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Agroclimatic Appraisal of Khedbrahma

Vyas Pandey and A. T. Patel

Dryland Research Project, GAU, Sardar Krushinagar

ABSTRACT

The different climatic and agroclimatic parameters of Khedbrahma have been studied for 18 years (1966-1983). The study revealed that the area falls under semi-arid climate with moisture index value of -52%. The coefficient of variability of annual rainfall has been found to be 43.2 per cent. Twenty-sixth standard week (June 25 to July 1) has been found to be the safe period for carrying out the *kharif*/Rainy-season sowing. It is found that it is possible to harvest sufficient amount of surplus water (201 mm) which can be recycled to crops at the time of water need. The study has also revealed that the agroclimatic parameters of the area are more suitable for growing 125 days duration crops. Further that this period can be extended reasonably upto 150 days by adjusting sowing dates suitably and recycling the available surplus water.

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INTRODUCTION

Khedbrahma is a northern most taluka of Sabarkantha district of Gujarat State and lies at the latitude 24° N and longitude 73° 5° E, height above MSL 203.91 m. The taluka covers an area of about 846.2 sq. km. More than 67 per cent of total area of the district is under cultivation and out of that only 11.5 per cent is irrigated and the rest depends upon the rainfall. The average annual rainfall is 810 mm and varies from place to place between 740 to 975 mm. Sandy, alluvial and medium black soils are found in the district. The main crops grown in the district during *kharif* season are cotton, maize, groundnut, redgram and rice. The adoptability of these crops is mainly on the basis of soil, topography, rainfall and to some extent on the availability of irrigation facilities. Although the district receives quite a good amount of rainfall, due to the vagaries of monsoon, the heavy rains, the agricultural droughts and water scarcity often occur side by side. As per statistical atlas of Gujarat (1982) Khedbrahma has been declared scarcity area in five years during the decade 1965-1974, and thus it is prone to water scarcity. Therefore, there is need to study the climatic and agroclimatic parameters to facilitate agriculturists and planners for increasing crop production. The studies of Biswas (1982) and Virmani *et al.* (1982) give some information on rainfall probability and agroclimatic classification of Gujarat State. In these studies soil factor has not been taken into account. The present study aimed to study the agroclimatic parameters in detail considering the soil characteristics of the area.

MATERIAL AND METHODS

The daily rainfall data in respect of cotton research sub-centre Khedbrahma, Gujarat Agricultural University for 18 years (1966-1983) have been considered in the present study. The potential evapotranspiration values used in the analysis were determined using Penman's equation (Penman, 1948).

The available water capacity of the soil column representing the root zone of crops (upto 1 meter depth) was considered for the area based on the soil characteristics. The monthly and weekly water balance parameters were computed using Thornthwaite and Mather (1955) methodology in which the soil moisture storage (SMS) has been determined by using the formula.

$$SMS = AWC \times Exp. \left[\frac{Acc-(RF-PE)}{AWC}\right]$$

Where AWC is available water capacity of the soil, Acc—(RF-PE) is accumulated value of negative RF—PE, RF is rainfall, PE is potential evapotranspiration, Exp. is exponential term.

The mositure adequacy index (MAI) which has been defined as the ratio of actual evapotranspiration (AE) to PE has been used to define excellent $\left[\frac{AE}{} > 0.75\right]$ good $(0.75 > \frac{AE}{PE} > 0.50)$ poor $(0.50 > \frac{AE}{PE} > 0.25)$ and very poor $\left[0.25 < \frac{AE}{PE}\right]$ periods. Virmani (1975) has suggested a value of .25 as $\frac{AE}{PE}$ requirement during seeding. In the case of Khedbrahma this value seems to be inadequate and hence a moderate value of 0.4 has been selected for determining the starting of sowing periods.

RESULTS AND DISCUSSION

Climatic features :

The climatic water balance chart is shown in fig. 1 and the different parameters are given in Table-1. Khedbrahma recieves the annual rainfall of 774.5 mm out of which 94% is received during four months (June to September). The area falls under semi-arid climate with Thornthwaite moisture index of -52 % and varied between -23 to -74 per cent during the period under study. The coefficient of variation of annual rainfall is 31.6%. The C.V. per cent of monthly rainfall has been more than 100 during the off seasons and it is minimum in August (43.2%). Mean monthly rainfall is maximum in August (281 mm) however, the highest monthly rainfall of 525.3 mm was recorded during July 1977.

