfall over the windward side of the eastern ghats and the mandals' comparitive prosperity. Palamaner, Gangavaram, Yerravanipalem get a rainfall over 1000 millimeters due to their proximity to the sea. Chowdepalli gets its high share of rainfall due to the geographic effect of the eastern ghats. Santhipuram also gets the rainfall due to the similar reason though the other mandals in the district are drought stricken during 1992-93. Thamballapalli shows a high rainfall compared to the other mandals in the north-western part of Chittoor during 1988-89 and 1992-92 due to the total factor of relief. The central areas of the drought prone Chittoor, receive an annual rainfall which varies between 550 millimeters to 850 millimeters. These mandals get their rainfall from the monsoons. Their rainfall does not show much of variation along the years. The rainfall during 1991-92 recorded over the whole area range from 900 millimeters to 1450 millimeters. The highest rainfall is at Gangavaram 1455 millimeters.


PERCENTAGE DEVIATION OF ACTUAL RAINFALL TO NORMAL RAINFALL, 92-93 - DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
PERCENTAGE OF RAINFALL
20 - 10
10 - 0
0 - -10
-10 - -20
-20 - -30
-30 - -40
> -40

MAP NO. 20

The intensity of drought when calculated from the percentage deviation from normal rainfall showed a couple of mandals were affected by drought in 1988-89 with deficient rainfall. About 6 mandals were affected during 1990-91 interestingly non of the mandals showed any deficiency in rainfall in 1991-92 (1235.1 mm). The reason may be routed to the cyclonic storms during the year which lashed during the north-east monsoon period. But the following year (1992-93) showed widespread drought conditions with high rainfall deficiency of -46.6 percent from 1235.1 millimeters to 659.4 millimeters. (See Map Number 20) A classic case of drought year which follows a flood year consecutively.

During the same drought year of upto 80 percent decrease from monthly normal (scanty rainfall) occurred in the whole area during the south-west monsoon. A feature which can be noted as failure of south-west monsoon, though the north-east monsoon followed its general trend.

Irrigation in Drought Prone Areas in Andhra Pradesh

CHAPTER THREE

"When the wells go dry, we know the worth of Water"

- Benjamin Franklin

The irrigation scenario in Andhra Pradesh is extended in the lower half of the percentage scale. The Net Irrigated Area has been taken as the standard base to measure the areal extent. By calculating the percentage of the net irrigated area to the net cultivated (sown) area, the regional differences and the trends of growth of irrigation is analysed.

As on 1991-92 in the State as a whole, 39.41 percent (43,50,795 hectares) of the Net Sown Area (1,10,40,629 hectares) is under irrigation. There has been a gradual increase in the areal extension of irrigation in Andhra Pradesh, since the onset of Green Revolution. It has increased from 27.49 percent in 1964-65 to the present of about 40 percent.

The Coastal Andhra Pradesh including the rice granaries of India - GODAVARI and KRISHNA deltas, obviously top the list with 58.16 percent of cultivated area under irrigation (22,71,843 hectares out of 39,06,368 hectares). Telangana and Rayalaseema follow with 33.74 percent (14,74,144 hectares of Net Irrigated Area to 43,69,424 hectares of Net sown Area) and 21.87 percent (6,04,808 hectares Net Irrigated Area to 27,64,837 hectares of Net Cropped Area) respectively.

The eight drought prone districts combindly show 24.54 percent net sown area irrigated i.e. 12,73,585 hectares of Net Irrigated Area to 51,88,792 hectares of Net Sown Area (1991-92). This percentage of irrigation increased from 15.21 percent in 1964-65 to 21.87 percent (1991-92). A significant increase in irrigated area has been seen during 1987-88 to 1989-90 which is about 5 percent. During these years the irrigated area increased from 8,98,355 hectares to 11,87,842 hectares and correspondingly the Net Sown Area increased from 48,61,951 hectares to 51,49,973 hectares.

The general trend in the 8 drought prone districts is positive, though increase is seen varying accordingly to the three physiographic regions of Andhra Pradesh. During 1985-92, Prakasam showed an increase of 8 percent increase i.e. from 26.57 percent to 34.59 percent. More significant is the scene in Telangana. Nalgonda shows a good 20 percent increase in irrigated area, i.e. from 14.45 percent to 35.65 percent (1991-92). It is presently having (1964-65) 2,05,040 hectares of net irrigated area to 5,75,125 hectares of net sown area. Chittoor district however is showing a decrease in the areal extent of irrigation. The proportion irrigated area decreased from 34.13 percent of the 4,45,896 hectares of net sown area (1964-65) to 26.16 percent (99,307 hectares of net irrigated area to 3,79,633 hectares of net sown area) during 1986-87. After this year there has been a gradual increase in the areal extent of irrigation and in 1991-92 it is 33.25 percent (1,69,699 of irrigated area to

4,95,309 hectares of net sown area). Similarly Kurnool also showed a similar trend. While it was 7.81 percent in 1964-65 it increased to 17.47 percent in 1991-92 (See Table-3.01)

TABLE 3.01

PERCENTAGE OF NET IRRIGATED AREA TO NET SOWN AREA

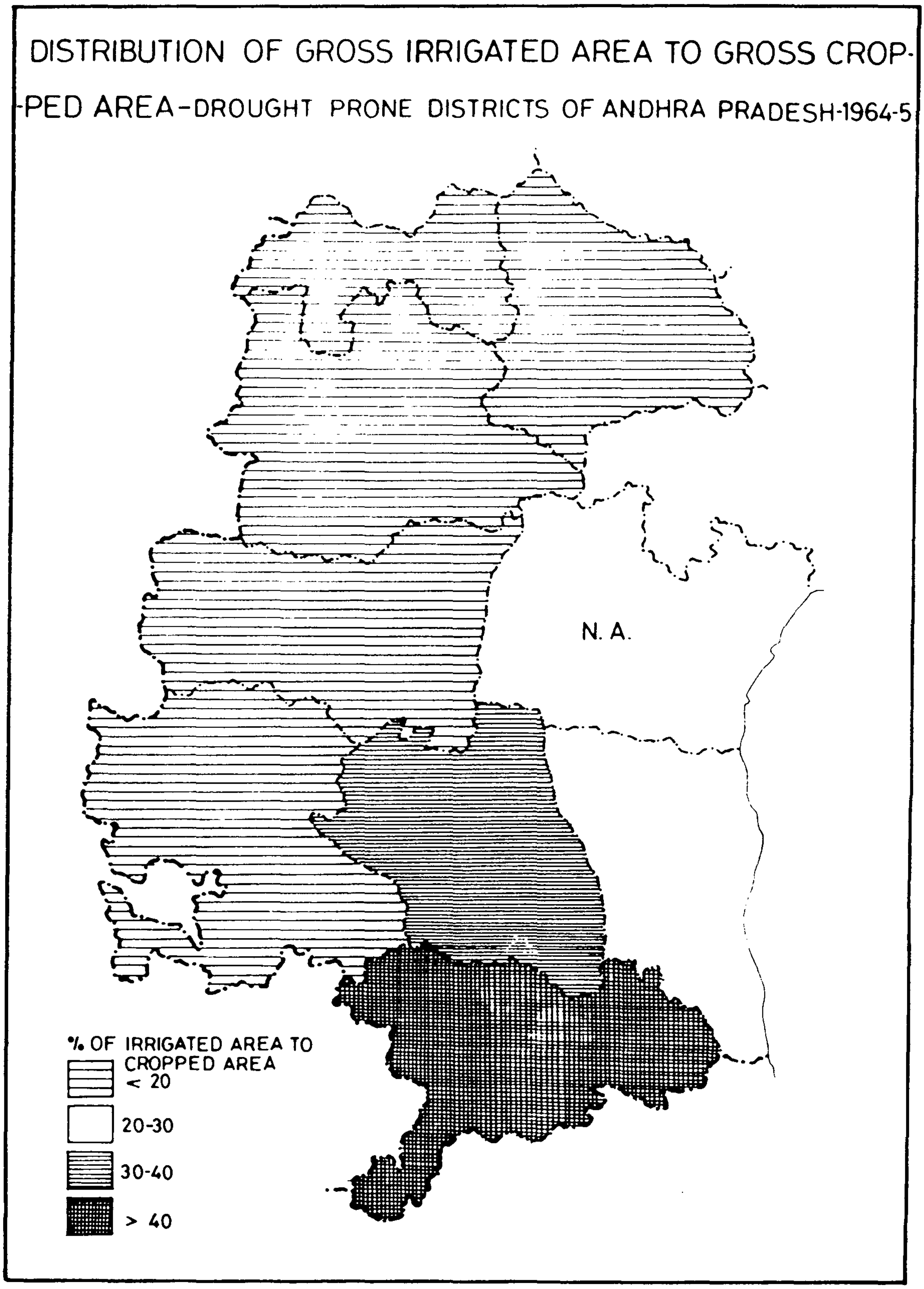
DISTRICT	1964-65	1985-86	1986-87	1987-88	1989-90	1991-92
Prakasam	-	26.58	29.19	24.02	30.83	34.59
Kurnool	7.81	13.05	12.88	12.22	16.37	17.47
Anantpur	12.65	12.96	14.67	15.24	15.87	15.63
Cuddapah	27.32	25.10	27.04	25.45	30.35	32.57
Chittoor	34.13	29.66	26.16	29.07	31.78	33.25
Rangareddy	15.11	12.38	12.83	15.28	20.19	22.76
Mahbubnagar	12.77	10.20	9.21	12.35	17.95	19.69
Nalgonda	14.44	26.97	27.74	22.40	34.53	35.65
Total of Drought Districts	15.21	18.53	18.93	18.48	23.07	24.54
Total of Andhra Pradesh	27.50	33.93	35.34	32.17	38.62	39.41

3.1 PERCENTAGE OF GROSS IRRIGATED AREA TO GROSS CROPPED AREA

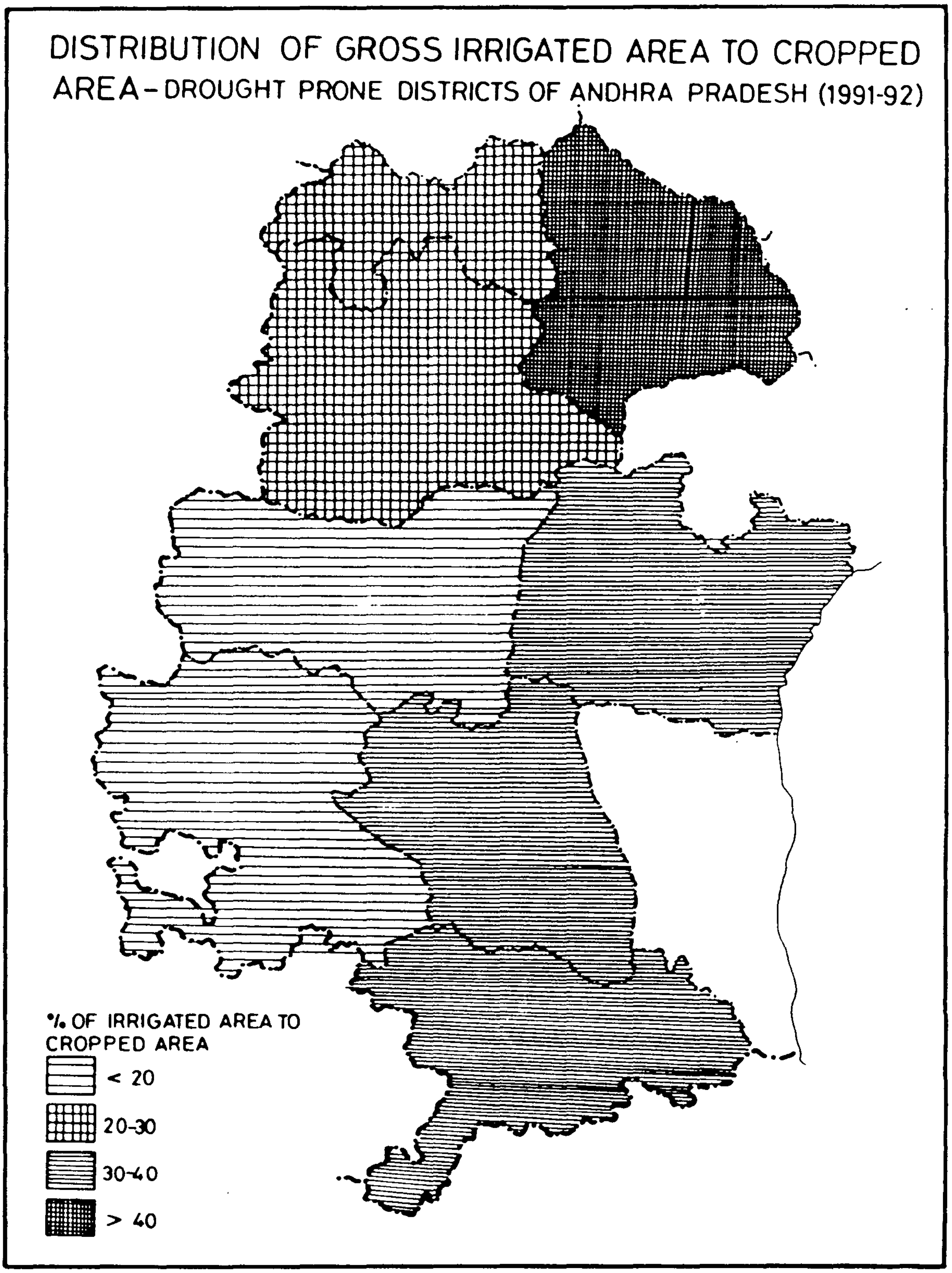
In Andhra Pradesh the percentage growth of gross irrigated area to gross cropped area does not boast of any success stories in the irrigation front except for the increased spatial extension in the non-drought tehsils of the state (i.e. eastern region Chittoor, Cuddapah, Prakasam districts and the whole of Nalgonda except Devarakonda Tehsil). The overall picture at the state level shows an increasing trend from 30.18 percent (1964-65) to 40.73 percent (1991-92).

The scenario of the drought prone districts confirms the growth tendency but from 18.95 percent to 28.53 percent.

Among the eight draught prone districts of Andhra Pradesh, Nalgonda showed a positive growth all along the years of study. Its percentage gross irrigated area to gross cropped area increased from 19.18 percent during the mid sixties to a respectable 45.51 percent by 1991-92. It should be noted that only Devarakonda division in the south-western region of Nalgonda is drought prone. While all the other districts except Kurnool showed an initial decreasing trend during the drought years of the 70's and 80's and then are gradually increasing every year ever since 1985. Nalgonda's success story can be explained by the completion of the Nagarjunasagar Project. The increase of about 7 percent of total irrigated area in the case of Rangareddy between 1988-


DISTRIBUTION OF GROSS IRRIGATED AREA TO GROSS CROP-
-PED AREA-DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH-1964-5
N. A.
% OF IRRIGATED AREA TO
CROPPED AREA
< 20
20-30
30-40
> 40

MAP NO. 24


DISTRIBUTION OF GROSS IRRIGATED AREA TO CROPPED AREA - DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH (1991-92)
% OF IRRIGATED AREA TO CROPPED AREA
< 20
20-30
30-40
> 40

MAP NO. 25

90 is due to the extra privilege given to the district which is in the hierarchical rings of the Agricultural location around Hyderabad the state capital city.

During the last thirty years of study time, the irrigation scenario in the eight drought prone districts abides by the general trend the state except for a decrease of upto 6 percent of irrigated during 65-85 in Rangareddy, Anantpur, Cuddapah and Chittoor. The later two districts were the most effected during these years of sporadic rains and insufficient irrigation, accentuating the effect of drought. Mahbubnagar and Nalgonda showed an increase of above 10 percent and 5 percent respectively during the same time period while all districts showed high percentage increase of crop irrigation between 87-88 and 89-90 Nalgonda had the maximum increase of 13 percent. The Telangana districts showed a comparatively higher increase than Rayalaseema and coastal Andhra. The extra water released from Nagarjunasagar and its canals during these years confirms with this boost of irrigation to the total food and non-food crops in Telangana.

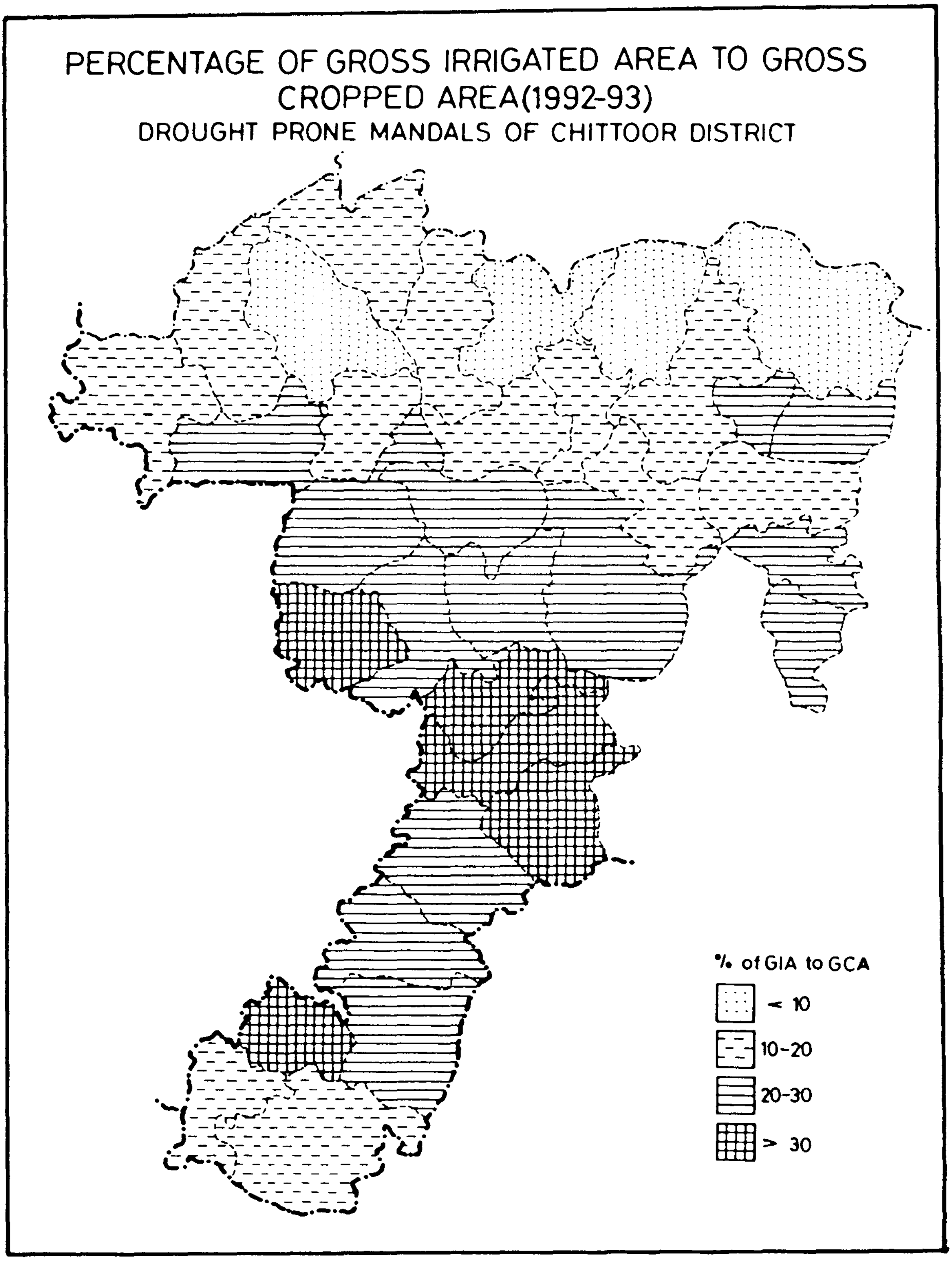
In Anantpur, the gross irrigated area as percentage of gross cropped area was 14.28 percent by the end of 1987 but increased to 18.0 percent by 1992. Chittoor district has the maximum perçentage of crop wise irrigated area of 36.42 percent followed by Cuddapah with 33.8 percent, Nalgonda (30.04 percent) with Prakasam (27.83 percent) See Maps 24 and 25 which give the irrigation scenario of 1964-65 and 1991-92.

The following Table 3.02 shows the percentage of gross irrigated area to the gross cropped area in the eight drought prone districts of Andhra Pradesh.

TABLE 3.02

PERCENTAGE OF GROSS IRRIGATED AREA TO GROSS CROPPED AREA IN ANDHRA PRADESH

DISTRICT	1964-65	1985-86	1986-87	1987-88	1989-90	1991-92
Prakasam	-	27.83	27.05	32.23	33.68	34.95
Kurnool	11.01	13.89	14.74	18.43	18.71	19.10
Anantpur	15.50	14.28	15.83	18.10	15.49	17.87
Cuddapah	31.18	26.77	30.05	32.09	33.47	36.47
Chittoor	42.12	36.42	34.65	36.53	36.01	38.55
Rangareddy	17.19	15.64	18.38	25.51	27.04	27.61
Mahbubnagar	14.54	13.00	14.08	20.74	20.74	23.83
Nalgonda	19.18	30.04	29.68	42.65	44.95	45.51
Total of Drought Districts	18.95	21.17	21.46	26.64	26.75	28.53
Total of Andhra Pradesh	30.18	35.75	35.37	41.14	40.70	40.73


PERCENTAGE OF GROSS IRRIGATED AREA TO GROSS CROPPED AREA(1992-93)
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
% of GIA to GCA
< 10
10-20
20-30
> 30

MAP NO. 26

GROSS IRRIGATED AREA TO GROSS CROPPED AREA IN CHITTOOR DISTRICT

In the Chittoor district the gross irrigated of 1,89,342 hectares is 37.20 percent of the 5,08,861 hectares of gross cropped area. The percentage during kharif is 10.43 percent 4134 hectares of 3,96,204 hectares of gross cropped area. During Rabi it is 70.46 percent 79,382 hectares of the 1,12,656 hectares of gross cropped area during the season. Table 3.03 shows percentage Gross Irrigated Area to Gross Cropped Area of all Mandals in Chittoor 92-93. Among the draught prone Mandals of Chittoor the percentage of gross irrigated area to the gross cropped area varies from one another with the maximum of 36.75 percent in Sodam (2617 hectares of gross irrigated area to 7122 hectares of gross cropped area) during 1992-93. See Table 3.03 for the percentage of gross irrigated area to the gross cropped area in all the 66 mandals of Chittoor. Mandals with serial numbers 36 to 66 have been broadly identified as drought prone with the inclusion of Pulicherla, Pakala and Puthalapattu mandals amongst the others since the percentage irrigated area to the gross cropped area is less than 30 percent

Khambhamvaripalle has the minimum irrigated area of 7.38 percent (938 hectares of gross irrigated area to 12719 hectares of gross cropped area.

The distribution of the percentage of Gross irrigated area to gross cropped area the drought prone mandals of Chittoor is depicted in Map Number. 26.

TABLE 3.03

Percentage of Gross Irrigated Area to Gross Cropped Area in Chittoor Mandal-wise 1992-93

S. No.	MANDAL	% GIA TO GCA	S. No.	MANDAL	% GIA TO GCA
1.	Chittoor	34.15	36.	Madanapalle	28.00
2.	Gudipala	50.18	37.	Nimmanapalle	25.39
3.	Yadamari	44.01	38.	B. Kothakota	21.49
4.	G.D. Nellore	39.43	39.	Kurabalakota	17.34
5.	Penumur	35.40	40.	Thamballapalle	9.36
6.	Puthalapattu	29.86	41.	Peddamandyam	10.96
7.	Bangarupalem	41.73	42.	Molakalacheruvu	15.19
8.	Thavanampalle	48.95	43.	P.T.M.	18.35
9.	Irala	35.67	44.	Vayalpad	14.11
10.	Puttur	59.73	45.	Gurramkonda	14.22
11.	Narayanavanam	85.26	46.	Kalikiri	13.07
12.	Karvetinagaram	60.46	47.	Kalakada	8.53
13.	Vedurukuppam	39.93	48.	Khambhamvaripalle	7.38
14.	Kammapalle	81.09	49.	Piler	15.35
15.	Vadamalapet	62.06	50.	Rompicherla	20.32
16.	Palasamudram	61.30	51.	Chinnagottigallu	22.40
17.	S.R. Puram	48.40	52	Y.V. Palem	9.23
18.	Nagari	82.96	53.	Punganur	28.45
19.	Nindra	83.74	54.	Ramasamudram	31.65
20.	Vijayapuram	83.14	55.	Chowdepalle	25.60
21.	Tirupati (U)	76.27	56.	Peddapanjani	31.67
22.	Tirupati (R)	90.10	57.	Somala	22.22
23.	Chandragiri	68.30	58.	Sodam	17.28
24.	Pakala	29.70	59.	Palamaner	36.75
25.	Pulicherla	15.09	60.	Gangavaram	31.92
26.	Renigunta	90.55	61	Baireddipalli	23.94
27.	Yerpedu	87.03	62	V. Kota	29.49
28.	Srikalahasti	93.39	63.	Ramakuppam	28.92
29.	Thottambedu	85.05	64.	Santhipuram	35.00
30.	KVB Puram	74.03	65.	Kuppam	15.40
31.	B N Kandriga	85.97	66.	Gudupalle	17.45
32.	Varadaiahpalem	90.70			
33.	Satyavedu	68.25			
34.	Nagalapuram	83.72			
35.	Pichatur	83.74			

3.2 SOURCE-WISE IRRIGATION

In 1991-92, the canals irrigated 42 percent of the net area irrigated in Andhra Pradesh, followed by other wells (24.5 percent) and Tanks (21.79 percent). Tube wells contribute to 7.73 percent while other sources cater to the remaining 4 percent.

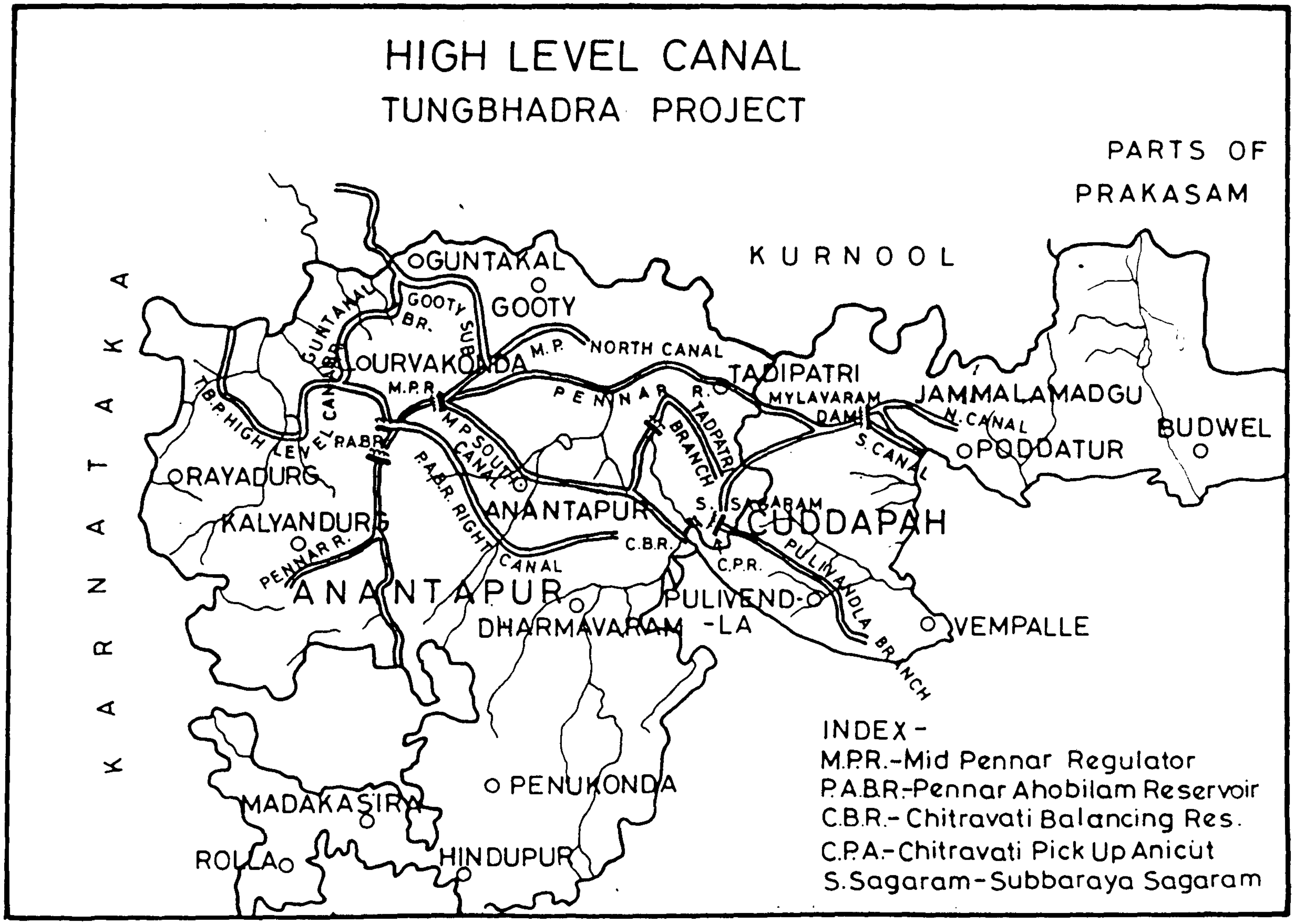
CANAL SYSTEM IRRIGATION

Andhra Pradesh is endowed with many sources of irrigation and is popularly known as the 'River-State'. The important rivers which are harnessed for irrigation include Godavari, Krishna, Pennar, Vamsadhara and Nagavali.

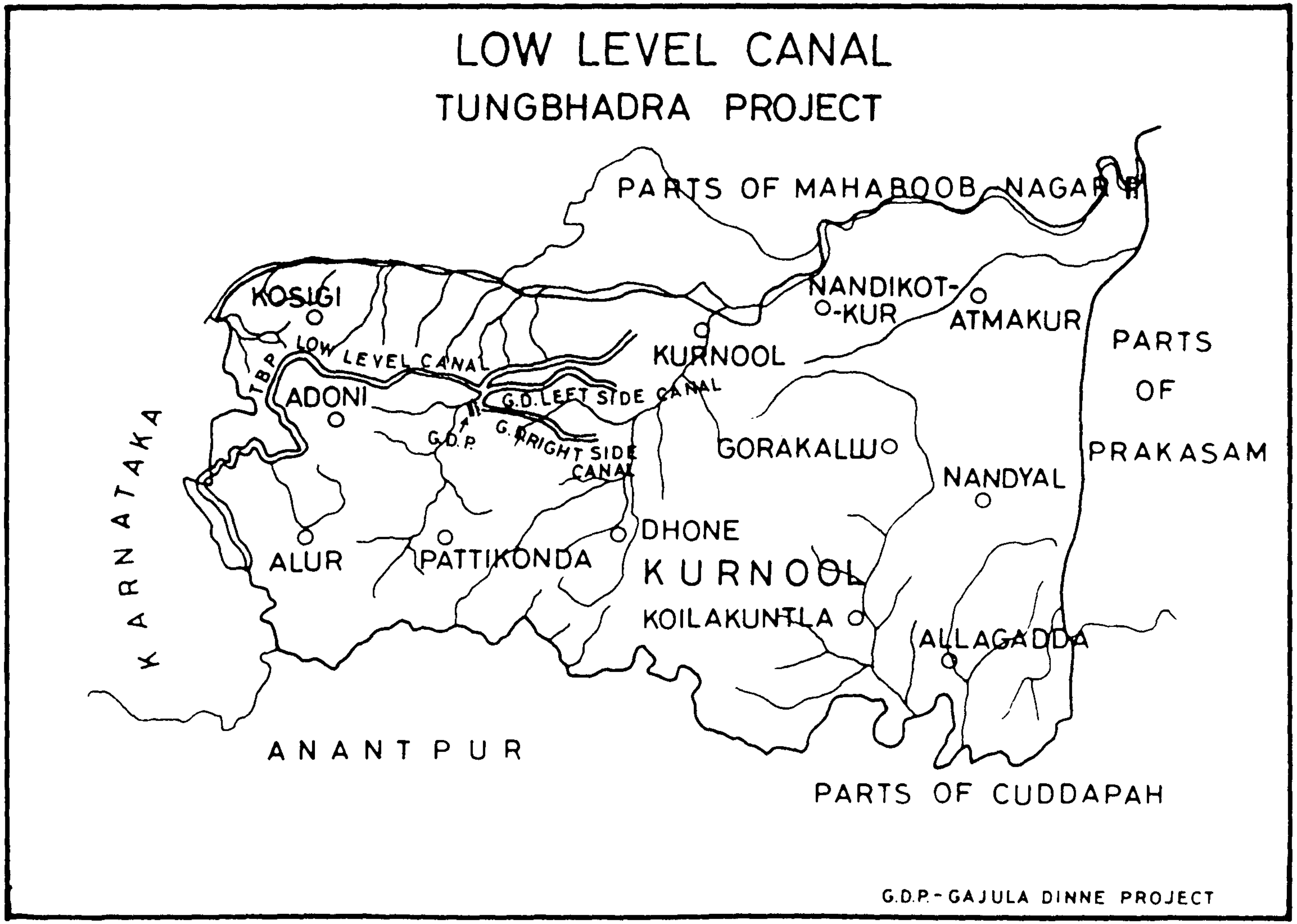
The canal systems of the rivers Godavari, Krishna, The Pennar barrage, Kurnool-Cuddapah Canal (K C Canal) and the river valley projects like Nagarjunasagar, Srisailam, Sriramsagar, Tungabhadra, Musi, Kadam, Nizamsagar are the important life time sources of irrigation.

Nalgonda is irrigated by the project canals of Nagarjunasagar, Dindi and Musi. Mahbubnagar gets its irrigation waters from Srisailam Project, Kakarvani project and Saralsagar project.

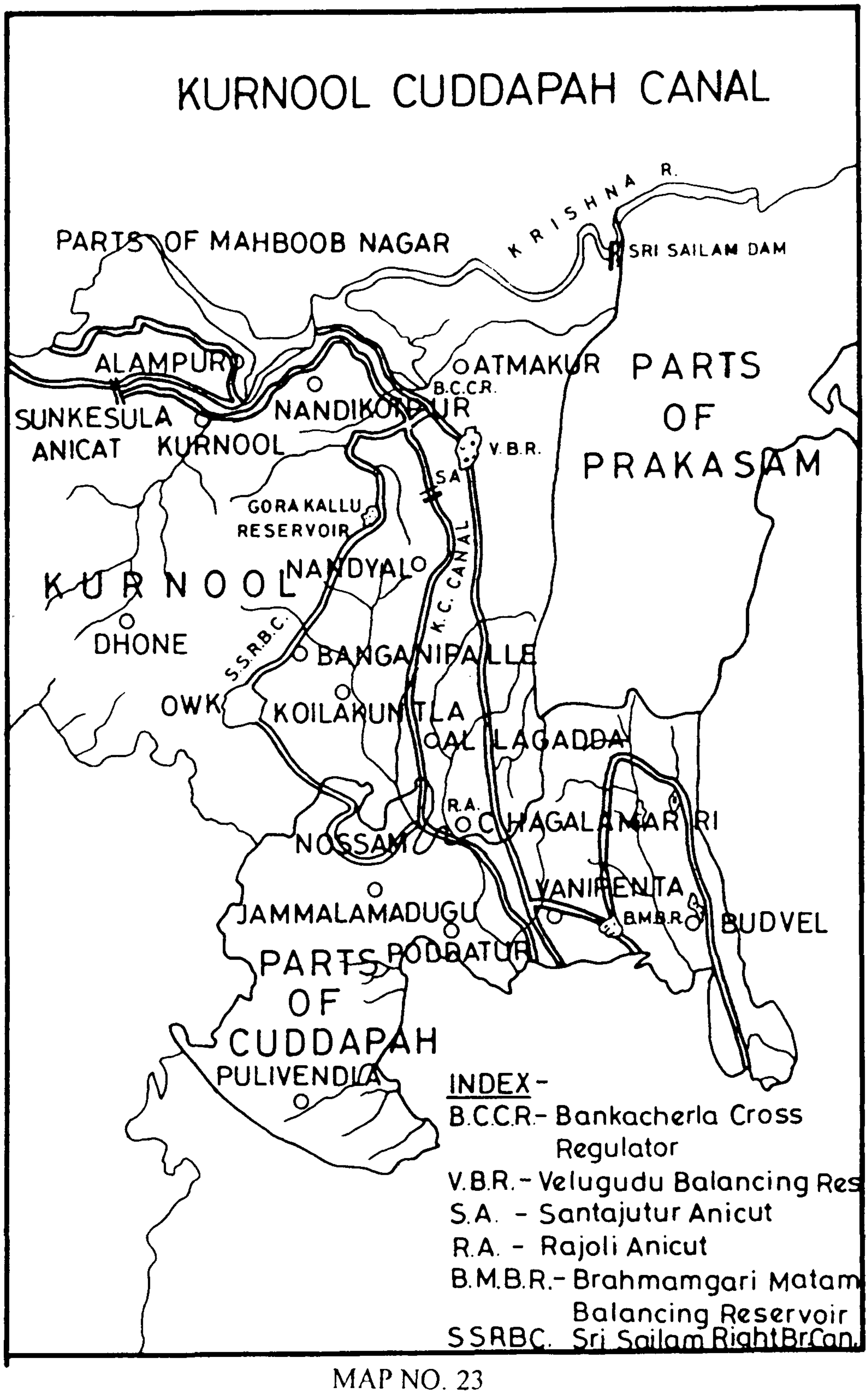
The scarce rainfall zone of Rayalaseema (See Annexure - IV for the Mandals in Scarce Rainfall Zone) occupies an area of 47,659 sq kms constituting 17.4 percent of the states geographical area. This zone lies in the southwest part of Andhra Pradesh extending approximately from 13 degree 6' to 16 degree north latitude and 77 degree to 79 degree 2' east latitude.


HIGH LEVEL CANAL
TUNGBHADRA PROJECT
PARTS OF
PRAKASAM
KURNOOL
KARNATAKA
GUNTAKAL
GOOTY
GOOTY BR.
GOOTY SUB
GUNTAKAL
URVAKONDA
M.P. NORTH CANAL
TADIPATRI
MYLAVARAM DAM
JAMMALAMADGU
N. CANAL
S. CANAL
PODDATUR
BUDWEL
M.P.R.
PENNAR R.
TADPATRI BRANCH
T.B.P. HIGH LEVEL CANAL
RABR
M.P. SOUTH CANAL
P.A.B.R. RIGHT CANAL
RAYADURG
KALYANDURG
ANANTAPUR
S. SAGARAM
CUDDAPAH
C.B.R.
C.P.R.
PULIVANDLA BRANCH
PENNAR R.
ANANTAPUR
PULIVENDLA
DHARMAVARAM
VEMPALLE
INDEX -
M.P.R.-Mid Pennar Regulator
P.A.B.R.-Pennar Ahobilam Reservoir
C.B.R.- Chitravati Balancing Res.
C.P.A.- Chitravati Pick Up Anicut
S.Sagaram - Subbaraya Sagaram
PENUKONDA
MADAKASIRA
ROLLA
HINDUPUR

MAP NO. 21


LOW LEVEL CANAL
TUNGBHADRA PROJECT
PARTS OF MAHABOOB NAGAR
KOSIGI
T.B.P.
LOW LEVEL CANAL
ADONI
G.D. LEFT SIDE CANAL
G.D.P.
G.D. RIGHT SIDE CANAL
KURNOOL
NANDIKOT-KUR
ATMAKUR
PARTS OF PRAKASAM
GORAKALLU
NANDYAL
DHONE
KURNOOL
ALUR
PATTIKONDA
KOILAKUNTLA
ALLAGADDA
KARNATAKA
ANANTPUR
PARTS OF CUDDAPAH
G.D.P. - GAJULA DINNE PROJECT

MAP NO. 22


KURNOOL CUDDAPAH CANAL
KRISHNA R.
PARTS OF MAHBOOB NAGAR
SRI SAILAM DAM
ALAMPUR
ATMAKUR
PARTS OF PRAKASAM
B.C.C.R.
SUNKESULA ANICAT
NANDIKOTKUR
KURNOOL
V.B.R.
S.A.
GORAKALLU RESERVOIR
NANDYAL
K.C. CANAL
KURNOOL
DHONE
S.S.R.B.C.
BANGANIPALLE
OWK
KOILAKUNTLA
ALLAGADDA
R.A.
CHAGALAMARRI
NOSSAM
VANIPENTA
JAMMALAMADUGU
B.M.B.R.
BUDVEL
PARTS OF CUDDAPAH
PRODDATUR
PULIVENDLA
INDEX -
B.C.C.R.- Bankacherla Cross Regulator
V.B.R.- Velugudu Balancing Res
S.A. - Santajutur Anicut
R.A. - Rajoli Anicut
B.M.B.R.- Brahmamgari Matam Balancing Reservoir
SSRBC. Sri Sailam Right Br Can.

MAP NO. 23

Tungabhadra and Pennar are the major irrigation sources in this region.

The following is the list of Projects on these two irrigation systems:

TABLE 3.04

IRRIGATION CANALS IN THE DROUGHT PRONE AREAS

S. No.	Irrigation Canals	District
1.	Tungabhadra Project High level canal	Anantpur & Cuddapah
2.	Tungabhadra Low level canal	Kurnool
3.	Kurnool-Cuddapah Canal	Kurnool & Cuddapah
4.	Upper Bhadra Project	
5.	Pennar Balancing Canal	
6.	Malavaram	Cuddapah
7.	Gajuladinne	Kurnool
8.	Rajolibanda diversion scheme	Mahbubnagar

The first three irrigation systems as given in the Table 3.04 are depicted in the Maps 21, 22 and 23.

The irrigation projects on Pennar basin have been studied under three sub basins: 1.Upper Pennar, 2. Middle Pennar, 3. Lower Pennar.

UPPER PENNAR : Pulivendla channel (major project) is under construction in Pennar sub-basin. Pennar Ahobilam balancing reservoir and Yadiki canal are the proposed two major projects in upper Pennar. In addition there are two medium projects viz. Maddileru and Uttar Pinakini and a few minor schemes in the sub-basin which are identified as future projects.

MIDDLE PENNAR : The existing projects in this area are medium projects Zurreru project on Kurnool near Banganapalle and Chennaraya Swamy Gudi Project in Chittoor district. The ongoing projects are Banakacherla regulator, Velugodu balancing reservoir, Mylavaram dam (Major projects) and Pedderu Project (Medium Project).

LOWER PENNAR : The medium projects which are situated in this sub-basin are 1. Upper Sagileru Project, 2. Lower Sagileru Project, 3. Pincha Project and 4. Bahuda Project.

Tungabhadra Reservoir was built across Tungabhadra river, a few kilometers south of Hospet in Bellary district of Karnataka state. As per the Krishna Water Dispute Tribunal Award (Bachawat Award) the following is the allotment of Andhra Pradesh entitlement for different canals.

TABLE 3.05

WATER ALLOCATION ACCORDING TO KWDT AGREEMENT

Project	Water Allocation as per KWDT Agreement Cu.MM	TMC
Tungabhadra right bank Low level canal	835	29.5
Tungabhadra right bank high level canal Stage I & II	920	32.5
Gajuladinne	57	2.0
Rajolibanda Diversion Scheme	450	15.9
Kurnool Cuddapah Canal	1130	39.9
Minor irrigation	183	6.46
Total	3575	126.26

Source: Technical Study No. WB-65, Tungabhadra Sub-basin, NWDA, New Delhi, Feb.93.

The total utilisable yield in a water year (from 1st June to 31st May) excluding evaporation and seepage losses is therefore 126.26 TMC for Andhra Pradesh which is used to irrigate the drought prone areas of the state. Srisailam Right tank canal and Telugu Ganga canal in Kurnool and Cuddapah district - Maddileru reservoir in Anantpur district are under execution.

The Kurnool Cuddapah canal is the right side canal of Sunkesula Anicut near Kurnool. This canal was aligned for utilising the existing local rivers, Nippulavagu, Galeru, Kundu and Pennar using them as carrier canals. The length of the 22.45 km 78.35 kms and 5.02 km in Kurnool, Cuddapah and Mahbubnagar districts respectively. In Kurnool district 153 villages, in Cuddapah 104 and Mahbubnagar 23 villages are under the service of the canal.

The Tungabhadra High level canal is 74 kms in length and benefits 194 villages and irrigates 35 lakh hectares. Gajuladimme project a medium irrigation project is in Gonegandla Mandal in Kurnool. This project provides irrigation facilities for an extent of 12,960 hectares during rabi season and also intended for protection of kharif crops in its entire ayacut project command Gonagandla, Kodumur, Krishnagiri, Deverakonda Mandals of Kurnool are covered by this project.

The much awaited TELUGU GANGA project to supply drinking water to Madras city from the Srisailam right tank canal will irrigate 2.30 lakh hectares in the drought prone Rayalaseema. As it is, Kurnool's maximum irrigation is from the canals dug from Krishna and Pennar. The Kurnool-Cuddapah canal in the Tungabhadra sub-basin is a major life line to the drought stricken Rayalaseema (Poet SRINADHA called it RATNALASEEMA - the land of gems) canals also have a major share in Prakasam.

Following Table 3.06 gives the medium irrigation projects in Chittoor as on 1992-93.

TABLE 3.06:MEDIUM IRRIGATION PROJECTS IN CHITTOOR 1992-93

S. No.	Name of the Project	Registered Ayacut		Ayacut area Irrigated	
		Acres	Hactares.	Net area	Gross Area
1.	Mallimadugu Project	3950	1598.54	1598.54	1598.54
2.	Kalangi Reservoir	4650	1881.83	1881.83	1881.83
3.	Araniar (K)	5500	2225.82	2225.82	2225.82
	(R)	3600	1456.9	1456.90	1456.90
4.	Swarnamukhi Project	10200	4127.88	4127.88	4127.88
5.	Siddalagandi Project	224	90.65	90.65	90.65
6.	Bahuda Project	2880	1165.52	1165.52	1165.52
7.	Pedderu Project (K)	4300	1740.19	1740.19	1740.19
	(R)			566.57	566.57
8.	Krishnapuram Reservoir	6125	2478.75	2478.75	2478.75
	TOTAL	41429	16766.08	17332.65	17332.65

Source: Executive Engineer (Irrigation Department), Madanapalle, Tirupati.

In the Rayalaseema the percentage area irrigated by canal to the net irrigated area increased from 19.84 percent to 42.22 percent in 1991-92 and thereafter decreased to around 30 percent in the coming years.

