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Probability Study of Rainfall for Bhal and Coastal Agro-Climatic Zone

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ABSTRACT

The monthly rainfall pattern of different stations of bhal and coastal agroclimatic zone were analysed. The year to year variability and variability in rainfall occuring during monsoon season alongwith other statistical parameters were worked out. Using simple probability percentage, the weekly probability of getting different amounts of rainfall for Arnej were computed for monsoon period. Moreover, the dry spells of different duration, water balance parameters and Moisture Adequacy Index were also worked out and presented in this paper.

The study reveals that the rainfall of the zone varies from 545 to 755 mm. The reliability of occurrence of rainfall at Arnej has been worked for different C. V. classes. Probability of recurring 20 mm or more rain after 42nd week was found to be zero at Arnej station. The intermittent dryspells are common feature and cause severe water stress. The water balance study shows that none of the week has surplus water whereas MAI curve indicate total crop season at Arnej is 14 weeks.

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INTRODUCTION

The rainfall of Bhal and Coastal agro-climatic zone is ranging from 545 to 755 mm. The zone received scanty and erratic rainfall. Most of the rains in the zone occurs from last week of June to mid of September received from the south-west monsoon currents. The main cropping pattern in the Bhal are cotton and sorghum (fodder) in *kharif* and wheat (dry) and gram (dry) in *rabi*. The soils are clay loam having low infiltration rate.

Apart from the scanty and uncertainty, the rainfall in the zone is subject to considerable year to year fluctuations. For better understanding of climatic pattern and crop planning, a detailed analysis of rainfall data for the past 43 years (1945-87) of Arnej station has been carried out in order to determine the agricultural potential of the zone.

MATERIALS AND METHODS

This zone is situated between North latitude 21°-45' and 22°-55' and east longitude 71°-15' and 73°-15'. The rainfall data of 7 different talukas viz., Dholka-Arnej station (1945-87), Dhandhuka (1962-86), Bhavnagar (1968-86), Vallabhipur (1975-86), Limbdi (1963-86), Khambhat (1973-86) and Vagra (1976-87) are collected which falls under this zone (Fig.1) Annual average rainfall, standard deviation and coefficient of variation were calculated. Using 43 years (1945-87) daily rainfall data for Arnej station, yearly, monthly and weekly variability/distribution of rainfall probability of different amounts of rainfall for