The potential evapotranspiration (PE) at Khedbrahma has been maximum during May (244 mm) followed by June (198 mm). A secondary maximum has been found in September. Atmospheric water need has been minimum (69 mm) during the month of December. The actual evapotranspiration (AE) which is the combined effect of RF and PE has been maximum and equal to PE during July. Soil moisture storage increase from July and reaches to field capacity in August. Thereafter, it decreased continuously. Water deficit is mainly during summer with peak value during May. During July and August there is no water deficit. The moisture adequacy index (AE/PE) more than 0.5 has been from June to November suggesting the water availability periods of six months. These values on monthly and annual basis give valuable information about march of different parameters with season and are useful as a

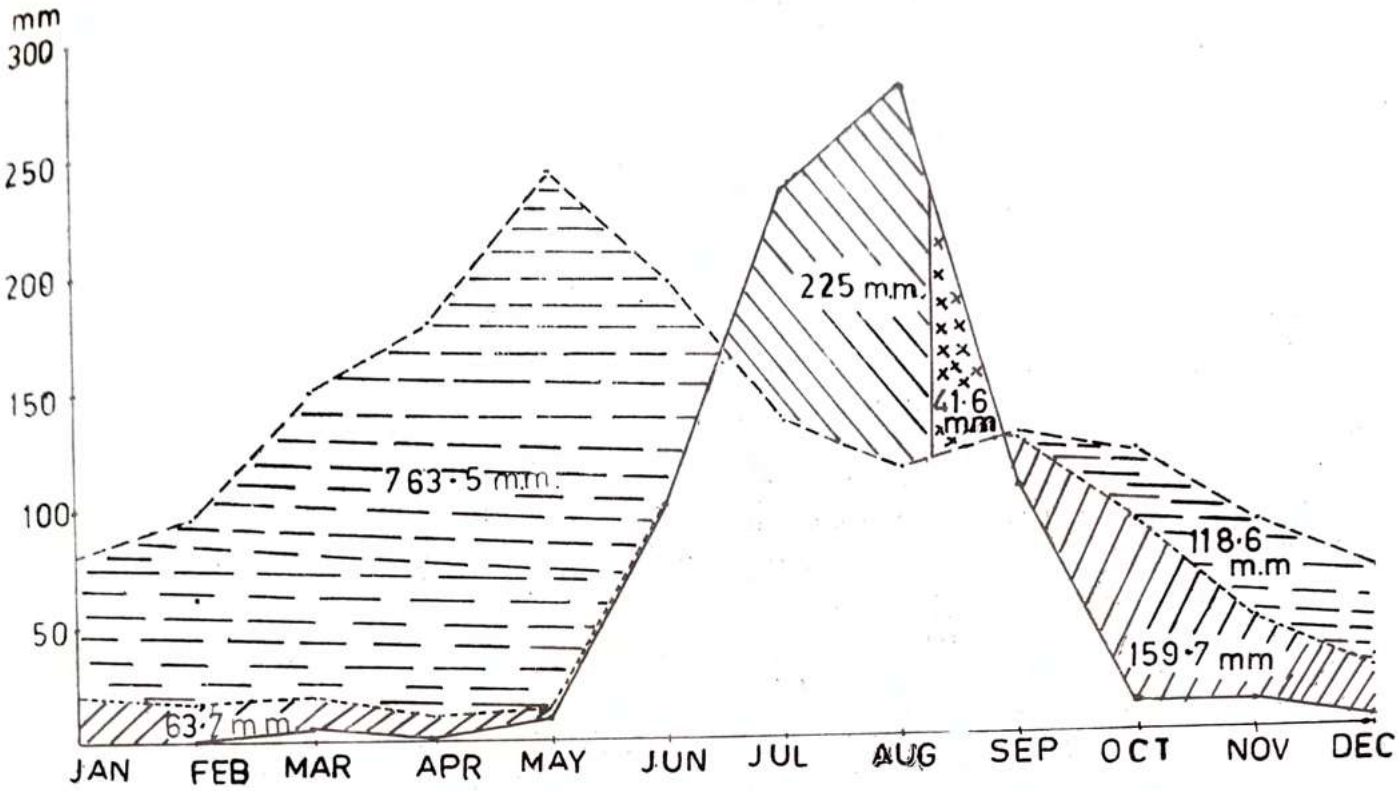

Fig 1 Climatic water balance of Khedbrahma.

Soil moisture recharge — Soil morsture utilization

Water surpius — Water deficit.

TABLE 1

Water budget parameters of Khedbrahma.