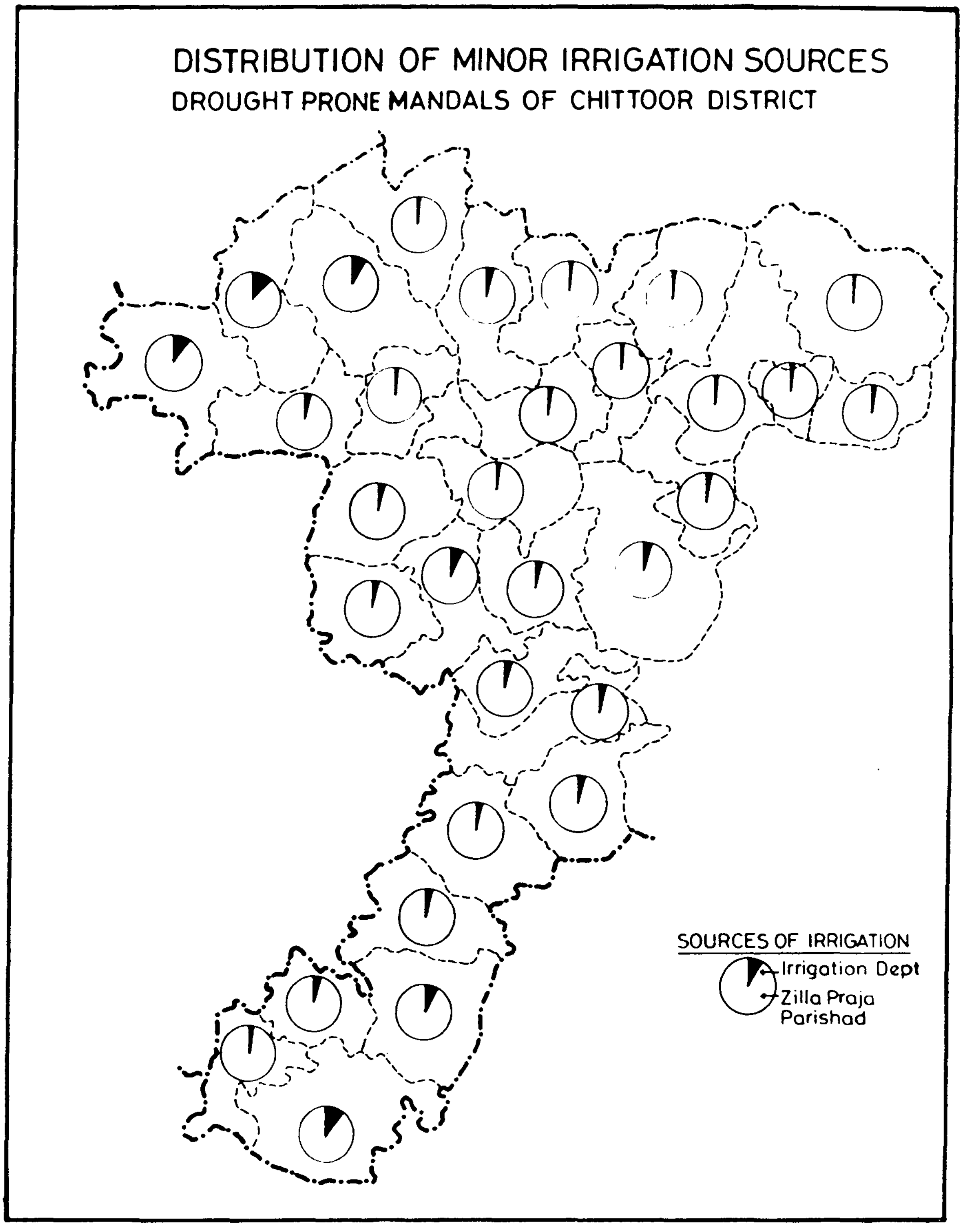
TANK IRRIGATION

In Andhra Pradesh, tank irrigation went into the backdrop from an initial high of 42 percent in 1964-65. it came down sharply to around 22 percent by 1985-86 and since then it is maintaining the same percentage to net irrigated area upto 1991-92.

In Rayalaseema tanks were the main source of irrigation in the 1960s. The percentage of area irrigated by tank to the net irrigated are was 47.74 percent in 1964-65 it came it came down sharply to 10.717 by 1986-87 and later its share increased to 19.01 percent in 1991-92.

In the drought prone districts of Rayalaseema the traditional tank irrigation system has of late came into disuse. The catchment area has come under cultivation and this has increased siltation. Siltation over the years has reduced storage capacity and percolation efficiency of the tanks.

Over the last fifty years, tank irrigation has been supplemented by dug wells and more recently by bore wells. The total quantum of ground water utilised has shown a sharp increase after electric power and pumps become available. In the districts of Telangana and Rayalaseema, overexploitation has reached a stage where dug wells remain dry even during monsoon months and water is at present being mined from borewells drilled at the bottom of dug wells. Artificial recharge of ground water through the construction of


DISTRIBUTION OF MINOR IRRIGATION SOURCES
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
SOURCES OF IRRIGATION
Irrigation Dept
Zilla Praja Parishad

MAP NO. 31

percolation tanks and farm ponds and recharge through well injection is necessary at any cost.

The data of the mandal-wise (31 drought mandals of Chittoor) sources of Minor Irrigation under the control of irrigation Department and Zilla Praja Parishad as on March 31, 1993 has been utilized to examine the irrigation scenario at the micro level. The numbers of sources of irrigation (Lakes, embankments, check dams etc.) in each mandal and the corresponding irrigated area - AYACUT has been studied.

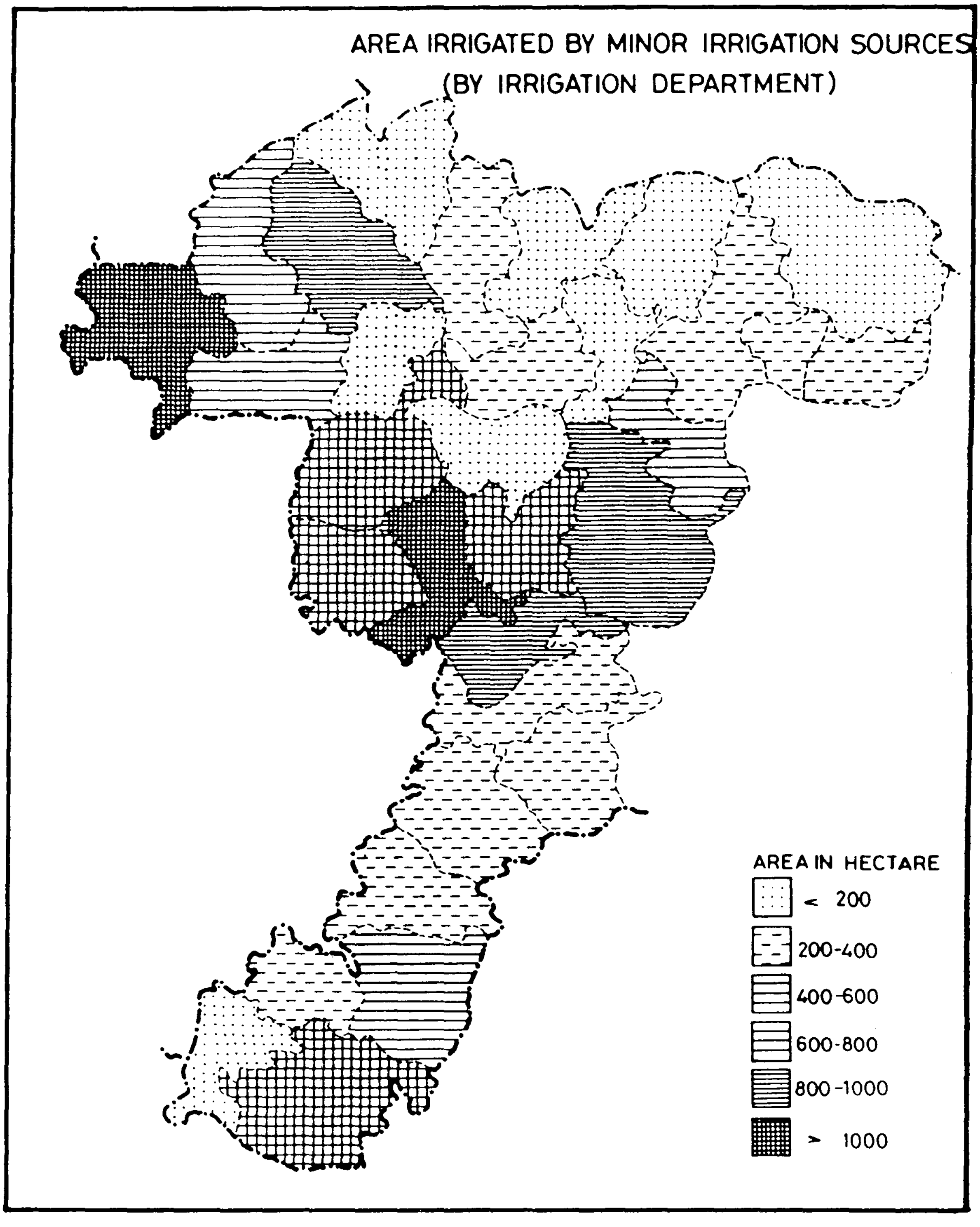
In Chittoor there are 765 minor irrigation sources under Irrigation department and 8049 under Zilla Praja Parishad. Their corresponding Ayacut areas are 58169 Hectares and 61242 hectares. In the Draught Prone Mandals, the Irrigation Department controls 177 and ZPP 5687 minor irrigation sources respectively. The irrigated area of 14264 hectares (24.52 percent of 58169 hectares) is under irrigation department and 33866 hectares (55.30 percent of 61242 hectares) is under the control and maintenance of the local government of ZPP.

The Ayacut area in the drought prone mandals of Chittoor under the Irrigation Department and Zilla Praja Parishad are given in Table 3.07 and the number of sources under the two have been depicted as circle and sector diagrams in the Map Number 31.

TABLE 3.07 : MINOR IRRIGATION IN CHITTOOR AS ON 31.3.93

Drought Prone Mandals in Chittoor Districts	Irrigation Department		Zilla Praja Parishad	
	No. of Sources	Ayacut in Hectares	No. of Sources	Ayacut in Hectares
Madanapalli	8	726.02	201	1475.95
Nimmanapalli	2	179.28	101	1159.48
B. Kothakota	6	545.53	168	1201.24
Kurabalakota	3	158.24	177	899.43
Thamballapalle	12	864.43	135	585.11
Peddamandyam	1	60.70	181	860.86
Molakalacheruvu	8	569.81	125	888.56
Pedatippasamudrum	7	2049.37	106	875.10
Voyalpad	4	269.93	168	1217.93
Gurramkonda	6	358.15	172	860.62
Kalikiri	1	47.75	200	615.10
Kalakada	2	65.56	176	967.38
Kambamvaripalle	3	142.86	270	1201.91
Piler	3	322.95	256	1128.54
Rompicherla	3	204.37	176	880.17
Chinnagottigallu	3	259.41	184	1029.41
Yerravaripalem	1	77.70	251	1081.36
Punganur	14	1099.96	192	1680.76
Ramasamudrum	8	665.32	169	1279.60
Chowdepalle	9	738.16	277	1533.34
Peddapanjani	9	872.12	272	1909.32
Somala	9	898.83	241	1043.51
Sodam	5	415.22	348	1781.67
Palamner	5	257.79	121	914.63
Gangavaram	5	358.96	157	1747.48
Baireddipalle	5	300.69	157	1117.75
Ramakuppam	7	414.81	100	321.71
Santhipuram	6	354.51	138	965.68
Kuppam	13	650.34	115	578.37
Gudupalle	3	92.27	163	733.26
Total of Drought Mandals	177	14263.86	5687	33865.70
Chittoor District - 66 Mandals	765	58169.16	8049	61242.23

Source: Executive Engineer (Irrigation Department), Madanapalle, Tirupati
Executive Engineer (Panchayat Raj), Madanapalle, Tirupati.


AREA IRRIGATED BY MINOR IRRIGATION SOURCES
(BY IRRIGATION DEPARTMENT)
AREA IN HECTARE
< 200
200-400
400-600
600-800
800-1000
> 1000

MAP NO. 32

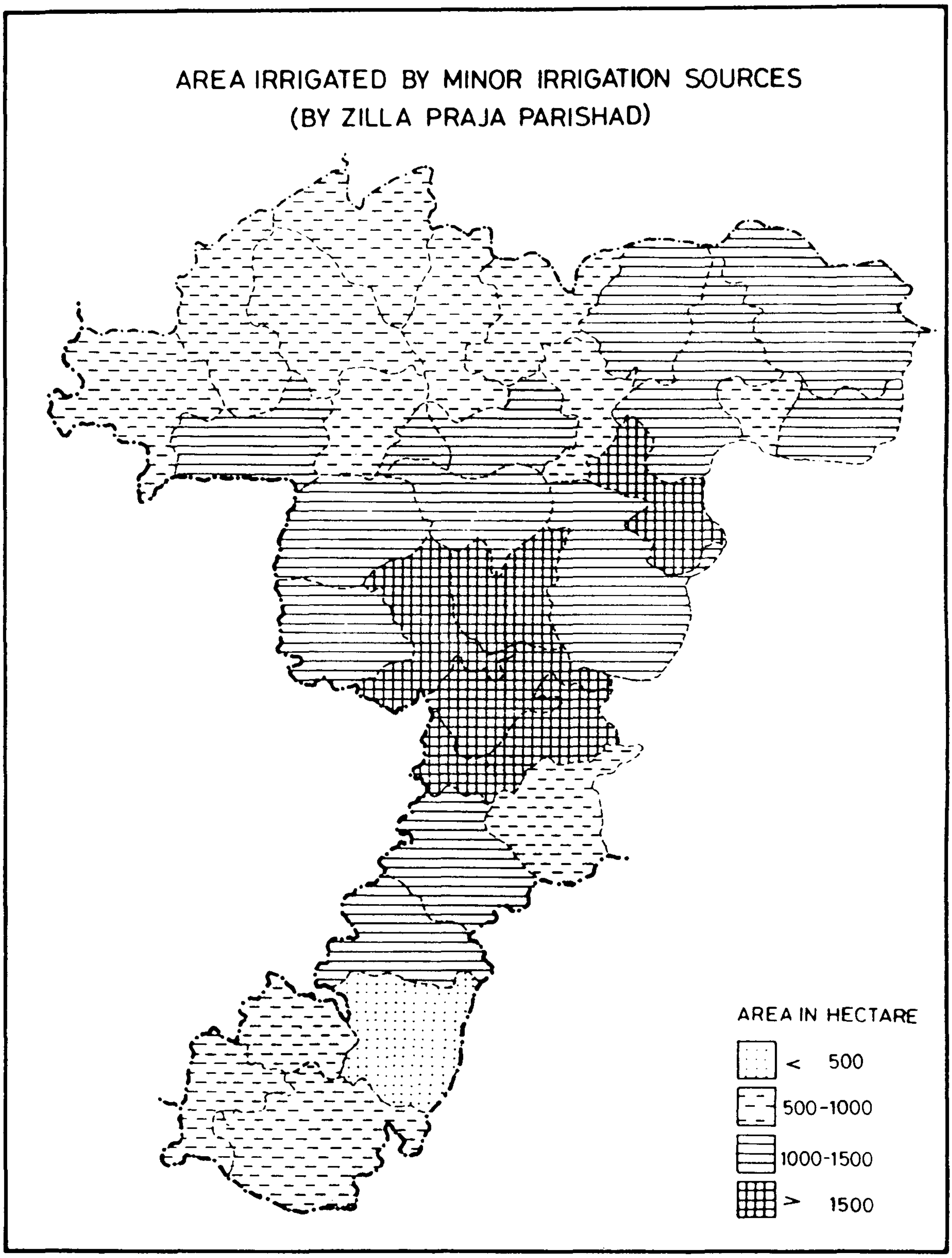
IRRIGATION DEPARTMENT

The irrigated area from the total number of sources in each mandal varies from one another Thamballapalli (12 minor sources) has the maximum irrigated ayacut of 864 hectares (71.30 percent of the gross irrigated area of 1212 hectares), where as Kalikiri has 48 hectares under one source (4.29 percent of 1112 hectares). Peddatippasamudram, Somala Chowdepalli and Kuppam has a better irrigated area-ayacut than the other mandals. Their ayacut percentage is between 40 percent to 60 percent the gross irrigated area. See Map Number 32 for distribution of area irrigated by minor irrigation sources (I.D.) in the drought prone mandals of Chittoor.

ZILLA PRAJA PARISHAD

Sodam has 348 minor sources having an Ayacut of 1782 hectares. Kalikiri and Kambhamvaripalle also have an ayacut area of 764 hectares and 938 hectares respectively. Yeravanipalem has 251 sources with an ayacut of 1082 hectares. Ayacut in all the mandals have a high proportion of more than 40 percent of the gross irrigated area. The only exception being Ramakuppam whose 100 sources have an ayacut of 322 hectares (14.20 percent of 2265 hectares of gross irrigated area).

In the drought prone mandals of Chittoor the ZPP's minor irrigation sources of Yerravaripalem is just 3.19 percent of the total ayacut area of 33866 hectares in the region while Punganur with 1681 hectares from 192 sources has


AREA IRRIGATED BY MINOR IRRIGATION SOURCES
(BY ZILLA PRAJA PARISHAD)
AREA IN HECTARE
< 500
500-1000
1000-1500
> 1500

MAP NO. 33

a percentage of 4.96 to the total ayacut in the drought prone region. See Map Number 33 for distribution of area irrigated by minor irrigation sources (Z.P.P.) in the drought prone mandals of Chittoor.

PERCENTAGE SOURCE-WISE IRRIGATION TO NET IRRIGATED AREA

The different sources of irrigation of the drought prone districts are considered separately for the study. They have been summed up to enable us to make an overall analysis of the trends in the source-wise irrigation.

For the areal extent under each source, the percentage of the land irrigated under the different sources to the net irrigated area is calculated for the years 1964-65 and from 1985-86 to 1991-92.

The percentage area irrigated by canals increased from 19.84 percent in 1964-65 to 42.22 percent in 1986-87 and thereafter decreased sharply by 30 percent during the next two years. It was 28.37 percent in 1991-92.

The most important source of irrigation in Rayalaseema is wells and tube wells. The percentage of net irrigated area served by well has increased from 27.01 percent in 1964-65 to 40.96 percent in 1991-92. The tube wells are gaining popularity. Tube well irrigation was insignificant in 1960s but its share in the net irrigated area has risen to 7.46 percent in 1991-92. In view of the dependence in well and tube well for irrigation in the drought prone areas, it is necessary to systematically evaluate the ground water resources.

WELLS

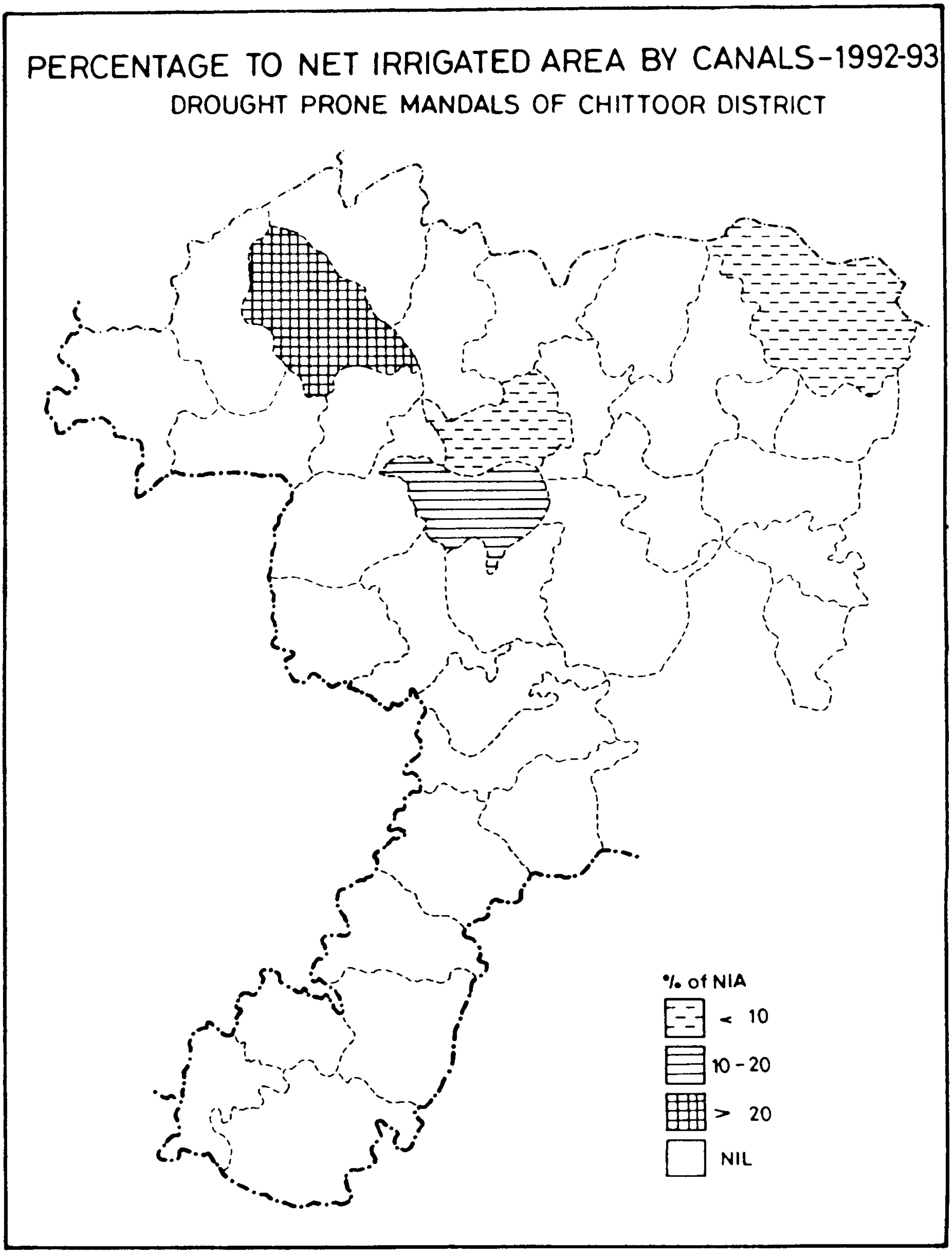
The geology and structure of drought prone districts has to be thoroughly studied and interpreted to identify the lineaments - the most probable source of springs and ground water. The appraisal will go a long way hand in hand with the water resources survey to develop a secure irrigation system. An integrated remote sensing based study for ground water development is a must in every district.

Remote sensing application in the areas of ground water have been put to use in the following areas based on the need:

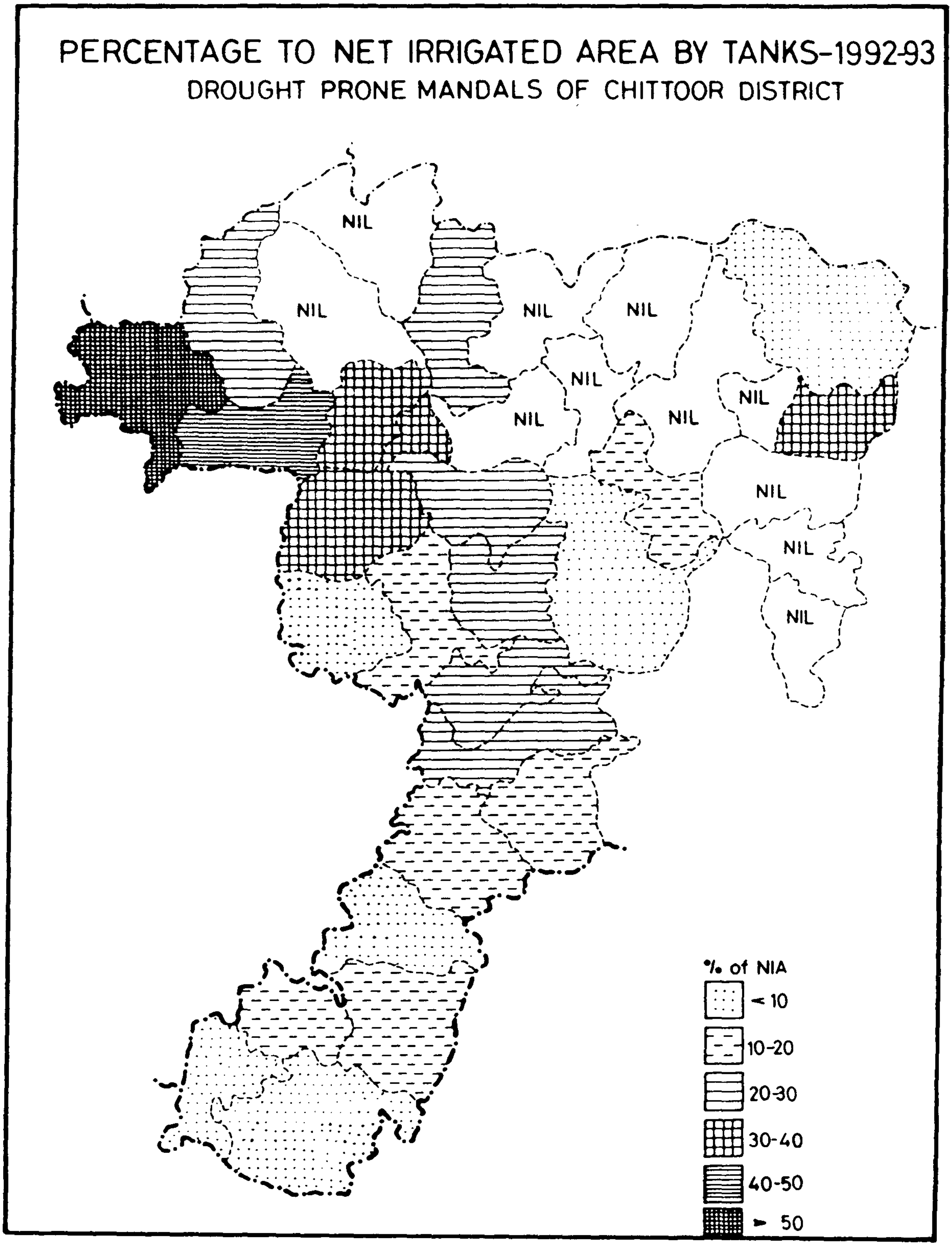
1. Hydrogeomorphological Mapping (GW Prospect Zones).
2. Potential zones for artificial GW Recharge.
3 Ground Water development areas identification.
4. Urban and rural water supply.

   (Rajiv Gandhi Drinking Water Technology Mission).
5. Ground water pollution.

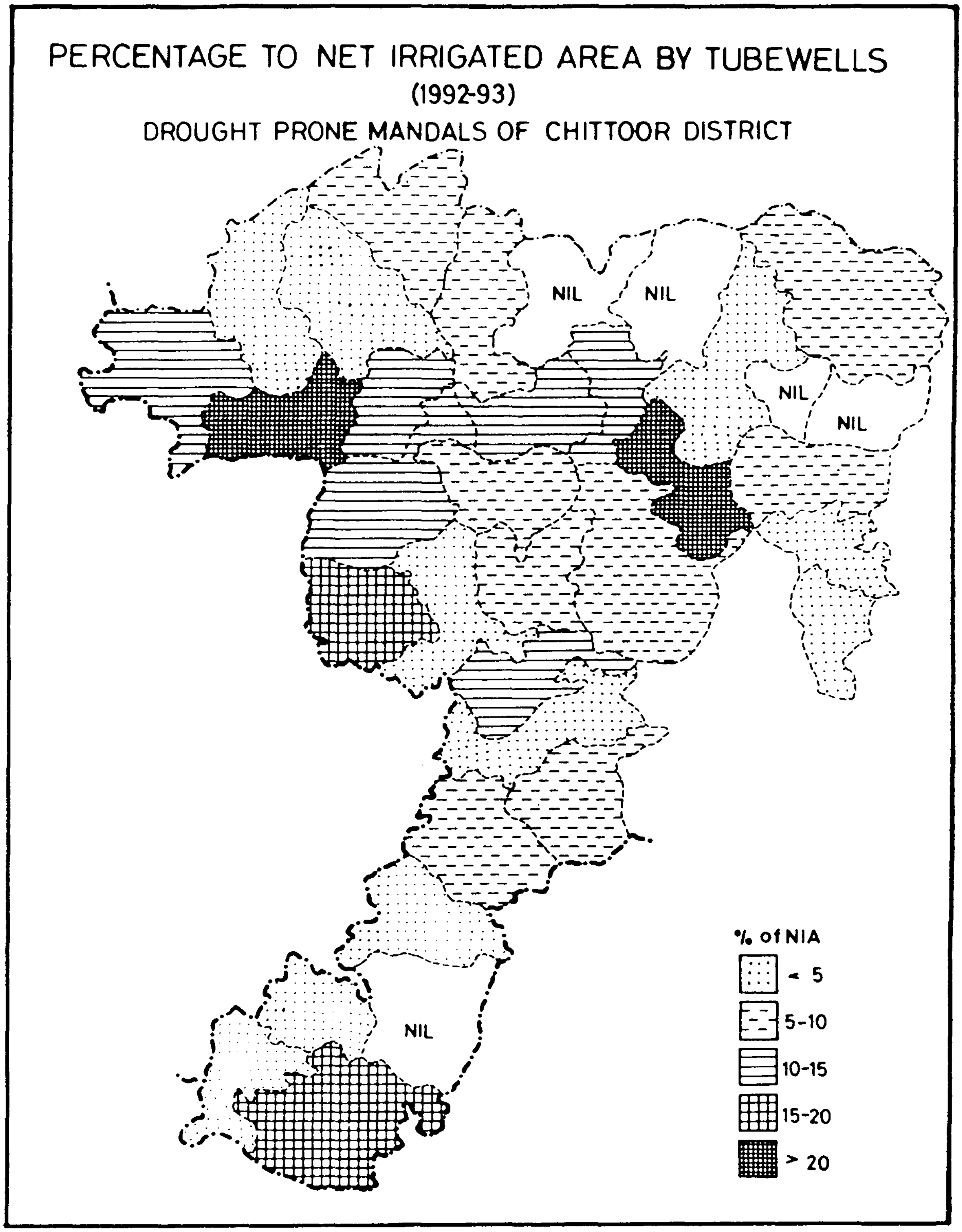
R.S. Rao (Director, Andhra Pradesh State Remote Sensing Applications Centre) in a regional seminar on applications of remote sensing techniques to landuse planning and environmental surveying 21-27 Oct 1991, Karachi, Pakistan, presented a pilot integrated study using remote sensing techniques for combating drought using natural resources and other socio-economic data from conventional techniques.


PERCENTAGE TO NET IRRIGATED AREA BY CANALS-1992-93
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
% of NIA
< 10
10 - 20
> 20
NIL

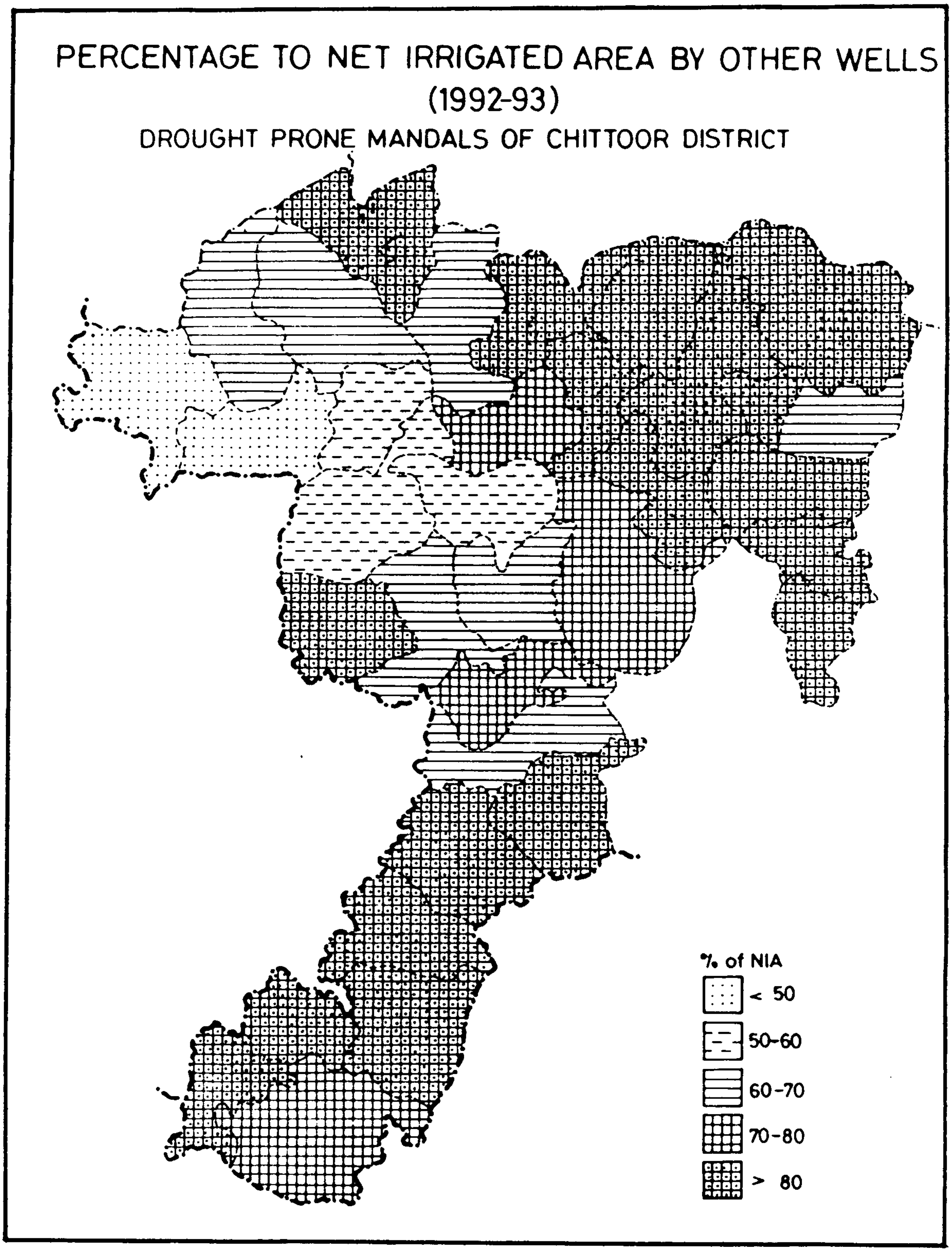
MAP NO. 27


PERCENTAGE TO NET IRRIGATED AREA BY TANKS-1992-93
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
% of NIA
< 10
10-20
20-30
30-40
40-50
> 50

MAP NO. 28


PERCENTAGE TO NET IRRIGATED AREA BY TUBEWELLS
(1992-93)
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
NIL
NIL
NIL
NIL
NIL
% of NIA
< 5
5-10
10-15
15-20
> 20

MAP NO. 29


PERCENTAGE TO NET IRRIGATED AREA BY OTHER WELLS
(1992-93)
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
% of NIA
< 50
50-60
60-70
70-80
> 80

MAP NO. 30

The total Ground Water potential in the state is estimated to be 4.1 million hectare meters, out of which the present exploitation is 0.98 million hectare meters, through dug wells and filter points mainly in the river basins. The left over balance of 3.12 million hectare meters of exploitable ground water potential can bring at least another 2 million hectares under assured irrigation, subject to availability of power.

The scenario of the state under the tubewells is having a continuous upward trend. Cuddapah district shows a significant increase in the number to Tube Wells. In the irrigation by the number of pumpsets and tubewells which are energised Chittoor leads the eight districts with 11.78 percent (68585 of 582197 in the state, 1989) followed by Nalgonda and Anantpur with 9.1 percent and 6.77 percent while the state percentage in the energised pumpsets and tubewells is 11.3 percent of the all India total. Since the start of the 1980's Prakasam is showing a steady increase in the other wells category. In the overall scenario, in Anantpur, wells are the principals source of irrigation with more than 50 percent of the net irrigated area canals and tanks come in second and third positions.

The distribution of the percentage of source-wise irrigated area to the net irrigated area in the drought prone mandals of Chittoor district in 1992-93 of the 4 important sources, that is canals, tanks, tube wells and other wells have been shown in the Map Numbers 27 to 30.

PERCENTAGE OF CROP AREA IRRIGATED TO THE TOTAL IRRIGATED AREA

The crop wise irrigation in the state varies from 100 percent in sugarcane, 96.6 percent in turmeric, 92.5 percent in rice, 58.9 percent in chillies to 9.6 percent in pearl millets (Bajra). The total irrigated area under the crops as percentage of gross irrigated area shows 73.6 percent under rice, 6.5 percent under groundnut and 3.8 percent under sugarcane. The irrigated area under sugarcane crop was 13.7 percent of the total gross area irrigated.

A large part of irrigated are is under food crops. In the drought prone areas of Andhra Pradesh the percentage of gross irrigated area under food crops was 93.56 percent in 1964-65 and 73.53 percent in 1991-92. Thus there is a decrease in the share of food crops in the total irrigated area correspondingly the share of non food crops irrigated has been increasing from 6.44 percent in 1964-65 to 26.45 percent.

All the drought prone districts had more than 90 percent of the food irrigated area under food crops in 1964-65 while in 1991-92 only Rangareddy and Mahbubnagar maintained the same of share, the other districts experienced a shift in irrigated area to food crops. The largest decline in share is noticed in Kurnool and Anantpur districts. In these districts around 57 percent of the irrigated area is under food crops in 1991-92.

TABLE 3.08

PERCENTAGE IRRIGATED AREA IN DROUGHT PRONE AREA

YEAR	FOOD CROPS	NON FOOD CROPS
1964-65	93.56	6.44
1985-86	79.01	20.99
1987-88	74.24	25.76
1989-90	78.78	21.22
1990-91	75.13	24.87
1991-92	73.53	26.47

There is a corresponding increase in the share of non-food crops irrigated in these districts.

Among the food crops irrigated a large percentage more than 50 percent is under rice. In Nalgonda district 85 percent of the gross irrigated area is under rice. Kurnool and Anantpur has 37 percent and 33 percent respectively of the gross irrigated area under rice.

The next important crop irrigated in ground nut. Except in Prakasam, Rangareddy and Nalgonda in all other districts more than 25 percent of the irrigated areas under ground nut, sugarcane is an important irrigated crop in Chittoor District.

TOTAL FOOD CROPS						
	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	90.46	80.30	84.90	83.91	83.01
Kurnool	83.67	63.20	58.24	60.37	54.93	57.78
Anantpur	95.23	63.79	63.77	69.00	59.47	57.63
Cuddapah	93.61	79.37	67.46	70.60	67.45	62.12
Chittoor	92.76	79.00	72.52	75.70	73.55	74.47
Rangareddy	96.85	91.00	88.91	90.34	89.12	89.65
Mahbubnagar	95.28	61.49	69.17	77.38	69.59	70.19
Nalgonda	98.51	93.18	92.02	93.68	92.46	91.82
A.P.	96.28	89.34	86.63	88.46	86.36	85.04
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	40.14	36.20	44.27	48.46	53.40
Kurnool	13.67	13.59	14.10	21.39	21.37	25.45
Anantpur	21.95	25.34	29.13	48.76	45.47	49.06
Cuddapah	41.86	39.69	38.33	53.26	56.18	66.11
Chittoor	56.00	58.35	56.90	64.40	62.69	66.83
Rangareddy	20.23	17.00	19.47	28.37	29.48	30.98
Mahbubnagar	17.48	11.70	14.20	24.57	22.92	24.20
Nalgonda	24.91	39.76	39.19	57.82	61.20	63.06
A.P.	36.59	44.23	43.67	52.70	52.39	53.46
TOTAL NON-FOOD CROPS						
	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	9.54	19.70	15.10	16.90	16.99
Kurnool	16.33	36.81	41.76	39.63	45.07	48.22
Anantpur	4.77	36.21	36.23	30.99	40.52	42.37
Cuddapah	6.39	20.63	32.54	29.40	32.55	37.88
Chittoor	7.24	21.00	27.48	24.29	26.45	25.53
Rangareddy	3.15	9.00	11.09	9.66	10.88	10.37
Mahbubnagar	4.72	38.51	30.83	22.62	30.41	29.79
Nalgonda	1.49	6.82	7.98	6.32	7.54	8.18
A.P.	3.72	10.66	13.35	11.54	13.64	15.06
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	7.12	13.33	12.74	13.01	13.00
Kurnool	5.52	14.44	15.73	15.22	16.25	15.07
Anantpur	2.26	8.06	5.74	7.56	7.87	9.59
Cuddapah	6.58	11.88	20.76	16.42	18.21	21.02
Chittoor	10.08	15.09	17.05	15.56	16.49	17.25
Rangareddy	3.06	8.64	12.70	13.16	16.12	14.25
Mahbubnagar	3.31	15.82	13.83	13.52	17.02	17.66
Nalgonda	1.18	6.92	7.81	8.73	10.56	11.03
A.P.	5.45	13.71	15.82	15.34	16.87	17.41

TABLE 3.09

RICE

	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	60.01	51.06	60.05	61.31	61.97
Kurnool	65.48	47.51	40.75	39.90	39.06	37.12
Anantpur	57.77	26.90	31.79	43.51	29.84	33.47
Cuddapah	56.24	47.02	44.58	44.83	48.55	43.79
Chittoor	71.37	54.58	47.84	50.56	48.58	52.58
Rangareddy	78.24	58.44	59.59	64.59	62.66	61.92
Mahbubnagar	92.67	55.19	62.26	72.32	64.40	65.23
Nalgonda	97.37	90.19	83.91	87.56	85.87	85.05
A.P.	82.55	74.92	71.37	73.67	71.32	69.53
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	99.26	97.23	-	99.09	99.31
Kurnool	89.95	88.46	92.25	-	91.11	92.07
Anantpur	96.42	99.87	100.00	-	99.85	99.90
Cuddapah	96.80	99.48	99.80	-	99.66	99.95
Chittoor	92.10	91.33	93.77	-	93.73	94.63
Rangareddy	83.32	87.93	94.06	-	94.70	94.46
Mahbubnagar	89.96	90.64	95.83	-	95.97	96.06
Nalgonda	99.85	100.00	99.99	-	100.00	100.00
A.P.	91.85	94.12	95.69	-	94.90	94.90

BAJRA

	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	10.56	9.54	7.97	7.38	6.82
Kurnool	2.34	0.06	0.02	0.70	0.06	0.16
Anantpur	0.04	0.91	0.49	0.32	0.16	0.20
Cuddapah	8.04	4.37	4.72	3.49	2.84	2.58
Chittoor	2.65	1.07	1.38	1.08	1.20	0.75
Rangareddy	-	0.02	0.06	-	0.01	0.01
Mahbubnagar	-	0.02	0.01	-	-	0.02
Nalgonda	-	-	-	-	-	-
A.P.	1.31	0.80	0.74	0.61	0.58	0.56
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	0.52	46.23	-	50.44	50.56
Kurnool	9.46	0.24	0.11	-	0.43	1.78
Anantpur	0.07	3.89	2.62	-	3.69	7.19
Cuddapah	37.06	59.29	73.82	-	50.85	74.48
Chittoor	15.83	17.50	24.63	-	37.40	32.39
Rangareddy	-	0.24	0.97	-	0.24	0.03
Mahbubnagar	-	0.07	0.03	-	0.02	2.94
Nalgonda	-	-	-	-	0.00	0.01
A.P.	8.45	9.70	10.21	-	13.54	15.58

TABLE 3.10

RAGI						
	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	10.79	10.36	1.36	4.90	3.93
Kurnool	5.14	0.01	0.02	-	-	0.01
Anantpur	20.85	12.87	9.64	0.32	7.56	5.79
Cuddapah	12.33	3.77	2.99	0.69	2.07	0.81
Chittoor	8.07	5.53	3.89	0.33	3.18	2.53
Rangareddy	0.09	0.11	0.07	0.53	0.04	0.17
Mahbubnagar	1.26	0.89	0.77	0.26	0.64	0.44
Nalgonda	0.07	0.02	0.01	-	-	-
A.P.	0.33	1.52	1.38	-	0.89	0.77
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	91.30	99.19	-	95.05	95.00
Kurnool	82.08	100.00	43.39	-	10.34	4.34
Anantpur	83.13	96.09	92.53	-	94.66	90.35
Cuddapah	96.22	99.92	97.70	-	99.83	100.00
Chittoor	29.22	33.51	25.41	-	32.03	34.04
Rangareddy	82.08	0.47	0.55	-	0.46	1.74
Mahbubnagar	0.49	0.21	0.28	-	4.24	4.18
Nalgonda	0.41	0.37	100.00	-	0.00	-
A.P.	37.66	30.98	34.15	-	29.06	28.36
GROUNDNUT						
	1964-65	1985-86	1987-88	1989-90	1990-91	1991-92
PERCENTAGE OF CROP AREA IRRIGATED TO GROSS IRRIGATED AREA						
Prakasam	-	5.21	17.56	12.06	11.73	11.98
Kurnool	13.84	25.09	29.01	21.53	24.37	26.48
Anantpur	3.57	20.63	22.51	19.64	23.18	24.60
Cuddapah	2.82	14.48	28.33	22.53	26.45	29.28
Chittoor	6.21	17.89	23.42	19.20	21.25	10.80
Rangareddy	0.31	0.06	4.88	5.63	6.68	5.92
Mahbubnagar	4.47	32.85	24.99	18.88	26.71	25.76
Nalgonda	1.30	4.35	7.46	5.99	7.20	7.63
A.P.	3.00	6.51	9.46	4.29	8.81	9.49
PERCENTAGE OF CROP AREA IRRIGATED TO TOTAL AREA UNDER THE CROP						
Prakasam	-	38.03	44.22	36.60	36.41	36.87
Kurnool	10.04	17.37	19.39	13.65	15.03	15.07
Anantpur	2.44	4.96	5.87	5.08	4.80	6.08
Cuddapah	3.54	9.00	18.95	13.29	16.26	18.06
Chittoor	9.07	13.47	15.24	13.00	14.01	14.72
Rangareddy	3.52	28.93	46.25	57.17	66.23	60.54
Mahbubnagar	6.76	22.52	24.07	21.63	28.25	29.50
Nalgonda	3.36	21.12	29.87	30.00	33.49	33.83
A.P.	7.06	16.96	21.27	17.36	19.76	20.56
			TABLE 3.11			

3.3 PERCENTAGE OF CROP AREA IRRIGATED TO THE TOTAL AREA UNDER EACH CROP

Rice is the predominantly irrigated crop. Almost the entire rice area is irrigated. Next in importance is Bajra in the percentage of area irrigated under Bajra is more than 50 percent in Prakasam district and 75 percent in Cuddapah district. The other districts have very less percentage area of Bajra irrigated among non food crop groundnut is well irrigated. Nearly 30 percent of the groundnut area is irrigated in most of the districts.