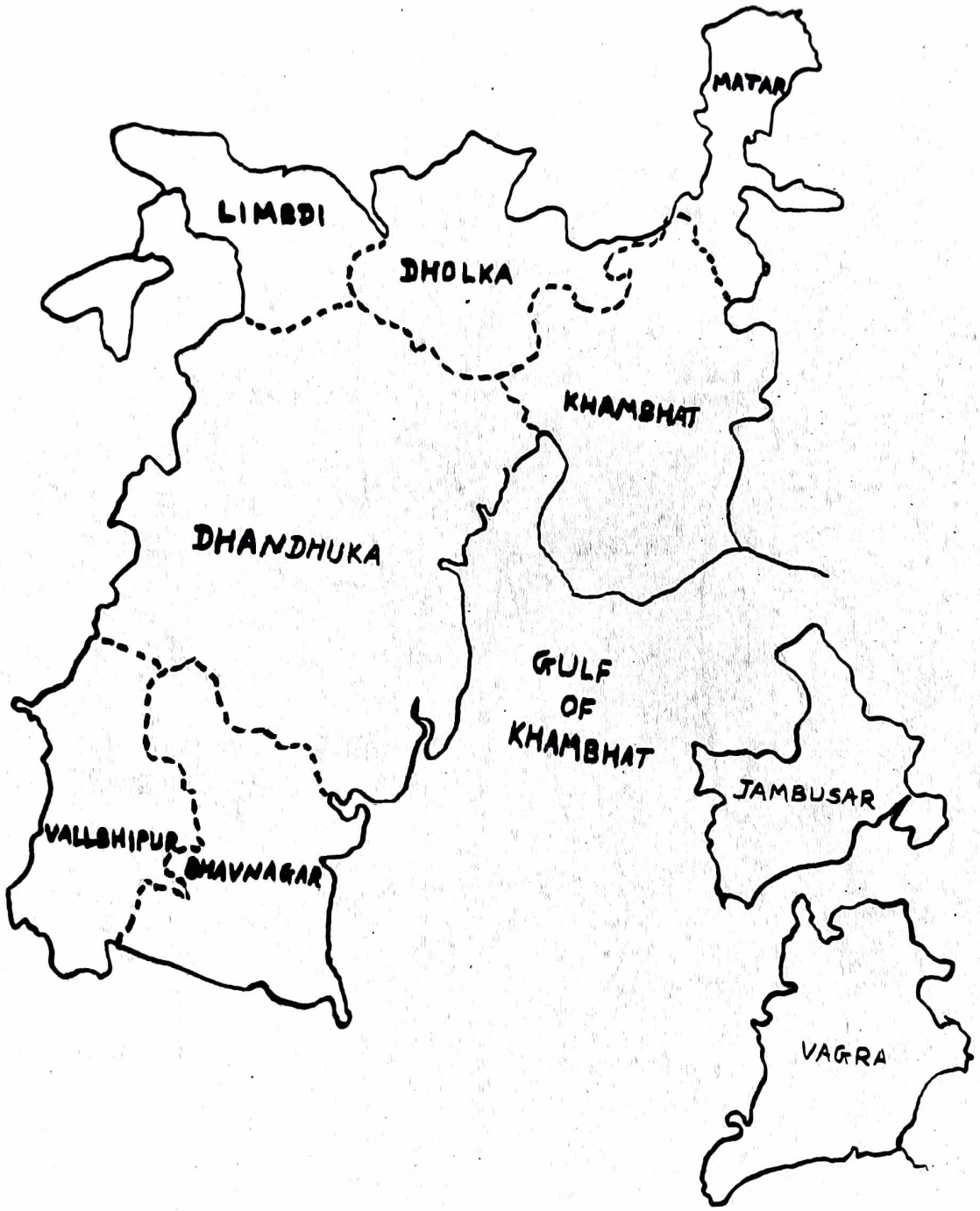
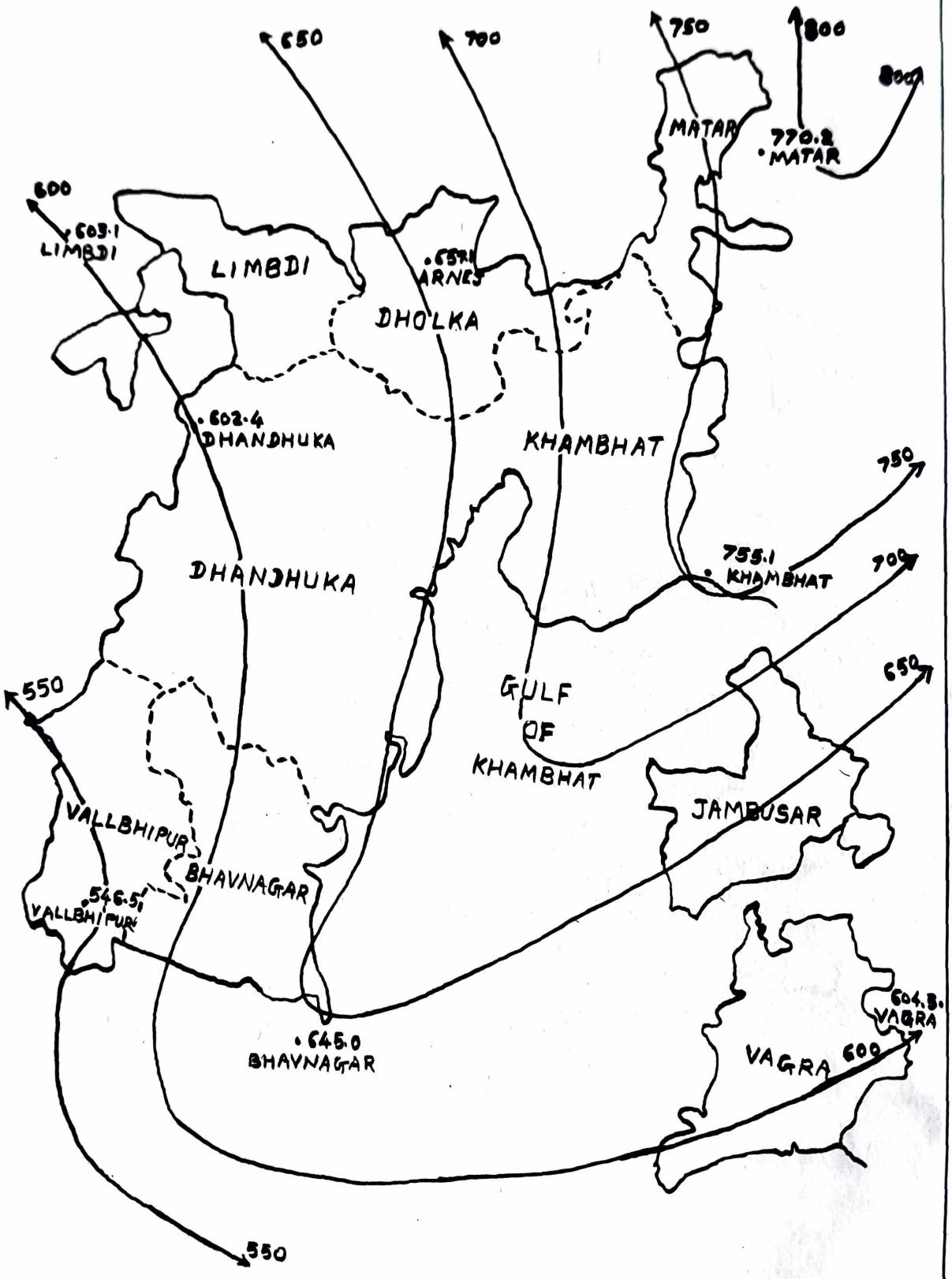