Months	*RF*	*PE*	*AE*	*SMS*	*WD*	*MAI*
January	1.0	81	20.5	45.8	60.5	0.25
February	1.5	96	17.2	30.1	78.8	0.18
March	5.4	150	19.7	15.8	130.3	0.13
April	1.7	180	10.3	7.2	169.7	0.06
May	9.1	244	13.8	2.5	230.2	0.06
June	103.1	198	104.0	1.6	94.0	0.53
July	237.4	137	137.0	102.0	0.0	1.00
August	280.6	116	116.0	225.0	0.0	1.00
September	107.6	131	129.8	202.8	1.2	0.99
October	11.8	123	90.9	123.7	32.1	0.74
November	11.7	90	48.1	87.3	41.9	0.53
December	3.6	69	25.6	65.3	43.4	0.32
Annual	774.5	1615	732.9	—	882.1	0.45

Where RF=Rainfall, PE=Potential Evapotranspiration, AE=Actual Evapotranspiration, SMS = Soil Moisture Storage at the end of the month, WD=Water Deficit, Values are in mm. MAI=Moisture adequacy index.

first hand information in hydrological and Agricultural planning (Subramanyam, 1982).

Agroclimatic features :

Sowing periods :

The successful sowings of different crops mainly depend upon sufficient rainfall and SMS.

Moisture availability index which takes into account both the parameters can therefore be used for deciding sowing periods.

The per cent chance of availability of MAI more than 0.4 is given in Table-2. It is found that the chances of availability of moisture for sowing are less than 17 per cent before 24th standard week. It is 33 per cent during 25th week (June-18-24). Twenty sixth and 27th standard weeks have 55 per cent chances of having MAI more than 0.4. Ninety five per cent chances have been found during 28th standard weeks. The results indicated that the sowing before 26th standard week (June 25) is very risky. It can be safely done during and after 26th std. week.

TABLE 2

Per cent chances of occurrence of MAI > 0.4 for sowing at Khedbrahma.

Std. Week	*Chance of occurrence of MAI > 0.4 in per cent*
23	11.1
24	16.7
25	33.3
26	55.5
27	55.5
28	94.5

Water balance parameters during cropping season :

Table-3 shows the different water balance parameters during cropping

TABLE 3

Agroclimatic parameters during 24th to 45th std. weeks.

Year	*RF*	*AE*	*SMS*	*WS*
1966	477.7	407.1	70.6	-
1967	672.4	441.1	86.0	142.3
1968	509.4	370.4	65.5	73.5
1969	543.0	415.0	79.3	48.7
1970	987.4	544.7	96.6	381.7
1971	540.0	454.2	85.8	-
1972	552.5	434.1	63.7	54.7
1973	1118.5	531.1	113.0	474.8
1974	358.0	282.1	75.9	-
1975	993.9	517.7	110.3	366.0
1976	931.5	434.2	76.7	420.6
1977	1199.3	541.2	77.5	580.6
1978	783.8	460.5	81.3	242.0
1979	526.5	415.5	55.1	55.9
1980	756.2	492.2	53.2	210.8
1981	799.0	527.5	151.0	172.3
1982	626.0	349.1	51.6	225.3
1983	713.8	473.4	71.9	168.5
Mean	727.2	449.5	81.4	201.0

Where RF, AE and SMS have their usual meanings and WS is water surplus in mm.

season of 22 weeks starting from 11th June to 11th November (24th to 45th std. weeks). The mean seasonal rainfall at the station was 727.2 mm with wide variation from year to year. Maximum (1199.3 mm) and minimum (358.0 mm) were recorded during 1977 and 1974 respectively. The mean AE during the cropping season was 449.5 mm and ranged between 282 to 545 mm.

The soil moisture storage (SMS) which is the important parameter of water balance studies indicated that about 13 per cent of rainfall remained in the soil at the end of 45th standard week. The third important parameter of water balance study is surplus water. The surplus water was found in as many as in 15 years with an average value of 201 mm. It was 28 per cent of its seasonal rainfall. This indicated that the area has good potential for water harvesting which can be recycled to crops at the time of water need.

Water availability periods:

The water availability periods of different types are given in Table 4. The water availability periods without stress conditions were mostly between 7 to 14 weeks with an average value of 11.3 weeks. Higher water availability periods were found between 2 to 5 weeks. No. of weeks with moderate stress conditions were more than that of slight stress and on average basis it was 4.3 weeks. The water availability with severe stress condition also ranged between 1 to 3 weeks

TABLE 4

No. of weeks of water availability periods with different MAI during 24th to 45th standard weeks.

Years	*No. of weeks of water availability periods*			
	Excellent	*Good*	*Poor*	*Very poor*
1966	7	5	9	1
1967	11	3	5	3
1968	9	3	7	3
1969	12	3	3	4
1970	14	5	2	1
1971	11	5	4	2
1972	10	5	5	2
1973	15	4	2	1
1974	5	2	9	6
1975	14	5	1	2
1976	11	4	4	3
1977	14	4	4	–
1978	13	3	4	2
1979	8	8	4	2
1980	12	4	5	1
1981	17	3	–	2
1982	7	4	6	5
1983	13	3	4	2
Mean	11.3	4.1	4.3	2.3

with one year (1974) experiencing the severe stress condition of 6 weeks during the cropping season.