The Tables 3.09, 3.10 and 3.11 give the percentage of crop area irrigated to gross irrigated area and the percentage of crop area irrigated to total area under the crop for total Food crops, total non-Food crops, Rice, Bajra, Ragi and Groundnut.

CROP-WISE IRRIGATED AREA IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

All through the years of the study, the study, the percentage of irrigated area under Rice to the total irrigated area has been decreasing from 75 percent of 32,49,487 hectares to the total irrigated crop area of 43,37,391 hectares in 1985-86 in the 69.53 percent 37,35,714 hectares of the total of 53,72,180 hectares of irrigated area in 1991-92. This crop gets the major share of irrigation due to its priority as staple food. Nalgonda and Mahbubnagar of Telangana show the highest irrigated area under the crop with around 85-90 percent Nalgonda showed a decreasing tendency from 97.37 percent during the 1960's to 85.05 percent.

Chittoor with 11.37 percent of irrigated area 1,04,187 hectares under rice has showed a decreasing trend upto 52.58 percent. This can be seen in the perspective of increased importance being given to groundnut cultivation. A similar trend is observed in all the other districts as for the irrigation. The irrigated area under Rice has stayed stagnant at around 7 percent in Kurnool and 6 percent in Anantpur, Cuddapah 15 percent highlighting the worst scenario of rainfed farming. The majority of farmers have to depend on rains which are scarce for their crop.

The area of the crops irrigated has been showing a gradual increase with 89-90 sharing a high percentage of 9.7 of 17,092 hectares to 174,781 hectares of gross irrigated area. In the rest of the districts the pattern is the same all through the years of study, i.e. about 30 percent irrigated area. The Rayalaseema districts are definitely in a well off position than the Telangana districts where less importance is given to Sorghum, Bajra is a preferred crop comparatively with Prakasam having 80 percent of irrigated area i.e. 17,079 hectare to 2,14,265 hectares (during 1989-90). In 1990-91 Prakasam had 11,110 hectares of Pearl Millet-Ragi i.e. 4.90 percent of the 2,26,529 hectares of gross irrigated area. Cuddapah of Rayalaseema covers second with 2.58

percent and 0.94 percent respectively. The Telangana districts have less of Bajra cultivation.

All through the time scale, Maize has been the forte of Rangareddy which in 1991-92 had 0.74 percent of the irrigated area 664 hectares of irrigated crop out of 91512 hectares of gross irrigated area. Though it is a decreasing trend from 1.03 percent in 89-90. The crops irrigated area to the total cropped area is high in Rangareddy which Kurnool is sharing a tremendous progress in Maize cultivation with 0.22 percent of cropped area under irrigation.

Prakasam had a high irrigated area of Ragi-Finger Millet during 85-88 of about 10.78 percent of 19,364 hectares of the 1,79,531 hectares of gross irrigated area (1985-86) during these years. During the later years Anantpur showed the respective areas of 5.79 percent and has been maintaining the lead among all districts. Occasionally Chittoor and Cuddapah showed same spurts of increased areas in the irrigated.

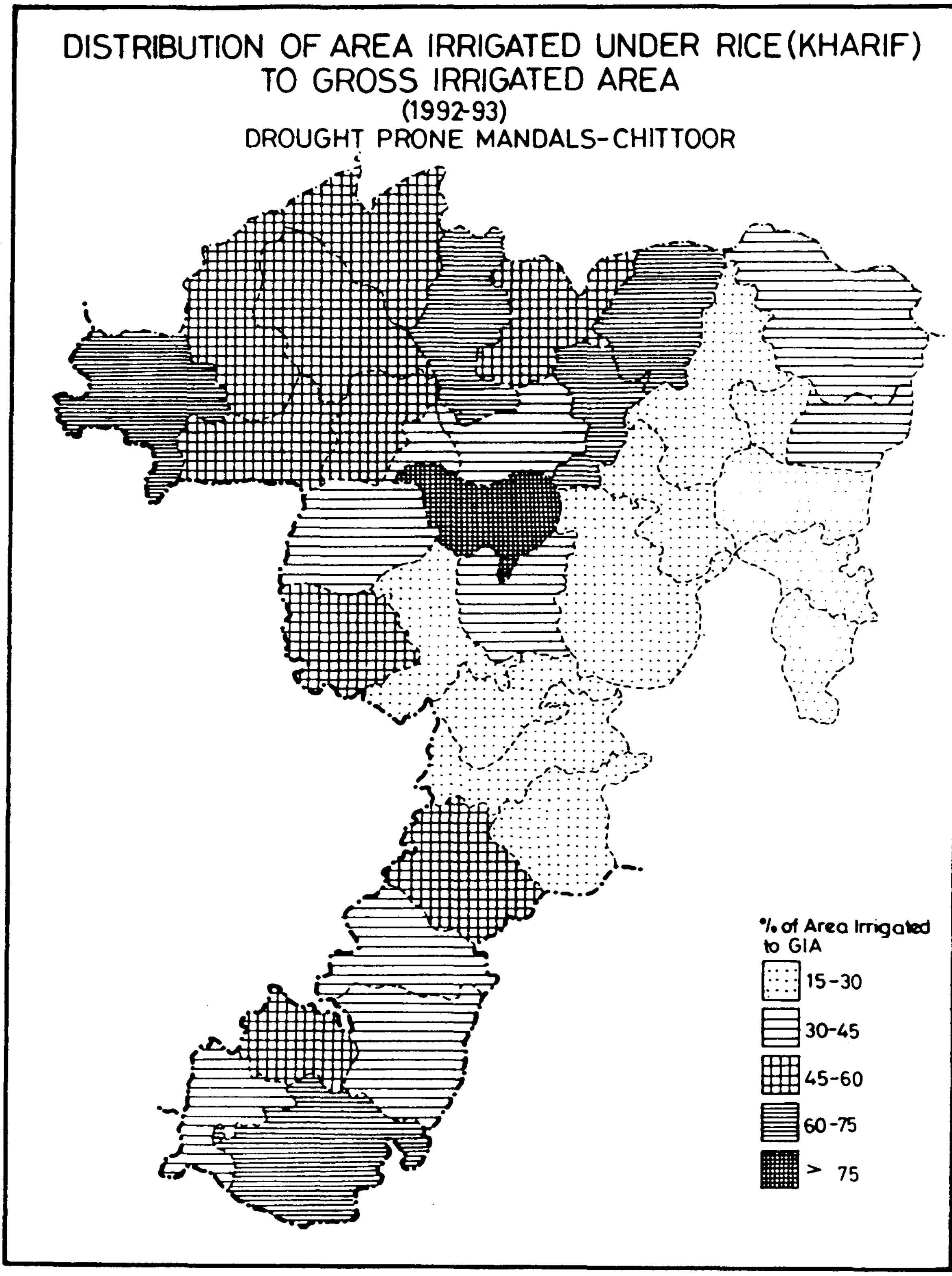
Prakasam district leads in the irrigated area under chillies with around 8256 hectares of irrigated area (4.59 percent of the gross irrigated area) area under the crop. Rayalaseema is comparatively higher than the Telangana area as far Chilli cultivation is concerned. The best varieties of chilli are no doubt from the Prakasam district. Cuddapah with 1.70 percent irrigated covers second among all the districts and has been maintaining its position along the years.

Groundnut is the most preferred crop after rice in Rayalaseema with about 25 percent 185,926 hectares of the 7,42,928 hectares gross irrigated area of irrigated area under the crop. Cuddapah is the district with highest irrigated are of 29 percent.

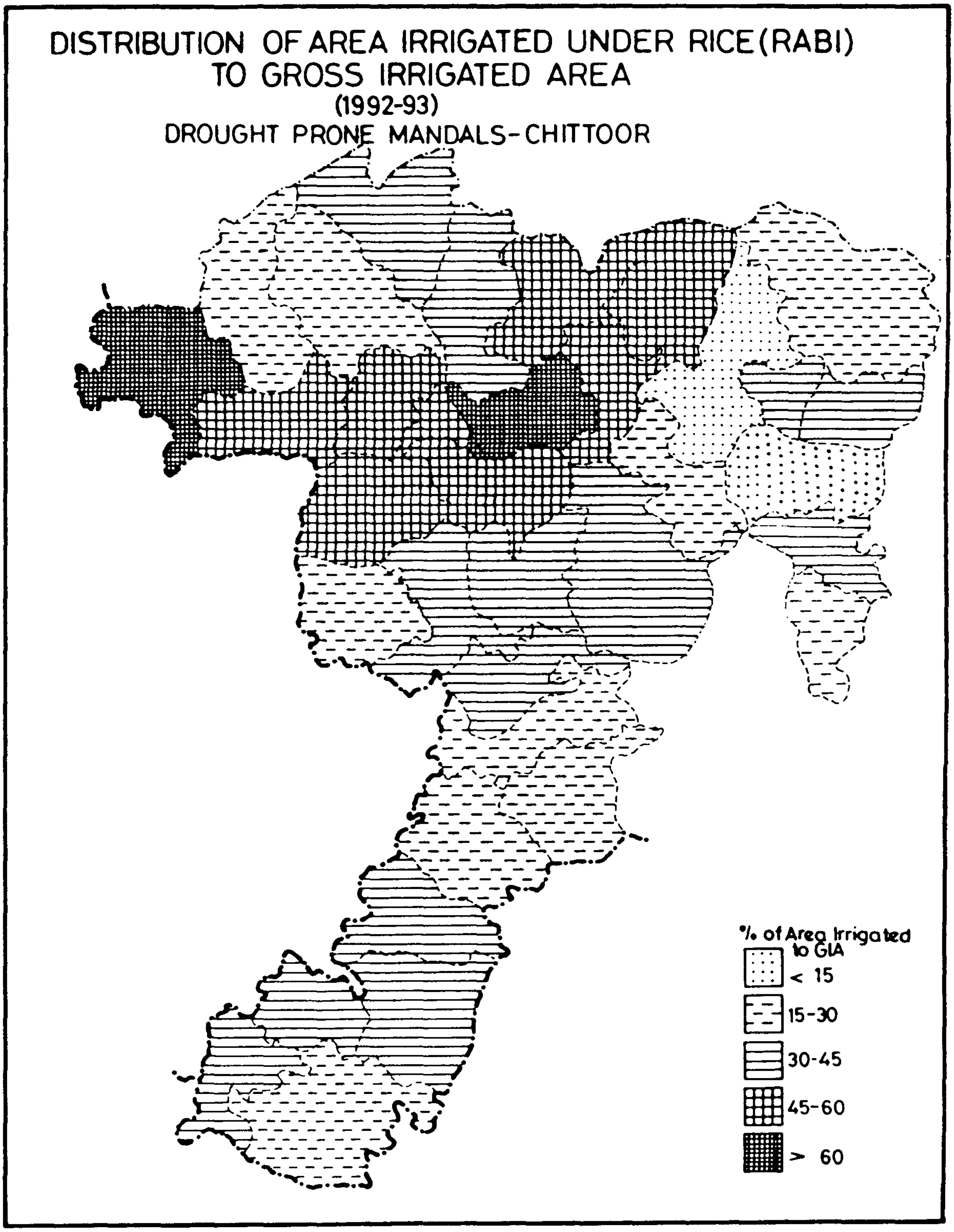
Kurnool and Anantpur, the districts with abundant Black soils obviously lead in the cotton crop with 5.44 and 4.18 percent of gross irrigated area. Kurnool has 10.468 hectares of area irrigated out of the total of 1,92,195 hectares of gross irrigated area. Anantpur has 7433 hectares of cotton area irrigated to the gross irrigated area of 1,77,809. Chittoor and Rangareddy have very negligible areas of cotton under irrigation. Cuddapah, Mahbubnagar and Prakasam lag behind with areas of 1.75 percent and 0.60 percent.

Fodder crops are given importance in Prakasam and Rangareddy districts with the latter leading with 2.79 percent of irrigated area. Prakasam has 3322 hectares of the crops irrigated out of the 2,38,182 hectares of gross irrigated area. Rangareddy has 2509 hectares of irrigation to fodder crops out of the 91,512 hectares of gross irrigated areas.

The coastal (eastern non-drought region) parts of Prakasam might be growing the fodder crops systematically under irrigation under the Dairy farming while in Rangareddy the affinity towards Hyderabad encourages the farmers to take up fodder crop cultivation to cater to the growing demand of the


DISTRIBUTION OF AREA IRRIGATED UNDER RICE (KHARIF)
TO GROSS IRRIGATED AREA
(1992-93)
DROUGHT PRONE MANDALS-CHITTOOR
% of Area Irrigated to GIA
15-30
30-45
45-60
60-75
> 75

MAP NO. 34


DISTRIBUTION OF AREA IRRIGATED UNDER RICE (RABI)
TO GROSS IRRIGATED AREA
(1992-93)
DROUGHT PRONE MANDALS - CHITTOOR
% of Area Irrigated to GIA
< 15
15-30
30-45
45-60
> 60

MAP NO. 35

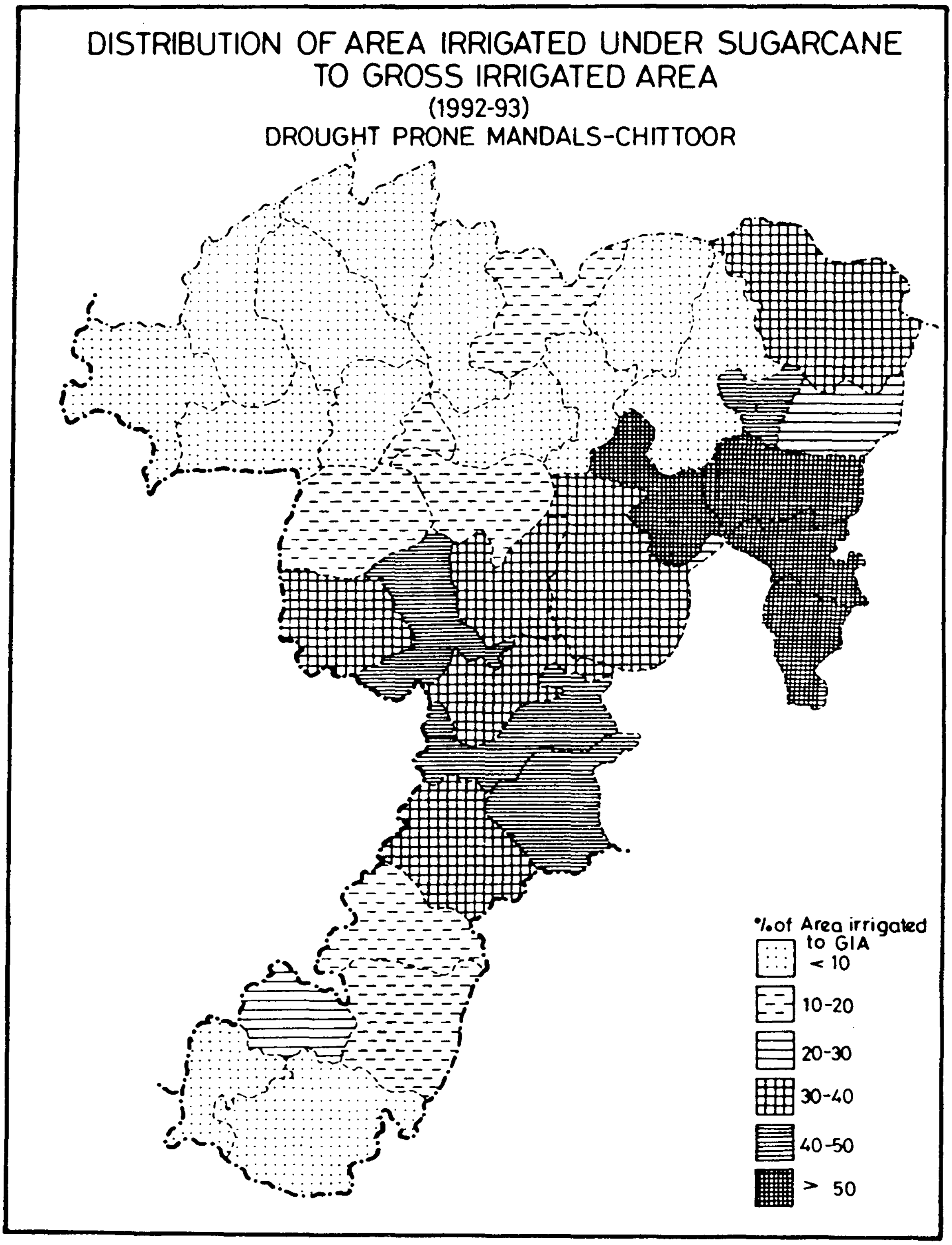
city. Increasing tendency is shown by Chittoor which is fast developing as a major facie in Dairying sector.

On the whole, the overall crop area irrigated of Food crops is decreasing though it is to a moderate decrease in Telangana, there is a sharp decrease in Rayalaseema with the percentage of crops irrigated to the gross irrigated area ranging from 40 to 60 percent. Rangareddy of Telangana and Prakasam of Telangana maintain a steady area of 89 percent and 83 percent of irrigation. While among the non-food crops Cuddapah leads with 37.82 of the crop area irrigated.

Nalgonda, Prakasam and Chittoor are the leading districts with 85 percent, 73 percent and 50 percent of cereals and millet crops irrigated. Kurnool and Anantpur have the figures of 42 percent and 8 percent while Mahbubnagar and Rangareddy have 65 percent of the cropped area irrigated.

There has been an increase in all districts irrigated area under pulses except Nalgonda which maintained about 3.60 percent area of pulses under irrigation mainly red gram, green gram, horsegram etc.

In the present study of the season-wise crop area irrigated as percentage to the gross irrigated area in the drought prone mandals of Andhra Pradesh the comparative irrigated areas under all the principal crops have been considered for the analysis. The comparative shift between Rice and Sugarcane have been considered in the study. The Map Numbers 34 and 35 give the irrigated area


DISTRIBUTION OF AREA IRRIGATED UNDER SUGARCANE TO GROSS IRRIGATED AREA
(1992-93)
DROUGHT PRONE MANDALS-CHITTOOR
% of Area irrigated to GIA
< 10
10-20
20-30
30-40
40-50
> 50

MAP NO 36

under Rice as percentage to the gross irrigated area during Kharif and Rabi respectively. Similarly Map Number 36 gives the distribution of irrigated area to the gross irrigated area under the annual crop Sugarcane.

The overall scenario of the food grains shows a decreasing tendency in the area of crops being irrigated from about 89 percent to 73 percent. Nalgonda and Prakasam showing very good figures of 88.74 percent and 73.29 percent in the former. A similar trend is seen in the total food crops all along the years of study.

In the whole of Chittoor district the percent of irrigated area of the crops to the gross area irrigated has been studied for the kharif and rabi season. Similarly the percentages have been calculated for all the 31 drought mandals in the district for a comparative study of the regions. (See Table 3.12 in next page)

In Chittoor district during 1992-93 the area of crops irrigated is 86.29 percent of 1,89,342 hectares of gross irrigated area. The irrigated area during Rabi is more than that during Kharif while it is 76.36 percent of 79,382 hectares during kharif, the area of crops irrigated during Rabi is 93.46 percent of 1,09,960 hectares of gross irrigated area.

Rice gets the major share of irrigation 39.51 percent (74805 hectares during 1992-93). It is 35.93 percent irrigation 28522 hectares of the total 79382 hectares of gross irrigated area during kharif. During Rabi 42.09 percent (46284 hectares) of crop is irrigated in the gross irrigated area of 109960 hectares.

TABLE 3.12

PERCENTAGE AREA OF CROPS IRRIGATED TO GROSS AREA IRRIGATED (1992-93)

CROP	KHARIF	RABI	TOTAL
CHITTOOR			
Rice	35.93	42.09	39.51
Jowar	0.03	0.05	0.04
Bajra	1.35	0.44	0.82
Ragi	3.86	2.48	3.06
Chillies	0.53	2.95	1.94
Sugarcane	29.84	16.79	22.26
Total	76.36	93.46	86.29
DROUGHT PRONE MANDALS			
Rice	42.51	32.39	37.34
Jowar	0.04	0.05	0.04
Bajra	0.04	0.36	0.20
Ragi	5.77	4.18	4.96
Chillies	1.04	4.34	2.72
Sugarcane	30.41	17.42	23.72
Total	79.81	58.7	69.04

Sugarcane has been given next priority for irrigation by the farmers which is 22.26 percent 42152 hectares of the gross irrigated area. This being an annual crop the irrigation requirement is continuously needed. Thereby 29.84 percent of the irrigation to sugarcane is during kharif (23685 hectares) while 18466 hectares (16.79 percent) of the gross irrigated area is received irrigation during Rabi season. Over the past few years there has been a shift from Rice to sugarcane cultivation due to the latter's lesser water requirements. The figures for the paddy and sugar cane shows significantly high percentages of irrigated area as it is obvious from the table. This percentage of irrigation can be shifted to the coarse grain sector (Sorghum-Jowar, Bajra-peal millet and Ragi-Finger millet) to get a maximum yield. But the staple food being rice the farmers persist with paddy cultivation. As per sugarcane the high return cash crop is given high priority because of its surety of productivity and high rate of income returns.

In the drought prone mandals of Chittoor the irrigation scenario is similar to the above state level. While the area of crops are irrigated was 69.04 percent of 68159 hectares of gross irrigated area, the Table 3.12 shows that the figures for kharif is more than Rabi in kharif season it is 79.81 percent of gross irrigated area while in rabi the area of crops irrigated was 58.74 percent of the gross irrigated area. Paddy receives higher irrigation of 42.51 percent of the gross irrigated area 33,328 hectares during kharif than rabi. During rabi season the area of rice irrigated is 32.39 percent of 34.832 hectares of gross irrigated area.

Sugarcane shows an irrigated area of 23.77 percent to gross irrigated area during 1992-93. It is higher during kharif (30.41 percent) than in Rabi (17.42 percent). However Ragi and Chillies were cultivated in the drought prone areas during Rabi season.

Ragi requires high irrigation for its cultivation. This explains the less percentage of irrigation to Rice during Rabi season. Jowar and Bajra have minute percentages of area of crop irrigated to gross area irrigated. This shows that plans have to be charted out to encourage farmers to cultivate these crops which give a higher yield when compared to paddy in the drought prone conditions.

3.4 SEASON-WISE IRRIGATION IN DROUGHT PRONE AREAS

Detailed irrigation data are available for Chittoor district. Data in area irrigated by source in kharif and rabi seasons in each of the drought prone mandals are utilized for the study.

In general, the area under irrigation has not shown significant increase in the district of Chittoor. The net irrigated area remained around 1,55,850 hectares through the years in the last decade. However, the gross irrigated area fluctuates year to year. In the five years from 1988 to 1993 it was as low as

1,82,730 hectares in 1990-91 and as high as 2,09,324 hectares in 1988-89. The drop in irrigated area is 12.70 percent.

Another significant aspect of irrigation is the high intensity of irrigation in 1992-93. The intensity of irrigation during that year was 128 percent. 1988-89 was the previous year with a slightly better intensity of 120 percent during which the area irrigated more than once was 47,342 hectares.

Wells are the major source of irrigation irrigating 1,39,622 hectares (73.74 percent of the gross irrigated area of 1,91,192 hectares) During the last five years their share of irrigated are has been increasing from 95,332 hectares in 1989-90 (51 percent of 186334 hectares of gross irrigated area) though there was a negative variability of 18.79 percent between 88-89 and 89-90.

Tanks come second in importance of irrigation. The irrigated area by tank constitutes 16 percent of the gross irrigated area. Their irrigation capacity widely fluctuated during the last five years. It shows a drastic fall of 50.74 percent during 1991-92 and 92-93. Its share was 18 percent of the gross irrigated area in 1992-93. While it rised by 36.5 percent during the previous couple of years. The area irrigated during kharif season is considerably less than rabi season. The area irrigated during kharif by the tanks in 1992-93 was 7056 hectares (9 percent of the total kharif irrigated area of 79382 hectares) while the area irrigated during rabi by the tanks was 23,590 hectares (21.45 percent of 109960 hectares) of gross irrigated area during rabi season.

Tube wells share of irrigated area during 92-93 is 7.17 percent 13585 hectares of the 191192 hectares of gross irrigated area. However during the recent past, this source of irrigation has been showing great prospects of utility and with new methods of exploitation.

Canal irrigation showed a dip of 67.67 percent from 3817 hectares in 1991-92 to 1234 hectares in 1992-93. Though there are medium irrigation projects in Chittoor (Refer Table 3.6) the area irrigated by canals is less than one percent i.e. 0.65 percent in 1992-93.

The decrease in the irrigation by tanks, canals and other sources during 1991-92 and 92-93 resulted in the decrease of the gross irrigated area. Overexploitation by wells and tube wells during these years though help to tide over the situation may lead to depletion of the ground water. Conjunctive use of water has to be implemented and practiced for the sustainability of the resources of irrigation in the district. More importantly in the drought prone western region of the district of Chittoor.

The source-wise irrigation scenario among the draught prone mandals in Chittoor has been studied from the data of the two seasons-kharif and rabi.

IRRIGATION DURING KHARIF

The source-wise irrigation in the drought prone Chittoor varies similar to the total irrigated area of Chittoor with other wells tanks and tubewells as the main sources. During kharif season tanks and tubewells are used to a lesser extent. The percentage of net irrigated area is 8.89 percent and 6.48 percent for tanks and tubewells respectively. The irrigated area in the drought prone mandals there is similar to that of districts. However tanks irrigate 17.04 of net irrigated area. Other wells are the chief source of irrigation with over three fourth of the net irrigated area under them. While 84.05 percent (66,717 hectares out of 79382 hectares of net irrigated area) is shown by the district during 1992-93 the drought region got 75.67 percent of irrigation during this water year.

IRRIGATION IN MANDALS DURING KHARIF

CANALS

Only two mandals in the Pincha river basin receive irrigation during kharif. Nimmanapalle (Pincha upper) gets 16.05 percent of area irrigated by canals while Yerravanipalem (Pincha Lower) has 2.16 of irrigation by canals.

WELLS

Wells are the main sources of irrigation in the northern mandals of the drought prone Chittoor. The irrigation during kharif i.e. of around 500 hectares of irrigated area in Tamballapalle, Peddamandyam, Kambamvaripalle, Piler, Kalakada, and Rompicherla is totally provided by the wells (100 percent of the net irrigated area in the mandals is by wells during kharif. Among the other mandals the well irrigation covers about 80 percent of the net irrigated area. The lowest irrigated area of 41.84 percent (715 hectares of the net irrigated area of 1710 hectares) is in Pedatippasamudrum. An anomaly in the well irrigation during kharif.

TANKS

Tanks are the next important irrigation source during kharif. Pedatippasamudrum holds the maximum area of 45.43 percent (777 hectares of 1710 hectares) irrigation. In addition to this mandal B Kothakota also has a high tank irrigation of 562 hectares out of 1061 hectares of net irrigated area.

This high irrigated area by tanks in these two mandals can be explained by the red clay soil which is predominant in these mandals situated in the north western region of Chittoor.

In the tubewells category, Kalikiri has 22.66 percent of net irrigated area of 392 hectares. Other sources of irrigation is insignificantly minute i.e. the maximum of 1.56 percent of 882 hectares in Nimmanapalli.

IRRIGATION DURING RABI

The source-wise irrigation of the net irrigated area in the drought mandals of Chittoor shows that irrigation by wells reduced to 57.70 percent (39,597 hectares) of the net irrigated area of 68621 hectares. Tanks however irrigated 34.38 percent 23,590 hectares of the Net Irrigation Area. Tubewells contributed to 6.52 percent while the other sources of irrigation (canals and others) are insignificant during the season.

WELLS

Wells cater to the total irrigation need of the northern mandals of Kalakada, Piler, Rompicherla and the southern mandals of Baireddipalli, Kuppam and Gudupalli. Whereas the lowest of 5.41 percent of 352 hectares of Net Irrigated Area is shown by Thamballapalli during Rabi season.

TANKS

Palamaner and Ramakuppam are two mandals with over 80 percent of net irrigated area under tanks. The latter has 152 hectares out of the net irrigated area of 197 hectares under the tank irrigation. The other mandals with major tank irrigation during rabi are Pedatippasmudrum, Gurramkonda and Kurabalakota.

TUBE WELLS

The mandals with maximum irrigated area under tube wells are B Kothakota with 61.16 percent of its 203 hectares of net irrigated area. Somala has 224 hectares (41.57 percent) of irrigated area by Tubewells.

CANALS

The irrigated area by canals in the Rabi season is confined to a couple of mandals in the Bahuda river basin Thamballapalle in Bahuda lower basin has 305 hectares (86.88 percent of the 352 hectares of NIA). In Bahuda upper basin Vayalpad has its 76 hectares irrigated (10.53 percent) out of 722 hectares of the net irrigated area.

Agriculture in
Drought Prone Areas in Andhra Pradesh

CHAPTER FOUR

Rainfed areas are such a harsh environment that quite often face problem of droughts and crop failure (Singh and Walker, 1983). Most of the districts (98%) in India with lowest productivity belong to dryland zone (Mitra and Mukherji, 1980). The major problem of dry farming is unstable, crop production due to uncertain rainfall, heterogeniety in soils and declining natural resource endowments. Low and stable production is the perennial problem of dryland agriculture. Therefore higher incidence of poverty is not uncommon in the drought prone areas (Singh and Hazel, 1989)

STATUS OF DRYLAND

Dryland areas contribute about half of the coarse grain cereals, pulses, oilseeds and cotton in the country. These areas are mostly dominated by Alfisols (red soil), Vertisol, (Black soil) and Entisols (sandy soils). Vertisols have relatively higher moisture retention capacity and are more productive red (alfisols) and sandy (entisols) soils are generally less productive and have poor moisture retention capacity. The drought prone areas one characterised by low and high inter - and inter year seasonal variability of rainfall. The large variability in the average annual rainfall trends to be inversely correlated with quantity.

Rainfall uncertainty at the time of planting causes great variability in area cropped from year to year and also causes actual cropping patterns to vary from intended cropping pattern.

The possibilities for increasing productivity in these areas largely depend on the agro-ecological environment. In medium rainfall areas, intercropping in the kharif season could increase land use intensity and hence productivity. Similarly landuse intensity could be increased on deep alfisols with higher rainfall by double cropping in the kharif and post monsoon (rabi) season. However in high potential areas, the development of improved cultivars for intercropping and fast maturing cultivars to allow for both kharif and rabi crop offer promise for increasing productivity of traditional subsistence crops. In lower potential areas, improved varieties offer promise for moderate increases in productivity without significant intensification of the resource use.

The balanced agricultural growth with environment protection is one of the major concern of the policy makers and this has been rightly recognised specially in the Eighth Five-Year Plan which calls for increased agricultural productivity and sustainable management of resources through agroclimatic regional planning, integrated watershed development and soil and water conservation as well as appropriate provision of inputs, credit price incentives and supports. During the last two decades development of these lands in integrated way was considered important for sustainable development of agriculture in drought prone areas.

In the drought prone areas, investing in technological options may be much more socially profitable than investing in larger irrigation schemes in deep vertisol regions. Aside from cost, the improved dryland farming technology has a number of technological features that make it highly competitive with irrigation on the hard to manage soils, where poor drainage constrains rainy season cropping.

The crops in these areas are grown under stress conditions and hazards caused by scanty, erratic rainfall excessive evapo-transpiration, prolonged by spells or drought lack of good quality irrigation water, low fertilizer application and inadequate use of plant protection measures thereby resulting in poor crop yields. Therefore, the shift from usual crop farming to growing of fruit orchards will have a beneficial consequences both economically and environmentally. This has been amply proved by the fact that in the drought prone west Chittoor district over the last decade area under fruit orchards like Mango and pomegranate has increased many fold.

In the present study we take a look at the change in trend of the different aspects of land utilization and Irrigation scenario of the eight districts in the study area of Andhra Pradesh and the position of agriculture i.e. area, production and yield of all cereals, pulses and oilseeds will be thoroughly analysed. the livestock situation is also studied of the drought prone area. Similarly the analysis is done at the mandal level of Chittoor to bring at a picture of the situation at the micro-level.

4.1 LANDUSE PATTERN

The gross cropped area in Andhra Pradesh constitutes 48 percent of the total geographical area. The net sown area comes up to 40 percent. The state has a total of 62,81,421 hectares which is about 23 percent. It has a vast tract of wasted lands (14 percent) in forms of fallowlands. About 3 percent is used as permanent pastures and other grazing land. Less than one percent (around 8.5 lakh hectares) of land is under miscellaneous tree crops and groves not included in the Net Sown Area . Barren and uncultivable lands and cultivable waterlands figure about 7.55 percent and 2.79 percent respectively. the land put to non-agricultural use in 8.57 percent of the total area of the state.

The eight districts in Andhra Pradesh which covers 43.36 percent of geographical area of the state has 54.14 percent of the follow lands of the state (91-92) the fallowlands make up 16.68 percent of the drought prone area in the state. While the Net Sown Area of the study are counts upto 47 percent it is 18.91 percent of the state's total. Barren and uncultivable land covers an area of 48 percent while the cultivable waste constitutes 44 percent of the area in the drought prone Andhra Pradesh districts. 38 percent of the state's forest cover is in this area and the permanent pastures and grazing lands make up 40.27 percent. The land under miscellaneous tree crops and groves is about 35 percent of the state's total.

The Banjar lands of drought prone districts (Till the end of 1991-92) are distributed over 51 percent of the state's total and is 2.92 percent of the state's geographical area. The districts with large area under this category are Chittoor and Anantpur which cover 12 percent and 11 percent of the districts geographical area. These two districts constitute around 50 percent of the total Banjar land in the drought prone area. Rayalaseema is covered by 64 percent of these type of lands in the whole study area. While Telangana with 19 percent and Prakasam of Coastal Andhra with 16 percent are affected by these lands. They constitute the major portions of the drought prone areas of the state.

The forest cover in the state during the time scale of the study has shown a stable figure with Cuddapah and Chittoor having a cover of above 30 percent throughout. Prakasam and Coastal Andhra have shown a sudden spurt of increase in forest cover towards the end of 1980's. This may be fairly explained that during this time the government has identified the coastal mangroves and tidal forests also the life source of oxygen.

The barren and uncultivable land of Anantpur has shown high rate of increase. It was 3.62 percent during 1964-65 but increased to 16 percent by 1985-86. This is due to the gradual reduction of the then basic irrigation by tanks, which were getting dried up by the lowering of ground water table and siltation. There has been a marginal decrease of two percent in Chittoor during the same period of time. Mahbubnagar has shown very good progress by the fact that during two years of time from 1988 to 1990 the area has been decreased from 6 percent to one percent.

The land put to non-agricultural uses and cultivable waste shown a complementarity with the farmer steadily increasing and the latter decreasing to put forth the idea of progressive development by optimal use of the land resources.

Nalgonda showed an increase of four times in the area under pastures and grazing lands, during 1965 and 1985. The cumulated fallowland cover in the districts has been steadily decreasing during the years of study with Mahbubnagar, Kurnool sharing positive progress. Prakasam showed atleast 50 percent decrease in the land under fallow during the latter part of the decade of 1980's.

The district-wise net sown area has shown a lot of dynamic properties. Telangana districts of Rangareddy, Mahbubnagar and Nalgonda showed significant decrease of 4 to 10 percent in the net cultivated area including the districts of Anantpur and Chittoor during 1965 and 1985. Anantpur during the years (1987-89 showed an increase of 6.5 percent of net sown area 7,67,675 hectares in 1986 and 10,14,457 hectares in 1989-90). While the others showed a slight improvement of 2 to 4 percent of the total sown area (net count).

In the drought prone mandals of Chittoor (31 mandals) which cover an area of 51.83 percent, the Net Sown Area (92-93) is 60.25 percent of the total sown area in the district which is inturn 18.59 percent of district geographical area. If we take the total area of drought mandals as a base in each of the categories and equate it to the total state area under the same, it has been noted that around 90 percent of the barren and uncultivable lands of district are in this mandals which is 52 percent of the district's total geographical area. Similarly 60 percent of the fallowlands cover this part of the district. there is a meagre consolation of the 62 percent coverage of permanent pastures and grazing lands. However 46 percent of the trees and groves fall in this part a positive sign for improvement of orchards and Horticulture.

CROPPING PATTERN

If we study the trend of the area under food and non-food crops in Andhra Pradesh from 1981-82 to 1991-92 it can be analysed that the percentage of food crop area is gradually decreased from 77.40 percent to 64.78 percent. The effected areas are rice, ragi and small millets. This may be due to the increase in the cropped land which is getting drought prone and the farmers inclination towards the intensive cropping pattern rather than the extensive one. The area under the non-food crop category gradually increased from 22.60 percent in 1982 to 35.22 percent in 1992. The stress given to the cash crops of oilseeds i.e. groundnut cotton and tobacco, Gingelly (Sesamum) by the farmers is showing up. If there is a total of 1.11 percent growth rate in the overall cropped area in the state, the area under food crops decreased by - 15.37 percent while the area under the non-food crops increased by 57.57 percent. Sugarcane is making inroads into the area under rice. It not only tilts the food grain scenario but also effects the irrigation front as it is a 100 percent irrigation crop. The main cause for the decreasing levels of agricultural development and the land use for food grains receives a serious setback though sorghum is best suited for this type of climate and rainfall regime.

Among the drought prone districts the area of crops irrigated and the total area of the crop grown are studied under the three heads of cereals, pulses and oilseeds. Date of all the 41 important crops have been utilized which over the last ten years to come out with a contingency cropping pattern, dealt in the chapter six for these areas.

4.2 CROPPING PATTERN IN CHITTOOR

The analysis of the data of the drought prone mandals of Chittoor district under the principal crops of Paddy, Jowar, Bajra, Ragi, Small Millets, Horsegram, Greengram, Mangoes, Fruits and Vegetables, Chillies, Sugarcane, Groundnut and Sesamum is studied for their percentage area coverage to the gross cropped area.

The Chittoor district has 15.78 percent of cropped area under paddy out of which the rabi crop is 41.93 percent while the kharif is 8.34 percent. Jowar and Bajra has around one percent of cropped area under them which is principally during kharif season. Ragi is comparatively higher with 3.16 percent with almost equal area cover during both the seasons. The small millets is mainly a kharif crop. Among the pulses Horsegram has one percent each during both crop seasons. Area under green gram is very minute of 0.07 percent during kharif. The harvest of mangoes which is during kharif accounts for 6.14 percent area in the district.

The varieties of Banginapalli, Suvarnarekha, Rasaalu, Jahangir, Himampasand of this area rank among the best of mangoes in India. The other fruits and vegetables are in Rabi is around 55 of the total cropped area. Chillies are also grown only during Rabi season and cover an area of 2.88 percent. The cash crop - sugarcane has around 16.39 percent area under it during rabi while during kharif it is 6 percent. The area of groundnut is the highest in the district with 55 percent. Kharif and Rabi seasons have 63 percent and 27 percent under the crop. The Sesamum crop is fast improving it cropped area though it is less than one percent during the rabi.

Among the drought prone mandals in Chittoor ragi is the main crop with 35.36 percent. Groundnut has 13.78 percent area of the total cropped area followed by rice (9.46%), Horsegram (8.8%) Jowar (8.51%), small millets (4.54 percent). During the rabi season during which the retreating south west monsoon is very rampant over these areas, Paddy has a percentage of 15.11 percent and Ragi has 16.43 percent. But the large part of the area is covered by horsegram a whopping 52.78 percent. This is gram in the southern mandals of the district i.e. Kuppam, Gudupalle, Punganur, Santhipuram etc. During Rabi season Ragi is the major crop with 38.12 percent followed by groundnut and paddy with 15.78 percent and 8.63 percent respectively.

TABLE - 4.01 : CROPS DURING SEASONS

MAJOR KHARIF CROPS	MAJOR RABI CROPS
Jowar	Rice
Ragi	Bajra
Small Millets	Ragi
Greengram	Horsegram
Mangoes	Fruits & Vegetables
Groundnut	Chillies
Sugarcane	Sugarcane
	Sesamum

Pedatippasamudram has the highest percentage area under rice with 70 percent of total cropped area during rabi while Kuppam tops the mandal's in having 14 percent of area during kharif. Chowdepalle however is the highest with 13.68 percent during the year (92-93). Gudupalle has around 17 percent under jowar which is mainly a kharif crop. Kalakada has a minute area of 1.97 percent during rabi. Bajra is mainly rabi crop in Chittoor with Peddamandyam having 3.27 percentage. Kuppam has 25.74 percent under Ragi during Kharif while during Rabi Gudupalle has 26.42 percent during Rabi. This shows that the southern Chittoor is suitable for ragi to be grown all through the year.

Gudupalle tops the mandals in the area under small millets also while its main crop horsegram during rabi with 28.83 percent. Palamaner is the mandal with the highest are of 12.41 percent and mango orchards. While the fruits and vegetables are grown mainly in Gurramkonda which has 36.81 percent during Rabi. Chillies are mainly grown in Ramakuppam in rabi over an area of 14.20 percent. Baireddipalli with 49 percent area under sugarcane tops in the cash crop area. The area in and around Palamaner i.e. the south east patron of the study area is dominant in sugarcane production during rabi. During kharif the whole cropped area of the 31 mandals have groundnut as their dominant crop.

4.3 AGRICULTURAL YIELD ANALYSIS

The agricultural area and production of all the different crops under cereals, pulses and oilseeds have been analysed after calculating the yield from area and production under each crop for each drought prone district as a bench mark study the tri-regional scenario of Rayalaseema, Telangana and Coastal Andhra are interpreted.

Agricultural Yield = Crop Production / Area under the crop

After the yield is calculated, the percentage area to the total area is calculated for each crop in the three categories of cereals, pulses and oilseeds i.e. for example, area under Paddy is calculated as a percentage of the total area under food grains while the percentage of pulses and oilseeds are as the percentage of total area under pulses and oilseeds respectively. This trifold categorization of crops will enable the present study to come out with recommendation of the crops for the drought prone districts in the contingency plan for agriculture which is dealt in chapter six.

CEREALS

Over the last ten years the overall cropped area under the cereals in Andhra Pradesh, decreased slightly from about 83 percent of the total to 77 percent and Rayalaseema has about 82 percent of the cropped area of food grains under cereals, the highest among the three regions in the state. Initially Cuddapah district had over 90 percent of cereal crops but not the position of the leader in cereal crops cultivated has been taken over by Chittoor. The yield of total food grains 1.91 tonnes / hectare in 1990-91 is also the highest in Chittoor while Cuddapah leads in the cereal yields with 2.27 tonnes/ hectare during 1991-92.

The area under the staple food crop - Paddy, is increasing in the state - the Rice Bowl of India i.e. 34,52,375 hectares in 1985-86 to 39,36,115 hectares in 1991-92 from (44 percent to 53 percent) with coastal Andhra having 66 percent of its total food grains area under rice. At the district level Nalgonda of Telangana has the maximum proportion of area under rice with 60 percent (2,67,815 hectares, 1991-92).

The area under Jowar is showing a decreasing trend from about 23 percent to 14 percent in the state. The most significant decrease is being observed in

Rayalaseema and Telangana. Mahbubnagar district maintained its top position with 45 percent though it too had about 55 percent of its food grain cultivation under jowar. Chittoor district has a high yield capacity of about one tonnes per hectare. Rayalaseema leads in bajra and Nalgonda has about 8 percent under the crop. Cuddapah district has a high yield capacity of 1.35 tonnes per hectare.

Due to the proximity to the state capital Hyderabad maximum cropped area among the wheat and Maize is in Rangareddy district of Telangana while Mahbubnagar has a high yield capacity in both these crops.

Ragi crops is showing a slight decrease from 2.72 percent to 1.96 percent (2,12,853 hectares in 1985-86 to 1,45,818 hectares on 1991-92) in trend of the cropped area in Andhra Pradesh. The change in life style and food habits may be the cause for the decrease. But Chittoor maintained the area above 10 percent during the last decade. However the yield rate in Anantpur is the highest in Ragi while Cuddapah shows a high productivity in small millets.

PULSES

Though there is a slight decreasing trend under the cropped are of pulses, Rayalaseema had maintained over 3 percent area under the miscellaneous pulses with Chittoor having 12 percent. There are mostly used as food far livestock.

Among the main crops of pulses the area under then has been fluctuating in the state. Coastal Andhra Pradesh (including Prakasam) shows a high yield productivity of around 0.60 tonnes / hectare.

Bengal gram was mostly grown in Rayalaseema. It had 36 percent of cropped area under this pulse. Kurnool maintained a cropped area of over 50 percent among the districts. This district has a high productivity yield rate of 1.05 tonnes / hectare (1991-92). This may be due to the moderate deep red soil which is very suitable for these crops.

In the red gram (Tuar) category, Rayalaseema has about 50 percent of cropped area under this commonly used DAL. The percentage area to the total pulses fluctuated over the years with the lowest of 42 percent in 1986-87 and 56 percent in 1987-88 as the maximum area cropped. Their yield in coastal Andhra (0.62 tonnes/hectare, 91-92) is the best Rangareddy with over 0.30 tonnes / hectare is on the top among the districts.

The green gram (Moong) is predominantly cultivated in the Telangana districts with Nalgonda having 56 percent of the total cropped area under pulses.

The horsegram (Kulthi) showed a very high decreasing trend from 32 percent in 1964-65 to 8 percent (1991-92). This crop which was used mostly as cattlefeed is now being replaced by new fodder and forage crops.

The Mash or black gram showed significant increase from (2,93,534 hectares in 1985-86 to 5,63,029 hectares in 1991-92) of cropped area while coastal Andhra has maximum area of above 5,00,482 hectares in 1991-92 which shows that the crop requires abundant irrigation and alluvial soils. Prakasam has 16,988 hectares (24 percent of total area of pulses cropped in 1991-92) though the yields over the regions have shown a decreasing trend. Rayalaseema has 5 percent under cowgram with Chittoor as the leader while the yield in Anantpur is comparatively higher.

OILSEEDS

Coastal Andhra is showing an increasing trend in the percentage cropped area of oilseeds which accentuates the fact that irrigation requirements of the crops should be satisfied in order to encourage the farmers to grow more of oilseeds to make India a self-sufficient country in the production of oils (edible and non-edible).

Out of all the oilseeds groundnut has been the largest cultivated crop over space. Rayalaseema showing the largest proportion of over 88 percent of the total 16,17,209 hectares of the cropped area of 2,02,490 hectares under oilseeds. The area under groundnut in Chittoor varies between 85 to 95 percent of the total oilseeds area and also maintains a high yield rate than compared to the other districts. Prakasam of coastal Andhra is showing an increasing trend in productivity from 0.72 tonnes / hectare in 1985-86 to 1.26 tonnes per hectare in 1991-92.

Castor is the second important oilseed crop with about 10 percent of cropped are among oilseeds. Telangana has more than 2,91,402 hectares (1991-92) 30 percent of its cropped area under caster with Nalgonda having more than 60 percent 1,33,744 hectares of its total cropped area under castor. Rangareddy has been having a steady yield of 0.40 tonnes per hectare until the sudden spurt of oilseed revolution of coastal Andhra and Rayalaseema in the early nineties (during the last three years) which boosted the productivity to surpass the Telangana region with yields of 0.42 tonnes per hectare.