Fig 1 Map of Bhal and Coastal agroclimatic Zone



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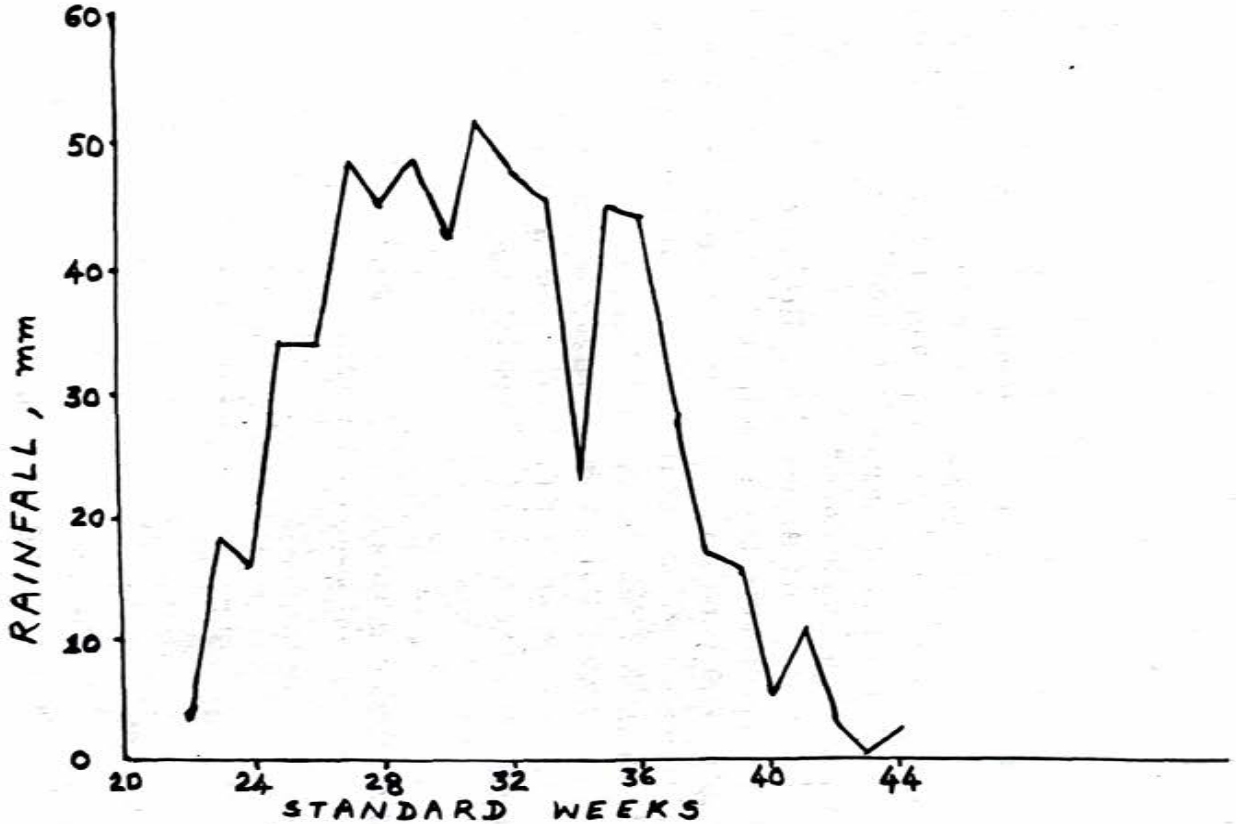

