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Short communication

Water balance studies for agricultural planning in Udaipur region

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In Udaipur region, which covers nearly 2/3 areas under rainfed agriculture, water is a major limiting factor in crop production. Apart from variation in the total seasonal rainfall, the region experiences large variability in the time of commencement of the sowing, rains as well as in the distribution of the rainfall within the crop growing season. The existing traditional and subsistence oriented cropping pattern lead to indiscriminate use of the agriculture land and also to low economic returns (Mann and Singh, 1977). In order to improve and stabilize the economy of the region, there is a great need for a rational crop planning with the aid of suitable agrometeorological methods. The crop growing season depends not only on the rainfall distribution but also on the water holding capacity and moisture release characteristics of the soil as crops extract stored moisture during the rainless period. The water balance method of Thornthwaite and Mather (1955) takes into account all these factors for estimating actual evapotranspiration. Application of this method on a short term weekly basis within the growing seasons would bring out a clear picture of the moisture deficiency and the surplus water during the rainy season, thus leading to a better assessment of the consumptive use and the crop yield. Earlier workers (Ramakrishna *et al.*,1985, Subramaniam and Sanjeeva Rao, 1986 and Sanjeeva Rao *et al.*, 1990) used this approach for crop planning.

The daily meteorological data for a period of 15 years (1981-1995) were collected from the college of Technology & Engineering, Udaipur. The region covers a geographical area of about 3.36 m ha. The terrain is irregular, the soils are lithosols at the foothills in Udaipur, but those away from hills are old alluvials. The major crops of the region are maize, sorghum, groundnut, cotton, blackgram, wheat, barley, gram and mustard. In *kharif*, the major area is covered by maize and by wheat and barley in *rabi*.

The reference evapotranspiration (ETo) is calculated by the Penman-Monteith method (Allen *et al.*, 1998) and weekly water balance following Thornthwaite and Mather (1955). Drought severity was classified using the standard deviation and median of aridity index after Subrahamayam and Sastri (1969). The length of growing season was determined by using moisture adequacy index (Ima) method of Thornthwaite and Mather (1955). Amount of the surplus water, its probable period of occurrence and probabilities of harvesting

Table 1 : Comparative moisture status of the Udaipur region

Year	Rainfall (mm)	Reference evapotranspiration (mm)	Actual evapotranspiration (mm)	Water deficit (mm)	Water surplus (mm)
Normal	584.8	1379.0	562.4	816.0	0.0
Wettest (1989)	895.7	1414.4	596.9	817.5	283.5
Driest (1987)	377.9	1408.6	361.9	1046.7	0.0

Table 2: Week for start and end of growing season in Udaipur region

	Start of growing season standard met. week	End of growing season standard met. week	Length of growing season (weeks)
Early monsoon	23	36	29 (Max.)
Late monsoon	29	52	9 (Min.)
Average monsoon	27	46	20 (Average)

surplus water of at least 20,40,60,80 and 100 mm were estimated.

The mean annual rainfall of the region is 584.8 mm with 26.5% coefficient of variation. Ninety per cent of the rainfall is received during the *kharif* season (June-September). The major kharif crops are maize, sorghum, and *kharif* pluses of 14 weeks and 10 weeks duration, respectively.

The actual evapotranspiration (AET) in driest year, due to a prolonged dry spell gives rise to a severe drought condition affecting the crop growth adversely. No surplus water was recorded during driest year (Table 1).

The highest rainfall of 57.8 mm with zero surplus water was noticed in 32nd week. Rainfall exceeds reference evapotranspiration (ETo) for 7 weeks (28th to 34th). No surplus water was observed in any week during the average year. Out of the total deficit of 816.6 mm, a water deficit deficit of 109.5 mm (13.4%) was noticed in the rainy season, while the rainfall was 526.0 mm . On an annual basis, the station has a water need of 1379.0 mm whereas rainfall was 584.8 mm.

Early start of the length of growing season occurs during 23rd week (Table 2). During the years with delay in onset of monsoon, the length of growing season may start as late as 29th week (July 16-22) in the region. Under normal condition, it starts by 27th week (July 2-8). During the years with early withdrawal of southwest

Table 3: Probability of occurrence for different amounts of surplus water during rainy season

Week	Average rainfall mm	Surplus water				
		20 mm	40 mm	60 mm	80 mm	100 mm
		Probability (%)				
26	23.2	0.0	0.0	0.0	0.0	0.0
27	33.5	6.7	0.0	0.0	0.0	0.0
28	40.3	0.0	0.0	0.0	0.0	0.0
29	49.4	13.3	0.0	0.0	0.0	0.0
30	57.0	13.3	13.3	6.7	0.0	0.0
31	41.9	13.3	13.3	0.0	0.0	0.0
32	57.8	20.0	13.3	0.0	0.0	0.0
33	48.3	13.3	6.7	6.7	6.7	0.0
34	48.8	6.7	6.7	6.7	6.7	6.7
35	28.4	13.3	6.7	0.0	0.0	0.0
36	28.4	20.0	20.0	13.3	0.0	0.0
37	26.6	0.0	0.0	0.0	0.0	0.0
38	7.4	6.7	0.0	0.0	0.0	0.0
39	14.2	6.7	0.0	0.0	0.0	0.0

monsoon, the length of growing season ends by 36th week (Sept. 3-9). Under normal conditions, it end by 46th week. During some of the years, the post monsoon rains may extend the length of growing season up to 49 to 52nd week (from December 3-9 to December 24-31).

The maximum length of growing season of 29 weeks (from June 4-10 to December 17-23), while, minimum 9 weeks (from July 9-15 to September 3-9) was recorded (Table 2). Under average conditions, the length of growing season was recorded as 20 weeks (from July 2-8 to November 12-15). Therefore, short duration maize i.e. Navjot and Mahi kanchan, *kharif* pulses and sesame are suitable in the region.

Data (Table 3) reveals that, the surplus water is likely to exceed 20 mm from 30th to 32nd week with 13.3% probability. During 34th week, the surplus water may exceed 80 mm with 6.7% probability and surplus water may exceed 60 mm during 33rd and 34th week with 6.7 per cent probability. The surplus water exceeding 40 to 100 mm can be harvested successfully in the years of its occurrence and can be recycled not only to save the crop during period of severe moisture stress but also to raise a second crop like, gram, mustard and taramira for increasing the cropping intensity and net returning from the agri-cultivated lands. Monitoring of soil water balance every year is suggested for such possibility on real time

basis.

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