The area under Linseed and sesamum has been occupying 0.2 percent and 5 percent respectively in Andhra Pradesh with the largest area in Rangareddy districts. An increase is shown by coastal Andhra and Rayalaseema for Sesamum while Mahbubnagar leads in Linseed.

Safflower; though it had an upstart during the early eighties decreased its trend of crop cover but Rayalaseema stays ahead in area and yield among whose districts Kurnool and Anantpur are high with around 0.50 tonnes / hectare.

The coastal Andhra leads in the crops - rapeseed and mustard, nigerseed and coconut. Which are showing an increasing trend of coverage area 2 percent, 10 percent and 3 percent of the total oilseed cropped area respectively.

They hold a high promise both in yield and cropped area. The present boost given to the oil palm (not widely used edible oil) has shown its effect in Prakasam. Yellow revolution has made its entry in Andhra Pradesh.

4.4 LIVESTOCK

The cattle and buffaloes of all three subgroups (males above 3 years, Female above 3 years and young stock) have a high percentage of the total with 45 percent and 28 percent of the total 3,36,66,698 livestock in 1987 in the Telangana and coastal Andhra Pradesh respectively. While the farmer is mostly used in agricultural labour the better one the main source of milk to the Dairy development. Operation flood 3 has made in-roads into these areas of the state. The cattle population is increasing in Rayalaseema and Chittoor among all drought districts has maintained about 43 percent of the total of 1,47,066 livestock. It also has a good percentage total of females and young stock as per the latest livestock census. So the district shows good promise. While Rangareddy is having high percentage of cattle above 3 years which shows that, it has been used as the main feeder district of Telangana mainly Hyderabad.

Similarly, the Buffalo population is increasing in Rayalaseema and Telangana. While Prakasam maintains a high percentage of Buffaloes (Male & Female above 3 years). Nalgonda, Mahbubnagar and Chittoor have a high percentage of over 40 percent which points out the bright future of dairying in these regions.

Rayalaseema and Telangana have a high figures of about 28 percent and 20 percent of sheep out of the total livestock with Mahbubnagar and Anantpur vying for top spot. Similarly, in the goat population, Anantpur leads the other districts with 3,79,880 goats per 18,10,169 livestock. Cuddapah also has the similar proportion of 3,18,143 goats per 14,68,981 livestock. A very good sign of sustainable development is that the goats do not deplete the pasture and grazing lands as compared to cattle and buffaloes. The milk productivity of goats in the drought prone areas is comparatively more than the latter taking into consideration the fodder costs (Goats 1.75 litres per day and some cows 2.5 litres per day).

Kurnool and Rangareddy have higher proportion of horses and ponies while Nalgonda and Prakasam lead in the percentage of pigs, camels make a small percentage in Chittoor. In the other livestock Rayalaseema and Anantpur hold higher position.

Poultry has been increasing in Andhra Pradesh as a whole pushing it towards a position of the largest producer of eggs in the country. Coastal Andhra and Rayalaseema are the leading producers of poultry. Rayalaseema among the districts has the highest poultry population of over 60 lakhs.

The district of Chittoor has about 16.5 lakh population of livestock and 38.5 lakhs of poultry. The drought prone mandals account for more than 55 percent of livestock and 23 percent of poultry. Kambhamvaripalli has maximum livestock of 5.62 percent among all the drought prone mandals. Peddapanjani with 12.23 percent leads in poultry among these mandals.

Kalikiri has 63.63 percent of total livestock as cattle. Molakalacheruvu leads with 48 percent of Male more than 3 years. Gudupalle has 55 percent of female more than 3 years. Sodam with 38.16 percent of young stock holds future prospects of development in the south, southeast mandals of the study area. Kalikiri and Rompicherla in the northeast are dominant in the three categories of buffaloes, Pedamandyam has 6.17 percentage of females the source of dairy development.

Vayalpad and Kalakada has 70 percent (19367) and 55 percent (18347) respectively of sheep among their livestock totals of 27,773 nos. and 33,252 nos. respectively. while Kuppam has 19.34 percent 5924 nos. of goats. Chinnagottigallu with 3.76 pigs and Pedatippasamudrum with 0.77 (353) percent of horses and ponies give us the mandals which are having the highest percentages among the various livestock in the Mandals.

Rainfall Variability and Agricultural Production

CHAPTER FIVE

The intimate relationship between the weather and crop production, especially the complexities associated with the vagaries of weather in terms of yield fluctuations has been a subject of wide concern in the national and international crop planning. Thornthwaite (1948), Bagnouls and Gaussen (1957) Troll (1965), Cocheme and Franquin (1967), Meher-Homji (1968) and Hargreaves (1971) etc. have laid emphasis on the need for the quantification of the variability of climatic factors.

EFFECT OF VARIABILITY OF RAINFALL

The three most important aspects of rainfall variability are the time factor, quantum factor and areal distribution factor. The effects of these three factor are tremendous.

1. Time Factor : The length of rainy season, the date of commencement and withdrawal of monsoon and the length and number of dryspells in between rain events are not definite in India. The onset of summer monsoon may be delayed by two to three weeks and the withdrawal advanced by as much as four weeks. The occurrence of dry-spells accentuates the conditions. The frequency and duration of dry-spells is highly variable thus affecting crop growth and development. This variable nature of rainfall in India adversely affects the agricultural calendar. Selection of crop variety on the basis of term duration is not possible. Contingency plans to counter and neutralise dry-spells and rainfall deficits are also difficult to plan and implement without loss of time.

2. Quantum Factor : Quantum of rainfall received during the season and over the entire year in also highly variable. The seasonal distribution of rains as mentioned earlier indicates the general predominance of south-west monsoon in India and North-East monsoon in Chittoor in particular. The former is also a season of high temperature and high evapo-transpiration. Thus, the effectiveness of precipitation is decreased. During dry-spell, water stress in crops and plants occur, which adversely a affects crop production. Alternatively during this season cloud bursts may occur resulting in flash floods and inundation of fields accompanied by total destruction of crops, settlements, human and livestock population.

3. Aerial Distribution Factor : The real extent of rainfall during a rain event is also not definite. Hence planning for agricultural activities, viz., preparation of fields levelling, ploughing, sowing, weeding etc., precisely, is difficult.

All these uncertainties are reflected on the agriculture and crop production of drought prone areas of Andhra Pradesh.

In the present study of the drought prone districts of Andhra Pradesh, the weather element - precipitation has been considered. The variability in the average annual rainfall has been considered for the years starting from 1985-86 to 1991-92. The impact of rainfall variation to the corresponding variations in the different agricultural factors (Cropping pattern, Irrigation, Crop production, etc) have been studied in detail.

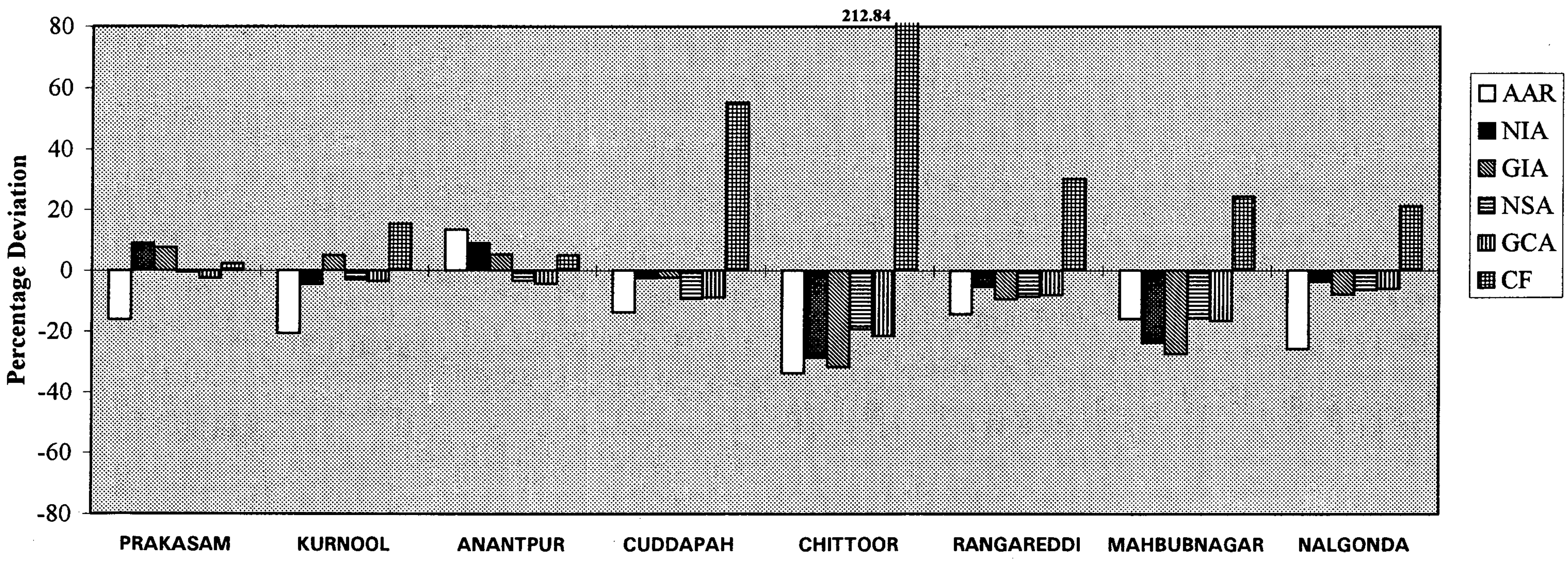
The percentage deviation for the year from the previous years is calculated as follows:

$$\text{Percentage deviation} = \frac{(\text{Rainfall of present Year} - \text{Rainfall of previous year})}{\text{Rainfall of previous Year}} \times 100$$

The deviation of annual rainfall from the previous year is statistically and graphically compared with the corresponding deviation in net sown area, gross sown area, current fallows, net and gross irrigate area and area and production of major crops.

In the study area the percentage annual rainfall deviation during the years 1986-87 has been the most significant in showing a consistent negative deviation upto -34 percent from the previous year of 1985-86 and 1987-88 is marked by equally significant positive deviation from the previous year upto +74 percent. The lowest rainfall during the year occurred in Anantpur district which recorded 439 millimeters. In 1986-87 in the previous year also Anantpur district received a rainfall 387 millimeters. The two years are consecutive years of low rainfall in Anantpur district. The rainfall in Chittoor district in the 1986-87 was 34.01 percent less than that of the previous year. (623 millimeters in 1986-87 from 945 millimeters in 1985-86).

The negative percentage deviation of annual rainfall in 1986-87 was the previous year was between 10 to 20 percent in Prakasam, Cuddapah, 5.1 (a) **Deviation of 1986-87 Rainfall, Irrigated Area, Cropped Area, Current Fallows Over 1985-86**



AAR = Average Annual Rainfall; NIA = Net Irrigated Area; GIA = Gross Irrigated Area

NSA = Net Sown Area; GCA = Gross Cropped Area; CF = Current Fallows

Rangareddy and Mahbubnagar districts. More than 20 percent decreasing deviation was found in Chittoor, Kurnool and Nalgonda districts.

5.1 EFFECT OF NEGATIVE RAINFALL DEVIATION (1985-86 TO 1986-87)

The resultant effect of the above rainfall deviation over the net sown area shows that there is a corresponding consistency of negative deviation. There is a positive correlation of the variations.

VARIATIONS IN IRRIGATED AREA, CROPPED AREA & CURRENT FALLOWS

The gross cropped area also shows a consistent negative variation during the two years (1986-87 from 1985-86) with Chittoor and Mahbubnagar remain as the most sensitive to the rainfall deviation with - 21.68 percent. (See Diagram 5.1a) and -16.82 percent (4,10,524 hectares in 1986-87 from 5,24,181 hectares in 1985-86) deviation respectively.

Ironically, there has been a high negative correlation shown by the districts in their increased area of current fallow due to the effect of deficient rainfall. There was a high percentage change of the shift in land utilization from the net sown area to the fallow lands due to the rainfall deficiency. Significant deviation has been shown by Chittoor from 30,700 hectares in 1985-86 to 96,041 hectares in 1986-87 a 212.84 percent increase in the current fallows. This definitely is the aftermath of the high rainfall deviation. This shows that agricultural land use and its cultivation is very much sensitive to rainfall in

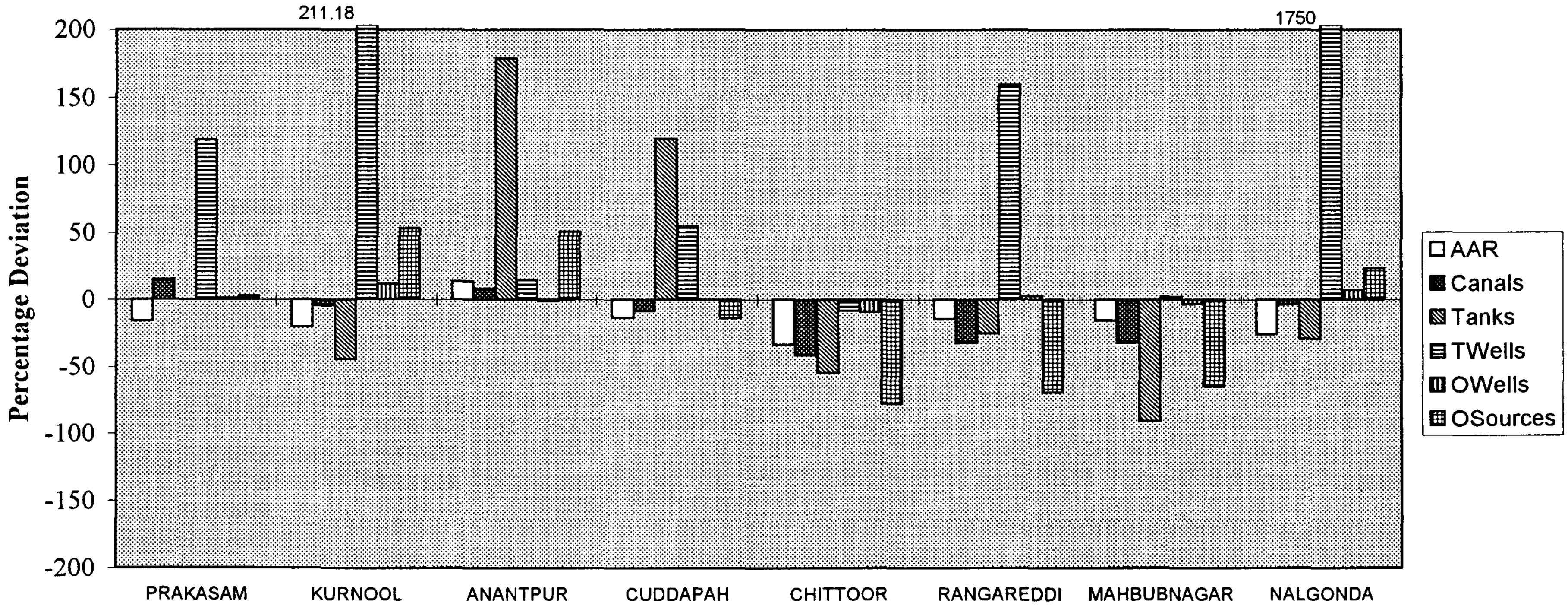
Chittoor district. The other district showing high sensitivity is Cuddapah whose area under current fallows increased from 54,504 hectares to 85,654 hectares (55.32%). Mahbubnagar, which had 4,15,412 hectares under current fallows showed 24.35 percent increase during the years 1985-86 and 1986-87 to 5,16,583 hectares. This district maintains its position as the one with maximum area under current fallows followed by Nalgonda and Anantpur with 3,88,068 hectares and 3,35,226 hectares respectively.

The net irrigated area in the districts also showed a consistency in their negative percentage change during the years 1986-87 from 1985-86. Chittoor showed maximum sensitivity of 28.99 percent decrease in net irrigated area from 1,39,845 hectares in 1985-86 to 99,307 hectares in 1986-87. The most affected source of irrigation being the tanks whose irrigated area decreased from 54,299 hectares in 1985-86 to 24,320 hectares in 1986-87. It a significant 55.21 percent for Chittoor district whose eastern regions are predominantly irrigated by Tanks. Mahbubnagar also shows a high sensitivity to rainfall deviation with a 24.11 percent decrease in net irrigated area whose tank irrigated area decreased from 9569 hectares in 1985-86 to 844 hectares in 1986-87. In other districts the variation of net irrigated area is less than 10 percent.

The gross irrigated area also shows a moderate sensitivity, barring Chittoor and Mahbubnagar which have high decreasing percentage change of

5.4 (a)

Deviation of 1986-87 Rainfall and Source-wise Irrigated Area Over 1985-86



AAR = Average Annual Rainfall; TWells = Tube Wells
OWells = Other Wells; OSources = Other Sources

the area. Kurnool which showed a decreasing change of 4.77 percent net sown area, however, showed an increase in deviation of 4.99 percent of gross sown area. This is mainly due to the increase of area irrigated more than once from 14,979 hectares in 1985-86 to 26,712 hectares in 1986-87 (78.33 percent). Though there has been a significant 20.87 percent decrease in the annual rainfall of the district, irrigated area might have been increased by canals chiefly the Kurnool-Cuddapah canal of the Tungabhadra sub-basin.

The source-wise irrigation also showed a positive correlation in almost all the drought districts of Andhra Pradesh. Other wells, canals, tanks, tube wells and other sources come in the descending order of the irrigated area under the respective sources. Canal irrigation was the most important source of irrigation with 350,856 hectares out of the 831061 hectares of net irrigated area in 1986-87 (42.22 percent) canals however lost its place to the other wells which surpassed them in the area irrigated. The most probable follow up action of the farmers increasing dependency on wells rather than canals. It is during these years (1985-86 and 1986-87) that Anantpur and Cuddapah increased their irrigated area by Tanks. In Anantpur irrigated area by tanks increased from 3138 hectares in 1985-86 to 8751 hectares in 1986-87. Similarly in Cuddapah the increase was from 2209 hectares to 4851 hectares during the same year (See Diagram 5.4a).

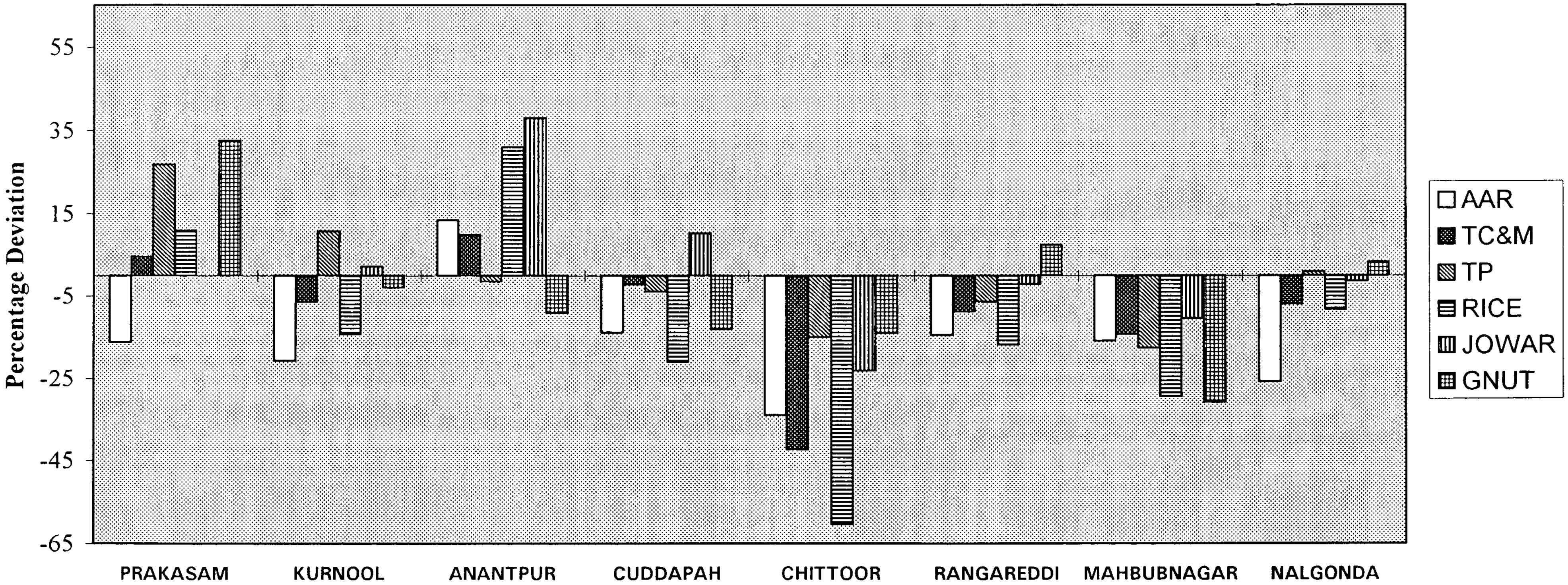
The irrigated area under the other wells however did not show any significant variation due to drought and deficient rainfall in the eight districts showing their least sensitivity to rainfall variability. The irrigated area by these sources was almost unchanged during these years in Anantpur and Cuddapah which had 57,398 hectares and 50,9010 hectares respectively in 1985-86. Chittoor showed a slight decrease of 9.26 percent (79,183 hectares in 1985-86 to 71,852 hectares in 1986-87).

VARIATION IN AREA UNDER DIFFERENT CROPS

Under normal rainfall conditions there is a sectoral shift between the cropped area under food crops and non-food crops. They show complementarity in the usage of cropped area i.e. the former's decrease shows up in the latter's increase and vice-versa. But during these years of variability study, both the sectors show negative changes consistently over all districts. Chittoor showed a higher negative deviation in the area under food crops than non-food cropped area, 30.09 percent and 13.51 percent respectively. The decrease is from 2,58,436 hectares to 1,80,681 hectares in food crops and 2,65,745 hectares to 2,29,843 hectares in non-food crops during the years 1985-86 and 1986-87. The cropped area under the foodgrains with a fall from 3,10,597 hectares in 1985-86 to 1,31,452 hectares in 1986-87 had been the most effected. A result of dependency on rainfall and high irrigation requirement, both of which decreased due to the drought situation.

5.2 (a)

Deviation of 1986-87 Rainfall and Area under Different Crops over 1985-86



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

The effect of the negative duration of annual rainfall during 1985-86 and 1986-87 had a moderately severe fallout on the cropping pattern of the food crops like rice while it is slightly moderate on jowar which showed decrease of cropped area. As a whole the area under the cereals and millets, has shown less sensitivity to rainfall deviation barring Chittoor which showed 42.33 percent decrease in cropped area (See Diagram 5.2a).

There has been a moderate decrease in percentage cropped area under groundnut, in all the districts of Andhra Pradesh, except Prakasam which showed 32.54 percent positive deviation from 24,601 hectares in 1985-86 to 3207 hectares in 1986-87. On the other hand Mahbubnagar showed a negative percentage change of 31.02 from 1,52,297 hectares to 1,05,041 hectares in 1991-92. While in 1985-86 the former showed negative correlation between the deviation of average annual rainfall (16.33 percent decrease during 1985-86 and 1986-87) and the cropped area, Mahbubnagar showed high positive correlation. This gives a strong indication of better irrigation facilities in Prakasam than compared to Mahbubnagar though decrease in area under groundnut in Prakasam is from 24,601 in 1985-86 to 32,607 hectares. However all the rest of the districts barring Mahbubnagar maintained the same cropped area. In Anantpur, whose area under groundnut decreased from 4,86,529 hectares to 4,41,720 hectares showed a slight to moderate sensitivity to rainfall deviations. The same is the case with the other districts of Rayalaseema.

The cropped area under total oilseeds and pulses showed a similar trend among all the districts. Since groundnut is the dominant oilseed crop its change reflected on the total oilseeds. Castor did show a slight positive deviation (17,720 hectares in 1985-86 to 18,955 hectares in 1986-87). Sesamum increased its cropping area by 56.46 percent from 6,175 hectares to 14,184 hectares during the years. A strong case of contingency cropping of oilseed pulses in place of the irrigation intensive crops like cereals and millets has been shown by the change in cropping pattern of these food crops during the years.

VARIATION OF CROP PRODUCTION / OUT-TURN

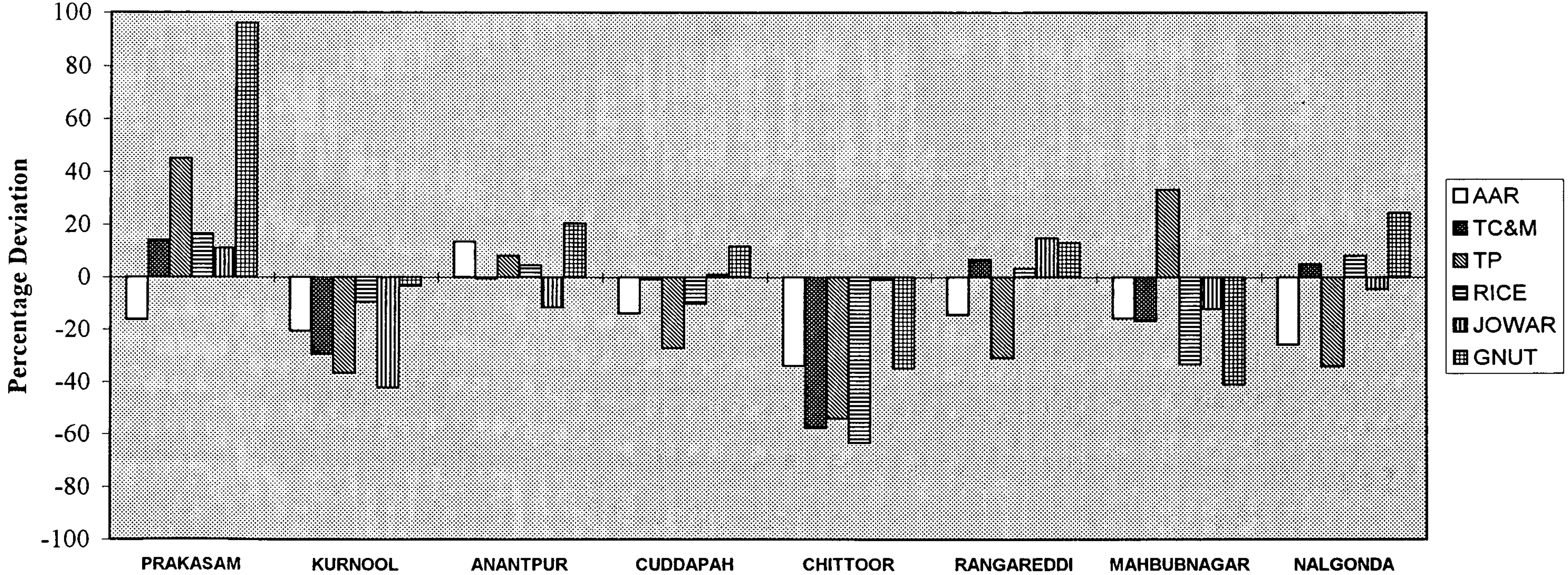
The effect of rainfall deviation can be best quantified by the change in crop out-turn and its productivity. In the present study, percentage change of out-turn of the major crops of Drought prone areas has been considered.

The crop out-turn or production of the crops (Rice, jowar, total cereals and millets, groundnut, total pulses) in Andhra Pradesh as a whole has shown negative deviation of 12.38 percent. The cereal crops Jowar and Rice show the most sensitivity of 14 percent to rainfall variation. The effect of the rainfall decrease on groundnut and pulses production is a minimal low decrease of 0.17 percent and 1.93 percent respectively, during the years 1985-86 and 1986-87.

Among the drought prone districts, rice production has shown high sensitivity to rainfall variation in Chittoor during the years with a 63.55 percent decrease from 2,41,829 tonnes to 88,152 tonnes. In Mahbubnagar it is a 33.45

5.3 (a)

Deviation of 1986-87 Rainfall and Production of Different Crops over 1985-86



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

percent decrease from 80,450 tonnes during 1985-86 to 53,536 tonnes in 1986-87. While Cuddapah and Kurnool showed a moderate sensitivity of 10 percent. These districts exhibit a positive correlation while Prakasam, Nalgonda and Rangareddy show an increase in percentage change of production. The fluctuating out-turn of rice in Anantpur might have resulted in the district showing a slight increase in percentage change of 4.39 percent.

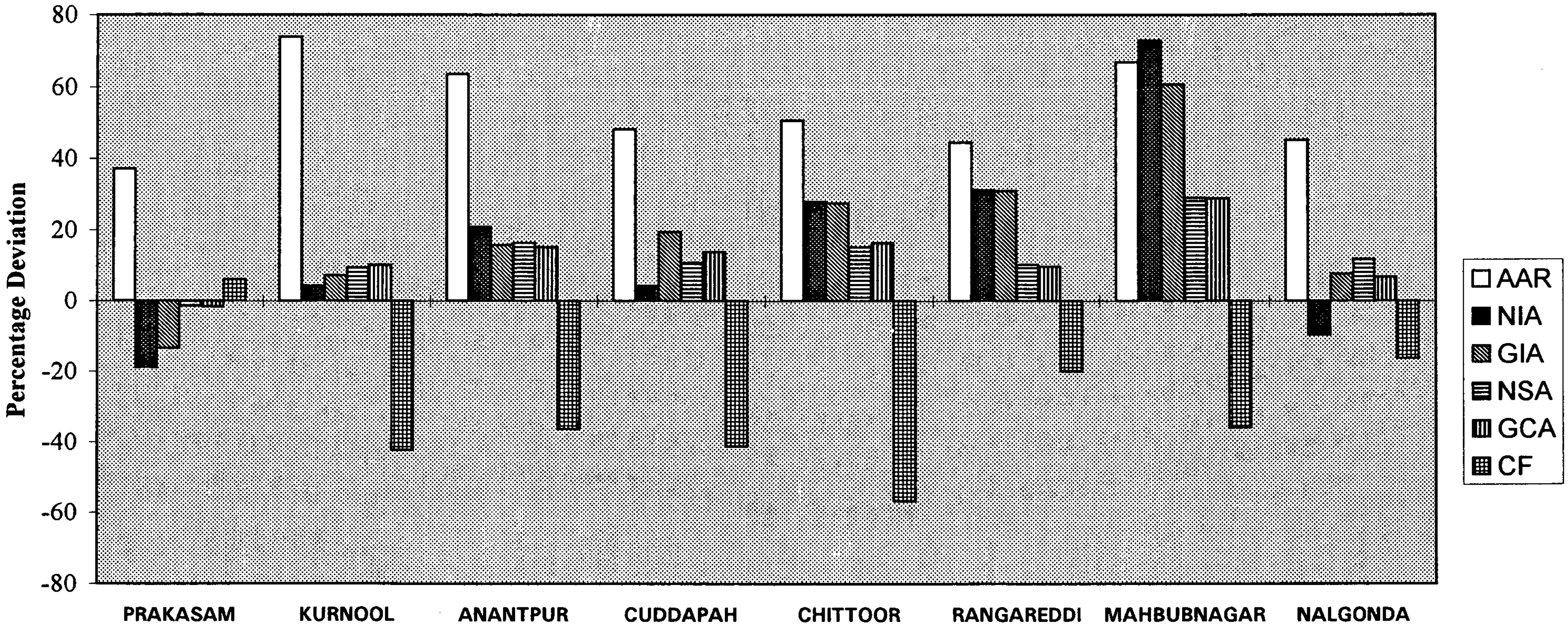
Kurnool with 42.54 percent of decrease in production of jowar from 2,04,992 tonnes to 1,17,790 tonnes during the years 85-86 and 1986-87 has shown the highest sensitivity. Moderate sensitivity of 12 percent has been shown by Mahbubnagar and Anantpur whereas Rangareddy and Prakasam showed an increase in production change. (See Diagram 5.3a)

The production of groundnut in Prakasam did not get hampered due to the deficient annual rainfall during 1986-87. Chittoor and Mahbubnagar had percentage decrease of 35 percent and 41 percent respectively showing a high positive correlation. High negative correlation is seen in the groundnut production of Prakasam which had an increase of 95.96 percent from 17807 tonnes to 34875 tonnes. The rest of the districts showed a moderate percentage increase of production over the two years 1985-86 to 1986-87.

The production of total pulses, crops has shown a decreasing change of 33 percent in Telangana districts. In Rayalaseema, except Anantpur, the rest of the

5.1 (b)

Deviation of 1987--88 Rainfall, Irrigated Area, Cropped Area, Current Fallows Over 1986-87



AAR = Average Annual Rainfall; NIA = Net Irrigated Area; GIA = Gross Irrigated Area

NSA = Net Sown Area; GCA = Gross Cropped Area; CF = Current Fallows

three districts Chittoor, Kurnool and Cuddapah showed the high sensitivity of 54.32 percent, 36.83 percent, 27.39 percent decrease respectively.

5.2 EFFECT OF POSITIVE RAINFALL DEVIATION (1986-87 TO 1987-88)

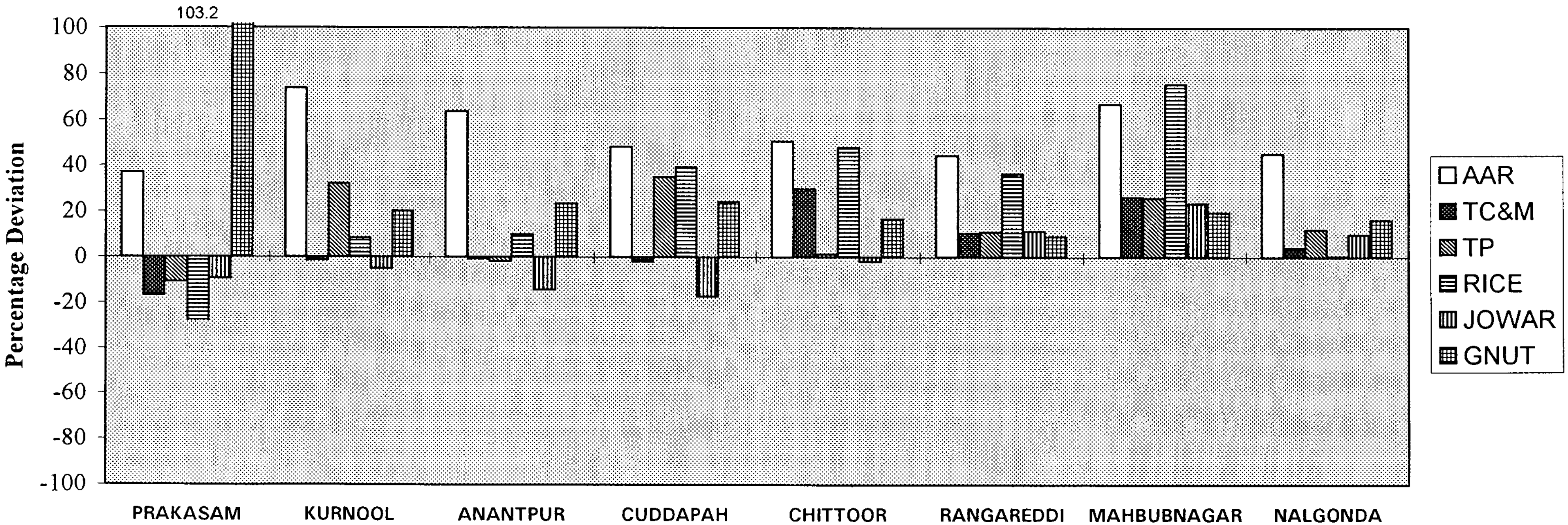
The average annual rainfall during the years i.e. 1986-87 and 1987-88 has shown a consistency in high increasing percentage change over all the eight drought prone areas. Correspondingly there has been a increasing percentage in their net sown area. A strong case of positive correlation is seen here. Whereas the current fallow has shown a high percentage decrease, confirming the case of negative correlation.

Except for Prakasam which showed a slight decrease of 1.66 percent, all the rest of the drought districts exhibited a moderate sensitivity to rainfall deviation by showing an increasing percentage change of net irrigated area and gross irrigated area. Mahbubnagar showed a high percentage increase of 72 percent of net irrigated area and 60.68 percent of gross irrigated area. (See Diagram 5.1b)

Similarly, the gross cropped area has shown slight sensitivity to rainfall deviation. The area under non-food crops has shown a consistent increase. While in the food cropped area there is an inconsistency observed among the districts. This indicates that the favourable rainfall conditions has allowed the

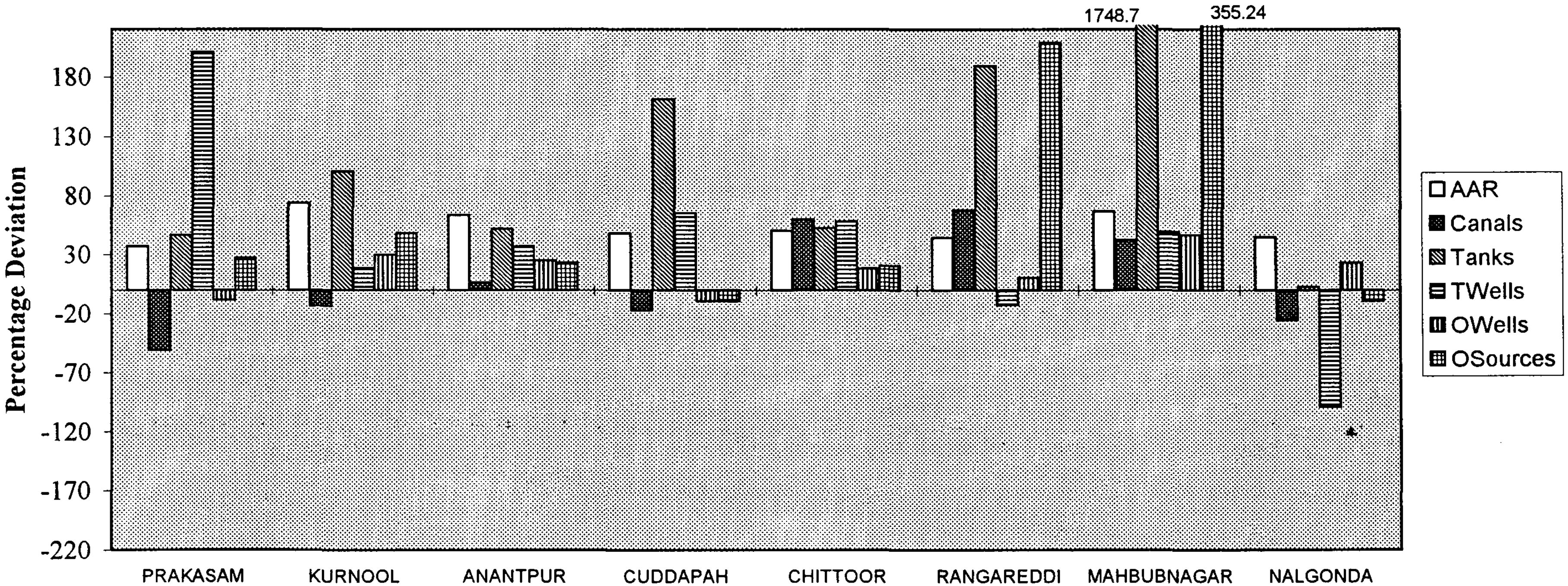
5.2 (b)

Deviation of 1987-88 Rainfall and Area under Different Crops over 1986-87



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

5.4 (b) **Deviation of 1987-88 Rainfall and Source-wise Irrigated Area Over 1986-87**



AAR = Average Annual Rainfall; TWells = Tube Wells
OWells = Other Wells; OSources = Other Sources

farmer a wider choice of crops to be cultivated. May be commercial crops are the more preferred ones. (See Diagram 5.2b)

In the source-wise irrigation though canals have shown a fluctuating tendency among the districts. Chittoor and Rangareddy exhibited a high percentage increase of above 60 percent although the area irrigated by the source is small when compared to the other districts. A high negative change is seen in Prakasam where the irrigation areally canals decreased from 95,253 hectares to 46,244 hectares during 1986-87 and 1987-88, a high 51.45 percent.

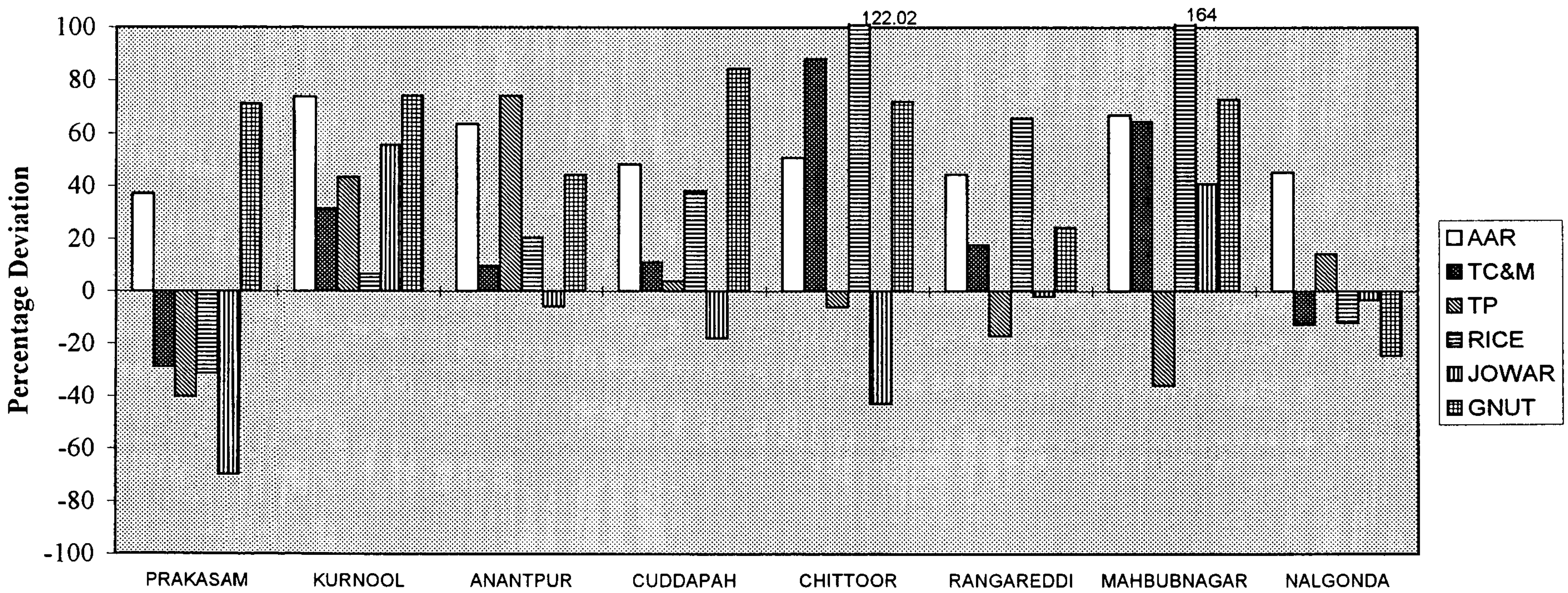
In the tank irrigation, the area under this source in Mahbubnagar has increased by 1748.70 percent i.e. from 844 hectares in 1986-87 to 15603 hectares in 1987-88.

However the irrigated area under tubewells, other wells and other sources did not show any significant change during these years. (See Diagram 5.4b)

While there has been a 39.30 percent decrease of area irrigated more than once in Anantpur from 10,438 hectares to 633 hectares. Cuddapah showed 170 percent increase from 9527 hectares to 25699 hectares. This shows that the irrigation by canals in Cuddapah might have been increased due to better rainfall conditions and water availability in the irrigation projects.

There has been no significant consistency shown by the drought prone districts in case of crop production and yield percentage change from the year 1986-87 to 1987-88.

5.3 (b) **Deviation of 1987-88 Rainfall and Production of Different Crops over 1986-87**



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

In rice production Chittoor shows a high increasing percentage change of 122.02 percent (from 88152 tonnes to 19711 tonnes) and Mahbubnagar shows an increase of 164 percent from 53536 tonnes to 141333 tonnes) during the years. The other districts show a marginal increasing change with moderate sensitivity to the positive rainfall deviation. (See Diagram 5.3b).

In jowar production Mahbubnagar and Kurnool show a positive correlation of increasing change with rainfall. Their percentage increase is about 40 percent and 56 percent respectively.

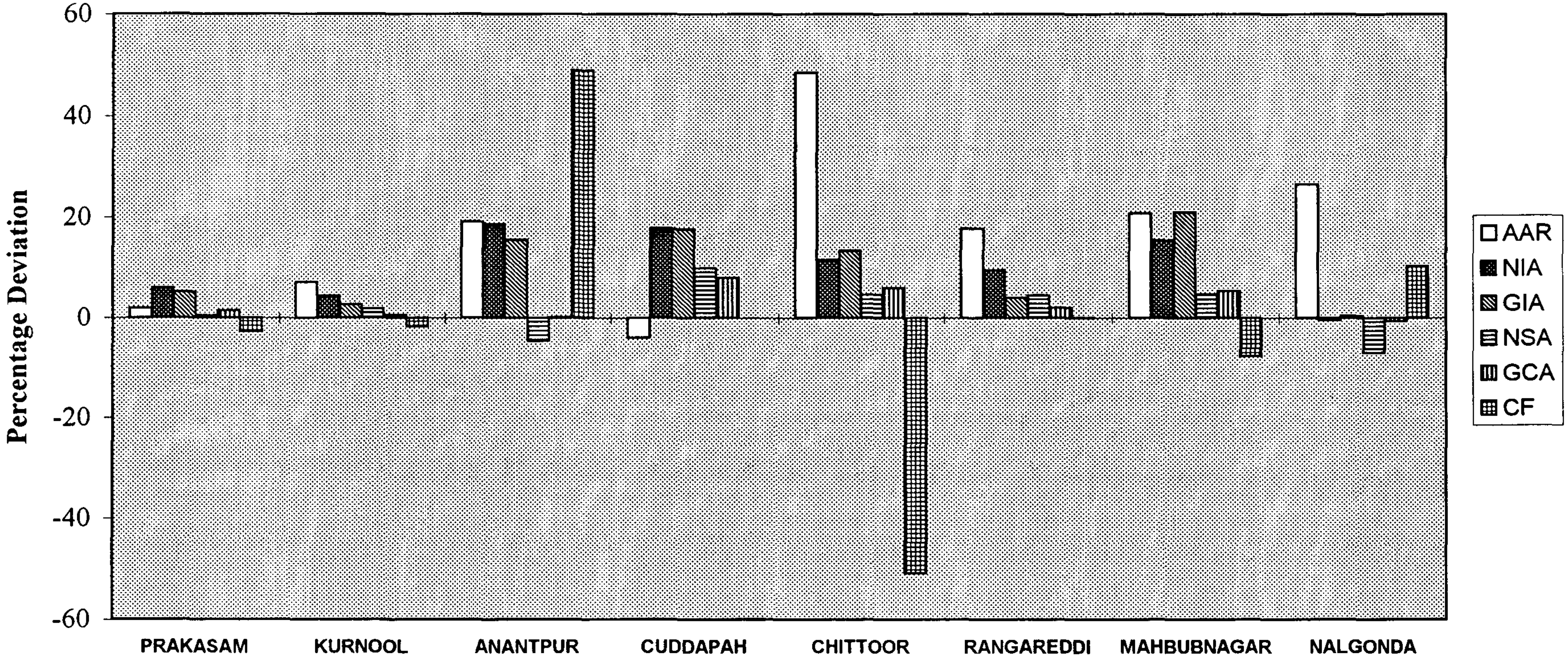
The groundnut production has shown high positive correlation with the high percentage increase shown by all districts (between 44 percent to 85 percent) except Nalgonda which recorded a decrease of production of 24.87 percent from 42118 tonnes to 31693 tonnes.

