

MOISTURE REGIME, ARIDITY AND DROUGHTS IN THE ARID REGION OF ANDHRA PRADESH

U.S. VICTOR, N.N. SRIVATSAVA AND B.V. RAMANA RAO

Central Research Institute for Dryland Agriculture Santoshnager,
Hyderabad - 500659

ABSTRACT

Weekly water balance computation were carried out for the years 1911-85 considering different available water holding capacities ranging from 25 to 200 mm to examine the extent to which the moisture regime and aridity are dependent on water holding capacity of the soil. The analysis reveals that the aridity is accentuated by the shallowness of the soil coupled with low rainfall in this region. The number of years with drought was found to vary from 3 to 6 per decades. The yields of groundnut and kodomillet were reduced by 25 and 50 percent during the years with large and severe droughts respectively. The water harvesting may be useful either for late sown kharif crops or for establishment of tree plantations in this region.

INTRODUCTION

A major proportion of the Indian arid region is confined to northwestern parts of the country spreading through Gujarat, Rajasthan and Haryana. In peninsular India, the arid regions stretches from Bellary and Tumkur districts of Karnataka State to Anantapur district in Andhra Pradesh. Anantapur is the driest district in the State situated in the middle of peninsular India and has the unique distinction of being subjected to rain shadow effect both during the southwest and northeast monsoon season. The geographical area of the district is 19,13,492 ha out of which net area sown is 8,77,473 ha with only 41,341 ha being sown more than twice. A total area of 1,79,948 ha is under irrigation through major and minor irrigation projects, tube wells and tanks. Among the rainfed crops, groundnut, kodomillet, sorghum and pearl millet are extensively grown. The area under groundnut in the district is 28.2 per cent of the area under groundnut in the state while the productivity is 79 percent of the state average productivity.

Red loamy soils with depth ranging from 10 to 30 cm are generally found in the district. The field capacity and wilting point of these soils at Anantapur are 16.6 and 3.6 percent respectively. There are few pockets of black soils particularly in the northern parts of the district.

The climatic characteristics of the arid region of Rajasthan investigated in greater detail by Krishnan (1977), Ramakrishna and Sastri (1980), Ramana Rao et al. (1984) using long term meteorological data. Some important observations made on

the moisture regime, aridity and droughts in Anantapur region are presented and discussed in relation to crop production in this paper.

MATERIAL AND METHODS

The daily rainfall data recorded at Anantapur for the years 1911-1985 were utilized. The weekly totals of rainfall were computed according to standard meteorological weeks yearwise. The normal weekly rainfall was computed and the extreme values of weekly rainfall during different weeks were identified.

Weekly water balance computations were carried out using Thornthwaite and Mather's (1955) book keeping procedure. The normal monthly potential evapotranspiration values computed by using modified Penman's formula and the weekly values were interpolated graphically. The aridity index (I_a) and moisture index (I_m) were calculated using Thornthwaite's (1948) formulae as follows:

$$I_a = \frac{\text{Annual water deficit}}{\text{Annual water need}} \times 100$$

$$I_m = \frac{\text{Annual water surplus} - \text{Annual water deficit}}{\text{Annual water need}} \times 100$$

The mean and coefficient of variation of both the moisture and aridity indices were calculated. The intensity of drought during different years was assessed on the basis of departure from the mean aridity index using standard deviation (σ) of the aridity index as suggested by Subrahmanyam (1982) as follows:

Intensity of drought	Criteria adopted
$0 - \frac{1}{2} \sigma$	moderate
$\frac{1}{2} \sigma - \sigma$	large
$\sigma - 2 \sigma$	severe
$> 2 \sigma$	disastrous

The percentage frequencies of occurrence of climatologically surplus water of 20, 40, 60, 80 and 100 mm were worked out weekwise to indicate the favourable periods for water harvesting.

In order to examine the extent to which moisture regime and aridity are dependant on the water holding capacity of the soil, the weekly balance computations were carried out for available water holding capacities ranging from 25 mm to 200 mm.