Fig 3 : WEEKLY MEAN RAINFALL AT ARNEJ

monsoon period, occurrence of different durations of dry spells and water balance were calculated and discussed.

RESULTS AND DISCUSSION

1. Rainfall pattern

The rainfall of the zone varies from 545 to 755 mm. The lowest rainfall recorded at Vallabhipur while highest at Khambhat (Fig.2). The maximum and minimum monsoon rainfall amounts vary from 234 to 1861 mm and rainy days from 16 in 1972, 1974 and 1987 to 59 in 1959 year.

2. Monthly rainfall distribution at Arnej

The monthly rainfall and per cent distribution of rainfall are computed for Arnej. The mean annual rainfall for the station is 657 mm received in 31 rainy days. The data indicated that among rainy months, July and August recorded the highest amount of rainfall i.e. 197 and 195 mm respectively in 9.3 and 9.5 rainy days which is approximately 60 per cent of the total annual rainfall. This followed by September rains i.e. 114.9 mm in 5.3 rainy days which constitute 17.5 per cent of annual rainfall. However, agriculturally significant rains at 50% probability commence in the beginning of July and withdraw in early September (Biswas and Basarkar, 1978; Biswas *et al.* 1989).

3. Rainfall distribution during monsoonal weeks

Weekly rainfall data are more useful than monthly, seasonal and annual rainfall for various cropping operations like seeding, interculturing and growth studies of different crops. The data (Fig.3) indicate that the mean rainfall exceeded 50 mm in std week 31 whereas it exceeded 40 mm in 27 to 33, 35 and 36. The period in which the weekly mean rainfall is 10 mm or more covers the period from 23rd to 39th Standard weeks (4th June - 30th September) indicating the normal period for growing of dryland crops. Biswas (1980) observed that a crop of 14-16 weeks duration can be raised in rainfed condition.

The coefficient of variation measures the reliability of occurrence of rainfall. Weeks with values of coefficients upto 180% are treated reliable for occurrence of rainfall. The analysis of data showed that the Std. weeks 25 to 34 and 37 are reliable weeks for receiving the rainfall as the coefficient of variation values are upto 175%.

TABLE 1

Per cent chance of getting different amount of rainfall for Arnej.

Meteorological week	*Rainfall, mm*				
	>10	*>20*	*>30*	*>40*	>50
22	12	7	2	2	2
23	12	9	9	5	2
24	33	23	9	7	7
25	60	56	47	40	26
26	58	44	42	33	26

1.	2.	3.	4.	5.	6.
27	67	60	51	44	35
28	63	53	47	42	37
29	70	56	42	40	40
30	63	49	40	26	26
31	65	49	47	40	37
32	77	58	47	37	33
33	56	51	40	37	30
34	47	42	30	26	21
35	49	42	30	28	21
36	49	40	35	26	23
37	53	33	26	23	21
38	33	23	14	12	9
39	26	23	16	16	12
40	16	5	2	2	2
41	16	14	9	7	7
42	9	7	7	2	0
43	2	0	0	0	0
44	5	2	2	2	2

4. Probability of getting different rainfall

Table 1 gives an account for per cent probability of getting different amounts of rainfall. At 25 per cent level of probability the period of receiving more than 50 mm rainfall ranged from 25th to 33rd week. However, the period for getting 40 and 30 mm of rain exceeded upto 36 and 37 week respectively. To receive more than 20 mm rainfall, the probability was 50 per cent or more for the period ranged from 25th to 33rd Std. weeks.

Dependable precipitation at 75% probability showed that 95 mm rainfall received in between 25th to 26th Std. week while 104 mm within 29th to 32nd Std. weeks. 40.8 mm rainfall received during 33rd to 36th week period.