In the total pulses production, while Rayalaseema showed a positive increase of 28 percent the districts of coastal Andhra and Telangana (Prakasam, Rangareddy and Mahbubnagar) shared sensitivity in the negative direction of rainfall deviation with a decreasing change of 18 percent to 40 percent.

The average and normal yield of principal crops in Chittoor has been utilised for the study of trends in variability for the years 1988 to 1994. Crops during kharif and rabi seasons are considered for the study. Except sugarcane which is an annual crop the seasonal crops whose change in yield was considered are rice, jowar, bajra, ragi and groundnut.

5.1 (c)

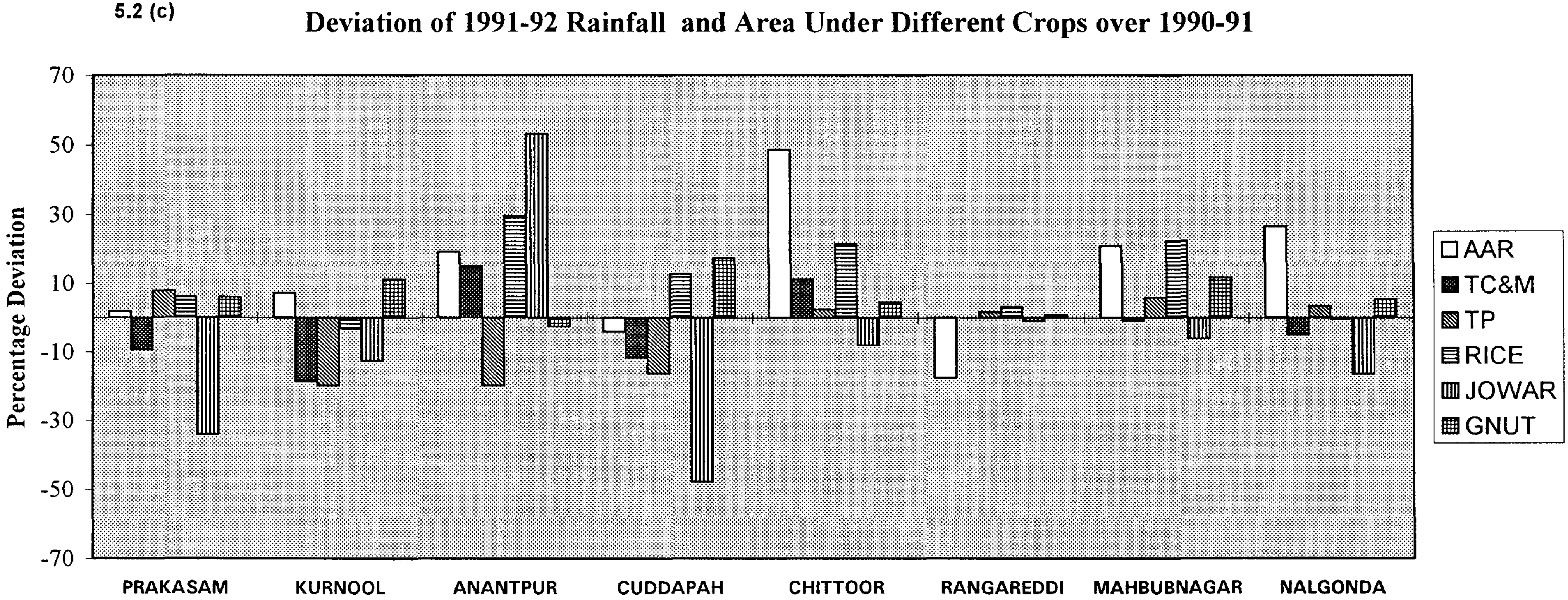
Deviation of 1991-92 Rainfall, Irrigated Area, Cropped Area, Current Fallows Over 1990-91



AAR = Average Annual Rainfall; NIA = Net Irrigated Area; GIA = Gross Irrigated Area

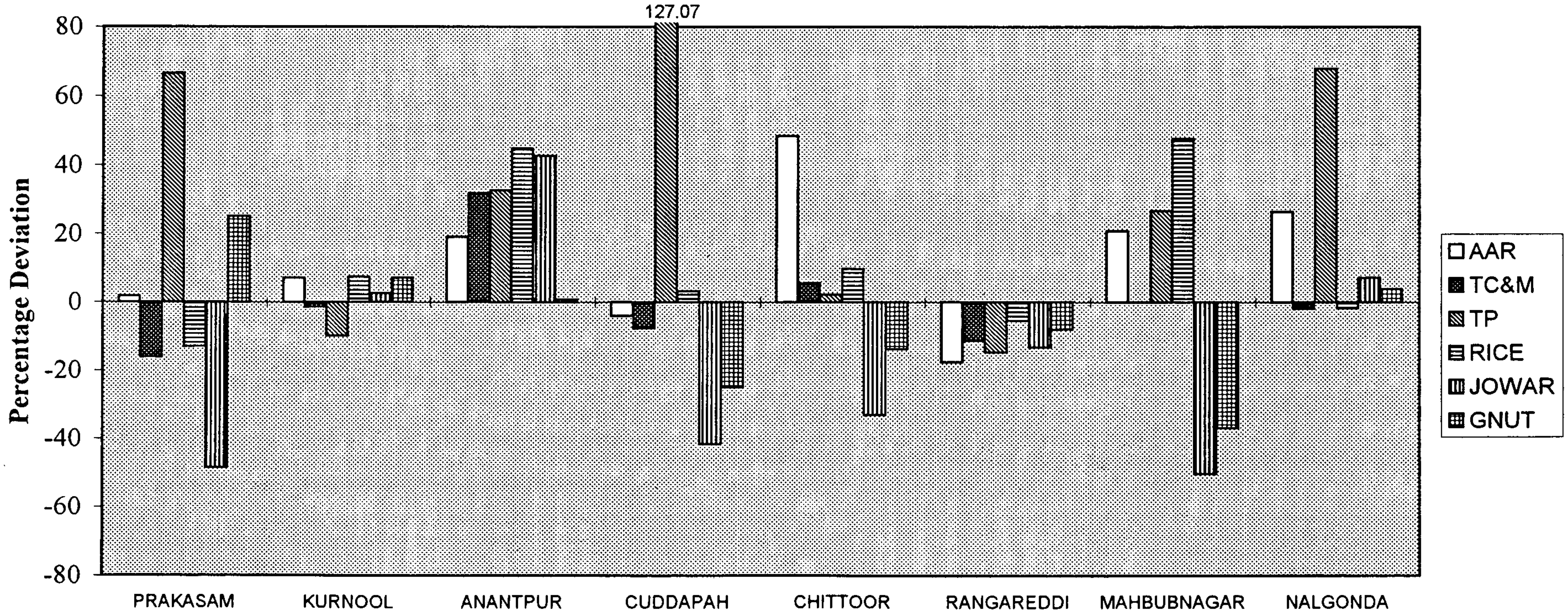
NSA = Net Sown Area; GCA = Gross Cropped Area; CF = Current Fallows

5.2 (c)



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

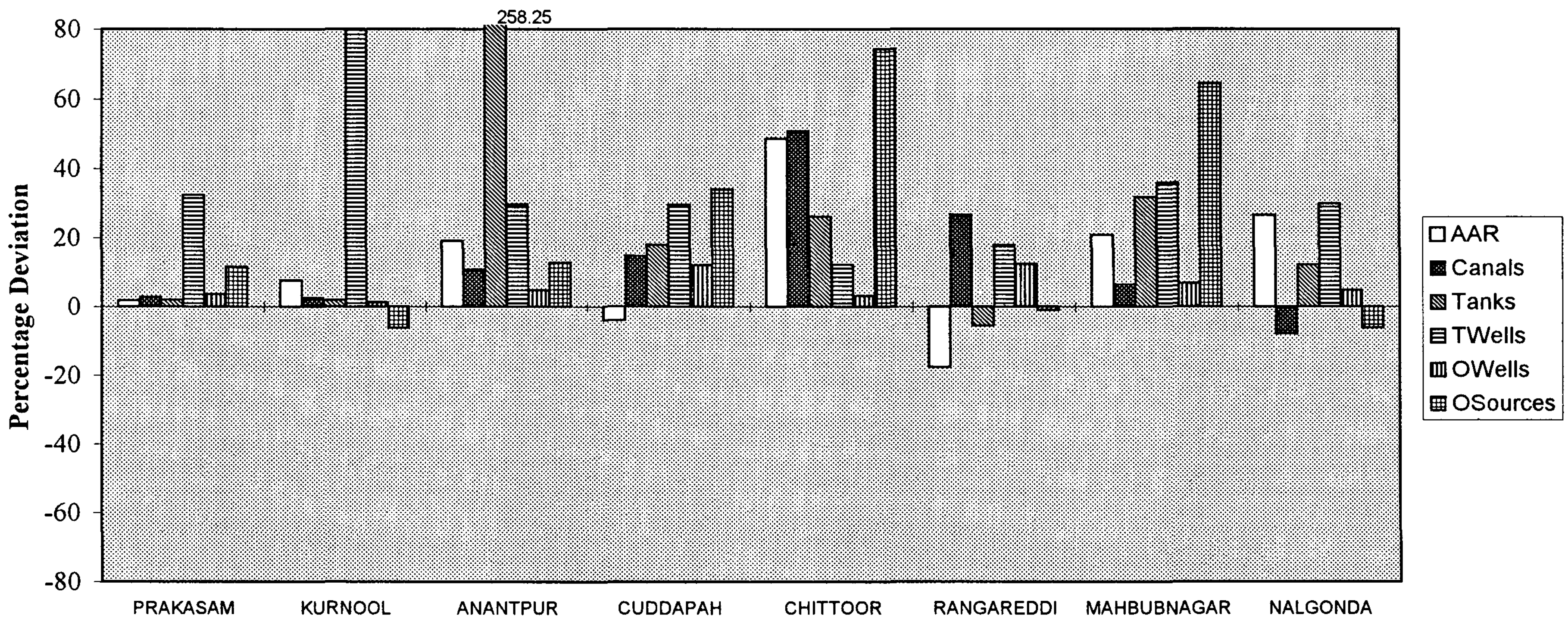
5.3 (c) **Deviation of 1991-92 Rainfall and Production of Different Crops Over 1990-91**



AAR = Average Annual Rainfall; TC&M = Total Cereals & Millets;
TP = Total Pulses; GNUT = Groundnut

5.4 (c)

Deviation of 1991-92 Rainfall and Source-wise Irrigated Area Over 1990-91



AAR = Average Annual Rainfall; TWells = Tube Wells
OWells = Other Wells; OSources = Other Sources

The out-turn of rice and its yield is found to be decreasing over the years while the out-turn and yield of Ragi has increased during the years. The out-turn of groundnut and sugarcane has been increasing.

Similarly the percentage deviation of 1991-92 over 1990-91 have been diagrammatically depicted in Diagram 5.1c, Diagram 5.2c, Diagram 5.3c and Diagram 5.4c. No definite consistency nor any correlation has been found between rainfall variability and other factors like source-wise irrigation, cropped area and crop production.

The livestock population also recorded a significant decrease in percentage during the years of study (See livestock in agriculture in Drought Prone Areas of Andhra Pradesh as in Chapter - 4). In the present study it is observed that the cattle and buffallo population decreased in number during these years rainfall deficiency. Dairying is considered less vulnerable to the negative rainfall deviation. The resultant effect of decrease in milk production which inturn has a serious affect both on the nutrition and income of the farmers. The lack of rains and decreasing rainfall deviation causes serious water and fodder shortage which may compel many farmers to sell their livestock, since all of them cannot afford to purchase fodder from very distant places.

As a consequence of decline in cropped area and livestock population the human labour employment records a significant decline. The technological developments in agriculture resulted in huge surpluses in foodgrain production in some parts while the impact of negative rainfall deviation affects the local farm economy. During these times the farmers expect help from the government in the form of increased food rations through Public Distribution System, supply of inputs (fertilizers and plant protection chemicals) and fodder. The employment generation programmes are the need of the hour. (The Welfare Approach discussed in the Chapter Seven). They may prevent the farmers to migrate to the neighbouring villages and cities.

In the study area of drought prone Chittoor despite a low level of irrigation and low and variable rainfall the variability of output has increased during the years of study. This may be due to the stronger resource position of farmer and the higher relative index of development of the district (See Table 5.01 in the next page). Ragi-Finger millet has shown a high rate of growth of output in the district.

The analysis of agriculture tends to suggest that development of irrigation from assured sources holds the key to reducing instability in agricultural output. Paucity of resources and the low priority given to this crucial sector are responsible for the slow growth of irrigation.

Agricultural research can play a major role by evolving cropping systems which enable the use of arable land for the maximum duration of time in a year

Evolving techniques for water harvesting and moisture conservation will enable the farmers to withstand droughts.

TABLE 5.01: AVERAGE AND NORMAL YIELD OF PRINCIPAL CROPS IN CHITTOOR DISTRICT

Crops	Season	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
Rice	Kharif	2069	2344	2183	2025	1957	2116
	Rabi	2360	2071	2722	2550	1669	2274
Jowar	Kharif	782	1155	1255	909	785	977
	Rabi	892	1201	971	1086	1311	1092
Bajra	Kharif	1388	909	1600	1341	1181	1284
	Rabi	1388	909	1600	1341	1181	1284
Ragi	Kharif	888	918	1035	1125	648	923
	Rabi	2243	2005	1363	1727	1572	1782
Groundnut	Kharif	885	839	1291	1004	760	956
	Rabi	2097	2128	2114	2109	2342	2158
Sugarcane	Cane	87584	70190	76765	78769	73988	77459
	Gur	-	-	-	-	-	-

Source: Outline of Agricultural Statistics, Directorate of Economics & Statistics, Government of Andhra Pradesh.

Of the two components of agricultural growth, namely cultivated area and yield per acre, the latter is far more sensitive to rainfall than the former. In the early phase of planning the expansion in cultivated area as a source of growth was much more important than in the recent times. The declining importance of area expansion, which is a relatively stable component of growth and the rising significance of yield, an unstable component, explains to a certain extent the increase in the amplitude of fluctuations in agricultural output. Further with the area ceasing to expand significantly, there is a greater competition for the given area between food grains and non-foodgrains. Thus when rainfall is favourable, more area is allocated to foodgrains whose yield per hectare will rise. The converse happens in the event of failure of rainfall.

A good part of the irrigated area is dependent on tanks and wells which are themselves dependent on rainfall. Over the second half of 1980's irrigation through canals has lessened. Previously during the 1960's, canals used to irrigate more area during the years of low rainfall. But now the irrigated area by canals is showing a clear tendency of decline in the years of low rainfall. The increase in complementarity between the new technology and water, and the rising sensitivity of surface irrigation to rainfall have an impact on the rise in sensitivity of crop outputs to variations in rainfall. This analysis indicates that the agriculture in the drought prone districts are sensitive to rainfall variation. Although, the degree of sensitivity varies from district to district. The most sensitive districts are Chittoor and Mahbubnagar. In the other districts it is only marginal, generally less than 10 percent.

This analysis indicates that the drought prone districts are sensitive to rainfall variation although the degree of sensitivity varies. The most sensitive districts are Chittoor and Mahbubnagar and in other districts it is only marginal generally less than 10 percent.

5.3 DROUGHT AND AGRICULTURAL PRODUCTIVITY

The inverse relationship between drought and food production is well established (Kaushalya Ramachandran, 1992). Drought is essentially caused due to deficiency in rainfall received. Although irrigation during crucial states of crop phenophases - seeding, vegetative, reproductive, grainfilling - can save a crop and augment foodgrain production drought adversely affects even the irrigation potential.

A regression analysis which was done to find out the correlation between magnitude of drought; inferenced by the total area affected by drought; and foodgrain production productivity and crop acreage in kharif and rabi. It was found that a significant relationship existed between magnitude of drought and cropped area in kharif season. This relation can be stated as follows

$Y = 83.03814 - 03088\ x$

$R = 0.59\%$

With every one million hectare drought area, any year, 0.03 million hectares or 30,000 hactares of good kharif cropping land lies fallow[1]. (Dhawan, B.D. 1993)

[1] Dhawan B.D. Trends & New Tendencies in Indian Irrigated Agriculture. Commonwealth Publishers, New Delhi, 1993.

The temporal changes in the area under different land use categories were analysed using the landuse budgeting model (C.A. Ramarao et al, 1994). whereas the area under agricultural sector recorded a positive growth in Telangana, it showed a declining trend in Rayalaseema and in coastal Andhra, it did not show any significant trend. The growth in agricultural sector in Telangana is taking place at the cost of ecological sector. The area put to non-agricultural purposes is expanding in Rayalaseema drawing the land away from the agricultural and ecological sectors.

The Operational Research Project formulated for Drought Prone Areas of Andhra Pradesh took a closer look into the technological inputs - improved seed and fertilizers. The input use in the drought prone areas was found to be conspicuous in irrigated paddy crop and rainfed castor cash crop. The increase of inputs for sorghum based cropping systems was marginal and inconsistent. The plant protection continues to suffer poor adoption.

For the efficient utilization of limited growing season (124 days), intercropping system of sorghum & pigeonpea was found to be optimum for the semi-arid red soils of Telangana (Shelke, 1977) - The stability and efficient utilisation of season was studied by (Rao and Willey 1979, U.M. Bhaskara Rao and K. Vijaya Lakshmi, 1986) and how it capitalises on good rainfall years.

The determination of the start, end and duration of the rainy season and their variability and the mid-season dry spells during the rainy season for evolving contingency crop planning in Andhra Pradesh is studied by (U.S. Victor et al. 1991)[2] .

TABLE 5.02 : CHARACTERISTICS OF RAINY SEASON

District	Start of Rainy Season			End of Rainy Season			Length of Rainy Season		
	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean
	STANDARD METEOROLOGICAL WEEKS								
Hyderabad	21	27	24	38	50	42	26	14	18
Nalgonda	20	27	24	37	49	43	29	11	19
Mahbubnagar	20	27	24	38	50	42	26	14	17
Kurnool	24	27	26	38	48	43	22	12	17
Cuddapah	24	30	27	42	50	46	25	15	19
Anantpur	5	31	28	39	50	44	20	9	16
Chittoor	25	31	27	44	51	48	28	16	22
Prakasam	20	29	25	43	51	47	28	17	22

(The rainfall accumulates to 75 millimeters by the starting week is adequate for land preparation in sowing of crops. The rainfall of atleast 50 millimeters can be expected after the end of rainy season.)

Source: Victor et al., 1991.

[2] Victor U.S., Ramana Rao B.V., Srivastava N.N., Vijaya Kumar, P. "Rainy Season and its Variability for Contingency Crop Planning in Andhra Pradesh", Indian Journal of Dryland Agriculture Research and Development, 1991, Vol.6 Nos. 1&2, pp.1-12.

Standard Meteorological Weeks Excess of rains and drought were found to be real constraints in the adoption of technology in drylands (Shaik Haffis et al, 1990) while conducting Kruskal-Wallis one way ANOVA Test by Ranks between the varieties of sorghum and castor.

Progress in some pockets - in terms of minor irrigation, dairying and sheep development, and tracterization (to counter the constraint of a very short wet period) (Jodha, 1974) suggests some improvement in resource development of drought prone areas.

Of the two components of agricultural growth, namely cultivated area and yield per acre, the latter is far more sensitive to the weather than the former. (CH. Hanumantharao, 1994).

The changing pattern of crop landuse and crop regions in the dry farming areas of Anantpur which are predominantly drought prone is studied by Y.V. Ramanaiah and Y.V. Kumar Reddi.

It has been observed that in the drought prone areas of Andhra Pradesh, ground nut based and sorghum based agriculture is dominant. Therefore in the present study the new scientific research and strategies to improve the agricultural productivity of groundnut and sorghum with works on other crops have been reviewed. The works done by CRIDA, ICRISAT, ICAR, APAU figure prominently in the review of literature on scientific research.

The inter-annual variability of yield of ground nut as affected by rainy days is studied by A. Yogeswara Rao, 1992. the shallow depth red sandy loams (Alfisols) predominate the district covering 82 percent of cropped area in Anantpur.

Drought Management

CHAPTER SIX

The major economic activity in the drought prone areas is agriculture. Therefore the management of drought is mainly concerned with improving dryland farming. In case of moderate drought these improvements can ameliorate the drought situations. But when severe drought occurs the State and the Central Government takes initiative to manage the drought. In this Chapter the attempts at improving dry farming techniques, organisational response to drought and watershed approach to drought prone area development are discussed.

6.1 EFFORTS AT IMPROVING DRY FARMING TECHNIQUES

In the past, some limited efforts were made to improve the dryland farming but these efforts were limited to a few locations and only to some aspects of dryland. The first effort to evolve solutions based dryfarming research was initiated by Indian council of Agricultural Research (then called Imperial council of Agricultural Research) in 1930's in five locations Sholapur, Bijapur, Hagari, Raichur, Rohtak. These efforts could not make much impact due to various reasons (Jodha, 1983). But this research was terminated much before the scientists could fully understand the problems and evolve solutions.

A package of practices, popularly known as Bombay Dry Farming System (BDF) was developed and recommended (Kanitkar et al, 1960). But BDF failed to attract farmers largely because it was resource-centered and did not have strong crop-centered components in terms of improved varieties which could reflect the benefits of soil moisture conservations in short run.

During the last two decades the drought prone areas received increased attention. Some initiative has been taken to improve the agricultural scenario by the government as well as non-governmental and voluntary organizations in an integrated way.

Agriculture in the drought prone areas has to bear the pangs of vagaries of monsoon rains. There are at least four important aberrations in the rainfall behaviour: (i) The commencement of rains may be quite early or considerably delayed. (ii) There may be prolonged "breaks" during the cropping season. (iii) There may be spatial and / or temporal aberrations. (iv) The rains may terminate considerably early or continue for longer periods.

Drought leads to moisture stress which in turn, affects crop production adversely. With the era of hybrids and high yielding varieties of crops, particularly cereals, a replacement of the existing locals with these varieties will usher in better crops in drylands. Rainfall being a random phenomenon, years tend to be as frequent (if not more) as the bad ones in the long run. In the present study crop varieties to suit normal and late sowing conditions are identified and recommended as a contingent crop pattern.

On account of drought foodgrains production are adversely affected. As a result food scarcity prevails. To get rid of food scarcity, food security system and scientific agricultural production are on progressive stage.

Following are the important measures with few suggested opinions:

* Crop contingency planning and drought tolerance crops.
* Seed banks
* Optimum use of water resources
* Sustainable utilization of agricultural lands
* Role of institutional organization
* Proficiency concerning application of scientific methods in agricultural output.

6.2 AGRICULTURAL CONTINGENCY PLANNING

This includes choice of suitable crops, choice of suitable crop varieties, alternate crop strategies mid-season corrections and crop-life saving measures.

To increase productivity, the choice of crop cultivation according to congenial environment is utmost necessary. For example for bumper rice cultivation atleast 1500 millimeters rainfall is necessary. This cannot happen in the drought prone areas of Andhra Pradesh. As far as the choice of suitable crop varieties for these areas are concerned, High yielding varieties and Hybrid crops have become famous. Their per hectare output is comparatively higher than the pureline selected crops despite shortage of water.

Monsoonal rainfall has been always playing hide and seek with the farmers (small and marginal farmers) owing to this crops are not being sown in proper time which by and large affect the normal production. So to make efficient production under such circumstances alternate crop strategies are extremely important.

Mid season correction of drought affected crops are extremely important to maintain the good harvest ratooning and thinning methods may be imminent.

Since rainfall is limited in the drought prone areas, soil moisture conservation becomes absolutely essential, either for extended use or use at a later date. Basically soil moisture conservation process is known as crop life saving measure which include run off recycling, use of mulches, off season tillage, etc.

Many varieties of drought tolerant seeds have been invented for better productivity. For this, physiological approach is supposed to be very important.

SEED BANK

Seed bank is an essential requirement for the success of contingent crop output. Actually farmers are unable to stock seeds according to circumstantial change. That is why they fail to sow proper crops at suitable time. Thus, it is the duty of local governmental bodies to store the seed of several varieties which may come in handy during the natures unfavourable situation.

FODDER BANKS

Perhaps the best that can be done is to follow the contingent plan for crop production as suggested above when alternate fodder as a byproduct would be available from arable lands.

ON FARM DECISIONS

A well managed crop with at least moderate fertility levels would stand the moisture stress more effectively.

Various means of utilization of water includes typology of irrigation system with conservation of ground water resource to sustain irrigation activities construction of embankments, bunds, check dams and so on are amongst the strategies to cultivate the agricultural land to maintain soil moisture condition for sufficient plant growth during the rainless days sometimes over irrigation and water logging accelerate, salinity and soil leaching process. Stress has been given time again for developing a suitable irrigation system for adoption in drought prone area. Conservation of scanty rainfall by arresting the run off is still to be developed in this domain. It is a fact that large amounts of foodgrains are still produced under erratic rainfall condition.

For example for groundnut which is widely grown in Rayalaseema, the choice of crop varieties for different sowing times may be as below:

Normal	-	KADIRI 1
Late	-	TMV 2 or KADIRI 3

Sowing of crop depends on onset of rains in the drought prone areas. But the rains may commence quite early or may be delayed considerably. And the same crop cannot be sown over time as the yields may be reduced because of pests and diseases or shorter growing season.

There could be moisture stress during the growth of the crop. If it is at a very early stage, i.e. within a week to 10 days of sowing it is better to resow with subsequent rains than allowing inadequate plant stands to persist and yield a poor harvest. On the other hand if the crop grew for 40-50 days, other means like ratooning and thinning need to be considered. But ratooning is a high management technique and success depends on the general vigour of the drought affected crops like Sorghum (jowar). For intermediate crops like castor and pigeonpea, if the drought affected plants were seen to recoup with the revival of the rains use of 2-3 percent urea spray will be useful after the foliage wetted with the rains.

In situ water harvesting (ridge and furrow), runoff, recycling, use of mulches, off-season tillage and fertilizer use are some of the crop life-saving measures. Storage of the moisture either for extended use or use at a later date should be considered. (See Annexure-V for the list of schemes eligible and non-eligible for inclusion under Drought Prone Area Programme).

Some beneficial practices which will help the farming are:

1. Deep ploughing once in three years with "Peddamadaka" or tractor drawn plough.
2. Opening dead furrows at 3.6 meters intervals across the slope with bullock drawn wooden plough.
3. Use of three tyred or four tyred "Eenati Gorru" for placement of seed and fertilizer simultaneously.
4. "Asha Guntaka" can be used for harvesting (tractor drawn) groundnut particularly when the field is dry making harvest difficult.

The recommended crops and varieties of drought crop varieties in Appendix for Rayalaseema and Telangana are in Appendix-8.

Water conservation is vitally important to agriculture in all environments and relatively more so as climates become more arid (A.L. Cogle and K P C Rao, 1994). The soil management aspect of water conservation on rainfed agricultural lands, specifically crop based systems should be given greater emphasis.

An understanding of how agroclimatic and variables affect crop farming in the drought prone areas is necessary before studying the production patterns and dynamics of resource use. One of the main sources of productivity growth in dryland agriculture in India in the 1980 and 1990 is varietal change. In the present study we take stock of same promising varieties in the food crops -

Sorghum, pearlmillet, pigeonpea and groundnut, and their intercropping in the alfisols of Telangana, Sorghum (Sorghum bicolor) is an important food crop in this regions of Andhra Pradesh. Studies have been conducted on the rainfall pattern and soil moisture regime of sorghum based intercropping system (Rao, 1983). Jowar (Sorghum bicolor) - Pigeonpea (Cajanus cajan) is an established intercropping system (Aiyer, 1949) keeping sorghum as base crop, short duration legumes like, cluster bean (Cyamopsis tetragonolola) and greengram (Vigna radiata) were also tested as intercrops (Andrews 1972, Osiru and Willey 1972).

Anantpur has 70 percent of total area under groundnut, the highest among all the drought prone districts of Andhra Pradesh which produces 25 percent of the total state production. Chittoor and Cuddapah follow it with 60 and 51 percent area under groundnut. A considerable cropped area is under Jowar and Rangareddy (43 percent), Mahbubnagar 36 percent and Kurnool (30 percent).

Cuddapah has 20 percent of its area under jowar with Nalgonda and Prakasam having 19 percent and 16 percent respectively coming down in the order.

Nalgonda has 24 percent of the area under castor crop Mahbubnagar with 11.5 percent and Rangareddy with 10 percent have area under castor, which is chiefly due to dry climate of this region.

The scarce rainfall zone of Rayalaseema receives the lowest rainfall ranging from 500 to 750 millimeters where dryland agriculture assumes greatest importance. The regions practicing dryland agriculture are characterised by uncertain and erratic rainfall, recurring droughts and unstable crop production. The annual average rainfall ranges from 544 (Anantpur) to 823 (Chittoor). The Telangana region on the other hand receives 700 millimeters to 1050 mm, while Prakasam of coastal Andhra receives 754 millimeters.

The fertility of red soils are universally poor in nitrogen, phosphorus and zinc. In areas of continuous cropping, calcium is found to be deficient (soils under groundnut), whereas the black soils in general have high reserves of potassium, secondary nutrients and micronutrients. Hard pan formation due to continuous cultivation may limit the feeding zone for roots.

Rainfed fruit crops should be introduced with improved techniques of propagation like in-situ grafting to reduce mortality rate etc.

ADAPTATION OF FRUIT CROPS TO DROUGHT

Plant phenology and developmental activity have a decisive effect on growth and yield under conditions of water stress. Most of the dryland fruit plants like Annona, ber, phalsa, pomegranate, jamun and guava abscise their shoot tips whenever water stress is felt and restrict the demand for water by checking the new growth under unfavourable soil moisture condition. Many of the dryland fruit crops like ber, jamun, annona exhibit sylloptic branching to maximise their growth and productivity and shed their leaves during summer months to postpone dehydration. They have thick epicuticular waxes to reduce the cuticular transpiration and increase the turgidity. One of the limiting factors for raising of the fruit orchards is the long gestation period.

The semi arid fruit crops that are best suited to Andhra Pradesh are given in the Appendix-VIII

TIMBER / FUELWOOD

These plantations can be effectively and conveniently raised on community lands and private lands not suited for agricultural production usually classified as classes V, VI, VII lands. This is close to a normal afforestation programme. Effective closure of the area by fencing would be very useful. They may be in the form of stone wall barbed wire, cattle proof, live hedge etc. An acceptable combination of the latter two can be advocated.

The suitable species for the timber and fuel plantations for the drought prone areas are given below in the Table 6.01:

TABLE 6.01 : TIMBER / FUELWOOD

SPECIES	USE
Eucalyptus (hybrid)	Fuel
Prosopis juliflora	Fuel
Acacia nilotica	Fuel, Tanning, Fruit
Acacia tortilis	Fuel, Tanning, Fruit
Cassion siamea	Fuel
Azadirachta indica	Fuel / Timber & Oilseed
Pongamia glabra	Fuel / Oilseed
Albizzia lebbek	Timber and Fuel
Dabergia sissoo	Timber and Fuel

All these can be raised in staggered contour trenches which help in harvesting the runoff and moisture conservation and also in providing a good and hospitable seed bed. Prosopis juliflora though not a good fuelwood or timber has been included with the objective of raising a very sturdy aggressive resilient plant which can establish easily and withstand man's onslaught whatever be its intensity and frequency. If it can be managed with little care, the timber / fuel plantations will serve the drought prone areas very well.

JATROPHA - A MULTIPURPOSE PLANT

Jatropha (*Jatropha carcus L*) is a wild relative of castor. Unlike castor Jatropha is perennial in nature. Armed with the hardiness to withstand moisture stress over long rainless periods Jatropha seems to adapt well to drylands.

It has a short gestation period of about 3 years and an estimated long productive life of about 50 years. The plant has several uses; its latex has medicinal value, roots are used to prepare yellow dye, oil from beans is utilised as lubricant, in illumination for combustion falls, varnishes, soaps, organic pesticide, etc. Rehabilitation of wastelands with Jatropha is expected to pose less problems since it is not browsed by animals. Thus it can be introduced in the drought prone areas as a part of the agricultural contingency plan.

FODDER AND FORAGE CROPS

Because of pronounced recurrent drought in these areas, it would be necessary to ensure fodder production by introducing a component of trees and shrubs which are established livestock feed. The species which would do well in the drought prone areas of Rayalaseema and Telangana are:

TABLE 6.02 : FODDER AND FORAGE CROPS

Hardwika binnata	*Acacia arabica*
Albizzia lebbek	*Azadirachta indica*
Prosopis spicigera	*Acacia tortilis*
Leucaena leucocephala (subabul)	*Dalbergia sisso*
Dendrocalamus strictus	*Acacia albida*

If the above trees are intermingled judiciously with shrubs like desmodium intortum and / or Alysicarpus rugosus will be an ideal addition to the existing grasslands for insurance against drought and erosion.

FODDER CROPS

The drought prone areas are already endowed with good breeds of cattle livestock rearing plays an important role in the economy of these areas. Strengthening of this programme necessarily involves expanding, improving and managing the grasslands. Production from grasslands is subject to lesser fluctuations than production from marginal agricultural lands, more so in the drought prone areas. Every effort has to be made to introduce good quality and nutritious grasses like cenchrus and legumes like Stylosanthes hamata.

The succession stage met within the red soil areas is given below:

Aristida stage

Heteropogon stage

Chrysopogan stage

Sehima stage

The percentage of key grasses chrysopogan and Sehima are 72 percent and 86 percent. it takes 4-6 years to reach the Sehima stage.

Similarly, the succession stage met within the black soils are:

Aristida stage

Eremopogon stage

Bothricochlora stage

Dichanthium stage

The last stage can be achieved in about 4-5 years.

The promising Forage crops which are adopted by farmers in Telangana are Maize-African tall; Sorghum-APFS-3 (as multicut) and CSH 13 R(dual purpose hybrid suitable for single cut) Guinea grass - PGG 14, Berseem JHB-SSB-86, bajra - APFB 2 and Lucerne LH 84.

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LIVESTOCK

Our country has the worlds best breeds of dairy buffaloes like Murrah, Nili Ravi, Surti, Jaffarabadi and Bhadawari. Draught cattle like Ongole, Hariana, Kankraj, Kangayam, Nagor are very popular. Carpet wool sheep are Magra and Chokla, and goats. Jamunapari and Beetal. These livestock are better adapted to the adverse tropical conditions of heat and humidity and are resistant to most of the tropical diseases.

Indian breeds though well adapted to tropical climate are poor producers. Crossbreeding with improved exotic breeds was adopted to improve the productivity of Indian breeds. In cattle, a number of new genotypes namely Taylor, Jersindh, Karan swiss, Karan fries, Sunandini and Fries, Sunandini and

Friewal Punganur Cow and Hill have been evolved. Among buffaloes the new breeds are Mehsana and Godavari. The new high producing strains of sheep which are evolved are Avikalin (Superior carpet wool). Avimanns (Mutton) Avivastra (Apparel wool) and Bharat Merino Nellore Jodipi N Palla N Brown. Bharat Merino fine wool synthetic is as good as Rambouillet and Merino purebreds.

Rabbit farming both for wool and meat has been accepted by the farmers as a full time occupation in the study area. broiler rabbits are Soviet chinchalla, White giant, Grey giant, New Zealand white, German Angora is for wool.

Two hybrids of poultry broilers - IBL - 80 and IBB - 83 and three layer strains ILT - 80, ILR-90 and ILM - 90 are developed and released. They are comparable to the international commercial stocks available in the market.

Among the pigs, in Chittoor district Large White Yorkshire crossbreed was adapted.

6.3 ORGANISATIONAL RESPONSE TO WIDESPREAD DROUGHT

India, fortunately less frequently experiences widespread drought. Nevertheless whenever it occurs, the economy is badly affected. Severe widespread drought occurred in the years 1918, 1965, 1972, 1979, 1982 and 1987. Over the years India was able to reduce the adverse effect of drought. It is worth summarizing the organisation response in India to widespread drought. The best effort was made in the year 1987.

The crop weather watch cell of the Ministry of Agriculture keep a close monitoring of the drought situations in the country. Whenever the drought situation worsens, a very high level committee is formed to formulate strategy to meet the drought situation and to monitor the implementation of the strategy. In 1987 when widespread failure of southwest monsoon noticed in the mid-July a cabinet committee on drought been formed at the union level. This committee initiated an actionplan. The main components of the action plan were (1) optimization of the reservoir water use to improve the rabi cultivation, (2) Assurance of adequate power supply, (3) Provision of drinking water, (4) Strengthening of the public distribution system, (5) Measures to provide adequate fodder and nutrients for the health and preservation of cattle and (6) Intensive use of technology package for extension and inputs.

The timely action and proper coordination checked the adverse effects of the drought. The overall fall in foodgrain production was only 7 percent over the previous year. Infact there was an increase of 2.8 percent in rabi production. However it should be noted that the late monsoon rain in many of the drought affected areas helped to tideover the situation.

The 1987 drought management, all said and done, is a fire fighting exercise. It is necessary to make the drought prone area self-sustaining. With this objective a technical committee under the Chairmanship of Prof. C.H. Hanumantha Rao was constituted in the April, 1993 to review the Drought

Prone Area Programme (DPAP) and the Desert Development Programme (DDP) and to recommend the steps to be taken to achieve the objectives of above mentioned programmes. The technical committee recommended the harmonious management of development and utilization of land, water and vegetation resources on watershed basis and the creation of complementary opportunities for processing and marketing opportunities for processing and marketing of value added goods produced in such areas. It also emphasises the participation of the local people in the developmental process.

In view of the importance given to watershed approach in the development of drought prone area, this chapter attempts to evaluate this approach.

6.4 THE WATERSHED QUESTION

"Micro Watershed should be the basic management unit and in each selected block the micro-watersheds may be classified into high, medium and low priority areas according to their vulnerability to droughts"(Hanumantharao Committee Report, 1994). For a complete watershed approach one has to bring soil conservation measures, water conservation and storage measures, dry land farming, animal husbandry, afforestation and mirror irrigation as the minimum number of disciplines under a coordinated approach.

Watersheds as units planning have several advantages (Peter Hagget). Edaphic changes in soil and vegetation reflect location within the watershed as the physiography of the basin directly affect the hydrologic characteristics.

Watersheds therefore, form the appropriate units for intervention in soil and water conservation and crop planning etc. It constitutes an ideal areal ecosystem for planned development of natural resources.

In areas with scanty rainfall, watersheds are important controlling factors. One of the most important objectives of watershed, planning in the drought prone areas is to bring back the ecological balance through scientific use of the land, so that the soil erosion is minimum, rain water percolates in the soil and the carrying capacity of the land increases.

The optimal size of micro-watershed largely depends on the specific emphasis of the development programme. In drought prone areas programme, where integrated area development is the main aim, emphasis is laid on optimal utilization and conservation of land and water resources. Water being the most precious element in drought prone areas, the desired watershed function of the land is primarily to receive precipitation and to utilize it in the most efficient way. Even in these areas of deficient rainfall, watersheds convert large amounts of rainfall to stream flow.

Watershed Management is thus primarily concerned with planning the landuse to suit the landscape. Land use planning in turn is closely linked with the farming activity. The basic unit for a micro-region or rural area for planning should be a farming locality with a radius no more than five kilometers. The optimum size of a micro-watershed for integrated area development should be no more than 10,000 hectares. A size between 5,000 hectares and 10,000 hectares would possibly be the optimum size.

The funds available for various sectors such as agriculture, forestry, animal husbandry, etc. should be used within the framework of the landuse plan prepared for the watershed within the constraints of this plan, animal husbandry and other such industries should also be developed.

Watershed Management[1] (Rajat De, 1995) aims at minimising risk associated with rainfed farming in the drought prone areas, by following the steps:

i. Conserving soil and water resources through mechanical and or cultural methods.

ii. Draining out excess water at a safe velocity and directing it for safe storage for utilization in dry season.

iii. Preventing gully formation through mechanical and vegetative means and storage of water for recharging ground water.

iv. Utilising land according to its capability and putting marginal land unsuitable for arable crop production to alternate landuse.

v. Developing a sustainable ecosystem in harmony with the man-land-water-plant-animal complex of the watershed.

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[1] Rajat De, Watershed Management, Kisan Goshthi, Agri-Expo-1995, New Delhi.

vi. Optimizing agricultural productivity per unit area, time and available water, and

vii. Improving the quality of life of the watershed inhabitants through infrastructure development.

The perceptions of researchers and farmers regarding soil and water conservation practices differ. Field experience in Andhra Pradesh has indicated that conventional graded binding as recommended, is not suitable for small farms. The centralised water disposal system creates a clash as farmers with fields at the terminal end of each bund suffer due to diversion of water from upper fields. Farmers perceptions and approaches to soil and water consumption differ from those of scientists in the following respects:

1. Bunding on field boundaries rather than on the contour.
2. Concentration of soil rather than conservation.
3. Short and long term advantages rather than only long-term.
4. Small and gradual investment as opposed to large and one-time investment.
5. Conservation of resources plus increased production rather than conservation alone.
6. Multiple objectives rather than a single objective, and
7. Reclamation rather than stabilization in case of gully erosion.

It is increasingly being recognised that researchers and planners have much to learn from people in the drought prone areas and programmes must take their ideas and experiences into account in order to be relevant. Observations indicate that farmers practices are ecologically sound and should be supplemented and improved by modern technology. Future planning must involve a proper blending of indigenous and recommended practices like the use of crop combinations to reduce soil erosion and degradation. Legume crops have the ability to fix atmosphere nitrogen and increase soil organic matter content thereby improving soil structure. This enhances internal aeration and drainage and improves soil moisture storage and nutrients thus favouring plant root growth and limiting soil erosion.

6.5 ROLE OF MICRO-WATERSHED HYDROLOGY IN RAINFED AGRICULTURE

M.S. Rama Mohan Rao, S. Chittaranjan and M. Chandrappa tested the proven experience of development of a watershed on an integrated basis to bring about improvement of productivity on sustained basis. It has been tested at the Chinnatekur watershed, 12 kilometers. from Kurnool, A.P. Based on the resource survey scientific landuse plan was developed which included conservation measures for non-arable and arable lands and treatment of waterways / gullies with check dams, ring bunds and nala bunds as gully control cum water harvesting structures. Crops / Varieties and management practices were also changed to enhance production.

A mathematical model of upland erosion was presented by M.S. Ahluwalia, Subhash Chander, P.N. Kapoor, S.R. Singh (1988) to stimulate the overland flow and sediment delivery from the fallow and upland small watersheds, overland flow is stimulated using Saint-Venant equations with kinematic wave approximation. Mannings equation has been used to determine flow discharge rates. Mein and Larsons approach based on original Green and Ampt method has been used to estimate rainfall excess rate.

There has been many hydrologic models proposed from time to time, some of them very elaborate (Linsley et al, 1982). A one parameter model is developed to predict the surface run-off and deep percolation from agricultural watersheds (Rama Prasad). The meteorological data needed as input for the model are: Daily rainfall, windspeed, relative humidity, temperature and sunshine hours.

Undulating topography coupled with faulty agricultural practices result in more runoff and loss of top fertile soil. the agriculture being rainfed, farmers are sceptic about the use of soil and water conservation measures and improved agronomic practices. The degree of runoff under such conditions depend on rainfall, especially during the early periods of low crop cover (Celestino, 1984). various methods of controlling soil erosion by water have been suggested (E.L. Swaify and Dangler, 1982). According to Celestino (1984) agronomic measures are more effective in controlling soil erosion than mechanical measures.

Hudson (1971) has reported that improved farm practices minimise soil erosion. Sastry et al (1980) and Verma et al. (1984) have reported. The possibility of collecting runoff water in farm ponds. The economic feasibility of farm ponds for runoff harvesting have been substantiated by Selvarajan et al (1984).

Watershed studies on Alfisols and Vertisols of Telangana and Rayalaseema by ICRISAT were made using the following models as tools to design soil and water management practices and structures.

1. RUNMOD - Runoff Simulation Model.
2. MCNM - Modified Curve Number Model.
3. NTRM - Numerical Technique Runoff Model.

The first two models require calibration at a given site, whereas the third model can be used without calibration. The first one requires daily rainfall amount and duration, the second requires only daily rainfall amount and the third model, data on storm intensity and duration.

The Modified Curve Number model was used to estimate runoff (A.K.S. Huda, R.C. Sachan and S.M. Virmani, 1988). Sorghum yields were simulated for these watersheds using a crop simulation model called "Resource Capture Model" (RESCAP).

S.P. Singh and U.M.B. Rao, in their paper 'Rain Water Management' suggest that "For stabilizing productivity of drylands the runoff and soil loss vary with crop and cropping system. Mechanical structures though cost intensive are quite effective in reducing soil loss. Vegetative barriers have also been found fairly effective economic and operationally feasible. Use of surface mulches reduces loss of conserved soil moisture and helps in getting higher crop yields".

A.K. Gosain and P.N. Kapoor in watershed modelling for yield assessment said that assessment of water yield in a basin is basic to the design and operation of an irrigation project. They used the continuous water balance model tank model. (Suguwara et al 1984).