Tables 3 and 4 altogether revealed that although rainfall during 1971 was only 549 mm, the crop growing season was of 16 weeks, whereas during 1967, 1969, 1972, 1976 and 1982 the rainfall was upto about 73 per cent more than that of 1971, the crop growing season was not more than 15 weeks. This revealed that it is the rainfall distribution which decides the length of crop growing seasons rather than total amount of rainfall.

The weekly distribution of MAI showed that 33 per cent of years experienced severe water stress conditions for at least one week before or one week after sowing. It is interesting to note that in such cases sowing rains had occurred before 25th std. week. The mean values of MAI in per cent for 24 weeks from 22nd to 45th standard weeks (May 28 to Nov. 11) are plotted in Fig. 2. The 50% MAI is considered to be good period for crop growth and development. The curve crosses the 50% level only after 26th std. week and continues to be above the level upto 43rd std. week and thus the total crop growing period at Khedbrahma is of 18 weeks. The moderate and severe moisture stress conditions are found before 25th and after 43rd std. weeks. This suggests that medium duration *kharif* crops of 125 days viz. maize, groundnut and cotton etc., may be grown under rainfed condition in the area.

It has already been stated that the area receives good amount of surplus water (about 200 mm), the same amount can be utilized for recycling it during the periods of crop water requirements. Since the atmospheric water demand during November and December is about 160 mm, the surplus water if stored suitably, will be sufficient to meet the water requirement of the crops for a period of atleast 30 days and therefore, crop growing periods can be increased upto 150 days.

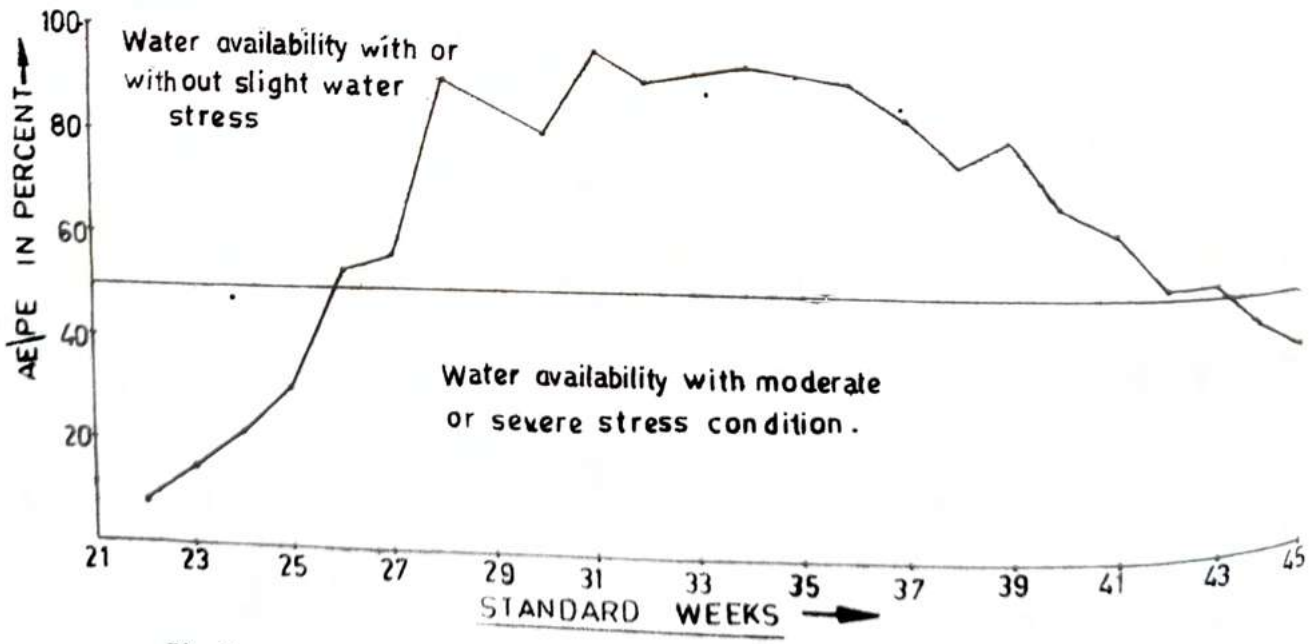

Fig 2 Mean water adequacy index at Khedbrahma during cropping season.

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