5. Analysis of dryspells

Drought periods of various duration are computerised from weekly rainfall data showed (Table 2) that ten continuous rainless weeks can be expected to once during the period with probability 12.9%. The analysis further showed that a maximum of four non-continuous rainless weeks can be expected to occur once with the high water holding capacity of medium black soils of Arnej these intermittent drought weeks should not have pose any moisture stress. But in reality even these intermittent drought weeks may cause severe water stress as water demand always exceeds supply and soil moisture status remains low during standard week 20 to 42.

TABLE 2

Drought period analysis.

	Duration	*Percentage probability*
1.	Occurrence of one rainless week only once during the season.	41.9
2.	Occurrence of non-continuous	
	(a) two rainless weeks	29.0
	(b) three rainless weeks	19.4
	(c) four rainless weeks during the season	3.2
3.	Occurrence of any number (1 to 4) of non-continuous rainless weeks during the season.	93.5
4.	Occurrence of two continuous rainless weeks	
	(a) once during the season	35.5
	(b) twice during the season	25.8
	(c) three during the season	6.5
	(d) four during the season	3.2
5.	Occurrence of three continuous rainless weeks	
	(a) once during the season	32.3
	(b) twice during the season	12.9
6.	Occurrence of four continuous rainless weeks once during the season	25.3
7.	Occurrence of five continuous rainless weeks once during the season	22.6
8.	Occurrence of any number (<10) of continuous rainless weeks once during the season	12.9

6. Water balance parameters

Table 3 showed the different water balance parameters during cropping season of 23 weeks starting from 11th June to 4th November (22nd to 44th Std. weeks). The A E ranged from 3 to 45 mm. The data showed that none of the weeks have surplus water while 27th to 36th week except 34th Std. week have no deficit of water.

7. Moisture Adequacy Index (MAI)

The values MAI in per cent for 23 weeks (22nd to 44th Std. weeks) are plotted in Fig. 4. The 50 per cent M A I is considered to be good period for crop growth and development. The curve crosses the 50% level upto 38th Std. week. Thus the total crop growing season at Arnej is 14 weeks. The moderate and severe moisture stress conditions are found before 25th except in 33rd Std. week and after 38th Std. week. This suggest that *kharif* crops of 90 days viz., jowar (fodder), paddy may be grown under rainfed condition in the area. However, drought resistant crops viz., cotton may be grown successfully which are harvested upto February-March. The conditions for growing