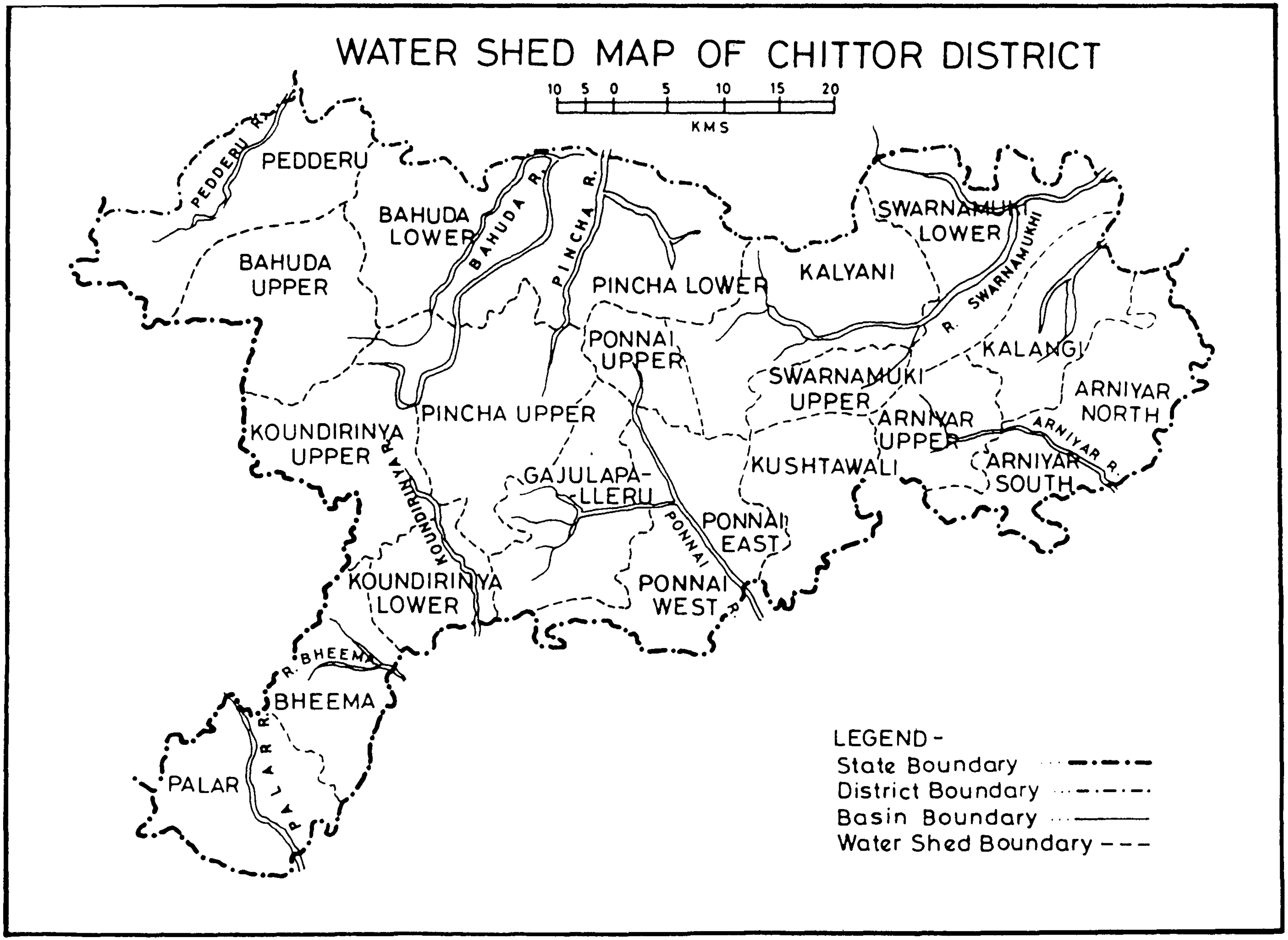
The small watersheds are largely unguaged and availability of hydrologic data for small watershed is a major constraint for rainwater management (Arun Sharma and Rajendra Mishra). Depending on physiographic similarity the synthetic unit hydrograph from guaged watershed may be used to predict hydrological characteristics of unguaged watershed.

In India most of the watersheds in the drought prone areas are unguaged and very limited hydrological data are available. Therefore simulation experiments could be a means to obtain empirical answers, provided a mathematical model could be developed based on the data. For efficient management of rainfall, prediction of both peak and total runoff are essential. It is also important to predict soil loss from cultivated areas and to evaluate change due to changes in farming practices. Water conservation is one of the most important production factors. Poor water conservation practices lead to inadequate vegetation cover which will result in accelerated erosion. So integrated land management practices for erosion control and water conservation have a significant influence on the hydrological behaviour of a watershed. The land management could consist of engineering, forestry, and agronomical practices whose influence depend upon the extent of application of these measures in the catchment area under them.

Favourable responses from farmers due to impact of soil and water conservation works are likely to be obtained when land development is taken up as an integral part of watershed development.

To investigate the effect of agroclimatological factors on phenology growth, biomass accumulation and grain yields S.M. Virmani, N. Vidyalakshmi and Karl Harmsen constructed a pigeonpea growth and development (PGNPGRO) model which was adapted from the crop model for ground nut (PNUTGRO).

Some of the pioneering efforts in this direction were made by Andhra Pradesh which started various schemes for integrated development in 105 watersheds of 2000 hectares each. The Drought Prone Area Programme has pin-pointed 76 Watersheds (See Annexure IX) in the 8 drought districts of the


WATER SHED MAP OF CHITTOR DISTRICT
10 5 0 5 10 15 20
KMS
PEDDERU
PEDDERU R.
BAHUDA LOWER
BAHUDA UPPER
BAHUDA R.
PINCHA R.
PINCHA LOWER
KALYANI
SWARNAMUKI LOWER
SWARNAMUKHI
R. SWARNAMUKHI
PONNAI UPPER
SWARNAMUKI UPPER
KALANGI
ARNIYAR NORTH
ARNIYAR UPPER
ARNIYAR R.
ARNIYAR SOUTH
KUSHTAWALI
PINCHA UPPER
KOUNDIRINYA UPPER
KOUNDIRINYA R.
GAJULAPA-LLERU
PONNAI EAST
PONNAI R.
PONNAI WEST
KOUNDIRINYA LOWER
R. BHEEMA
BHEEMA
PALAR R.
PALAR
LEGEND -
State Boundary
District Boundary
Basin Boundary
Water Shed Boundary

MAP NO. 37

state. Map Number 37 shows the macro watersheds (Catchment areas) map of Chittoor District.

TABLE 6.03 :

MICRO-WATER SHEDS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

Name of the District	Total blocks	Blocks covered under DPAP	No. of Watersheds
Kurnool	13	13	16
Anantpur	16	16	16
Cuddapah	12	6	6
Chittoor	20	8	8
Rangareddy	10	3	3
Mahbubnagar	16	12	13
Nalgonda	15	2	2
Prakasam	17	9	12
Total	119	69	76

Maharashtra initiated most Comprehensive Water Development Program (COWDEP) in one village in each block. Also a Comprehensive Land Use Management Project (CLUMP) was initiated in all the 629 mandals of 5 selected drought prone districts of Karnataka. These were comprehensive projects for the integrated development and optimum use of land, water, animals, energy and forest resources. These models were being emulated by Andhra Pradesh implemented by a watershed development team under District Dryland Development Board.

The programs initiated by non-governmental and voluntary organizations such as Sukhomanjari (Haryana), Ralegaon Sidhi and Adgaon (Maharashtra), Kabbalnala and Mittemari (Karnataka) Jhabua (Madhya Pradesh) Nalgaon and Daltonganj (Bihar) do indicate increased attention for the development of drought prone arable land in a more integrated way.

The Agricultural Development Projects, with the assistance from World Bank were presently being implemented in the states of Bihar, Rajasthan and Tamilnadu.

Watershed Areas Rainfed Agricultural Systems Approach (WARASA) is a budding project being concieved by the Ministry of Agriculture, Government of India.

National Watershed Development Project for Rainfed Areas (NWDPRA) is intended to generate successful models of development of 500-5000 hectares, in all the community development blocks where less than 30 percent arable area is under assured means of irrigation. It covers 115 agroclimatic zones. 115 model micro watersheds were approved by Government of India and 2456 micro-watersheds were sanctioned by the state government.

The objectives of NWDPRA are :

1. Production of biomass on a sustainable basis.

2. Restore ecological balance

3. Reduce regional disparity

4. Generate employment

5. Increase income levels of people living in the rainfed areas.

Integrated Watershed Development Programme (IWDP) looks at the soil conservation and watershed management with following activities:

1. Terracing

2. Continuous Contour trenches

3. Live check dam

4. Brush wood dam

5. Vegetative Contour hedges

6. Loose boulder structure with vegetative support

7. Earthen nalla bund

8. Cement Nalla bund

9. Farm ponds.

The priority blocks in different drought prone districts of India where the wastelands (other than notified forest and barren rocky areas) constitute more than 15 percent of total geographical area are listed out in the order of percentage of wastelands (See Annexure VII). For example in Chittoor district, the Chinagottigallu, Thamballapalli and Chowdepalli. the names of the blocks with less than 15 percent wastelands are not indicated.

National Informatics Centre Network (NICNET) monitoring of the progress of physical and financial achievements of the projects will go a long way in successfully operating the watershed projects in India.

DROUGHT VS. AGRICULTURE

The Semi-Arid Tropics (SAT) of India which encompass the drought prone areas account for an estimated 170 million hectares of land (54 percent of the country's total) supporting over 400 million people. In these areas mostly the coarse grain cereals and legumes are planted. For those crops grown mostly in the drought prone areas, annual growth in yields per unit of area has marginally increased between 1949-65 to 1967-89, from 1.29 o 1.39 for coarse cereals, from 0.77 to 0.74 for pulses and from 0.13 to 1.70 for oilseeds (Government of India, 1990).

It is estimated that at present about 45 percent of the total production is obtained from drylands and if the estimated requirement are to be met the productivity of dryland has to be increased by 72 percent (Hegde, 1990). Here, a slight increase in productivity has been noticed in favourable environment due to technical change, but intensive use agricultural resources has hastened the degradation of soil and water resources.

The drought prone areas in India face a serious trade-off between on one hand technical change and intensification of resources for increasing agricultural productivity on the other hand long-term sustainability of its resource base (Meri et al 1991)

Most of the dryland areas suffer from soil erosion and low moisture. It is estimated that about 6000 million tonnes of soil is eroded every year from 80 million hectares of cultivated land loosing 8.4 million tonnes of nutrients. (Hegde, 1990).

Though about 50 percent of the farmers have access to irrigation most of them are hardly able to provide irrigation to more than 20 percent of their cropped area (Singh and Desai, 1991). Bulk of the fertilizer (85%) is used in irrigated areas which account for about 30 percent of the total cropped area whereas dryland which account for about 70 percent of the cropped area, receive only about 15 percent of the total fertilizer use (ICRISAT, 1984).

In the drought prone areas farmers heavily rely on farmyard manure for plant nutrients to their crops. Moreover they consider it more as a soil-amendment strategy than yield improvement. Evidences suggest that the declining livestock population has adversely affected adequate use of formyard manure to a large extent.

The attitudes of the policy makers and farmers are often conflicting as farmers constantly negotiate the problem of low but stable production through available adjustment mechanism while the former awaken when problems get aggrevated (Jodha, 1979). Most the crops grown in dryland areas are low value crops (Jodha & Singh 1982) and therefore do not get preference for yield-enhancing high cost inputs. Insufficient attention has been paid to how improved cultivation will fit into crop and livestock system (Walker, 1983).

In the black soil areas of Rayalaseema and Telangana the declining common pastures and fodder availability has adversely affected. Livestock-based farming system and created a major problem of unavailability of adequate draft power (Kelly, 1990) and the farmers feel it more economical to use the draft power on rental basis. The agricultural productivity in the drought prone areas could not increase partly due to severe agro-ecological constraints and partly due to failure of researchers to understand reasons behind the complexities of traditional farming system they seek to improve (Put et al 1990).

The shift from usual crop farming to growing of fruit orchards in drought prone areas will have a beneficial consequence both economically and environmentally. Drought is a combined result of the neglect and over exploitation of common environmental resources - essentially the systems that provided a cushion against the problems caused by dry periods. (The Wrath of Nature, Centre for Science and Environment, 1987). Overexploration of forests, grazinglands and groundwater and neglect of tanks in addition to the inequitable distribution of canal irrigation water accentuate the drought situation.

Drinking water and fodder shortage are very common during droughts. The Scarcity of fuelwood intensified with heavy deforestation. Women are the worst sufferers, with the workload increasing day by day due to their unrelenting struggle to meet the basic needs for living. The period just before monsoon harvest, which has been referred to as "the hungry season" Longhurst (1986) - is one of considerable stress. Whereas the monsoon is the hungry season for people, the summer is the hungry season for animals. And the worst season in the year differs by Occupation (Huss - Ashmore, 1988). The spatial and temporal dimensions of drought and its impact on different occupational groups have been argued by Martha Alter Chen in her book tilled coping with Seasonability and Droughts. It is important to distinguish between localised and widespread droughts in a single year and prolonged droughts.

Micro Level Planning

CHAPTER SEVEN

"May this village evolve into a peaceful and self reliant unit of the Universe"

- Yajurveda 16/48
- Rigveda 1/114/1

Substantial areas of India periodically experience droughts. This leads to loss of crops and livestock on the one hand and deterioration in the quality of life on the other. Mitigation of distress caused by droughts were mainly restricted to ad hoc relief works to create employment for increasing the purchasing power of the people which provided some immediate relief. Systematic efforts at long-term ameliorative measures to tackle these problems of drought started only after planning for economic development was launched in the country.

The problems of drought can be addressed properly only if the regional specificities are given adequate consideration. There are different types of droughts caused by various sets of factors operating at regional levels. All drought prone areas are peculiar in their own way so far the problem of drought is concerned. It does not need any exaggeration therefore that the problems of drought prone areas can only be solved with a micro-plan framework.

Why Micro Planning?

Micro-level planning is a variant of regional planning. For regional planning the micro-level regions and their particular problems are identified and thereafter a set of policies is evolved to address the problems of development.

The micro-level planning is an alternative to the centrally sponsored macro-level plan. Micro-level plan is based primarily on the consideration such as local resource base and people's participation to address special problems of development of the concerned region. Contrary to it, a macro-level plan subscribes a unique plan for the whole economy and advocates trickle - downism. But in the macro-level planning area-specific peculiarities of resources, climate and human behaviour do not get adequate weightage. Due to this the special problems such as droughts, floods, water management, environmental depletion etc. fail to be addressed by the macro-level planning. Therefore, it is increasingly being realised that any plan of development at macro-level is prone to aggravating regional imbalances until and unless it is entrenched in a micro-level perspective. Thus the variations in resource base and problems of development at grassroot level can only be given adequate weightage in a micro-level plan.

The micro approach to planning regards a region as an autonomous and individual phenomenon while the macro-approach considers such a region 'within' the framework of a nationally integrated system of planning and decision making. the micro approach is concerned more with physical land - use problems than with economic and social considerations and planning is either very loosely associated or not at all associated with the national plan and policies.

In micro-level planning the plan is framed and operationalised by the democratic institutions such as panchayats, block-level development units and district level development units. It is, nevertheless, the purpose of the planning which determines the size of the micro-region. Further micro-level planning is equally applicable to rural and urban areas and also to various sectors such as agriculture, industry and services.

7.1 RELEVANCE OF MICRO-LEVEL PLAN TO DROUGHT PRONE AREAS

India is basically an agrarian economy and there is a very heavy pressure of population on arable land for livelihood and food and fodder supply. In such a situation India cannot afford to allow any degradation in soil and fertility of its farmland as well as farm yield and productivity. But India being such a vast country consists of many topographically and climatically vulnerable drought-prone areas.

The problem in the drought prone areas is further aggravated by unsustainable human (farming) practices. Nevertheless human practices cannot be judged better or worse in any absolute sense without giving considerations to the fact as to why certain types of land and environment degrading practice is prevalent in a region. For instance the problem of food, fodder and fuel supply may compel the poor people to indulge in undesirable practices. This may also happen due to lack of awareness.

This droughts can either be caused by physical and climatic factors or due to undesirable human practices existent in a certain region. The macro approach to plan is prone to missing finer details of the drought causing factors in a region. Therefore there is need to pursue a micro-level planning in drought prone areas so that geographical as well as human factors are given due consideration.

Droughts can be classified in various categories such as meteorological droughts, hydrological droughts and agricultural droughts. The meteorological droughts are very common in India because the monsoon itself is a fluctuating phenomenon. So far the ground water or surface water potential of various regions are concerned we find substantial variation in various regions are hence there are certain regions prone to hydrological droughts. Like the meteorological and hydrological drought the agricultural drought also results under the influence of external factors like erratic rainfall and adverse soil texture, although it is basically refers to the total crop failure.

In India the physiographic features such as soil fertility, soil texture and irrigation requirements vary substantially from region to region. So does rainfall and human practice. Any micro-level plan for drought prone areas therefore is required to encompass the above mentioned factors. Also the overall development of the drought prone areas needs special consideration to the resource base of the different regions and human skills. In a micro-level plan, therefore, the decisions about the most feasible cropping pattern and irrigational and fertilisation requirements for a certain region can be taken, given the physical and human constraints. Moreover the problems of water management and forest depletion can also be paid adequate attention in a plan with a micro framework.

The importance of micro-level plan for the drought prone areas can be understood by making reference to a case study by Samar Datta et al of eastern zone. According to the study since the soil condition varies from region to region and even from one micro-region to other, the importance of micro-level planning in drought prone areas is immense. The study cites the examples of Barind land (unfertile land) in the Malda district of West Bengal and the Black Cotton Soils in the Kalahandi district of Orissa. These regions often suffer from agricultural drought due to its adverse soil texture. In these areas the inter granular attractive force is so higher that the plant cannot suck water and nutritional elements from soil as per its requirement. This causes damage to crop production and leads to agricultural drought even if the available rainfall and other endowments are sufficient for a good crop production.

It is clear from the above case study that the problems of drought prone areas can be resolved only in a micro-plan framework. there can be several other examples which establish the need for micro-level planning in drought prone areas. Just to take on more example, there are three kinds of soils according to water requirements -

1. ustic soil - where water requirement is very high.
2. uetic soil - where water requirement is moderate.
3. aquic soil - minimum water requirement.

Now if flow irrigation is resorted to in regions consisting of various types of soils as mentioned above, not only crop is damaged but there is loss of water resources. Hence the need for micro-planning.

The Invitation in the direction of Micro-level Planning for Drought Prone Areas

The Rural Works programme initiated first in 1970-71 with the object of creating assets designed to reduce the severity of drought was basically micro level plan for 54 identified drought prone districts in the country with parts of another 18 districts contiguous to them. The programme covered 12 percent of the country's population and nearly one-fifth of the area in the country. Labour intensive schemes such as medium and minor irrigation, road construction, soil conservation and afforestation were taken up under this programme. The mid-term appraisal of the 4th plan redesignated the programme as the Drought Prone Areas Programme. The fourth plan continued to lay emphasis on dryland farming technology.

According to the recommendations of the Task Force (1971) constituted by the Planning commission under the Chairmanship of Dr. B.S. Minhas, the drought prone areas programme laid emphasis in the fifth plan on resource endowment analysis and potential for development of project areas. It recommended that the programme should aim at integrated development of agriculture with focus on conservation, development and utilisation of land, water, livestock and human resources in an optimum manner. The need to provide more stable income and employment to weaker sections of the society was also emphasised. The another task force under Ministry of Rural Development Chaired by Dr. M.S. Swaminathan emphasised the need for planning the programmes for productive agriculture through irrigation and dryland farming and proper infrastructure on a watershed basis in an integrated manner. Thus the objective of ecological restoration through proper land and water management was emphasised in the programmes.

The main thrust of the two programmes Drought Prone Area Programme and Desert Development Programme in the successive plans continued to be income generating and infrastructure schemes. As regards the unit of planning and development, micro-watershed was considered to be the most scientific basis for adequate utilisation of available resources, inspite of several operational problems. L.C. Jain Commission on Drought Prone Area Programme and Desert Development Programme under Eighth Plan emphasised the need to greater scope for voluntary organisations to articulate and stress their needs. The recent Hanumantha Rao Committee too laid emphasis on micro level planning.

Thus it can be seen that micro planning has been the basis of drought prone area development schemes.

The Seventh Five Year Plan (1985-90) objectives for Drought Prone Areas of Andhra Pradesh aimed at mitigating the incidence of drought through creation of permanent assets and utilization of land resources and at restoring ecological balance over a period of time.

However, during the annual plans of 1990-91 and 1991-92 financial outlays were proposed under a Special Component Plan. The budgeted flow towards this during the two years was 83.78 lakhs and 92.22 lakhs respectively out of the total outlay of 683.10 lakhs for the five year plan.

All the 69 drought prone blocks were covered during the two annual plans while physical targets for the 8th plan was 50,000 hectares of Minor Irrigation 75,000 hectares of soil and water conservation 20,000 hectares of Afforestation Pasture Development did not have any specific target. During the two Annual Plans the targets for the first three items wee 10000 hectares, 12500 hectares and 6000 hectares respectively. These targets were set according to the achievements of the last year of the 7th Five Year Plan. During that year 8421 hectare were brought under minor irrigation, 8398 hectares under afforestation.

The cumulated achievements of the Seventh Plan wee 87514 hectares of Minor Irrigation, 1,58,225 hectares of Soil and Water Conservation. 88710 beneficiaries were identified during this plan while 28.16 lakhs of them got assistance.

Out of the total outlay of Rs. 2470 lakhs was the approved outlay, Rs. 2715 lakhs were expended. The proposed outlay for the 8th plan was Rs. 5025.00 lakhs. Out of which Rs. 662 lakhs were proposed for the Annual Plans of 1990-91 and 1991-92. There was no financial allocation to the Drought Prone Areas of Andhra Pradesh in the Tribal sub-plan.

Larger amounts for the development of Sericulture in the state were received from the Drought Prone Areas of Andhra Pradesh during the plans. During 1974-79 it received 34.63 lakhs. During 1980-85 it received 299 lakhs. And during 1985-90 it received 470.58 lakhs. This shows that sericulture is gaining popularity in the drought prone areas of Andhra Pradesh.

SEVENTH PLAN REVIEW

During the 7th plan period the programme was implemented in 66 blocks of the state. The outlay of Rs. 2734.04 lakhs was provided in the VII Plan towards the state share against which 2715.61 lakhs was incurred during the 7th Five Year Plan. During the 7th Plan period an area of 69,592 hectares was covered by soil and water conservation. 15.29 lakh beneficiaries were assisted against the target of 6.76 lakhs.

A total irrigation potential of 47,514 hectares was developed. An area of 39,710 hectares was covered under afforestation and positive development.

Physical performance of DPAP during 7th Plan shows that upto 1992-93, 8,45,800 hectares has been brought under Land Shaping and Development, Soil Moisture Conservation. The Water Resources Development was achieved 2,69,600 hectares and Afforestation and Pasture Development has been achieved 6,01,800 hectares. Under these three broad activities achievements upto September 1993-94 are 45,925 hectares, 7,714 hectares and 44,277 hectares respectively.

DRAFT OF EIGHTH FIVE YEAR PLAN

Drought Prone Areas of Andhra Pradesh is aimed at mitigating the incidence of drought through creation of permanent assets and utilization of local resources and restoring ecological balance over a period of time. A large part of the state is chronically drought affected. 76 taluks covering 47.5 percent of the total area and 34.7 percent of the population of the state are chronically drought affected. The strategy is aimed at optimum utilization of major resources viz. - Land, water and livestock. The programme also aims at integrated development of the area at a watershed or sub-watershed being the most scientific selection of the area for the proper landuse management. The objective of the programme is to restore ecological balance and drought proofing the area on watershed basis. Micro watershed of the size of 1000-2000 acres is taken up in each Drought Prone Areas of Andhra Pradesh block. The annual action plans are prepared by an integrated approach. Soil and moisture conservation measures, dry land technology development of surface and ground water irrigation potential, afforestation, fodder and pasture development, development of horticulture, sericulture, pisiculture etc. are taken up for each watershed to optimise productivity. The financing pattern is on the basis of equal sharing between centre and states. Small and marginal farmers who constitute the weaker sections in the Agricultural economy received priority attention. The funding norm is at the rate of Rs. 15 lakhs per block per year.

EIGHTH PLAN OBJECTIVES

The core sector to be developed in the 8th Five Year Plan are :

1. Soil and Moisture Conservation
2. Development of Irrigation Potential
3. Water Harvesting
4. Afforestation and Pasture Development

75 percent of the budget allocation will be spent on these sectors on a watershed basis during the plan period. Out of the balance 25 percent allocation, 15 percent of the funds are earmarked to other sections viz. Horticulture, sericulture, pisiculture, etc. and 10 percent of the allocation is intended for staff cost under soil and moisture conservation the emphasis will shift to vegetative bunding and soil moisture conservation measures like

contour cultivation, dead furrow land smoothing, etc. Under irrigation sector the thrust will be maintained on construction of mini water harvesting structure on a watershed basis to impound runoff and improve the overall moisture regime. The strategy will be designed to meet the requirements of small and marginal farmers for small timber, fuel wood and fodder simultaneously for the ecological restorations. Under other sectors development of a dry land horticulture will be given on high priority apart from fodder development etc. The water shed will be the basic unit of planning. Based on rainfall, status of erosion and backwardness of the area and present land use, micro-water sheds of the size of 20,000 to 30,000 hectares will be prioritised for sustained treatment during 8th plan. Out of the micro-watersheds, micro-catchments will be selected for detailed survey and integrated execution of sectoral programmes every year.

EIGHTH PLAN PROGRAMMES AND TARGETS

The Government of India has appointed a National Committee to review the Drought Prone areas of Andhra Pradesh and suggest improvement / changes if any during the 8th plan. Pending recommendations of the Committee it is proposed to provide Rs. 100.50 crores during the eighth five year plan out of which Rs. 50.25 crores will be states share, 50.25 centre share. It is proposed to generate employment potential of Rs. 1.50 crores mandays during the 8th five year plan period. The provision made for 1990-91 is Rs. 614.80 lakhs towards state share. The Report of the Technical Committee on Drought Prone Area Programme and Desert Development Programme under the Chairmanship of CH. Hanumantha Rao was submitted in April 1994.

In brief as far as drought is concerned, the goal has to be as follows:

* **Removal of poverty**
* **Elimination of unemployment**
* **Fulfilment of minimum needs programme of the people at large.**

Some of the very important and vital factors concerning drought as noted below deserve to be further highlighted:

* **Drought code: on the lines of the famine code of 1883.**
* **Micro level planning.**
* **Agriculture in its widest sense including animal husbandary, dairy, poultry, fishery, piggery, sericulture.**
* **Irrigation - Major, medium, minor and command area development.**
* **Forestry: Agroforestry and social forestry.**
* **Rural Development and poverty alleviation programmes as in welfare approach.**
* **Power / Energy (Non conventional).**
* **Implementation and monitoring at the field level.**

DROUGHT CODE

The salient features of the famine code of 1883 still play a dominant role in our agricultural production. And our fight with drought, should be suitably revised, keeping in view our short term and long term requirements. Those projects which can be completed during the Eighth Five Year Plan (1992-97) should be treated as short term. Those which are likely to go up to and beyond 2000 AD (like river basin, inter state irrigation and power grids, etc.) may be treated as long-term ones. As between the projects priority should be given to short term projects with immediate relief, like minor irrigation, drinking water, inputs for package of practices in agriculture, forestry including social forestry, non-conventional energy, rural development and poverty removal schemes, etc. New major irrigation projects have to be taken in hand only if they do not have adverse impact on environment, ecology and uprooting of thousands of families.

A 'Drought Relief Fund' should be established at the centre on 50-50 basis between the Central government and the State Governments. The fund should be at the disposal of the Central Government to be given as relief to the drought affected people living below poverty line on the recommendations of the central teams appointed by the centre to assess the loss caused by the havoc of the drought.

Drought as a major disaster contributed in bringing about qualitative improvements in disaster management efforts in India. Drought of 1965-66 contributed to building up of a reliable Public Distribution System (PDS) to take care of the food emergencies. The drought of 1972 focussed on the need for evolving massive employment generation programmes for enhancing the purchasing power of the people rather than running free kitchens. The drought of 1979 underlined the need for creating durable and productive assets for enabling the people of the affected area to withstand future droughts with greater resilience.

In 1979, the Seventh Finance Commission recommended that if the ceiling of expenditure for drought relief is upto five percent of the states annual plan outlay, the central government should give Advance Plan Assistance to the state. If the ceiling of expenditure exceeds five percent of the annual plan, half of excess expenditure will be treated as loan.

The Government of India issued guidelines in 1980 for preparing relief manuals in the light of changes in approaches towards drought management. The State Government of Andhra Pradesh brought out a Drought Handbook.

The drought of 1987 focussed not only on the need for providing access to food to the affected people but also on maintaining their quality of life.

In 1990, Calamity Relief Fund (CRF) has been constituted for each state with an allocation amount 75 percent of which shall be provided by the Central

Government as a non-plan grant. The progress of the relief expenditure will be monitored by the Central Government in the Department of Agriculture and Cooperation[1] . (Pant J.C.)

Funds from the Chief Minister's Relief Fund and the Prime Minister's Relief Fund are released for providing assistance to the affected people from time to time.

The central theme of relief today is to meet the food and nutritional needs of all sections of the people keeping in view their normal energy requirements, supply of drinking water, providing adequate health care and fodder for the cattle also.

7.2 WELFARE APPROACH

The Drought Prone Area Programme which covers 69 blocks out of 119 in the eight selected districts of Andhra Pradesh has the following allocations per block:

1. Blocks with area upto 500 sq kms - Rs 15 lakhs (92-93) 22.50 lakhs (93-94)
2. 500 to 100 sq km - Rs. 16.50 lakhs (92 - 93) 24.75 lakhs (93-94)
3. Above 1000 sq km - Rs. 18.50 lakhs (92-93) 27.75 lakhs (93-94)

[1] Pant J.C., Additional Secretary, Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

The pattern of funding for the Drought Prone Area Programme is 50:50 by Government of India and the State.

Core components of the programme:

	Components	Percentage Allocation
1.	Soil & Moisture Conservation	30 %
2.	Water Resources Development	20 %
3.	Forestry & Pasture Development	25 %
4.	Horticulture, Sericulture, Fisheries etc.	5 %
5.	Staff cost	10 %

During November 1993 revised guidelines for implementation of DPAP were issued by Ministry of Rural Development with a view to wean the programme, away from the official orientation towards peoples centres approach. A clean break from the past is envisaged.

In the districts with acute poverty and unemployment, the Government of India decided to launch a new scheme for better wages and employment. From 1-4-1989, the then existing programmes of NREP and RLEGP were merged to form Jawahar Rozgar Yojana (JRY) to alleviate the problem of rural poverty and unemployment. The I-JRY or Intensive JRY programme is introduced to provide supplementary resources.

In the I-JRY covers nine districts out of which the DPAP districts are Anantpur, Kurnool, Mahbubnagar, Prakasam, Nalgonda. The basket of schemes in JRY are

1. Construction of all weather roads
2. Minor Irrigation Works
3. Soil and Water Conservation Works
4. Water harvesting structures
5. Wastelands development
6. Farm forestry etc. to further sustained rural employment and drought - proofing in the area.

The rural employment schemes during 1993-94 under I-JRY cover 65 mandals of Chittoor district, 50 of Cuddapah, 63 of Anantpur, 53 of Kurnool, 64 of Mahbubnagar 33 of Rangareddy, 59 of Nalgonda and 56 of Prakasam. The highest allocation of Rs. 8,45,000 lakhs going to Mahbubnagar.

EMPLOYMENT ASSURANCE SCHEME (EAS)

The Eighth Five Year Plan aims at bringing employment into a sharper focus with a goal of reducing unemployment to a negligible level within the next ten years. The EAS is aimed at tackling the problem of unemployments. It is open to all rural people residing in the area covered by the scheme but targeted to the poor who are needy and want work. Among others the following works are given emphasis.

1. Works for water conservation, land protection, vegetative barriers, afforestation, agro-horticulture, silvi-pasture etc. under the watershed development.
2. Minor irrigation tanks, percolation tanks village tanks, canal works etc.

The EAS is in action in all the 69 DPAP blocks of 8 districts in Andhra Pradesh with each block getting an allocation of Rs. 62.50 lakhs.

EMPLOYMENT GUARANTEE SCHEME (EGS)

In Andhra Pradesh poverty is concentrated among agricultural labour in dry and poorly irrigated areas. The EGS rural employment generation scheme operates in the rural areas of selected mandals and gives be a standing offer to all adult residents (for manual, unskilled employment) who register with the authority.

MILLION WELLS SCHEME OF JRY (MWS)

The state government is allocating MWS resources to the districts with reference to the un-irrigated land with potential for well irrigation held by scheduled castes and scheduled tribes.

RURAL WATER SUPPLY

The Government of India has taken up mini-mission schemes in the districts of East Godavari, Kurnool and Mahbubnagar in 94-95 among which the latter two are drought affected districts. It has various sub-missions for control of Fluorosis, Brackishness and scarcity and safe drinking water.

THE DISTRIBUTION OF IMPROVED TOOL-KITS TO RURAL ARTISANS

Under this scheme which started in 1992-93 the drought districts of Anantpur (1992-93), Prakasam (Giddalur assembly constituency), Cuddapah, Kurnool (1993-94) Nalgonda, Mahbubnagar and Chittoor (1994-95) were being covered among other districts. The release of funds is through DRDA.

INTEGRATED RURAL DEVELOPMENT PROGRAMME (IRDP)

(IRDP) started in 1978-79 and was extended to the whole state on October 2, 1980 with all the 1,092 Mandal Parishads under its cover. The target groups are small farmers, marginal farmers, agricultural labourers, non-agricultural labourers and rural artisans whose annual family income is less than Rs. 11,000/-.

Priority is being given for coverage of those having family income upto Rs. 6,000/-.

Small farmers are those having land holding from 2.5 to 5.0 acres dryland in non DPAP areas or 3.75 to 7.5 acres dryland in DPAP areas. Marginal farmers are those having land holding upto 2.5 acres in non DPAP areas or 3.75 acres in DPAP areas in terms of dryland.

The IRDP schemes are the ones as approved by NABARD under Agriculture and Allied Sectors like Horticulture, Minor Irrigation, Animal Husbandry, Fisheries, Sericulture, Industries, Services and Business.

Almost all the mandals in the drought prone areas were covered by the programme. DWCRA - development of Women and Children in rural Areas which started in 1983-84 and TRYSEM.

While the watershed approach looks at the land through the spectrum of a multi-disciplinary approach, the above programmes were taken upto ensure convergence of funds towards an integrated area development.

The Drought Prone Are Programme in India is in operation (as on October 1994) in 627 blocks in 96 districts in 13 states out of 627 blocks, 9 blocks in Jammu & Kashmir and 3 in Tamilnadu have been created by bifurcating the existing DPAP blocks.

The establishment of wool processing units and tanneries in drought prone areas can raise the employment and income for local people and thus reduce nomadism and migration which will have favourable impact on environment. Sericulture is eminently suited for drought prone areas as the water requirement is less and employment potential very high. Many small and medium farmers in Madanapalli, Chittoor are engaged in sericulture where the first Cocoon Market was started under DPAP. Devarakonda block in Nalgonda is also well suited for sericulture. Sheep development is an important activity in Cuddapah. While Anantpur is excelling in the development of Silvi pasture.

INTEGRATED WASTELAND DEVELOPMENT PROGRAMME (IWDP)

The integrated wastelands development programme was launched in 1991-92. Districts with wastelands above 15 percent were taken up for mapping based on the categorization of wastelands. The process of identification and mapping of wastelands of 243 districts which have upto 5 percent of wastelands will be likely to be completed by 1996.

Integrated and coordinated approach are the prerequisites for development of the vast areas of wastelands in the country. Incidentally the high percentage of wasteland coverage in the Drought Prone blocks hinders the development plans of the blocks unless both of them are tackled combinedly. See Annexure-VII for the drought prone blocks with 15 percent or more percent of wastelands. The blocks are arranged in descending order of wasteland area. Blocks below 15 percent area of wasteland are not listed.

The extent of wastelands identified by NWDB in the Drought Prone Districts of Andhra Pradesh given in the Table 7.01 in the next page.

It would be necessary to ensure greater involvement of scientific and technical institutions to come up with cost-effective technologies to reclaim wastelands. It has been decided by the Department of Wasteland Development that the component of soil and moisture conservation should be enhanced for public lands from the current 20 percent to 40 percent. The enhancement of the underground water region would increase the availability of ground water and encourage production of horticulture and fodder.

TABLE - 7.01 :

EXTENT OF WASTELANDS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

District	Area in sq.km.
Prakasam	3783.85
Kurnool	3879.10
Anantpur	3421.34
Cuddapah	4597.59
Chittoor	3649.49
Rangareddy	1461.13
Mahbubnagar	2496.12
Nalgonda	1729.17

Farmers are being encouraged to grow trees on their own lands through the various social forestry schemes being implemented by the state governments. Under the IWDP scheme and the Grant-in-aid, there is a provision for plantation of trees on farmers lands. The grants in aid scheme is essentially implemented through the voluntary agencies and is a part of the efforts to ensure peoples participation.

New initiatives like Jo-Jo-Ba plantation in Rajasthan and Gujarat, Red Oil Palm plantation in the southern states of Andhra Pradesh and Karnataka are emphasised in wasteland development.

In the drought prone districts of Andhra Pradesh, Chittoor has been given the highest allocation for wasteland development. Out of the total outlay of Rs. 880.58 lakhs the western drought prone region was cleared projects worth Rs. 491 lakhs. Mahbubnagar with Rs. 722.65 lakhs and Anantpur with Rs. 316 lakh and Cuddapah with Rs. 110 lakhs follow Chittoor. During 1994-95, for Chittoor (West) - the drought prone region Rs. 91.17 lakhs have been envisaged.

MEMBER OF PARLIAMENT (MP'S) LOCAL AREA DEVELOPMENT SCHEME

This latest development scheme which got the final approval of the Parliament of India in March 1995, offers many development projects at the micro-level. The development schemes are as follows:

- Construction of school buildings
- Provision of drinking water
- Bridges on approach roads
- Village roads or approach roads

- Buildings for the Gram Panchayats
- Afforestation & Social forestry
- Irrigation canals and lift irrigation
- De-silting and digging of village ponds
- Common gobar gas plants
- Public toilets and bath rooms
- Drainage and gutters
- Crematoriums
- Public utilities in slum areas
- Provision of electricity
- Shelters for the old and handicapped
- Buildings for cultural and sports activities
- Hospitals, Primary Health Centres
- Creches
- Public Reading Rooms or Study Rooms
- Ashram Shalas in Tribal Areas
- Bus Sheds / stops for passengers
- House gallies between old buildings
- Footpaths and pathways
- Any other development items

There is every scope that the development aspects of drought prone areas will be given high priority in this local development scheme which is under implementation.

The need for a decentralized planning with an important part of planning functions being discharged at the district instead of at the State or Central level is now realized. A prerequisite for the success of this transfer is detailed information at the district level and mandal level.

There can be no denying the fact that inter-district disparities within the country and within the states are inexcusably and unacceptably large. Every opportunity should be utilized to focus public attention on this fact and develop pressures for remedial action. In fact this is the principal purpose of the present study of the levels of regional development.

For reasons that can be well understood the Centre for Monitoring Indian Economy (CMIE) Bombay has assumed a set of weights (for the 9 indicators) for their relative index of Development to measure the level of development of the districts in India.

The following table gives the comparative level of development of the eight drought prone districts in the present study.

It can be seen from the table that except in Rangareddy district, all the districts show decrease in the relative index of development.

TABLE - 7.02

RELATIVE INDEX OF DEVELOPMENT OF DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

DISTRICT	RELATIVE INDEX OF DEVELOPMENT		
	1980 CMIE	1985 CMIE Nov. 1987	AROUND 1990 CMIE Nov. 1993
PRAKASAM	118	114	86
KURNOOL	96	88	83
ANANTPUR	65	78	92
CUDDAPAH	92	73	83
CHITTOOR	100	86	84
RANGAREDDY	24	57	95
MAHBUBNAGAR	69	57	53
NALGONDA	105	72	71

Source: Profiles of District, November 1987 and November 1993.
Centre for Monitoring of Indian Economy (CMIE), Bombay.

As part of the present study, an attempt has been made to measure the levels of regional development. The Drought Prone Mandals in Chittoor have been considered to arrive at a relative index. The set of indicators twenty seven have been used to compute the index. The mandals chosen are those having gross irrigated area to gross cropped area percentage less than 30 percent. It they are slightly above 30 percent, the normal annual rainfall of 750 millimeters is considered to identify a drought prone mandal.

7.3 MICRO LEVEL PLANNING IN CHITTOOR DISTRICT

The list of twenty seven indicators considered are:

1. Density of Population. Population per sq. km (Negative)
2. Percentage of Urban Population. Percentage to Total Population (Positive).
3. Sex Ratio Females for 1000 Males (Negative)
4. Scheduled Caste Population. Percentage to Total Population (Negative)
5. Scheduled Tribe Population. Percentage to Total Population (Negative)
6. Percentage of Main Workers. Percentage to Total Population (Positive)
7. Percentage of Cultivators. Percentage to main Workers (Negative)
8. Percentage of Agricultural Labourers. Percentage to Main Workers (Negative).
9. Percapita Net Sown Area. Acres (Positive).
10. Percentage of Gross Irrigated Area to Gross Cropped Area (Positive)
11. Livestock population (Positive).
12. Poultry Population (Positive).
13. Number of Agricultural Service Units. (Rice Mills) as on 31.3.93. (Positive)
14. Number of Industrial Service Units. (Factories under Factories Act 1948 & 1950 as on 1993) (Positive).
15. Number of Banks (Including Scheduled Commercial Banks, Scheduled Cooperative Banks, Regional Rural Banks, Others) (Positive)

Agricultural Machinery of 6 Indicators from 16-21

16. Number of Ploughs (Wood & Iron) (Positive)

17. Water Pumps for Irrigation (Oil Engines and Electrical Motors) (Positive)

18. Number of Tractors (Power tillers and Tractors) (Positive)

19. Number of sprayers and Dusters (Operated with hand and power) (Positive)

20. Number of Bullock Carts (Positive)

21. Number of Sugarcane Crushers (Power and Bullocks) (Negative)

22. Cooperative Societies (Including Credit Cooperatives, Industrial Cooperatives, Fishermen Cooperatives, Milk Supply Cooperatives and other types of cooperatives) (Positive)

23. Working Capital of Cooperative Credit Societies Rupees in Lakhs (Positive)

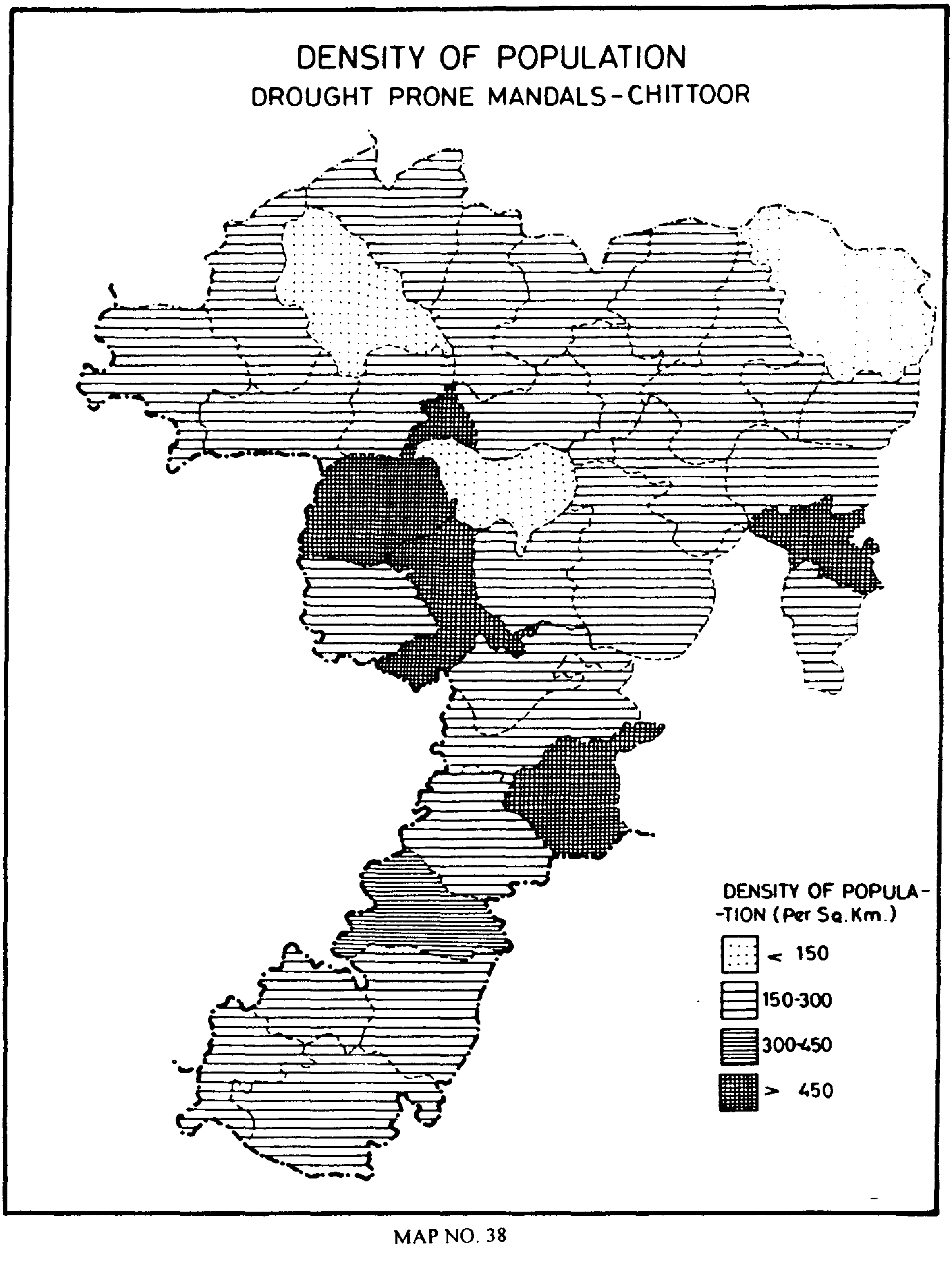
24. Number of Fair Price Shops - Public Distribution System (Positive)

25. Enrollment of Upper Primary Schools (Positive)

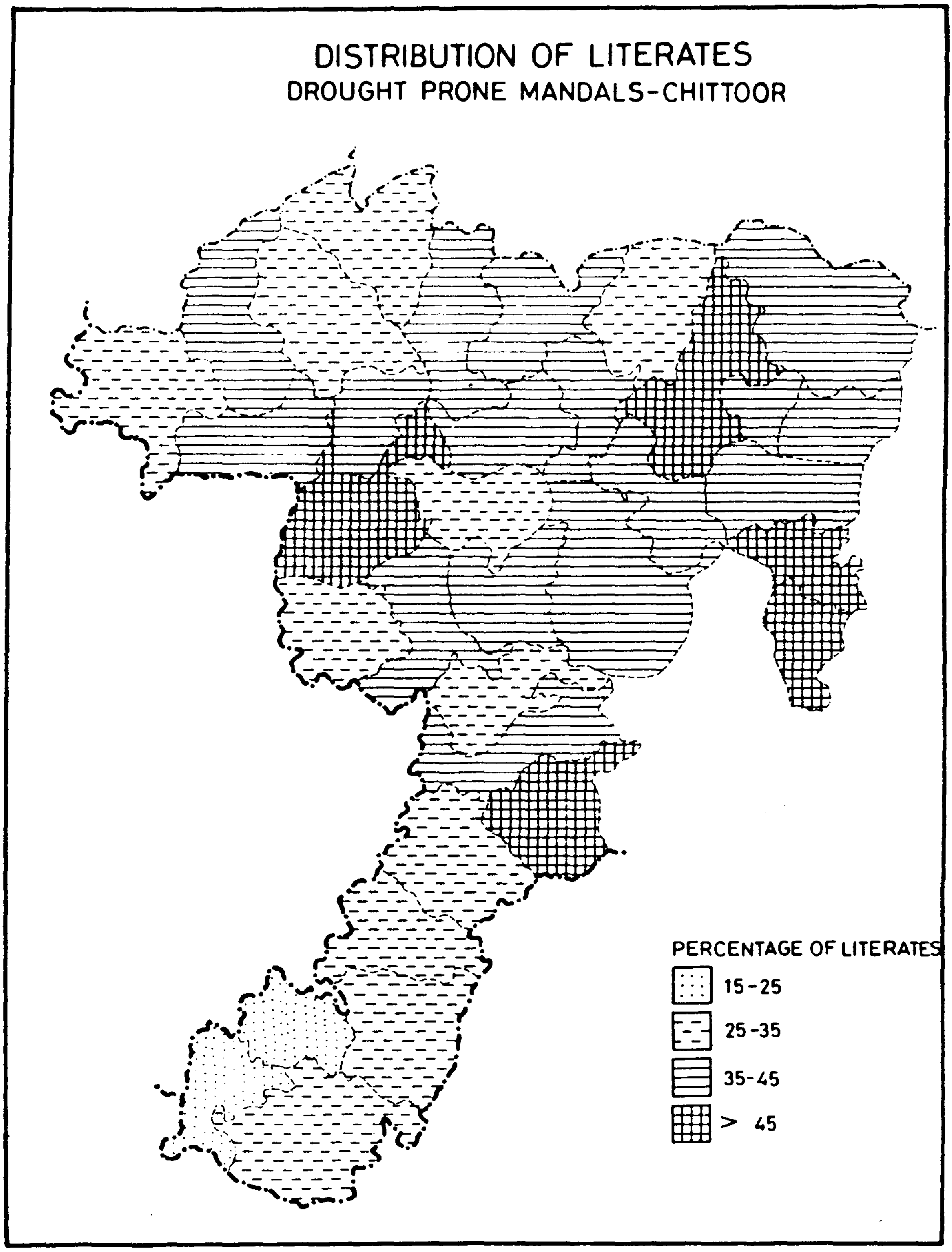
26. Total Number of High Schools (Managed by Municipalities, State Government, Zilla Praja Parishad, Private aided, Private Unaided, including these in the municipalities) (Positive).