RESULTS AND DISCUSSION

The average annual rainfall at Anantapur is 567.6 mm and the coefficient of variation of annual rainfall is 29 per cent. The mean weekly rainfall is more than

10 mm continuously from 29th to 45th week with peak rainy season from 37th to 41st week when the mean weekly rainfall is more than 30 mm. The lower limit of rainfall received is zero during all the weeks while the upper limit of rainfall recorded is as high as 298.8 mm during the 4th week. The rainfall is erratic and meets the evaporative demand at potential rate under normal conditions for hardly 4 weeks during the rainy season from 37th to 40th week. Therefore, the rainfed crops have to be sown such that the crop completes its reproductive stage preferably by 40th week. In case of groundnut, the crop has to be harvested before the rainy season terminates. As the mean weekly rainfall is more than 10 mm upto 45th week, the bunch type groundnut of 100 to 110 days duration can be sown upto 31st weeks only.

The march of annual rainfall, moisture and aridity indices are given in Fig 1 (a to e). The aridity and moisture indices are presented for both the extreme cases considering the available water holding capacities of 25 mm and 200 mm. The mean annual rainfall in the past 75 years has been 567.6 mm with a low of 209 mm in 1984 and a high of 954 mm in 1919. The aridity index values are higher in case of soils with available water holding capacity of 25 mm by 6 to 8 per cent thereby indicating that the problem of aridity in the region is aggravated by the shallow soils.

The decade wise frequencies of occurrence of droughts of different intensities based on departure from normal aridity index (for shallow soil regions) are given in Table 1. The maximum number of years with drought occurred during the decades 1921-30 and 1941-50 and the least number of years with drought occurred during the decade 1951-60. The first half of the current decade has already experienced drought conditions during four years out of which disastrous condition prevailed during one year.

Table 1. Decadal frequencies of droughts for shallow soil (1911-85)

Decade	Number of arogits			
	Disastrous	Severe	Large	Moderate
1911-1920	—	—	4	1
1921-1930	1	1	2	2
1931-1940	—	1	1	—
1941-1950	—	1	2	3
1951-1960	—	1	2	—
1961-1970	—	1	1	2
1971-1980	—	2	1	2
1981-1985	1	—	1	2

The years affected by various degrees of drought during the period 1911-85 are given in Table 2. Drought conditions prevailed for a maximum of five consecutive years 1920-24 at Anantapur. The severe and disastrous droughts have not occurred for