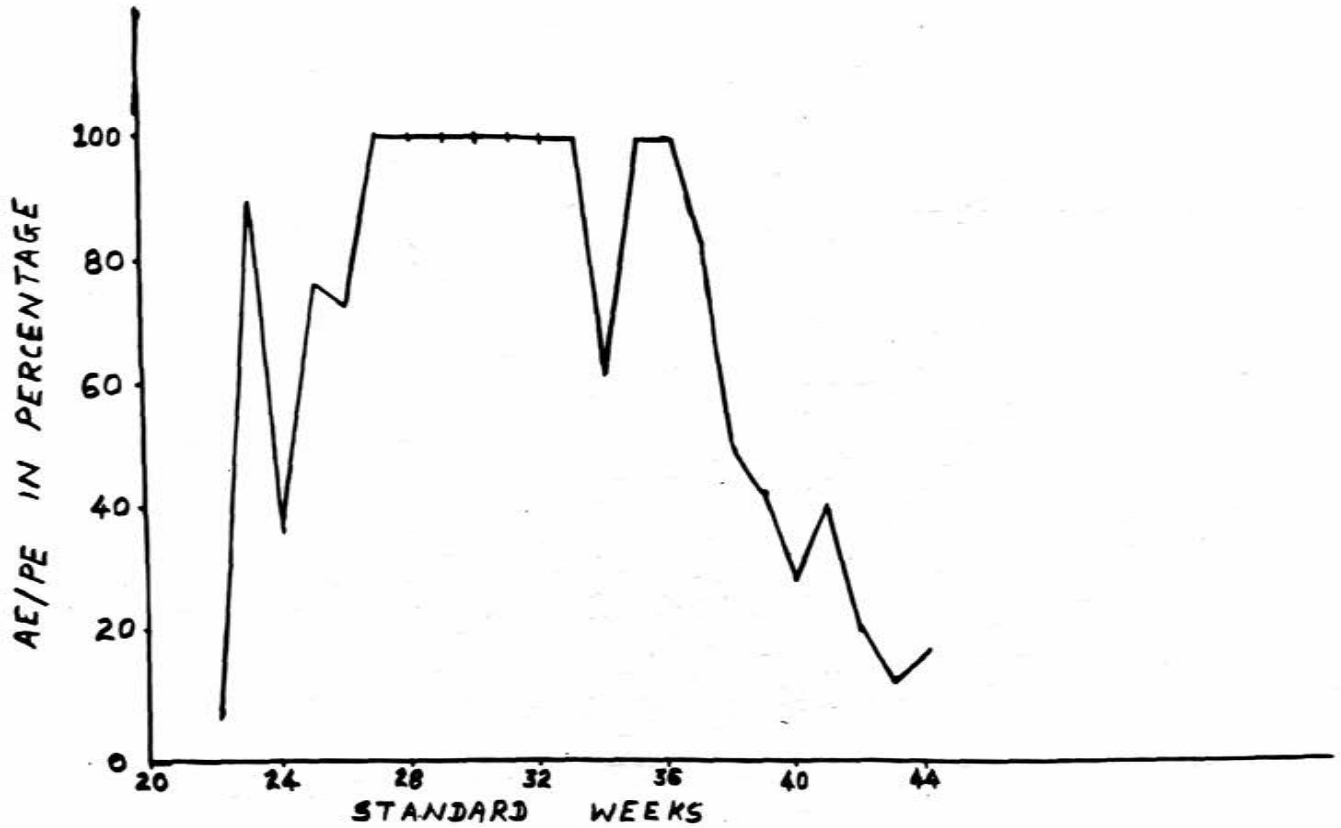

Fig 4: MEAN WATER ADEQUACY INDEX AT ARNEJ DURING CROPPING SEASON

TABLE 3

Climatic water balance at Arnej (1945-87) at 250 F.C.

Std. week	Potential evapotranspiration	Precipitation	Actual evapotranspiration	Water deficit	Water surplus	M A I (AE/PE)
22	47.9	3.0	3.0	44.9	0.0	0.06
23	47.3	42.2	42.2	5.1	0.0	0.89
24	46.5	16.6	16.6	29.9	0.0	0.36
25	45.7	34.9	34.9	10.8	0.0	0.76
26	44.1	32.1	32.1	12.0	0.0	0.73
27	44.5	48.1	44.5	0.0	0.0	1.00
28	43.7	44.3	43.7	0.0	0.0	1.00
29	42.0	48.7	42.0	0.0	0.0	1.00
30	42.0	42.8	42.0	0.0	0.0	1.00
31	39.8	52.3	39.8	0.0	0.0	1.00
32	39.8	48.8	39.8	0.0	0.0	1.00
33	39.0	45.0	39.0	0.0	0.0	1.00
34	39.8	22.0	24.8	15.0	0.0	0.62
35	39.8	46.4	39.8	0.0	0.0	1.00
36	36.4	45.7	36.4	0.0	0.0	1.00
37	36.0	28.1	29.8	6.2	0.0	0.83
38	37.8	14.7	19.3	18.5	0.0	0.51
39	38.6	11.8	16.7	22.9	0.0	0.43
40	37.6	5.2	10.4	17.2	0.0	0.28
41	36.9	10.9	14.6	22.3	0.0	0.40
42	36.2	3.4	7.6	28.6	0.0	0.21
43	34.1	0.4	4.2	29.9	0.0	0.12
44	30.3	2.3	5.1	25.2	0.0	0.17

rabi crops are not much suitable unless rain water conserved in the field keeping fallow during monsoon or providing life saving irrigation after harvesting excess rainwater in farm pond. Adhikari *et al.* (1989) are of the opinion that the rainfall runoff modelling can be used for designing water harvesting systems.

The yield obtained for different crops under the situation are 8 to 10 q/ha of cotton 'G.Cot.13'; durum wheat 'GW 1' gave 9 to 12 q/ha and gram "Chaffa" 8 to 10 q/ha.

Conclusion

The rainfall distribution in the zone is uneven and varies year to year. It was also found that the early cessation of monsoon was very common in the zone. On the basis of the rainfall pattern, the potential crop season is from the beginning of July to end of September. The dry spells are the common feature of the zone. The water balance parameters showed that none of the weeks have surplus water. Therefore, growing of *rabi* crops depend upon moisture conserved in the soil and supplementary irrigation from harvested run-off water in farm pond.

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