27. Percentage of literates to total population. (Positive)

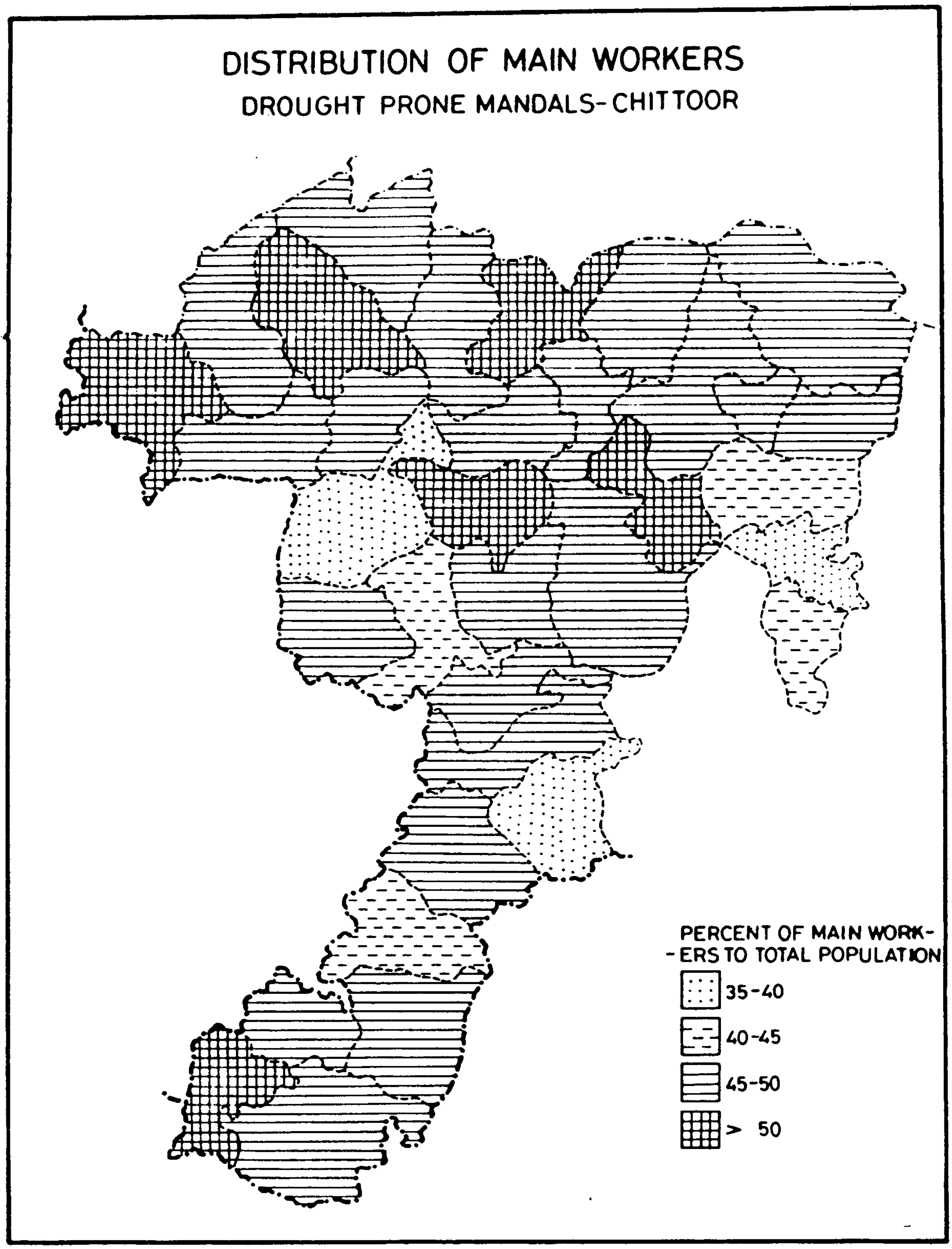
The positive indication denotes that the highest value gets the highest rank of one. The negative indicator considers the highest value with a rank of 34.


DENSITY OF POPULATION
DROUGHT PRONE MANDALS - CHITTOOR
DENSITY OF POPULA-
-TION (Per Sq. Km.)
< 150
150-300
300-450
> 450

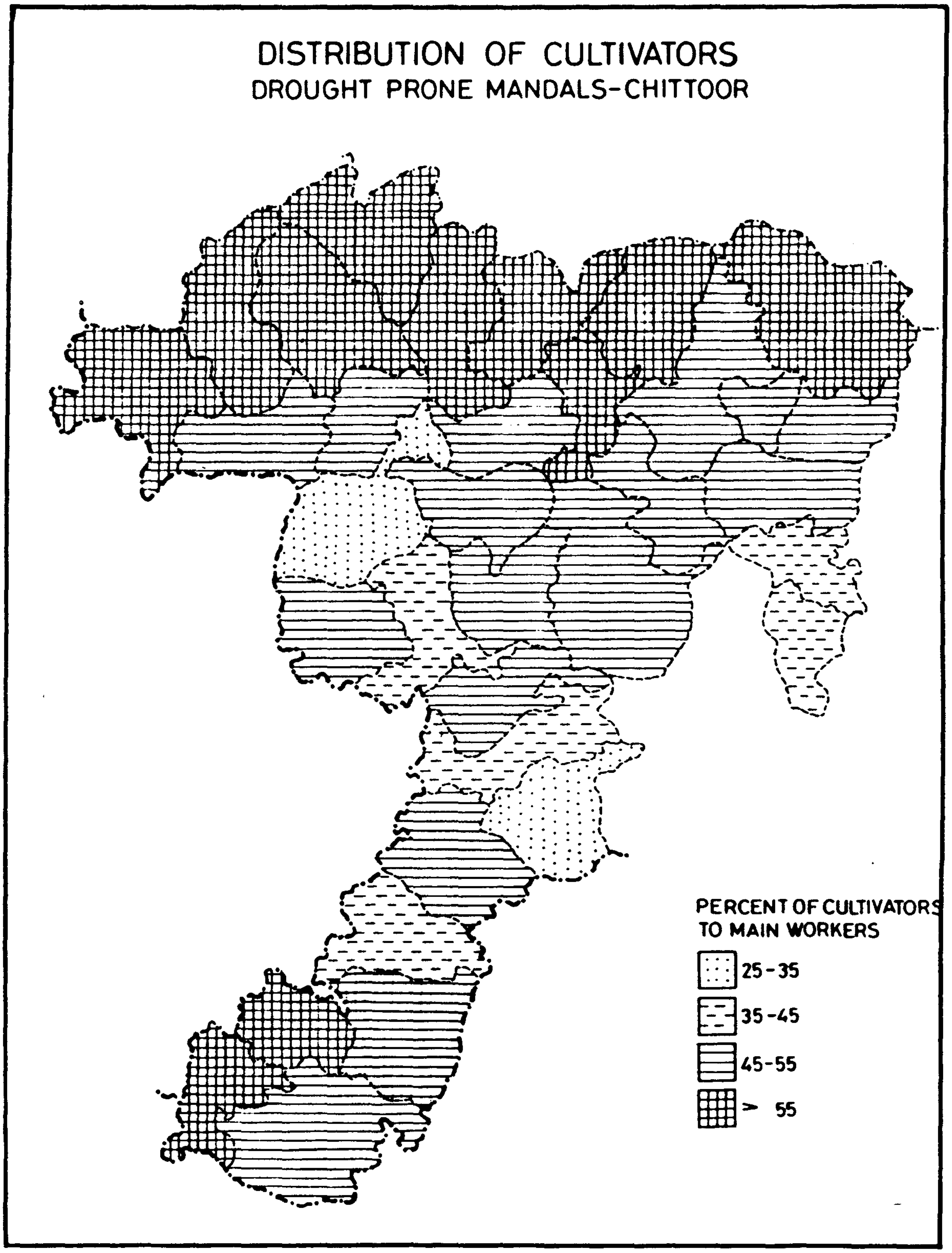
MAP NO. 38


DISTRIBUTION OF LITERATES
DROUGHT PRONE MANDALS-CHITTOOR
PERCENTAGE OF LITERATES
15-25
25-35
35-45
> 45

MAP NO. 39

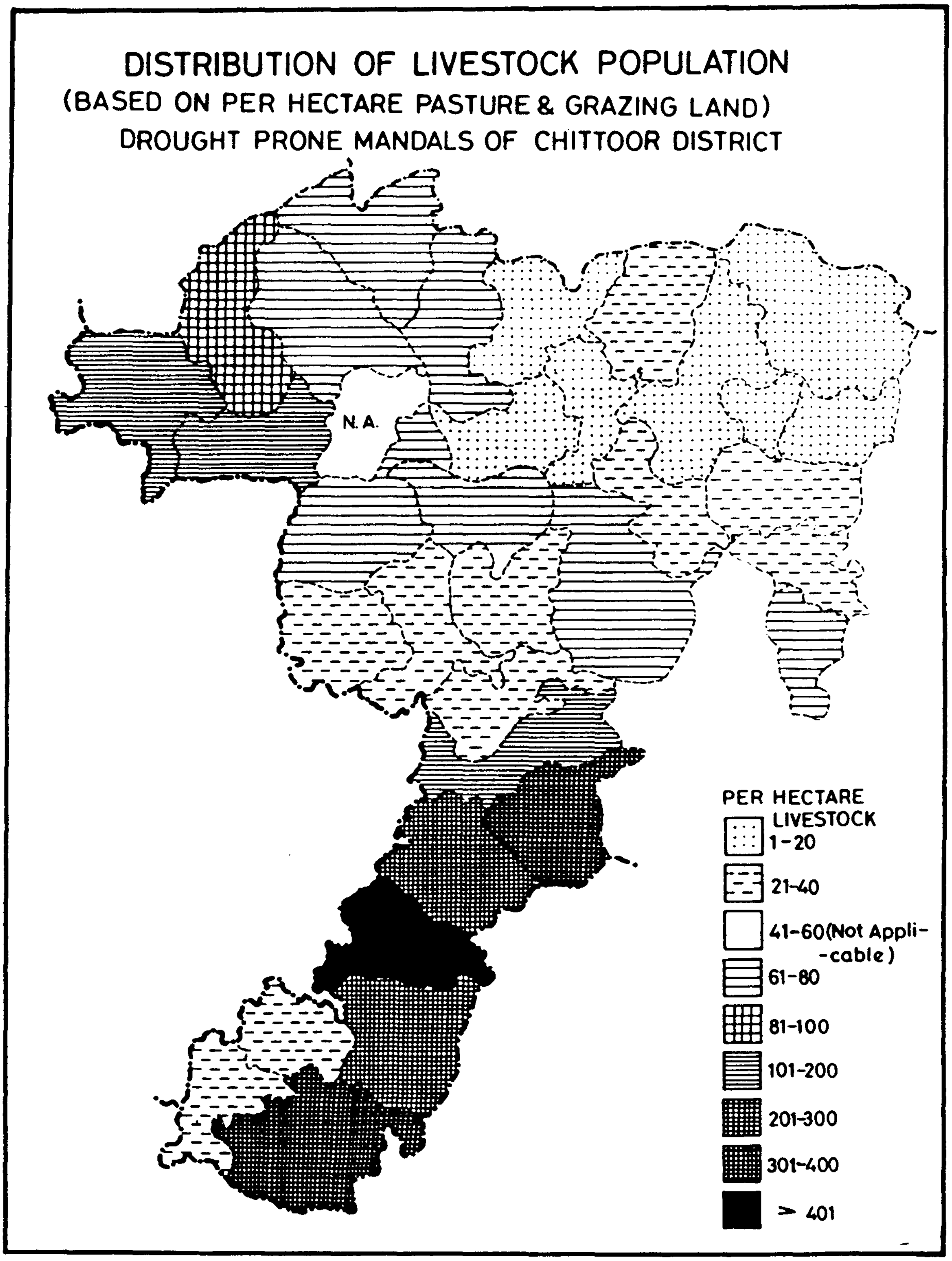

DISTRIBUTION OF MAIN WORKERS
DROUGHT PRONE MANDALS- CHITTOOR
PERCENT OF MAIN WORK-
- ERS TO TOTAL POPULATION
35-40
40-45
45-50
> 50

MAP NO. 40



DISTRIBUTION OF CULTIVATORS
DROUGHT PRONE MANDALS-CHITTOOR
PERCENT OF CULTIVATORS TO MAIN WORKERS
25-35
35-45
45-55
> 55

MAP NO. 41


DISTRIBUTION OF LIVESTOCK POPULATION
(BASED ON PER HECTARE PASTURE & GRAZING LAND)
DROUGHT PRONE MANDALS OF CHITTOOR DISTRICT
N.A.
PER HECTARE LIVESTOCK
1-20
21-40
41-60(Not Appli-cable)
61-80
81-100
101-200
201-300
301-400
> 401

MAP NO. 42

Some of the indicators have been shown in the form of choropleth maps. Map Number 38 shows the density of population. Map Number 39 shows the percentage of literates to the total population. Map Number 40 shows the distribution main workers as percentage to total population. Map Number 41 shows the percentage of cultivators to the main workers.

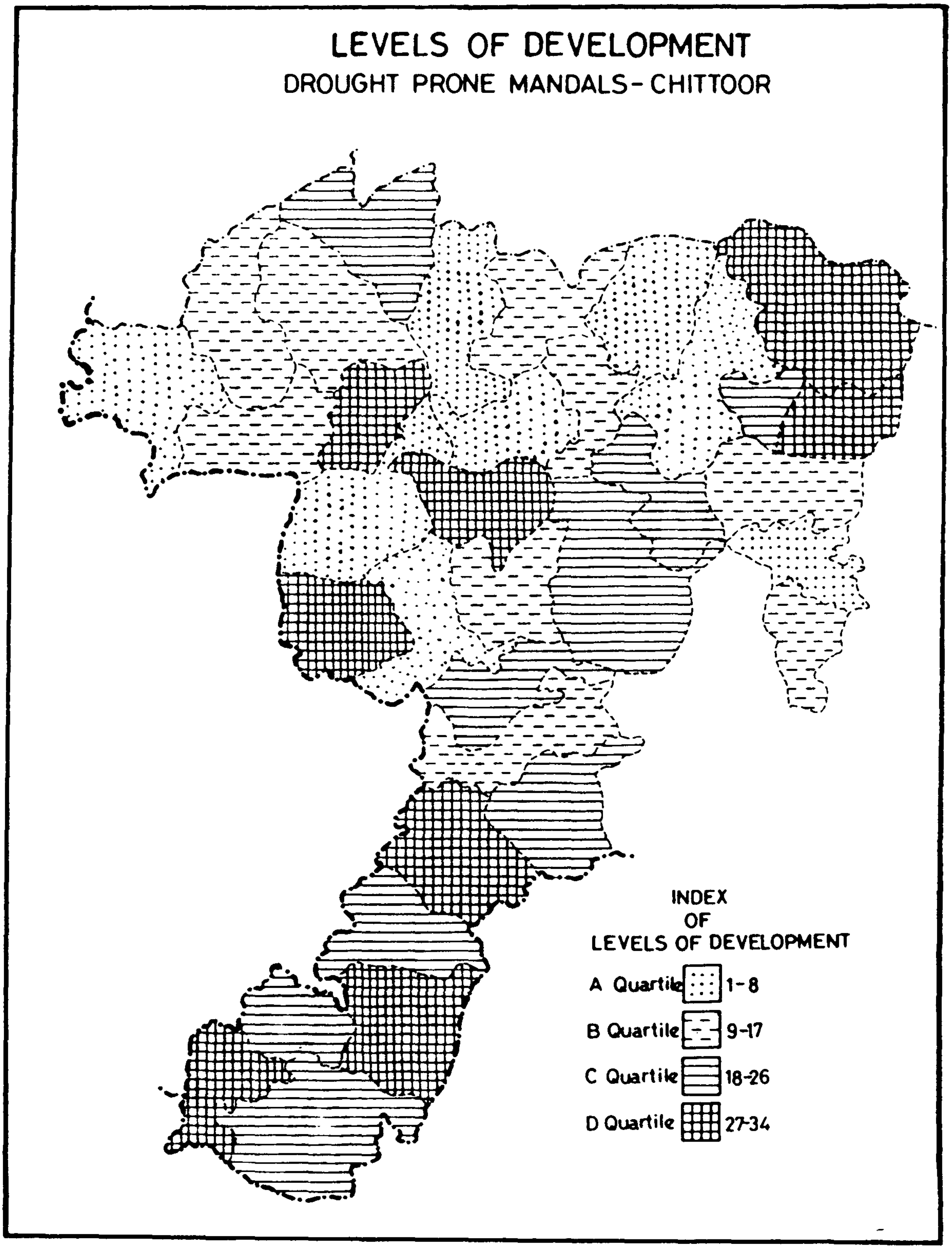
The distribution of livestock per hectare of permanent pasture and grazing land (See Map Number 42) shows that the southern mandals have a large population of livestock though their pasture and grazing land is very small. Venkatagiri Kota has the highest density of livestock on its pasture on grazing land (28155 livestock population on 66 hectares). Palamaner and Kuppam also have a population of above 300 livestock per hectare of pasture and grazing land. However the northern and north-eastern mandals have good prospects of dairy development since they have a vast expanse of grazing land which ranges from 2064 hectares in Gurramkonda to around 453 hectares in Vayalpad. All of them have a population of upto 80 livestock per hectare of grazing land.

In the absence of any comparable mandal level data on crop productivity the ranks of the indicators considered are aggregated to arrive at the final index number. Quartiling has been done and the mandals being divided into four categories of developedness i.e. High Moderate, Slight and Low.

TABLE 7.03:

27-INDICATOR RELATIVE INDEX OF DEVELOPMENT (RID) OF DROUGHT PRONE MANDALS - CHITTOOR

MANDAL	RID	RANK	QUARTILE
Madanapalle	252	1	Quartile one
Kambhamvaripalle	349	2	Quartile one
Punganur	351	3	Quartile one
Pedatippasamudrum	353	4	Quartile one
Gurramkoda	400	5	Quartile one
Pakala	400	5	Quartile one
Piler	417	7	Quartile one
Vayalpad	424	8	Quartile one
B Kothakota	427	9	Quartile two
Kalikiri	427	9	Quartile two
Pulicherla	427	9	Quartile two
Chowdepalle	429	12	Quartile two
Kalakada	429	12	Quartile two
Gangavaram	429	12	Quartile two
Molakalacheruvu	433	15	Quartile two
Thamballapalle	433	15	Quartile two
Puthalapattu	436	17	Quartile two
Somala	447	18	Quartile three
Palamaner	463	19	Quartile three
Kuppam	471	20	Quartile three
Peddapanjani	477	21	Quartile three
Venkatagiri Kota	480	22	Quartile three
Santipuram	480	22	Quartile three
Rompicherla	484	24	Quartile three
Sodam	486	25	Quartile three
Peddamandyam	489	26	Quartile three
Yerravanipalem	490	27	Quartile four
Nimmanapalle	501	28	Quartile four
Ramasamudram	508	29	Quartile four
Chinagottigallu	514	30	Quartile four
Baireddipalle	527	31	Quartile four
Ramakuppam	540	32	Quartile four
Kurabalakota	560	33	Quartile four
Gudupalle	605	34	Quartile four


LEVELS OF DEVELOPMENT
DROUGHT PRONE MANDALS - CHITTOOR
INDEX
OF
LEVELS OF DEVELOPMENT
A Quartile 1-8
B Quartile 9-17
C Quartile 18-26
D Quartile 27-34

MAP NO. 43

The Relative Index of Development shows that Madanapalli with the lowest index of 252 is the most developed mandals among the 34 drought prone mandals of Chittoor. Gudupalle comes last in this development scale with the maximum index number of 605.

When quartiling is done to the index, the mandals which group together in different quartiles is as given below.

TABLE 7.04 :

LEVELS OF DEVELOPMENT OF DROUGHT PRONE MANDALS OF CHITTOOR.

Quartile	No. of Mandals	Range of Index	Development Category
A Quartile	8	252-424	High
B Quartile	9	427 to 436	Moderate
C Quartile	9	447-489	Slight
D Quartile	8	490-605	Low

Nine mandals each fall in the Quartile B and C which show their level of development as moderate and slight respectively. Quartile A with 8 mandals show high level of development. The Quartile D show the 8 mandals which show low level of development. (See Map Number 43).

The relative Index of development of the drought prone mandals might help the planners to allocate contingency fund to the under developed mandals to elevate their level of development.

CONCLUSION

One of the severest constraints in achieving our socio-economic objectives since the inception of our first five year plan has been the population explosion. An annual increase of 2.1 percent in population imposes a strain on foodgrain stocks. The occurrences of drought reduce the agricultural productivity only. But it does not affect the population growth over the drought prone areas. When population pressure is increasing reclamation of land is also continuing side by side. As a consequence, vegetation cover gets destroyed, soil erosion accelerates and finally productive land is getting converted into stony and barren wastelands. Demographic explosion of this magnitude is also the root cause of over exploitation of natural resources. Hence, burgeoning population plays a significant role in resource degradation and the occurrence of drought. A small deficit in rainfall can aggravate the problem. Errant fluctuations in rainfall distribution produce adverse influence on agriculture and foodgrain production which control 32.3 percent of India's Gross national product.

The people living in drought prone areas have meagre resources and low management skills. Thus level of development also low.

The per hectare yield of the drought prone areas is generally low. There are wide variations in the yield of principal crops and this leads to an instability in the economy of the region. Because of the predominance of mono-crop culture, lack of rainfall and irrigation facilities, there is a very low intensity of cropping. The animal labour requirement is low and unevenly distributed. This has lead to under-employment of the rural cultivating population. The stabilizing and elevating of crop production in these areas holds the key to achieving stability in Agricultural Production.

There is an urgent need to protect the environment in these areas. The degradation of environment in the drought prone areas is basically attributed to the increasing biotic pressure on the fragile ecosystems in the absence of adequate investments and appropriate management practices to augment and conserve the land and water resources. Population growth and poverty on the one hand and the pressure of rising demand from affluence on the other, have been exerting powerful pressure on the ecosystems. The macro-economic policies which provide inducement to the over exploitation of natural resources, that is, at a higher rate than the rate of regeneration, are also responsible for denudation of environment. For example in the drought prone areas, the pumping of water has been proceeding at a faster rate than the rate at which ground water is being recharged. This is on account of the Availability of electricity at a flat rate regardless of the amount of electricity used for pumping water.

The breakdown of traditional institutions for managing common property resources and the failure of new institutions to fill the vacuum has also been responsible for the denudation of natural resources. The traditional community based institutions have given place so far to individualized or market driven exploitation of natural resources without any regard for adverse externalities of such actions and to numerous official programmes for the development of land and water resources which are dependent almost entirely on the top-down bureaucracy with very little participation from the Tehsil / Mandal village communities at the micro-level.

The present study aims to critically analyse the drought situation in the drought prone areas in Andhra Pradesh. There are eight drought prone districts namely Prakasam, Kurnool, Anantpur, Cuddapah, Chittoor, Rangareddy, Mahbubnagar and Nalgonda. Since mandals-wise data is available for Chittoor district only, detailed analysis is confined to this district.

The normal annual rainfall in the drought prone mandals of Chittoor varies from around 550 millimeters to 750 millimeters. The frequency of occurrence of drought has been studied for the drought prone tehsils in the 8 districts of Andhra Pradesh. Rainfall departure from normal adversely affects the cropping pattern and agricultural production. The area of current fallow decreases sharply with decrease in rainfall. Although negative agricultural production is noticed in drought years in all the districts, Chittoor and Mahbubnagar districts are more sensitive to the rainfall fluctuations.

Out of the eight drought prone districts Chittoor maintained a high gross irrigated area as percentage to gross cropped area while Anantpur continued to be low. The drought prone Mandals have been identified by the percentage of gross irrigated area to the gross cropped area. The tank irrigation has come into disuse and is being fast supplemented by dug wells and more recently by bore wells. Rice though is the main food crop, it is fast loosing its total cropped area to the commercial crops like sugarcane.

Percentage deviation of 1986-87 rainfall , irrigation, cropped area and crop production over 1985-86 showed a consistent positive correlation, while that of the current fallow expressed negative correlation.

Though welfare approach is the need of the hour the integrated development of watershed has to be pursued as per the recommendations of Swaminathan Committee Report and Hanumantha Rao Committee Report.

More crop research has to be taken up to develop area specific crops which can be added to the recommended Agricultural contingency plan for the Drought prone Areas of Andhra Pradesh.

Rice remains the major crop irrigated from both surface and ground water resources. Though they are drought prone mandals, the cultivators are used to grow rice as staple food grain both in the kharif and rabi seasons. Thus utilising the maximum quantity of available water resource. This heavy duty crop i.e. should be grown only in one season for economic use of water so as to bring more area under irrigated semi-dry crops like groundnut and pulses.

A lot more emphasis is required to be given to farming research in the drought prone areas. A study of the complete resources available is the need of the hour. It should provide a real base to the farmers in recommending crop farming, animal production and then the type of mixed farming. In view of the large percentage of small and marginal farmers mixed farming and diversified agriculture could be the best solution to their economic upliftment. However further research is necessary for the in-depth analysis in relation to cropping sequences and their interactions which influence the production as well as soil fertility. Crop Rotation in the drought prone Mandals of Chittoor, the cereal and millet crops should be rotated with pulses, vegetable, groundnut and gingelly. Mixed Cropping Groundnut can be grown mixed with castor or sorghum or maize. Ragi can be grown mixed with indigo and groundnut with Gogu (Bengal hemp) can be mixed with sugarcane.

There are various developmental programmes in operation in the drought prone area. But the objectives of these programmes are far from realised. One of the main reason for the failure of these programmes is the lack of local participation in developmental efforts and proper coordination among the implementing agencies. There is a need to reorient the planning approach.

The micro level planning study which came out with a relative index of development to show the levels of development can be used as a model for a more future research work. The study has been one of the works on Micro-Level Planning at Mandal level. The Mandals which are the subdivisions of Tehsils / Taluks are taken as the basic units of study. The first ever data source at this micro-level of the Mandals of Chittoor have been used in the study to bring out a plan for the development of drought prone areas. In addition to this, the three tier system of government which gives more emphasis to the Panchayat Raj at the grass root level of villages should come as a welcome sign for more efficient functioning of the plan.

RECOMMENDATIONS FOR MICRO-LEVEL PLANNING

The present study recommends that:

* Conservation of natural resources has to be made privately profitable by providing necessary infrastructure, technologies and institutional backup.
* Greater attention has to be given to peoples own strategies and their own indigenous technologies including the locally preferred plants so as to incorporate them in the programmes to mitigate the rigours of drought.
* Establishment of wool processing units and tanneries in drought prone areas can raise the employment and income for local people and thus reduce nomadism and migration which will have favourable impact on environment. Development of crafts and handicrafts will also have a similar effect.
* A harmonious management, development and utilisation of land, water and vegetation resources on watershed basis, and the creation of complementary opportunities for processing and marketing of value added goods produced in these areas should be the essence of these area development programmes.

* The governmental funding for the programmes should be project based rather than area based.
* The latest study proposes to include three ecosystems semi-arid and dry sub-humid under DPAP instead of drought prone areas as at present and also propose following irrigation criteria for different ecosystems on district basis. These areas where irrigated area constitutes more than 40 percent & 30 percent of the net sown area respectively may be excluded from the programme.

Some of the long term planning elements include:

* Infrastructural development for the conjunctive use of groundwater seepage.
* Moisture retention in soil and slopes.
* Agricultural and Horticulture Development
* Agro-forestry and social forestry.

While the short term planning includes:

* Relief Works
* Deep boring of bore wells.
* Mother and Child Care
* Improvement of Public Distribution System and Free Rations.
* Animal Husbandary / Fodder Cultivation.
* Planning is an essential component of development strategy and this should be done preferably at the grass root level.

Purely welfare oriented approach such as providing relief supplies during droughts should be complemented by productive activities leading to the Creation of Social assets through afforestation soil conservation works etc. However, the appropriate choice of these works (e.g. percolation tanks, contour bunding, pasture a forest development etc.) also require quantification and understanding of the environment and socio-economic variables and their spatial patterns.

There should be shift from purely adhoc measures to systematic and planned efforts to help drought prone areas.

Drought has an effect on employment, health and nutrition.

* The unemployment is endured by agricultural labourers, particularly women workers. This can be averted by timely and locally available public works programme.
* The lack of water is probably the greatest constant to the well being of all villages. When compared with severe shortage of electricity, the scarcity of readily available clean water will lead to sizeable increase in water related morbid symptoms - diarrhoea, eye infections and scabies.

The three situations have to be highlighted and implications should drawn for drought relief policy.

The role of the agricultural cooperatives and credit cooperatives is very important drought prone areas. They need to be reformed. Many of these banks suffer from problems of poor loan recovery and excessive overdues due to the limited credit worthiness of the local population.

Drought should be dealt with by incorporating the compensatory development plan into the national plan. It will be noble alternative to the adhoc measures which tend to fail in times of crisis.

Rural Industrialization will accelerate the economic development of the mandals in the Chittoor district. An increase in industrial output and productivity through optimal utilization of resources is seen as the one of the cures for socio-economic ills in these drought prone areas.

Members of parliament concentrate more on drawing attention to the drought conditions in their constituencies and on pleading either for greater relief or that certain areas within their constituencies should be declared drought sticken so as to qualify for relief assistance. It is a valid point but to overemphasize it will divert attention from crucial issues of improvement of irrigation facilities and agricultural production in the drought prone areas of Andhra Pradesh

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ANNEXURES

ANNEXURE-I

BLOCKS / TEHSILS IN DISTRICTS OF THE DROUGHT PRONE AREAS PROGRAMME (DPAP) AS ON 17 OCTOBER 1994

1. ANDHRA PRADESH

1. ANANTPUR

1. CHENNAKOTHAPALLI	2. DHARMAVARAM	3. GOOTY
4. HINDUPUR	5. KADIRI-EAST	6. KADIRI-WEST
7. KALYANDURG	8. KAMBADUR	9. KANEKAL
10. KUDIAR	11. MADAKASIRA	12. PENUKONDA
13. RAYADURG	14. SINGANAMALA	15. TADIPATRI
16. URAVAKONDA		

2. CHITTOOR

1. CHINNAGOTTIGALLU	2. CHOWDEPALLE	3. KUPPAM
4. MADANAPALLI	5. PALAMANER	6. PUNGANUR
7. VAYALPAD	8. TAMBALAPALLI	

3. CUDDAPAH

1. JAMMALAMADUGU	2. KAMALAPURAM	3. LAKKIREDDIPALLI
4. MUDDANUR	5. PULIVENDLA	6. RAYACHOTI

4. KURNOOL

1. ADONI	2. ALUR	3. ATMAKUR
4. BANGANAPALLI	5. DHONE	6. KODUMUR
7. KOILAKUNTLA	8. KURNOOL	9. ALLAGADDA
10. NANDIKOTKUR	11. NANDYAL	12. PATTIKONDA
13. YEMMIGANUR		

5. MAHBUBNAGAR

1. ACHAMPET	2. AMANGAL	3. ATMAKUR
4. BIJINEPALLI	5. GADWAL	6. KALWAKURTHY
7. KOLLAPUR	8. MAKTHAL	9. MANOPAD
10. NAGARKURNOOL	11. SHADNAGAR	12. WANAPARTHY

6. NALGONDA

1. CHINTAPALLI	2. DEVARAKONDA	

7. PRAKASAM

1. BESTAVARIPET	2. GIDDALUR	3. KANIGIRI
4. MARKAPUR	5. PODILI	6. TALLUR
7. TARLAPADU	8. VELIGANDLA	9. YERRAGONDAPALEM

8. RANGAREDDY

1. CHEVELLA	2. IBRAHIMPATNAM	3. MAHESWARAM

2. BIHAR

1. JAMUI

1. CHAKAI	2. JAMUI	3. KHAIRA
4. JHAJHA	5. LAKHMIPUR	6. SIKANDRA
7. SONO		

2. NAWADAH

1. AKBARPUR	2. GOVINDPUR	3. HISUA
4. KAWAKOLE	5. NARHAT	6. NAWADAH
7. PAKARIBARAWAN	8. RAJAULI	9. SIRDALA

3. PALAMAU

1. BALUMATH	2. BARWADIH	3. CHAINPUR
4. CHANDWA	5. CHHATARPUR	6 DALTONGANJ
7. GARU	8. HARIHARGANJ	9. HUSSAINABAD
10. LATHAR	11. LESLIGANJ	12. MAHUADANR
13. MANATU	14. MANIKA	15. PANKI
16. BISHRAMOUR		

4. GARHWA

1. DHURKI	2. BHANDARIA	3. MAJHIAON
4. BHAWANATHPUR	5. GARHWA	6. NAGARUNTARI
7. PIPRAKALAN	8. RANKA	

5. ROHTAS

1. CHENARI	2. NAWAHATTA	

6. BHABHUA

1. ADHAURA	2. BHABHUA	3. BHAGWANPUR
4. CHAND	5. RAMGARH	

7. GODDA

1. BOARIJORE	2. GODDA	3. MAHAGAMA
4. MEHRMA	5. PATHARGAMA	6. PORIYAHAT
7. SUNDERPAHARI		

3. GUJARAT

1. AHMEDABAD

1. DHANDHUKA	2. VIRAMGAM	

2. AMRELI

1. BABRA	2. DHARI	3. JATRABAD
4. KHAMBHA	5. KUNKAVAV	6. LATHI
7. LILIYA	8. RAJULA	

3. BHAVNAGAR

1. GADHDA	2. GARIADHAR	3. SAVARKUNDLA

4. JAMNAGAR

1. KALYANPUR	2. DWARAKA	

5. KUTCH

1. ABDASA	2. ANJAR	3. BHACHAV
4. BHUJ	5. LAKHAPAT	6. NAKHATRAM
7. RAPAR		

6. PANCHMAHALS

1. DOHAD	2. GODHRA	3. JHALOD
4. LIMBHEDA	5. LUNAWADA	6. SANTRAM FUR
7. SHEHRA		

7. RAJKOT

1. JASDAN	2. LODHIKA	3. MALIYA
4. PADDHARI	5. WANKANER	

8. SURENDRANAGAR

1. CHOTILA	2. DASADA	3. DHRANGADHRA
4. HALVAD	5. LAKHTAR	6. LIMBDI
7. MULI	8. SAYLA	9. WADHWAN

4. HARYANA

1. MOHINDERGARH

1. ATELI	2. KAMNA	3. NARNAUL
4. MOHINDERGARH	5. NAGAL CHAUDHRY	

2. REWARI

1. REWARO	2. BAWAL	3. KHOL
4. JATUSANA		

5. JAMMU & KASHMIR

1. DODA

1. ASSAR	2. BHADERWAH	3. BALESA
4. DODA	5. KISHTWAR	6 MARWA
7. PADDAR	8. RAMBAN	9* BHAGWA
10* INDERWAL	11* RAMSU	12* THATARI
13* BHANIWAL	14* WAR	

2. UDHAMPUR

1. ARNAS	2. CHENANI	3. POUNI
4. RASI	5. UDHAMPUR	6* PANCHARI
7* GOOL	8* MAHORE	

6. KARNATAKA

1. BELGAUM

1. ATHANI	2. GOKAK	3. RAMDURG
4. SAUNDATTI		

2. BELLARY

1. HADAGALLI	2. HARAPANAHALLI	3. KUDLIGI
4. MELLAPURAM	5. SANDUR	

3. BIDAR

1. BAAVAKALYAN	2. HUMANABAD	3. SANTHPUR

4. BIJAPUR

1. BADAMI	2. BAGALKOT	3. BAGEWADI
4. BIJAPUR	5. BILAGI	6. HUNGUND
7. INDI	8. JAMAKHANDI	9. MUDDEBIHAL
10. MUDHOL	11. SINDAGI	

5. CHICKMAGALUR

1. KADUR

6. CHITRADURGA

1. CHALLAKERE	2. CHITRADURG	3. HOLAKERE
4. HOSADURGA	5. JAGALUR	6. MOLAKALMURUA

7. DHARWAR

1. BYADAGI	2. DHARWAR	3. GODAG
4. HAVERI	5. HIREKERUR	6. HUBLI
7. KALGHATAGI	8. KUNDGOL	9. MUNDARGI
13. SHIRHATTI	14. SHIGGAON	

8. GULBARGA

1. AFZALPUR	2. ALLAND	3. CHITTAOUR
4. VULBARGA	5. SEDAM	6. SHAHAPUR
7. SHORAPUR	8. YADIGIRI	

9. KOLAR

1. BAGEPALLI	2. BANGARPET	3. CHINTAMANI
4. GUDDIBANDA	5. KOLAR	6. MALUR
7. MULBAGAL	8. SIDDALAGHATTA	9. SRINIVASAPUR

10. RAICHUR

1. DEODURGA	2. KUSHTAGI	3. LINGSUGUR
4. YELABURGA		

11. TUMKUR

1. CHIKKANAIKANAHALLI	2. KORATGERE	3. MADHUGIRI
4. PAVAGADA	5. SIRA	6. TIPTUR

<u>7. MADHYA PRADESH</u>

1. BETUL

1. AMLA	2. BETUL	3. BHIMPUR
4. CHICHOLI	5. GHODADONGRI	6. MULTAI
7. PRABHAT PATAM	8. SHAHPUR	9. MULTAI

2. DHAR

1. BAGH	2. DAHI	3. GANDHWANI
4. KUKSHI	5. MANWAR	6. NISARPUR
7. SARDARPUR	8. UMARVAN	

3. JHABUA

1. ALIRAJPUR	2. BHABRA	3. JHABUA
4. JOBAT	5. KATHIWARA	6. MEGHNAPUR
7. PETLAWAD	8. RAMA	9. RANAPUR
10. SENDHWA	11. THANDLA	12. UADAIGARH

4. KHARGAON

1. BARWANI	2. BHAGWANPURA	3. BHIKANGAON
4. PATI	5. RAJPUR	6. THIKARI
7. ZIRNIA		

5. SHAHDOL

1. BEOHARI	2. JAISINGH NAGAR	3. MANPUR
4. PUSHPARAJGARH	5. SOHAGPUR	6. UMARIA

6. SIDHI

1. CHITRANGI	2. DEOSAR	3. KUSMI
4. MAJHAULI	5. RAMPUR NAIKIN	6. SIDHI
7. SIHAWAL	8. VAIDHAN	

<u>8. MAHARASHTRA</u>

1. AHMEDNAGAR

1. AHMEDNAGAR	2. AKOLA	3. JAMKHED
4. KARJET	5. NEWASA	6. PARNER
7. PATHARI	8. SANGAMNER	9. SHERGAON
10. SHRIGONDA		

2. SURANGABAD

1. AURANGABAD	2. GANGAPUR	3. KANNAD
4. KHULLABAD	5. PAITHAN	6. VAIJAPUR

3. BEED

1. ASTHI	2. BEED	3. GEORAI
4. KAIJ	5. MANJLEGAON	6. PATODA

4. DHULE

1. DHULE	2. NANDURBAR	3. SAKRI

5. JALGAON

1. AMALPUR	2. CHALISGAON	3. EDLABAD
4. PACHORA	5. PAROLA	

6. JALNA

1. AMBAD		

7. NASIK

1. BAGLON	2. CHANDWAD	3. DINDORI
4. KALWAN	5. MALEGAON	6. NANDGAON
7. NASIK	8. NIPHAD	9. SINNAR
10. YEOLA		

8. OSMANABAD

1. BOOM	2. KALAM	3. PARANDA

9. PUNE

1. AMBEGAON	2. BHRAMATI	3. DHOND
4. HAVELI	5. INDAPUR	6. JUNNAR
7. KHED	8. PURANDHAR	9. SHIRUR

10. SANGLI

1. ATAPADI	2. JATH	3. KAVATHAMAHAKAL
4. KHANAPUR	5. MIRAJ	6. TASGAON

11. SATARA

1. KOREGAON	2. KHANDALA	3. KHATA
4. MAN		

12. SHOLAPUR

1. AKKALKOTI	2. BARSI	3. KARMALA
4. MADHA	5. MANGALVEDHA	6. MOHOL
7. NORTH SHOLAPUR	8. PANDHARPURSANGOLA	9. SANGOLA
10. SOUTH SHOLAPUR		

9. ORISSA

1. BOLANGIR

1. BANGOMUNDA	2. BELAPARA	3. KHAPRAKHOL
4. MURIBHAL	5. PATNAGARH	6. SAINTALA
7. TITILAGARH	8. TUREIKELLA	

2. KALAHANDI

1. BODEN	2. GOLAMUNDA	3. KESINGA
4. KHARIAR	5. KONA	6. LANJIGARH
7. MADANPUR RAMPUR	8. NARLA	9. NAWAPARA
10. SINAPALI	11. THUNAMAL RAMPUR	

3. PHULHANI

1. BALIGUDA	2. CHAKAPAD	3. DARINGBADI
4. G. UDAYAGIRI	5. HARABHANGA	6. KANTAMAL
7. KHAJURIPADA	8. KOTARGARH	9. NUAGAON
10. PHIRINGIA	11. PHULBANI	12. RAIKIA
13. TIKABALI	14. TUMUDIBANDHA	

4. SAMBALPUR

1. BIJEPUR	2. GAISILAT	3. KHARABHANDHA
4. PADMAPUR	5. PAIKMAL	6. SOHELLA

<u>**10. RAJASTHAN**</u>

1. AJMER

1. JAWAJA	2. MASAUDA

2. BANSWARA

1. ANANDPURI	2. BAGIDORI	3. GARHI
4. GHATOL	5. KUSHALGARH	6. PIPALKHUNT

3. DUNGARPUR

1. ASPUR	2. BICHIWARA	3. DUNGAPUR
4. SAGWARA	5. SIMALWARA	

4. JHALAWAR

1. DURG	2. JHALRAPATAN	3. KHANPUR

5. KOTA

1. CHACHAT	2. SANGOD

6. BARAN

1. CHHABRA	2. SHAHBAD

7. SAWAI MADHOPUR

1. KHANDAR	2. NANDUTI

8. TONK

1. DEOLI	2. TODARAISINGH	3. UNIARA

9. UDAIPUR

1. JHADOL	2. KHERWARA	3. UNIARA

<u>**11. TAMILNADU**</u>

1. CHIDAMBARANAR

1. KAYATHUR	2. KOILAPATTI	3. OTTAPIDARAM
4. PUDUR	5. SATTANKULAM	6. TUTICORIN
7. UDANGUDI	8. VILATHIKULAM	

2. DHARMAPURI

1. BARGUR	2. BORAPUR	3. DHARMAPURI
4. HOSUR	5. KELAMANGALAM	6. NALLAMAPALI
7. PALACODE	8. PANNAGRAM	9. SHOOLAGIRI
10. THALLI	11. UTHANGARAI	12. VEPPANAPALLI
13* KARIMANGULAM	14. MUTHUR	

3. KAMARAJAR

1. KARIAPATTI	2. NARIKUDI	3. SATTUR
4. SIVAKASI	5. VEMBAKOTTAI	

4. PASUMPMUTHURAMALINGAN

1. DEVAKKOTTAI	2. ILLALYANGUDA	3. KALAYARKOIL
4. KALLAL	5. KANNANDUGI	6. SINGAMPUNERI
7* S. PUDUR		

5. RAMANATHAPURAM

1. BOGALUR	2. KADALADI	3. KAMUTHI
4. MANDAPAM	5. MUDUKULATHUR	6. PARAMAKUDI
7. THIRUPULLANI		

6. TINUNELVELI

1. KURUVIKULAM

7. PUDUKOTTAI

1. GANDARVAKOTTAI	2. KARAMBAKUDI	3. PUDUKOTTAI
4. THIRUVARANKULAM		

<u>12. UTTAR PRADESH</u>

1 ALLAHABAD

1. SHANKERGAGH

2. AMORA

1. BHIKIASEN	2. DWARAHAT	3. KAPKOT
4. LAMGARA	5. SALT	6. SYALDE
7. TAKULA	8. TARIKHER	

3. BAHRAICH

1. BALHA	2. FAKHARPUR	3. GISAULA
4. HARIHARPUR RANI	5. HAZURPUR	6. IKAUNA
7. JARWAL	8. KAISERGANJ	9. MAHSI
10. MEHINPURWA	11. NAVABGANJ	12. SHEOPUR
13. SIRSIA	14. TAKWAPUR	