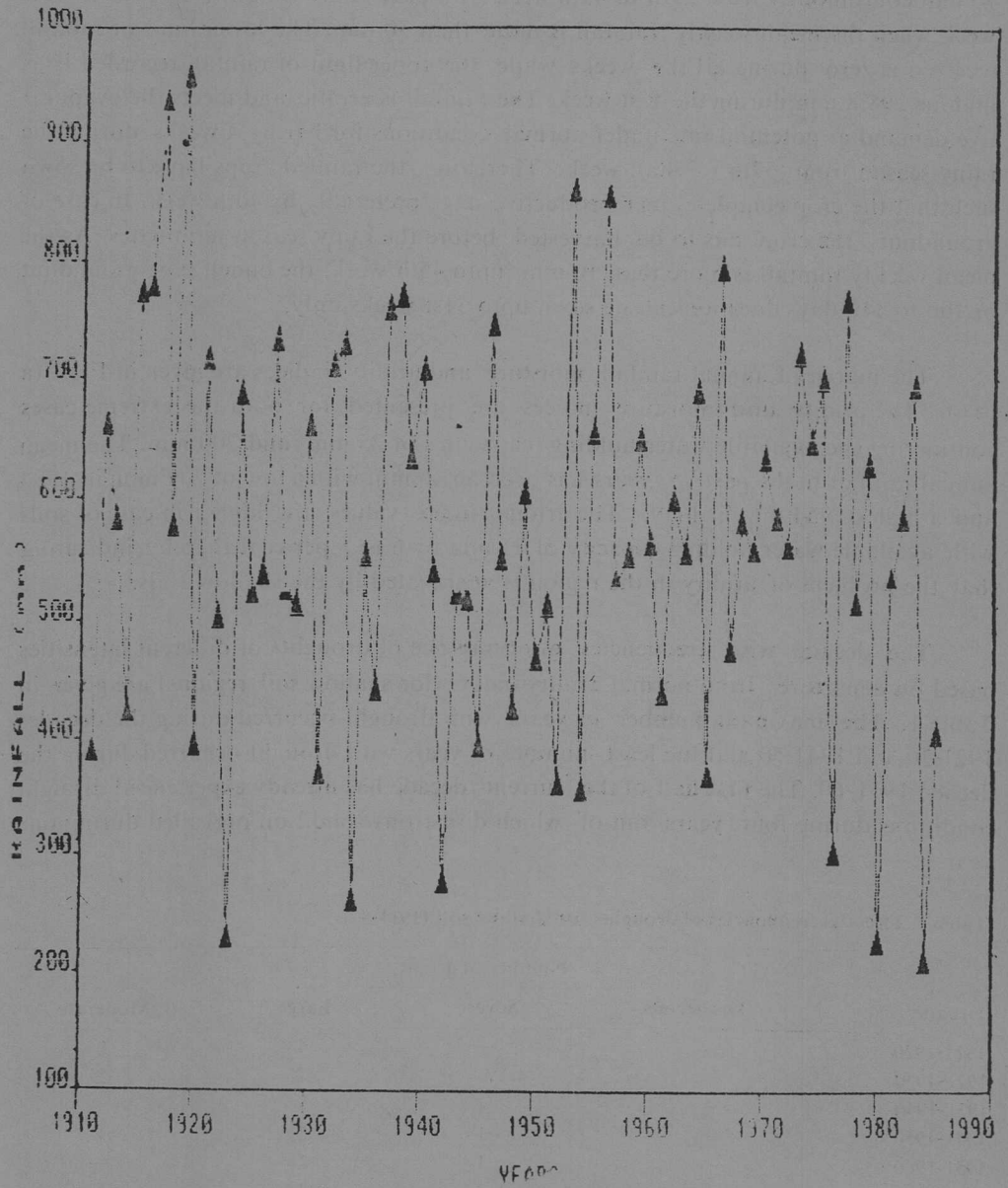


Fig. 1a. March of Annual Rainfall at Anantpur

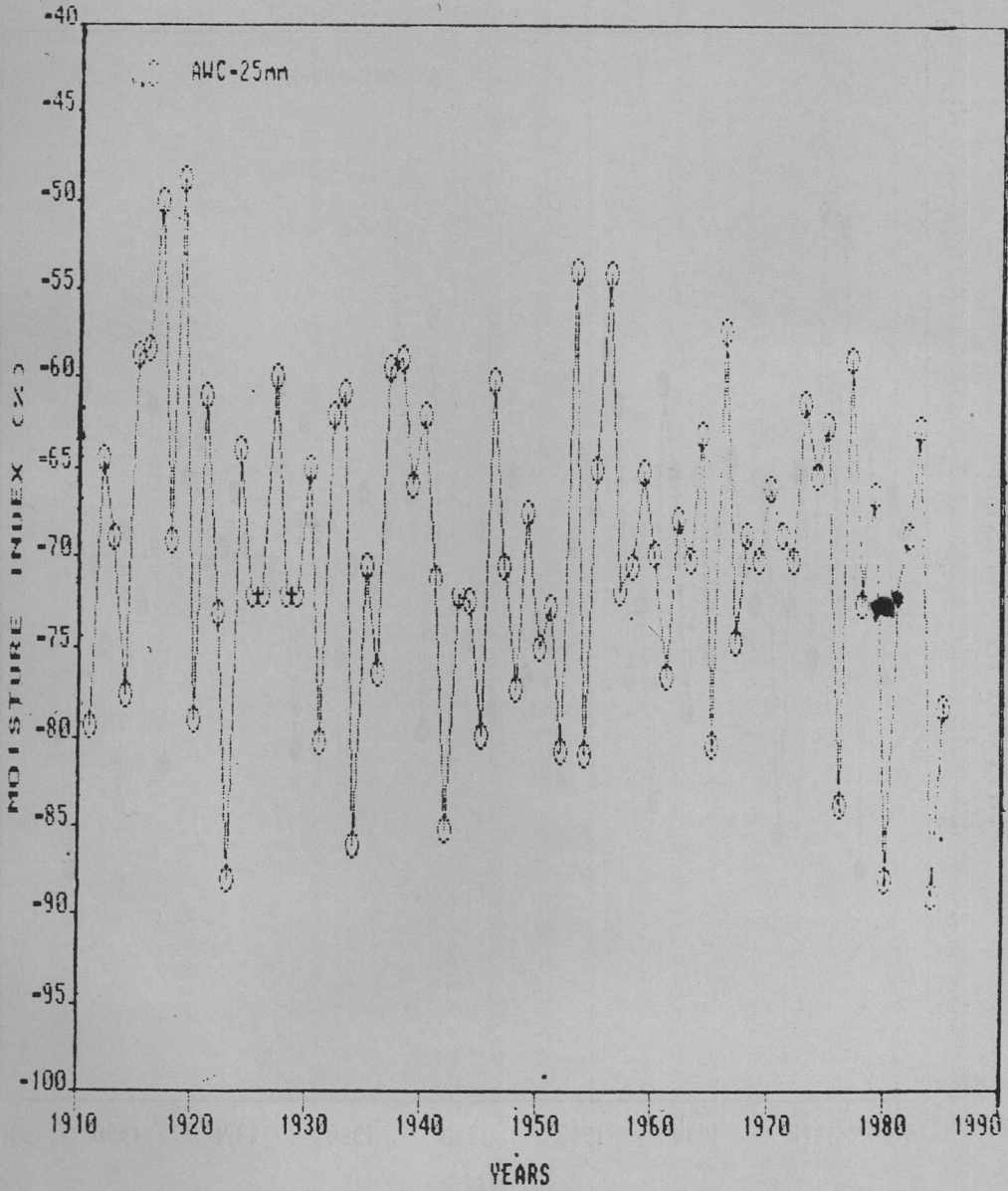


Fig. 1b. March of moisture index at Anantpur

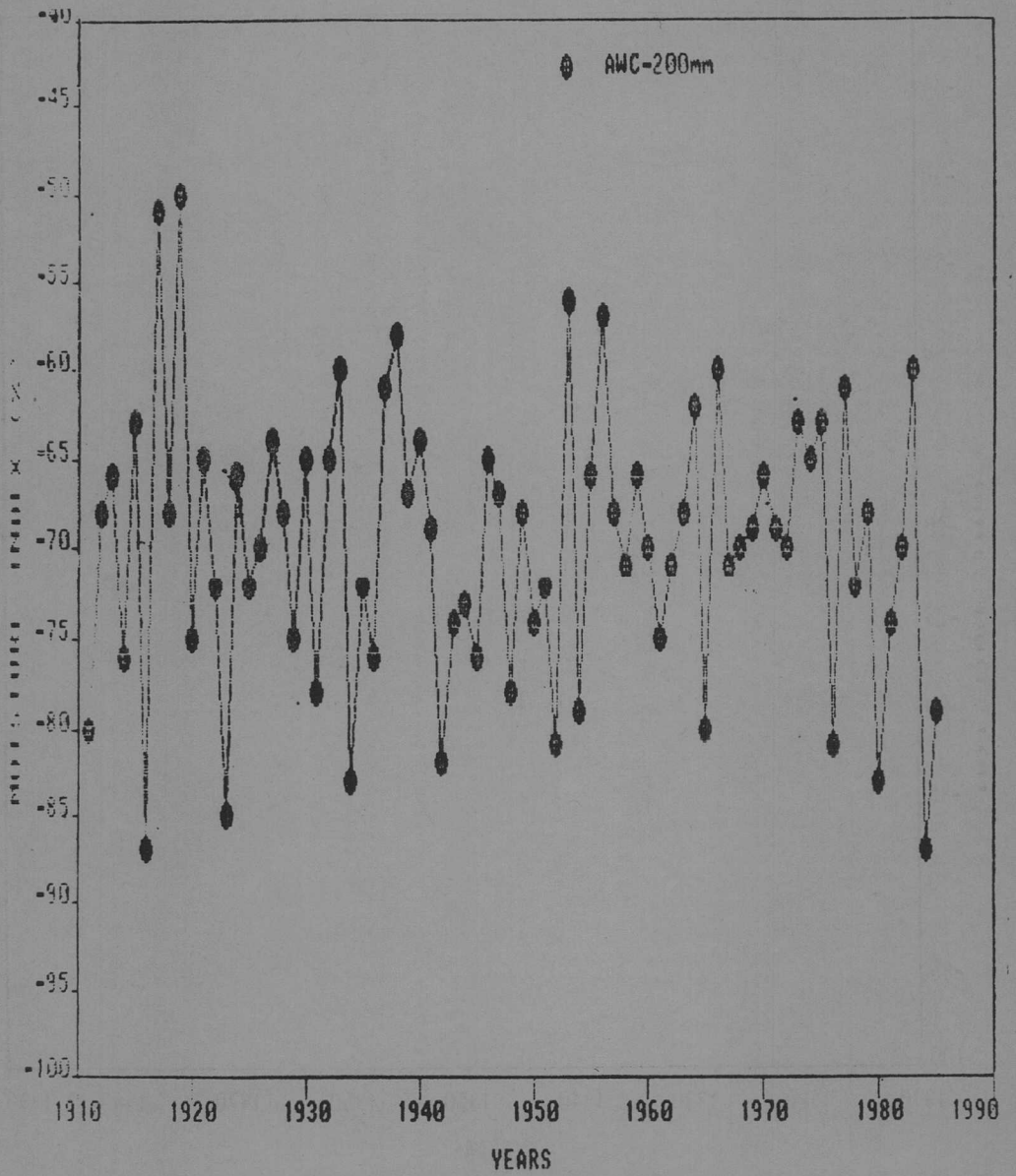


Fig. 1e. March of Aridity Index at Anantapur

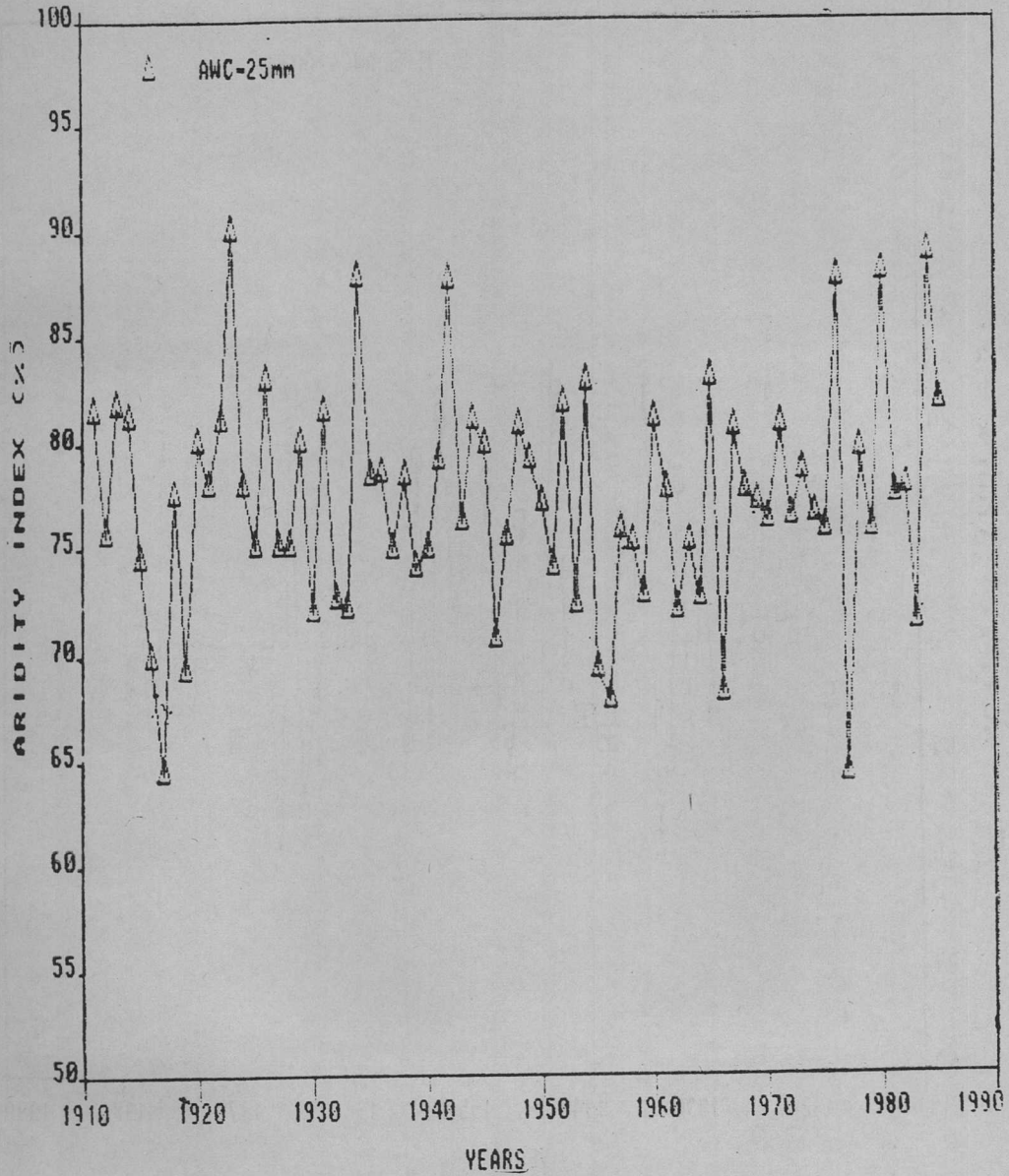


Fig. 1d. March of Aridity Index at Anantapur

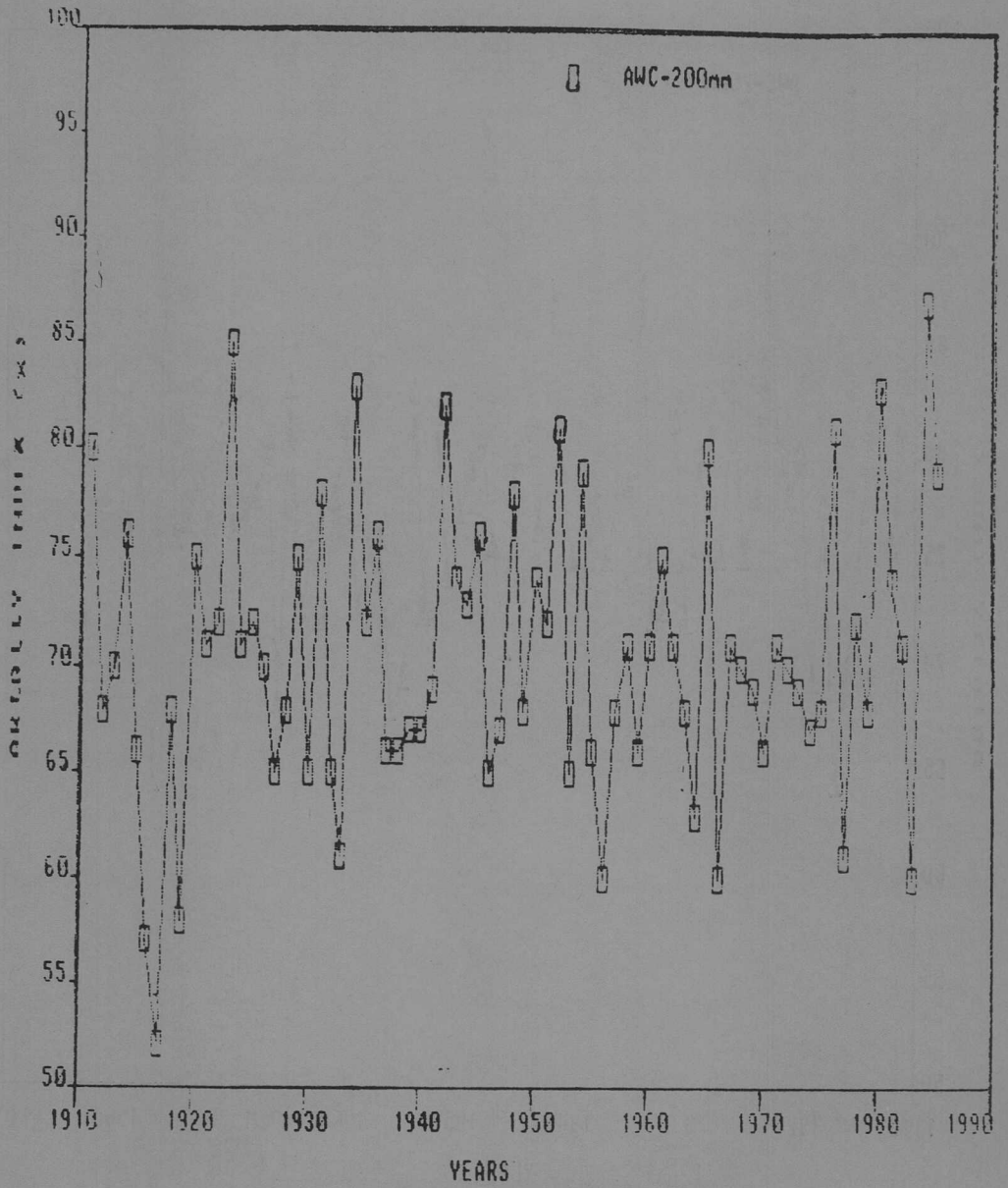


Fig. 1c. March of moisture index (%) Anantapur