4. BANDA

1. BAROKHAR KHURD	2. JASPURA	3. KAMASDIN
4. KARVI	5. KANIKPUR	6. MAU
7. NARANI	8. PAHARI	

5. CHAMOLI

1. GAIRSAIN	2. JOSHIMATH	3. NARAIN BAZAR
4. THARALI		

6. GARHWAL (PAURI)

1. DANGU	2. KALLZIKHAL	3. KHIRSU
4. KOTA	5. LANDSDOWN	6. PABAU
7. PAURI	8. THAILISAIN	9. VIROKHAL
10. YAMKESHWAR		

7. GONDA

1. GAINSARI	2. HARRIAYA-SATPURWA	3. PACHPURWA
4. TULSIPUR		

8. HAMIRPUR

1. CHARKHARI	2. SAMERPUR	3. MAUDHARA
4. SARILA		

9. JALAUN

1. DOKORE	2. KADAURA	3. MAURANIPUR

10. JHANSI

1. BAMOUR	2. KADAURA	3. MAHEWA

11. LAKSHIMPUR KHERI

1. BIJUA	2. NAKHA

12. LALITPUR

1. BIRGHA	2. MADAWARA	

13. MIRZAPUR

1. CHANVE	2. HALTA	

14. PITHORAGARH

1. BORACOT	2. CHAMPAWAT	3. GANGOLIHAT
4. LOHAGHAT	5. PITHORAGARH	

15. SITAPUR

1. BEHTA	2. REOSA	3. SARKAN

16. SONEBHADRA

1. CHATARA	2. CHOPAN	3. DUDHDHI
4. GHORWAL	5. BABHANI	6. MYOREPUR
7. NAGAVA	8. ROBERTAGANJ	

17 TEHRI GARHWAL

1. CHAMBA	2. DEOPRAYAG	3. KIRTINAGAR

<u>13. WEST BENGAL</u>

1. BANKURA

1.CHHATNA	2. GANGAJALGHATI	3. INDPUR
4. KHATRA-II	5. MEJHIA	6. RANIBANDH
7. SALTORA		

2. MIDNAPUR

1. BINPUR-1	2. GOPIBALLAVPUR-I	3. GOPIBALLAVPUR-II
4. JAMBANI	5. JHALDA	6. NAYAGRAM

3. PURULIA

1. ASHAR	2. BAGMUNDI	3. BALARAMPUR
4. BARABAZAR	5. BURDWAN	6. HURA
7. JAIPUR	8. DALDA-II	9. JHALDA-II
10. KASHIPUR	11. MANABAZAR-I	12. MANBAZAR-II
13. NETURIA	14. PARA	15. PUNCHA
16. PURULIA-I	17. PURULIA-II	18. RAGHUNATHPUR-I
19. RAGHUNATHPUR-II	20. SANTURI	

GRAND TOTAL - 13 STATES	96 DISTRICTS	627 BLOCKS

* : NEWLY ADDED BLOCKS

ANNEXURE - II

DROUGHT PRONE MANDALS IN ANDHRA PRADESH
(Dilineated according to the Drought Prone Blocks / Taluks of DPAP - 1994)

1. PRAKASAM

1.	PULLALACHERUVU	2.	ERRAGONDAPALEM	3.	TRIPURANTHAKAM
4.	KURICHEDU	5.	PEDDA ARAVEEDU	6.	DORUALA
7.	ARAVEEDU	8.	RACHERLA	9.	MARKAPUR
10.	DONAKONDA	11.	TARLAPADU	12.	PONAKONAMITLA
13.	PODILI	14.	TALLUR	15.	MARRIPUDI
16.	KANIGIRI	17.	PEDACHERLAPALLI	18.	PAMURU
19.	CHANDRASEKARAPURAM	20.	KOMAROLU	21.	GIDDALURU
22.	BESTAVARIPETA	23.	CUMBUM	24.	HANUMANTHUNIPADU
25.	VELIGANDLA				

2. KURNOOL

1.	SRISAILAM	2.	ATMAKUR	3.	KOTHAPALLI
4.	PAGIDYALA	5.	VELUGODU	6.	PAMULAPADU
7.	JUPAD BANGLOW	8.	NANDIKOTKUR	9.	BANDI ATMAKUR
10.	GADIVEMULA	11.	ORVAKAL	12.	PANYAM
13.	NANDYALA	14.	MAHANANDI	15.	GOSPADU
16.	SIRVEL	17.	RUDRAVARAM	18.	KOILKUNTLA
19.	DORNIPAPU	20.	ALLAGADDA	21.	CHANGALAMARRI
22.	UYYALAWADA	23.	SANJAMALA	24.	KOLIMIGUNDLA
25.	OWK	26.	PYAPELLI	27.	BANGANAPALLI
28.	BETHAMCHERLA	29.	DHONE	30.	KODUMUR
31.	KALLUR	32.	KURNOOL	33.	GUDUR
34.	C. BELAGAL	35.	NANDAWARAM	36.	MANTHARALAYAM
37.	KOSIGI	38.	KOWTHALAM	39.	PEDDA KADUGUR
40.	YEMMIGANUR	41.	GONEGANDLA	42.	ADONI
43.	HOLAGUNDA	44.	ASPARI	45.	DEVANKONDA
46.	KRISHNAGIRI	47.	ALUR	48.	PATTIKONDA
49.	HALAHARIVI	50.	VELDURTHI	51.	CHIPPAGIRI
52.	MADDIKERA	53.	THUGGALI		

3. ANANTPUR

1.	GUNTAKAL	2.	GOOTY	3.	PEDDAVADUGUR
4.	YADIKI	5.	TADAPATRI	6.	PUTLUR
7.	YELLANUR	8.	TADIMARRI	9.	MUDIGUBBA
10.	TALUPULA	11.	NAMBULI PULI KUNTA	12.	KORANTLA
13.	NALLAMADA	14.	NALLA CHERUVU	15.	TANEKAL
16.	AMADAGUR	17.	OBULADEVARA-CHERUVU	18.	GANDLA PENTA
19.	CHILA MATHUR	20.	REPAKSHI	21.	HINDUPUR
22.	PARGI	23.	MADAKASIRA	24.	ROLLA
25.	AGALI	26.	GUDIBANDA	27.	AMARAPURAM
28.	KUNDARTHI	29.	SETTUR	30.	BRAHMASAMUDRUM
31.	GUMANGATTA	32.	RAYADURG	33.	DANDINA HIRAHAL
34.	BAMMANAHAL	35.	VIDAPANAKAL	36.	VAJRAKARUVU
37.	PAMIDI	38.	URAVAKONDA	39.	KANEKAL
40.	GARLADINNE	41.	BALUGUPPA	42.	ANANTPUR
43.	BUKKARAYASAMUDRUM	44.	NARPALA	45.	BATTALAPALLI
46.	DHARMAVARAM	47.	CHENNEKOTHAPALLI	48.	PENUGONDA
49.	SOMANDEPALLI	50.	RODAM	51.	RAMAGIRI
52.	KANAGANAPALLI	53.	KAMBADUR	54.	KALYANDURG
55.	SINANAMALA				

4. CUDDAPAH

1.	JAMMALAMADUGU	2.	PEDDAMUDIAM	3.	KONAPURAM
4.	JAMMALAMADUGU	5.	MUDDANUR	6.	SIMHADRI PURAM
7.	THONDUR	8.	ERRAGUNTLA	9.	CHAPADU
10.	KAMALAPURAM	11.	VEERAPPANAYANIPALLI	12.	VEMPALLI
13.	VEMULA	14.	PULIVENDLA	15.	LINGALA
16.	CHKRYAPET	17.	LAKKIREDDIPALLI	18.	RAMAPURAM
19.	VEERABALLI	20.		21.	GALIVEEDU
22.	CHINNAMANDEM	23.	SAMBEPALLI	24.	THUNDUPALLI

5. CHITTOOR

1.	GUDUPALLE	2.	KUPPAM	3.	SANTHIPURAM
4.	RAMAKUPPAM	5.	VENKATAGIRI KOTA	6.	BAIREDDIPALLI
7.	PALAMNER	8.	GANGAVARAM	9.	PEDDAPANJANI
10.	CHOWDEPALLI	11.	PUNGANUR	12.	RAMASAMUDRUM
13.	MADANAPALLI	14.	NIMMANAPALLI	15.	SODAM
16.	PILER	17.	ROMPICHERLA	18.	CHINAGOTTIGALLU
19.	YERRAVANIPALEM	20.		21.	KAMBAMVARIPALLI
22.	KALIKIRI	23.	VAYALPADU	24.	KALAKADA
25.	GURRAMKONDA	26.	PEDDAMANDYAM	27.	TAMBALLAPALLI
28.	MOLAKALACHERUVU	29.	PEDATIPPASAMUDRUM	30.	B. KOTAKOTA
31.	KURABALAKOTA	9+	SOMALA		

6. RANGAREDDI

1.	SANKARPALLI	2.	CHEVELLA	3.	MOINABAD
4.	SHAHABAD	5.	SHAMSHABAD	6.	MAHESWARAM
7.	IBRAHIMPATNAM	8.	KANDUKUR	9.	YACHARAM
10.	MANCHAL				

7. MAHBUBNAGAR

1.	KONDURG	2.	NAWABPET	3.	BALANAGAR
4.	KESAMPET		(YAMANAGANDLA)	5.	TALKONDAPALLI
6.	AMANGAL	7.	MADUGAL	8.	VELDANDA
9.	VANGUR	10.	KALWAKURTHI	11.	MIDJILI
12.	JADCHERLA	13.	KOILKONDA	14.	NARAYANPET
15.	UTKUR	16.	DHANWADA	17.	BOOTHKUR
18.	THIMMAJIPET	19.	TADOR	20.	UPPUNUTHALA
20+	AMANGAL	21.	TELKAPALLI	22.	ACHAMPET
23.	AMBRABAD	24.	BALMOOR	25.	LINGAL
26.	PEDAKOTHAPALLI	27.	KOLLAPUR	28.	VEEPANAGANOLA
29.	PANGAL	30.	GOPALPET	31.	NAGARKURNOOL
32.	BIJINAPALLI	33.	GHANAPUR	34.	MOOSAPET
35.	DEVARAKONDA	36.	CHINNACHINTAKUNTA	37.	NARVA
38.	MAKTHAL	39.	MAGANUR	40.	ATMAKUR
41.	KOTHAKOTA	42.	WANAPARTHI	43.	KODAIR
44.	PEDDAMANDADI	45.	DHARUR	46.	GADWLA
47.	GHATT	48.	MALDAKAL	49.	PEBBAIR
50.	IEEJ	3+	KOTHUR	-	FARUQNAGAR

8. NALGONDA

1.	NAMPALLI	2.	GURRAMPADU	3.	CHITAPALLI
4.	DEVERAKONDA	5.	GUNDLAPALLI	6.	PEDDADSERLA PALLI
7.	PEDDA VOORA	8.	CHANDAPET	9.	CHINTAPALLI

ANNEXURE-III

DROUGHT PRONE AREAS - ANDHRA PRADESH - IDENTIFIED BY DIFFERENT COMMITTEES

DISTRICT - TEHSIL/BLOCK	IRRIGATION COMMISSION	NAT.COM. ON DEV. OF BWD AREAS	HANUMANTHA RAO COMMITTEE
	1972	1981	1994
ANANTAPUR			
Chinnakothapalli	X	√	√
Dharmavaram	√	√	√
Gooty	√	√	√
Kadiri East	√	√	√
Kadiri West	√	√	√
Kalyandrug	√	√	√
Kudair	X	√	√
Hindupur	√	√	√
Kambadur	X	√	√
Kanikal	X	√	√
Madakasira	√	√	√
Penukonda	√	√	√
Rayadrug	√	√	√
Singanamala	X	√	√
Tadipatri	√	√	√
Uravakonda	√	√	√
Anantapur	√	X	X
CHITTOOR			
Bangarvapalem	X	√	X
Chandragiri	√	√	X
Chinnagothgallu	X	√	√
Chittoor	√	√	X
Chowdepalle	X	√	√
Kuppam	√	√	√
Gangadharanallore	X	√	X
Madanapalle	√	√	√
Palamaner	√	√	√
Pulicherla	X	√	X
Punganur	√	√	√
Puttur	X	√	X
Tamballapalli	X	√	√
Vayalpad	√	√	√
Tarvetinagar	X	√	X
CUDDAPAH			
Cuddapah	√	√	X
Jammalamadugu	√	√	√
Kamalapuram	√	√	√
Kodur	X	√	X
Badwel	√	X	X
Lakkireddipalli	X	√	√

DISTRICT - TEHSIL/BLOCK	IRRIGATION COMMISSION	NAT.COM. ON DEV. OF BWD AREAS	HANUMANTHA RAO COMMITTEE
	1972	1981	1994
Cuddapah (contd).			
Muddanur	X	√	√
Porumamilla	X	√	X
Proddutur	√	√	X
Pulivendla	√	√	√
Rajampet	√	√	X
Rayachoti	√	√	√
KURNOOL			
Adoni	√	√	√
Alur	√	√	√
Allagadda	√	√	√
Atmakur	√	√	√
Banganapalli	√	√	√
Dhone	√	√	√
Kodumur	X	√	√
Koilkuntla	√	√	√
Kurnool	√	√	√
Giddalur	√	X	X
Nandikotkur	√	√	√
Nandyal	√	√	√
Pattikonda	√	√	√
Yemmiganur	X	√	√
Markapur	√	X	X
MAHBUBNAGAR			
Achampet	√	√	√
Amangal	X	√	√
Alampur or Manopad	√	√	√
Atmakur	√	√	√
Bijinepalli	X	√	√
Gadwal	√	√	√
Jadcherla	X	√	X
Kalwakurthy	√	√	√
Kolhapur	√	√	√
Makthal	√	√	√
Nagarkurnool	√	√	√
Shadnagar	√	√	√
Wanaparthy	√	√	√

DISTRICT - TEHSIL/BLOCK	IRRIGATION COMMISSION	NAT.COM. ON DEV. OF BWD AREAS	HANUMANTHA RAO COMMITTEE
	1972	**1981**	**1994**
RANGAREDDY-HYD			
Chevella	√	X	√
Hyderabad East	√	X	X
Hyderabad West	√	X	X
Ibrahimpatnam	√	X	√
Maheswaram	X	X	√
NALGONDA			
Bhongir	√	X	X
Chintapalli	X	√	√
Devarakonda	√	√	√
Miryaluda	√	X	X
Nalgonda	√	X	X
Huzurnagar	√	X	X
Ramannapet	√	X	X
Suryapet	√	X	X
PRAKASAM			
Bestavaripet	X	√	√
Giddalur	X	√	√
Kanigiri	X	√	√
Markapur	X	√	√
Podili	X	X	√
Tallur	X	X	√
Tarlapadu	X	X	√
Veligandla	X	√	√
Yerragondapalem	X	√	√

ANNEXURE - IV

MANDALS IN SCARCE RAINFALL ZONE OF ANDHRA PRADESH

1. KURNOOL

1.	Kurnool	2.	Kallur	3.	Orvakal
4.	Kodumur	5.	Gudur	6.	C. Belagal
7.	Dhone	8.	Bethamcherla	9.	Veldurthy
10.	Krishnagiri	11.	Peapully	12.	Nandikotkur
13.	Midthur	14.	Pagidyala	15.	J. Banglow
16.	Atmakur	17.	Velgodu	18.	Pamulapau
19.	Kothapally	20.	Srisailam	21.	Nandyal
22.	Mahanandi	23.	B Atmakur	24.	Panyam
25.	Gadivemula	26.	Allagadda	27.	Rudravaram
28.	Sirvel	29.	Chagalamarri	30.	Gospadu
31.	Koilkuntla	32.	Donipadu	33.	Uyyalawada
34.	Sanjamala	35.	Kolimigundla	36.	Banganapalli
37.	Yemmiganur	43.	Nandavaram	44.	Manthralayam
45.	Alur	46.	Chippagiri	47.	Aspari
48.	Holagunda	49.	Halaharvi	50.	Pathikonda
51.	Devanakonda	52.	Tuggali	53.	Maddikera
54.	Gonegandla				

2. ANANTPUR

1.	Anantpur	2.	Raptadu	3.	Garladinne
4.	Atmakur	5.	Kudair	6.	Singanamala
7.	Bukkarayasamudram	8.	Narpala	9.	Tadipatri
10.	Yadiki	11.	Peddapappuru	12.	Putlur
13.	Yellanur	14.	Guntakal	15.	Gooty
16.	Pamidi	17.	Peddavaduguru	18.	Uravakonda
19.	Vajrakarur	20.	Vidapanakal	21.	Dharmavaram
22.	Tadimarri	23.	Bathala Palli	24.	C.K. Palli
25.	Kanaganipalli	26.	Ramagiri	27.	Kalyandurg
28.	Beluguppa	29.	Kambadur	30.	Kundurp
31.	Brahmasamudram	32.	Settur	33.	Rayadrug
34.	D Hirchal	35.	Gummagatu	36.	Kanekal
37.	Bommanahal	38.	Penukonda	39.	Somandepalli
40.	Roddam	41.	Puttaparthi	42.	Kothacheruvu
43.	Bukkapatnam	44.	Madakasira	45.	Amarapuram
46.	Gudibanda	47.	Rolla	48.	Agali
49.	Hindupur	50.	Parigi	51.	Lepakshi
52.	Chilamathur	53.	Gorantla		

3. CUDDAPAH

1.	Proddutur	2.	Jammalamadugu	3.	Muddanur
4.	Thondur	5.	Vemula	6.	Vempalli
7.	Pulivendula	8.	Lingala	9.	Simhadripuram
10.	Kondapuram	11.	Mylavaram	12.	Peddamudiam
13.	Rajupalem	14.	Duvvur	15.	Chapadu
16.	S. Mydukur	17.	Brahmamgarimattam	18.	Badvel
19.	Gopavaram	20.	B Kodur	21.	Porumamilla
22.	Narasapuram				

4. PRAKASAM

1.	Markapuram	2.	Dornala	3.	Peddaraveedu
4.	Yerragondapalem	5.	Tripuranthakam	6.	Pullalacheruvu
7.	Giddalur	8.	Racherla	9.	Komarolu
10.	Bestavaripeta	11.	Cumbum	12.	Ardaveedu

5. MAHBUBNAGAR

1.	Alampur	2.	Monopad	3.	Waddapalli
4.	Itkyal				

ANNEXURE V

LIST OF SCHEMES ELIGIBLE AND NOT ELIGIBLE FOR INCLUSION UNDER DPAP

Sector	Eligible Schemes	Ineligible Schemes
1.	2.	3.
Agriculture	Land shaping and bunding, water harvesting structures (Check dams, percolation tanks), horticulture, transfer of technology land treated with soil and moisture conservation.	Distribution of agricultural implements, plant protection equipments, general training of farmers within and outside the State, establishment and strengthening of seed farms, buildings and staff quarters, seed processing units and laboratory equipments.
Horticulture	Vegetable and fruit nurseries, fencing of areas identified for horticulture development. in watersheds, supply of planting material at admissible rates of subsidy.	Establishment of orchards, meeting of cost of digging pits, manure etc. in private land should be borne by cultivators, coconut development., : parasite breeding centre Palmgur cultivation / palm complex, palm gur industry and mini kit distribution of inputs.
Water Resource Development	Construction of water harvesting structures, excavation of kachha channels, percolation tanks, community irrigation wells for IRDP beneficiaries.	Sprinkler / drip irrigation, purchase of rigs for ground water survey, lift irrigation schemes involving huge costs on energisation and running lining of channels etc. ground water exploration and exploitation schemes which need to be covered under respective sectoral programmes.
Animal Husbandry	Fodder production and grassland development	Supply of foot and mouth vaccine, establishment. of liquid nitrogen plants, veterinary cover, cross breeding programmes, organisation of cow and calf rallies / shows, distribution of breeding bulls and construction / strengthening of buildings / staff quarters.
Dairy Development	Fodder Production	Construction of chilling plants & milk processing plants in areas where operation flood programme is operating feed mixing and pellatisation plants, construction of milk routes, transport subsidy, milk procurement team, Management subsidy, buildings, provision of facilities to milk coop. societies.
Sheep Development	Development of pastures and their productivity through re-seeding, fencing, moisture conservation and water harvesting, plantation of fodder trees, etc.	Deworming of sheep, establishment. of sheep multiplication farms, cross breeding programme, construction / modernisation of slaughter houses and construction of feed godowns, sheep research and development programmes.

Sector	Eligible Schemes	Ineligible Schemes
1.	2.	3.
Forestry	Establishment of nurseries (grass, fodder trees and timber), plantation on degraded forests, social forestry, farm forestry and waste land development and development of water resources for establishing and maintaining plantations.	Development of parks, wild life conservation, plantation in reserve forest areas (unless forming integral part of micro-watershed to be developed) and eucalyptus plantation.
Drinking Water		
a) Cattle & Sheep	Water harvesting and storage structures for cattle and sheep, small tanks / tanks meeting the requirement of animals in the watersheds selected for integrated development / areas selected for sheep and livestock development.	Construction of channels / pipelines for supply of water for cattle.
b) Human beings	-	To be excluded from the programme and taken up under the sectoral programme
c) Rural Electrification	-	To be excluded from the programme and taken up under the sectoral programme
Sericulture	Development of rainfed mulberry plantation for supply of leaves	Establishment of high capacity grainages, silk reeling and twisting units, silk exchanges, market yards, disinfection squad, and silk hamlet, establishment of chawkie rearing units.

Source: Manual of Drought Prone Area Programme, 1992.

ANNEXURE-VI(a)

NORMAL RAINFALL OF DROUGHT PRONE TEHSILS

400 mm to 500 mm of Normal Rainfall

Anantpur	Kalyandurg	499.2
	Kanekal	443.7

500 mm to 600 mm of Normal Rainfall

Anantpur	Madakasira	594.3
	Hindupur	593.9
	Penukonda	597.7
	Dharmavaram	532.2
	Thavakonda	507.1
	Gooty	561.8
	Tadapatri	547.5
	Rayadurg	527.7
	*Anantpur	583.0
Cuddapah	Pulivendla	563.9
	Jammalamadugu	594.5
Kurnool	Koilkuntla	587.7
	Dhone	574.0
	Pathkonda	596.8
	Alur	590.1
	Yemmiganur	585.3
	Kodumur	578.6
Mahbubnagar	Wanaparthy	593.6
Rangareddi	Chevella	599.8

600 mm - 700 mm of Normal Rainfall

Anantpur	Kadiri	617.0
Cuddapah	Kamalapuram	613.5
	Rayachoti	667.6
	Lakkireddipalli	634.4
Chittoor	*Arogyavaram	688.6
Kurnool	Allagadda	688.5
	Nadikotkur	664.9
	Adoni	663.8
	Banganapalli	604.8
	Kurnool	606.9
Mahbubnagar	Nagar Kurnool	634.1
	Makthal	652.5
	Kalwakurthy	662.8
	Gadwal	683.3
	Achampet	655.1
Nalgonda	Deverakonda	634.2
Rangareddi	Ibrahimpatnam	691.4

Prakasam	Podili	659.2
	Markarpur	652.1
	Giddalur	691.5
	Yerragondapalem	659.6
<u>700 mm to 800 mm</u>		
*Cuddapah	Cuddapah	747.6
Chittoor	Madanapalli	741.6
	Thamballapalli	725.2
	Vayalpad	792.3
	Punganur	758.0
	Kuppam	754.1
Kurnool	Atmakur	766.9
	Nandyal	765.4
Mahbubnagar	Atmakur	777.5
	Shadnagar	754.5
	Kollapur	793.1
	*Mahbubnagar	792.3
Nalgonda	*Nalgonda	762.3
Hyderabad	*Begumpet	772.2
Prakasam	Kanigiri	730.8
<u>800mm to 900 mm</u>		
Chittoor	Palamaner	851.7
<u>900 - 1000 mm</u>.		
Chittoor	*Tirupati	951.4
Prakasam	*Ongole	936.3

* The 8 stations taken as bench marks (IMD observatories)

ANNEXURE-VI(b)

FREQUENCY OF DROUGHT

DEFICIENT RAINFALL

NO. OF EPISODES	DISTRICT	TALUKS	TOTAL NUMBER OF TEHSILS
One	Mahbubnagar	Kalwakurthy	2
	Kurnool	Atmakur	
Two	Cuddapah	Jammalamadugu	5
	Mahbubnagar	Mahbubnagar	
	Kurnool	Kodumur	
	Nalgonda	Nalgonda	
	Rangareddy	Ibrahimpatnam	
Three	Anantpur	Penukonda	10
		Kadiri	
	Mahbubnagar	Wanaparthi	
	Kurnool	Allagadda	
		Nandikotkur	
		Dhone	
	Rangareddy	Chevella	
	Hyderabad	Begumpet	
	Prakasam	Podili	
		Ongole	
Four	Chittoor	Kuppam	12
		Thambalapalli	
	Cuddapah	Lakkireddipalli	
	Anantpur	Hindupur	
		Uravakonda	
		Gooty	
	Mahbubnagar	Nagarkurnool	
	Kurnool	Koilkuntla	
		Yemmiganur	
	Nalgonda	Deverakonda	
	Prakasam	Markapur	
		Giddalur	
Five	Chittoor	Punganur	8
		Madanapalli	
		Arogyavaram	
	Cuddapah	Kamalapuram	
	Mahbubnagar	Shadnagar	
		Achampet	
	Kurnool	Pathikonda	
		Banganapalli	
Six	Cuddapah	Rayachoti	10
		Cuddapah	
	Araulpur	Rayadurg	
		Kanekal	
		Dharmavaram	
		Kalyandurg	
	Mehbubnagar	Makthal	
	Kurnool	Adoni	
		Kurnool	
	Prakasam	Yerragondapalem	

NO. OF EPISODES	DISTRICT	TALUKS	TOTAL NUMBER OF TEHSILS
Seven	Chittoor	Tirupathi Palamner Vayalpadu	6
	Cuddapah	Pulivendla	
	Anantpur	Anantpur	
	Prakasam	Kanigiri	
Eight	Anantpur	Madalkasira Tadapatri	3
	Mahbubnagar	Gadwal	
Nine	Mahbubnagar	Atmakur	2
	Kurnool	Nandyal	
Ten	Mahbubnagar	Kollapur	1
Eleven	Kurnool	Alur	1

SCANTY RAINFALL

One	Kurnool	Kodumur	5
	Anantpur	Hindupur Rayadurg Kanekal	
	Mahbubnagar	Achampet	
Two	Kurnool	Yemmiganur	1

TEHSILS / BLOCKS IN DIFFERENT DROUGHT PRONE DISTRICTS OF INDIA WHERE WASTELANDS (OTHER THAN NOTIFIED FOREST AND BARREN ROCKY AREAS) CONSTITUTE MORE THAN 15% OF TOTAL GEOGRAPHICAL AREA

1. ANDHRA PRADESH

1. Anantapur

1.	Kadiri East	2.	Kadiri West	3.	Tadipatri
4.	Chennakothapalli	5.	Penukonda	6.	Dharmavaram
7.	Kudair	8.	Gooty		

2. Chittoor

1.	Chinnagottigallu	2.	Thamballapalli	3.	Chowdepalle

3. Cuddapah

1.	Pulivendla	2.	Jammalamadugu	3.	Muddanur
4.	Rayachoti	5.	Lakkireddipalli	6.	Kamalapuram

4. Kurnool

1.	Banganapalli	2.	Dhone	3.	Kurnool
4.	Pattikonda	5.	Nandyal		

5. Mahbubnagar

1.	Wanaparthy	2.	Kollapur	3.	Amangal
4.	Bijinapalli	5.	Achampet	6.	Kalwakurthy
7.	Nagarkurnool	8.	Atmakur	9.	Gadwal
10.	Shadnagar				

6. Nalgonda

1.	Chintapalli	2.	Devarakonda

7. Prakasam

1.	Kanigiri	2.	Bestavaripet	3.	Giddalur
4.	Y. Palem	5.	Markapur	6.	Tarlupadu
7.	Podili				

8. Ranga Reddy

1.	Ibrahimpatnam	2.	Chevella

NOTE / EXPLANATION

1. The Tehsils / Blocks are listed in the order of percentage of wastelands. For example, Kadiri-East Block has more percent area under wastelands than Kadiri-West Block, both having morethan 15% wastelands and so on.

2. The names of Tehsils / Blocks having lessthan 15% wastelands are not indicated.

3. For the districts which are not covered under wasteland mapping, the estimates of the blocks are made using landuse / landcover maps (1:250,000 scale). These districts are marked by "*".

2. BIHAR

1. Munghyr

1. Chakai	2. Jamui	3. Sono

2. Nawadah

1. Sirdala	2. Rajauli	

3. Palamu

1. Daltonganj	2. Chandwa	3. Garhwa

4. Rohtas NONE

5. S. Parganas (Dumka) NONE

3. GUJARAT

1. Ahmedabad

1. Dhandhuka

2. Amreli

1. Babra	2. Khamba	3. Jafrabad
4. Dhari		

3. Bhavnagar

1. Gadhda	2. Savarkundla	

4. Jamnagar

1. Kalyanpur	2. Dwaraka	

5. Kutch

1. Lakhapat	2. Bhuj	3. Nakhtram
4. Bhachav	5. Rapar	6. Anjar
7. Abdasa		

6. Panchmahals

1. Santrmpur	2. Jhalod	

7. Rajkot

1. Wankaner	2. Jasdan	3. Paddhari

8. Surendranagar

1. Chotila	2. Muli	3. Sayla

4. HARYANA

1. Mohindergarh

1. Mohindergarh	2. Nangal-Chaudhary	3. Narnaul
4. Bayal		

5. JAMMU & KASHMIR

1. Doda Wasteland mapping note done.

2. Udhampur

1. Chineni	2. Udhampur	

6. KARNATAKA

1. Belgaum

1.	Ramdurg	2.	Gokak	3.	Athani
4.	Saundatti				

2. Bellary

1.	Sandur	2.	Harapanahalli

3. Bidar

1.	Humnabad	2.	Basavakalyan	3.	Santhpur

4. Bijapur

1. Bijapur

5. Chikmaglur

1. Kadur

6. Chitradurga

1. Challakere

7. Dharwar

1. Hubli

8. Gulbarga

1.	Shahapur	2.	Chittapur

9. Kolar

1. Gudibanda

10. Raichur

1.	Lingsugur	2.	Yelaburga

11. Tumkur

1.	Chikkanaya-kanahalli	2.	Tiptur	3.	Sirsa

7. MADHYA PRADESH

1. Betul

1.	Chicholi	2.	Betul	3.	Amla
4.	Shahpur	5.	Multai		

2. Dhar

1.	Gandhwani	2.	Dahi	3.	Bagh
4.	Kukshi	5.	Manwar		

3. Jhabua

1.	Alirajpur	2.	Jobat	3.	Petlawad

4. Khargon

1.	Bhikangaon	2.	Thikari

5. Shahdol

1.	Manpur	2.	Umaria

6. Sidhi

1.	Rampur Naikin	2.	Vaidhan

8. MAHARASHTRA

1. Ahmadnagar

1.	Jamkhed	2.	Pathardi	3.	Karjat
4.	Ahmadnagar	5.	Shrigonda	6.	Parner
7.	Sangamner	8.	Akole	9.	Shevgaon

2. Aurangabad

1.	Khuldabad	2.	Aurangabad	3.	Kannad

3. Beed

1.	Ashti	2.	Beed

4. Dhule

1.	Dhule	2.	Sindhkheda

5. Jalgaon

1.	Amalner	2.	Edlabad	3.	Parola

6. Jalna NONE

7. Nasik

1.	Nasik	2.	Nandgaon	3.	Sinnar
4.	Chandwad	5.	Kalvan	6.	Yeola
7.	Malegaon				

8. Osmanabad

1.	Bhoom	2.	Kalam

9. Pune

1.	Haveli	2.	Baramati	3.	Purandhar
4.	Daund	5.	Jumnar	6.	Indapu
7.	Khed	8.	Shirur	9.	Ambegaon

10. Sangli

1.	K. Mahankal	2.	Atpadi Jat	3.	Khanapur
4.	Tasgaon	5.	Miraj		

11. Satara

1.	Man	2.	Khandala	3.	Koregaon
4.	Khatav				

12. Sholapur

1.	Kharmala	2.	Sangola

9. ORISSA

1. Bolangir

1.	Khaprakhol	2.	Patnagarh	3.	Bangomunda

2. Kalahandi

1.	Golamunda	2.	Nawapara

3. Phulbani

1.	Daringibadi	2.	Tumudibandha	3.	G. Udaigiri
4.	Baliguda	5.	Khajuripada		

4. Sambalpur

1.	Bijepur	2.	Paikmal	3.	Jharabandha

10. RAJASTHAN

1. Ajmer

1.	Masauda	2.	Jawala		

2. Banswara

1.	Garhi	2.	Talwara	3.	Sajjangarh
4.	Ghantol	5.	Kushalgarh	6.	Bagidora

3. Dungarpur

1.	Dungarpur	2.	Aspur	3.	Sagwara
4.	Bichiwara				

4. Jhalawar

1.	Dag				

5. Kota

1.	Shahbad	2.	Chhabra	3.	Chechat

6. Sawai Madhopur

1.	Nandauti	2.	Khandar		

7. Tonk

1.	Deoli	2.	Todaraisingh		

8. Udaipur

1.	Kherwara	2.	Kotra		

11. TAMILNADU

***1. Chidambaranar**

1.	Tuticurin	2.	Kovilpatti	3.	Ottapidaram
4.	Sattankulam				

2. Dharmapuri

1.	Veppanapalli	2.	Palacode	3.	Nallampalli
4.	Shoolagiri				

3. Kamarajar

1.	Vembakottai				

4. Pasumpon

1.	Devakkottai				

5. Ramanathpuram

1.	Kamuti	2.	Mundapam		

***6. Tirunelveli** NONE

***7. Pudukottai**

1.	Pudukottai	2.	Thiruvarankulam	3.	Karambakudi
4.	Gandarvakottai				

12. UTTAR PRADESH

1. Allahabad

1.	Shankergarh				

2. Almora — Wasteland mapping not completed

3. Bahraich — Wasteland mapping not completed

4. Banda

1.	Kamasdin	2.	Manikpur	3.	Pahari
4.	Ramnagar	5.	Mau	6.	Karvi

5. Chamoli — Wasteland mapping not completed

6. Garhwal (Pauri) — Wasteland mapping not completed

7. Gonda — Wasteland mapping not completed

8. Hamirpur

1.	Charkhari	2.	Maudaha		

9. Jalaun

1.	Kadaura	2.	Mahewa		

10. Jhansi

1.	Gurusarai	2.	Bamaur	3.	Mauranipur

11. Lakhimpur Kheri — Wasteland mapping not completed

12. Lalitpur

1.	Birgha	2.	Madawara		

13. Mirzapur

1.	Chatara				

14. Pithauragarh — Wasteland mapping not completed

15. Sitapur — Wasteland mapping not completed

16. Sonebhadra

1.	Myorepur	2.	Nagava	3.	Chopan

17. Tehri Garhwal — Wasteland mapping not completed

13. WEST BENGAL

1. Bankura

1.	Chatna	2.	Khatara-II	3.	Gangajalghati

2. Midnapur — NONE

3. Purulia

1.	Kashipur	2.	Para	3.	Bhagmundi
4.	Huru	5.	Burdwan	6.	Arshar
7.	Santuri	8.	Barabazar	9.	Balarampur
10.	Puncha	11.	Jaipur		

Source: National Remote Sensing Agency, Hyderabad, August 1994.

ANNEXURE - VIII

AGRICULTURAL CONTINGENCY PLAN FOR DROUGHT PRONE AREAS OF ANDHRA PRADESH

RECOMMENDED CROPS AND VARIETIES FOR DROUGHT PRONE RAYALASEEMA REGION

CROP	VARIETIES
SORGHUM	SPV 351; CSH5; N12; CSH9; SPV86; N13 NJ-2277
SETARIA (KORRA)	Chitra; Prasad (Nallamala)
BAJRA	WCC 75; MBH 110; MH 426, MH 462
GROUNDNUT	TMV 2; K 1; K 3 ; J11; JL 24; DH 3-30; GIRNAR-1; JK 11, TMV-3; ICG-4
CASTOR	ARUNA; GAUCH 1; R 63 (BHAGYA); SOUBHAGYA
REDGRAM (PIGEON PEA)	PDMI; LRG 30
GREENGRAM	11 / 395; K 851; LGG 433, LGG 471
MESTA	AMV 1
COTTON	SREESAILAM; NA-1325, NHH-390; PANDARIPUR; NDLA 2708, JAYADHRA; N.A. 920, VARALAXMI
KORRA	LEPAKSHI; SIA 2593

Intercropping can be done which is as follows:

Groundnut + Redgram
Groundnut + Castor
Bajra + Redgram
Setaria + Redgram

RECOMMENDED CROPS AND VARIETIES FOR DROUGHT PRONE TELANGANA REGION

CROP	VARIETIES
SORGHUM (Kharif) (Jowar)	CSH 5; CSH 6; CSH 9; SPV 351; MOTI; MS 142
Sorghum (Rabi)	CSH 5; CSH 9, CSH 6; SPV 351; MOTHI; MS 142; M35-A
RAGI (Finger Millet)	Godavari; PL 1044
Bajra (Pearl Millet)	WCC 75; MBH 110; RBS 2
Maize	Ganga 5; Deccan 101; Deccan 103; Rohini
Redgram	LRG-30; HY2; C 11; PDM 1
Greengram	MM 267; PIMS-4; PUSA; Baisakhi; PS 26; VS 16
Safflower	Manjeera; APR-3 (Sagar Mutyalu)
Bengalgram	A1; Jyothi; T9; Panth; U30
Korra (Foxtail Millet)	Nallamala (Prasad)
Sesamum	T 85; Gowri; Madhavi
Chillies	G3, G4, X 235, G5, Sindoori; Pusa Jawala
Cotton	H-4, Gowarani G; Varalaxmi; Saraswathi 2147, B 1007
Tobacco	Godavari special, CTRI Special
Castor	Aruna Gauch 1, Bhagya SBH 18

The intercropping may be done as below:

Sorghum + Redgram	2:1 in radials
Sorghum + Redgram	3:1 in black soils
Ragi + Redgram	
Maize + Redgram	
Bajra + Redgram	

CONTINGENT CROPPING IN RAYALASEEMA

MONTH	CROP
Early May June	Greengram, Sorghum, Redgram, Castor
Normal July	Groundnut, Redgram, Bajra, Korra
Late August	Bajra, Setaria
Very late September	Horsegram, Bajra

CONTINGENT CROPPING IN TELANGANA

MONTH	CROP
Upto End of June	Sorghum, Bajra
July	Hybrid Sorghum, Groundnut, Castor, Ragi, Bajra, sesamum
August	Sesamum, Castor, Ragi, Sunflower, Chillies, Tobacco, Linseed
September	Horsegram, Bengalgram, Sorghum, Safflower, Coriander, Maize
October	Safflower, Bengalgram

FRUITS GROWN IN DROUGHT PRONE AREAS

ANNONA (SITAPHAL)	*Annona squamosa*
AONLA	*Emblica officianalis*
BER	*Zizyphus mauritiana*
GUAVA	*Psidium guajava*
KARONDA	*Carissa carandus*
PHALSA	*Crewia subinequlis*
POMEGRANATE	*Punica granatum*
TAMARIND	*Tamarindus indica*
FIG	*Ficus carca*

The number of species and varieties and the popular varieties in use are given below:

Fruit	No. of Species	Varieties	Popular Varieties
Annona	5	32	Balanagar, Atemoya, Red Sitaphal, Mammoth, British Guinea, Washington, Rayadurg
Aonla	2	16	Banarasi Aonla, Krishna, chakan Kanchan, francis (Hathr Yhod) Deshi Green tinged, Red tinged, White streaked, bansi Red, Anand-1, Anand-2
Ber	7	161	Gola, Seb, Kaithili, Mundia Banarasi karaka, Uinran, Maharwali
Guava	3	60	Lucknow-49, Safeedjam, Allahabad safeda, Chitudar, Kohir Safeeda, Red guava
Karonda	18	12	American white, American red, Deshi green
Phalsa	3	9	Sherbati, Tall Dwarf
Pomegranate	1	155	Jyothi, Jodhpur red, Jalore seedless, Ganesh seedless, Dholka, Papershall, Yarachid-1, Muscat, Modakasua, Bassain seedless, GKVK-1
Tamarind	1		Anantpur selection and Tirupathi selection
Fig	2	23	Poona, Maisazaram

DROUGHT TOLERANT FRUITS AND VEGETABLES

Fruits	Cultivars	Vegetables	Cultivars
Mango	Banglora	Guar	HG-315, Pusa Naubahar, Pusa Sada Bahar
Barsati		Cowpea	C-49, pusa Dofasali, Pusa
Guava Custard Apple	Kohir Safeda, Safed Jam Balangar	Brinjal	H-8 (Hissar Shyamal), PH-4, Aushy, White fruited brinjal, Azad Kranti Arka Kusumkar
Pomegranate	Jalor seedless, Ganesh, Jyoti	Tomato	Sel 8, Sel 18, Pusa ruby
Aonla	NA-7, Chaikaiya, Francis	Watermelon Bottle guard	Sugar baby, Arka manik - Pusa, Summer prolific

FRUIT AND VEGETABLE CROPS IN DIFFERENT RAINFALL REGIONS

Rainfall below 250mm	Rainfall 250-450 mm	Rainfall 400-600mm
1.	2.	3.
A. FRUITS		
Ber Cvs. Gola, Seb, Mundia	Ber Cvs, Gola, Seb, Munidia	Ber Cvs, Gola, Seb and Umran
Aonla Cvs. Krishna, Francis	Pomegranate Cvs. Jalor seedless Ganesh	Pomegranate Cvs. Jalor seedless, Ganesh, G-137, P-26
Pomegranae Cv Jalor-seedless	Aonla Cvs NA-7, Chakaiya, Francis, Krishna	Mango Cvs, Dashari, Mallika Totapuri, Langara
	Custard apple Cv. Balanagar; Kagzi lime; Mango Cv Banglora	Aonla Cvs. Krishna Chakaiya, Kanchan, Francis, NA-7
	Guava Cvs. Kohir, Safeda Safed Jam	Custard apple Cv. Balanagar
		Grape Cv. Beauty Seedless

Rainfall below 250mm	Rainfall 250-450 mm	Rainfall 400-600mm
1.	2.	3.
B. VEGETABLES		
Clusterbean Cvs. HG-315, Cowpea Cvs. C-49, Pusa Barasati,	Clusterbean, Cvs. HG-315, HG-348, Pusa Navbahar, Pusa Sadabahar	Clusterbean, Cvs. HG-315 HG-348, HG-340, Pusa Navbahar, Pusa, sadabahar, Cowpea, Cvs Pusa Dofasali, C-40, Pusa Barasati
Drumstick; Watermelon Cvs. Sugar baby Arka Manik	Cowpea, Cvs. Pusa Dofasali, C-49, Pusa Barasati Okra Cvs Pusa Sawani, IC-6653; brinjal Cvs. R-34, PPL, Aushy, Azad Kranti	
Muskmelon Cvs. Hara Madhu; Bottle guard Cvs. Pusa Summer, Prolific long, Thumpa Anapa	Tomato, Cvs. Pusa Ruby, Pusa early dwarf, Sel-28; Drum Stick; Watermelon Cv. Sugar-baby, Arka manik, Arka Jyoti HW-22	Okra Cvs. Pusa Sawani IC-6633, S-249, Pharbhani, Kranti and P-7; Sem-HD-60, HD-105, HD-116
		Brinjal Cvs. R-34, PPL PH-4, Aushy, Azad Kranti, Arka, Kusumakar, White fruited brinjal H-8, Bhagyamati, PH-41; Watermelon Cv. HG-22 Sugarbaby, Arka Manik, Arka Jyoti; Bottle guard Cvs. Pusa summer profile long
Brinjal Cvs. Hissar Shyamal, PH-4, Azad Kranti	Muskmelon Cvs. Hara, Madhu, Arka Rajasthan	Tomato Cvs. HS-101 Pusa ruby Pusa early dwarf, Sel-28, Sel-18 PED
Okra Cv Pusa Sawani Pusa Dofasali	Brinjal Cvs. Aushy, Azad Kranti Arka, Kusumaker, white fruited brinjal H-8 (Hissar shyamal)	
	Chilli Cv. Marutham	Chilli Cv. Marutham, Guntur Chillies N-1
	Onion Cv. H-53 Agrifound dark red	Onion Cvs. N-53, Agrifound Dark Red
	Bottle guard Cv. Pusa Summer proflific long, Thumba Anapa	Carrot Cv. Deshi Long Orange Spinach Cv. HS-23
		Sem Cvs. HD-60; HD-116

ANNEXURE - IX

MICRO-WATER SHEDS UNDER DROUGHT PRONE AREA PROGRAMME AS ON JUNE 1995

KURNOOL

1. Gundala	2. Kommemarri	3. Jaladurgam	4. Kolusulapalli
5. Peddanagu	6. Maddikara	7. Beldona	8. Chennampalli
9. Banawasi	10. Akumala	11. Ulehala	12. Kunderu
13. Kothapalli	14. Laddagiri	15. Gandaleru	16. Paleru

ANANTAPUR

1. Kudair	2. Salakamcheruvu	3. Yellanur	4. Venkatampalli
5. Muddinayanipalli	6. Amidala	7. Enumuladoddi	8. Honnur
9. Moradi	10. Darsimala	11. Kanaganapalli	12. Guttur
13. Somaghatta	14. Cheerepalli	15. Ethodu	16. Chigathurthi

CUDDAPAH

1. Papagni - XI	2. Pennar - X	3. Kunder-IV	4. Kalawala vanka
5. Mandaya-III	6. Papagni-I		

CHITTOOR

1. Pincha-I	2. Pincha-II	3. Poddaru	4. Palar
5. Bahuda-I	6. Bahuda-II	7. Koundinya-I	8. Koundinya-II

RANGA REDDY

1. Narepally	2. Eliminedu	3. Kakloor

MAHBUBNAGAR

1. Padkal	2. Bollampally	3. Narasaipally	4. Lingampally
5. Avancha	6. Pinjerla	7. Salakalapur	8. Talpanur
9. Kudikilla	10. Undikode	11. Rayapuram	12. Amaravai
13. Marikal			

NALGONDA

1. Junutala	2. Timmapur

PRAKASAM

1. Katragunta	2. Ramagopalapuram	3. Ballipalli	4. H.M. Padu
5. Chandaluru	6. Kocherlakota	7. Salakalaveedu	8. Goliyetugulla
9. Kandaluru	10. Thymmlacheruvu	11. Komarada	12. Dormala