two consecutive years so far. Out of 21 years when large to severe intensity drought occurred so far, on one occasion the intensity of drought was large or still more for two consecutive years.

Table 2. Drought years and their severities (1911-1985)

Disastrous	Severe	Large	Moderate
1983	1926	1911	1918
1984	1934	1913	1921
	1942	1914	1924
	1954	1920	1935
	1965	1922	1936
	1976	1929	1938
	1980	1931	1941
		1944	1945
		1948	1949
		1952	1961
		1960	1968
		1967	1973
		1971	1978
		1985	1981
			1982

In order to project the impact of drought on productivity of rainfed crops, the crop yields of groundnut and kodomillet which are the major crop grown in the district (Bureau of Economic and Statistics, Govt. of Andhra Pradesh) for some representative years are given in Table 3.

Table 3. Crop yields of groundnut and Kodomillet in representative drought years

Intensity of drought	Year of occurrence	Aridity index	Productivity (q/ha)	
			groundnut	kodomillet
No drought	1977	64.3	9.33	5.00
Moderate drought	1978	79.5	7.91	4.83
Large drought	1971	80.7	7.07	3.43
Severe drought	1980	88.0	4.03	2.37

During large and severe drought years, the reduction in the crop yields were more than 25 and 50 per cent respectively.

The percentage frequencies of occurrence of climatologically surplus water (which includes both runoff and deep drainage) of 20, 40, 60, 80, and 100 mm during different standard weeks of the main cropping season are given in Table 4. The surplus water is likely to exceed 20 mm from 28th to 40th week, with probability of more than 20 per cent. During 38th week, the surplus water may exceed 80 mm once in ten years. Therefore, the water harvesting may be useful either for late sown kharif crops or for establishment of tree plantations in this region.