MOISTURE ADEQUACY INDEX BASED ON RAINFALL PROBABILITY

In rainfed regions for formulating a cropping pattern tailored to the rainfall pattern of an area, studies on variability of rainfall, frequency of dry and wet spells and probabilities of occurrence of rainfall over short periods assume significance and provide basic information.

In such areas where rainfall is the only source of meeting the Actual Evapotranspiration needs (AET) a ratio suitably linking the dependable or assured rainfall with the potential water requirements of the crop (PET) during different crop phenological stages would provide a useful index in identifying the moisture adequacy periods in the cropping season. This enables the determination of the length of the growing period at a station.

Weekly rainfall probabilities were computed by fitting mixed gamma distribution, following Thom (1966) using daily rainfall data for the 30-year period (1941-70) recorded at the farm observatory of the Indian Agricultural Research Institute, New Delhi. The analysis covers 18 weeks of the kharif cropping season, the first week starting on 29 June and the 18th week ending on 1 November. Variance ratio test (Mooley 1973) applied to the data showed that the sample values (weekly precipitation) and theoretical gamma distribution values are not significantly different at 5 per cent level. The assured rainfall values thus derived are expressed as a fraction of PET. For expressing PET, mesh covered pan evaporation values have been used, which were found to be a useful measure of PET and consumptive use of water during the monsoon period (Stanhill 1962, Sharma and Dastane 1966).

TABLE 1

Frequency distribution of weekly rainfall (mm)

Period	Week No.	20%	40%	60%	80%
29-5 Jul	1	44.4	17.8	6.8	—
6-12 Jul	2	100.0	50.0	20.4	—
13-19 Jul	3	74.0	36.8	17.6	0.5
20-26 Jul	4	103.0	59.2	20.0	—
27 Jul-2 Aug	5	80.4	50.4	29.8	4.0
3-9 Aug	6	72.0	35.8	15.0	6.0
10-16 Aug	7	87.1	53.4	32.5	13.4
17-23 Aug	8	81.4	42.0	19.4	3.2
24-30 Aug	9	55.0	27.8	10.8	16.4
31 Aug-6 Sep	10	62.0	17.0	3.0	4.0
7-13 Sep	11	52.4	21.5	7.0	2.0
14-20 Sep	12	61.0	24.4	7.2	—
21-27 Sep	13	42.0	8.8	—	—
28 Sep-4 Oct	14	10.0	—	—	—
5-11 Oct	15	8.5	—	—	—
12-18 Oct	16	—	—	—	—
19-25 Oct	17	—	—	—	—
26 Oct-1 Nov	18	—	—	—	—

The weekly assured rainfall values at different probability levels, using the mixed gamma distribution are shown in Table 1. Depending on the crop species, the pattern of distribution of dependable rainfall can be directly obtained from the table at any desired probability level. The weekly index values which are termed as Moisture Adequacy Index (MAI) by Hargreaves (1975) expressing the assured rainfall (from which AET needs of the crop are met in areas without supplementary irrigation) as a fraction

TABLE 2

Moisture adequacy index at different crop phenological stages

Probability (%)	Moisture adequacy index for week No.															
	1 July	2	3	4	5	6 August	7	8	9	10	11 September	12	13	14	15 October	16

Bajra

	Sowing & germination		Tillering				Flowering				Maturity					
80	0.01	—	0.07	0.13	0.32	0.08	0.43	0.16	0.06							
70	0.02	0.20	0.19	0.29	0.48	0.21	0.63	0.44	0.22		0.12	0.03				
60	0.10	0.42	0.31	0.45	0.72	0.40	0.86	0.77	0.31	0.09	0.21	0.20				
50	0.16	0.58	0.46	0.54	0.97	0.66	1.17	1.19	0.55	0.25	0.39	0.61				

Maize

	Sowing & germination		Vegetative						Tasselling		Maturity					
40	0.26	1.02	0.65	1.32	1.22	0.95	1.44	1.67	0.81	0.52	0.64	0.68	0.26			
30	0.40	1.43	0.88	1.60	1.54	1.32	1.89	2.30	1.17	0.88	0.98	1.09	0.67	0.02		
20	0.65	2.04	1.31	2.30	1.95	1.90	2.35	3.23	1.60	1.89	1.56	1.71	1.34	0.26	0.23	

Sorghum

	Sowing & germination		Panicle initiation				Flowering				Maturity					
10	0.99	3.06	1.84	3.57	2.59	2.91	3.23	4.33	2.33	3.60	2.38	2.80	2.13	1.30	0.88	0.26

of PET are shown in Table 2; superimposed on this are the phenological stages for bajra, maize and sorghum crops in the Delhi region. This illustrates the utility of this index in identifying the moisture adequacy periods and for determining the length of growing season available at different probability levels, from a climatic point of view. From a study of a number of crops in the rainfed areas Hargreaves (1975) suggested that MAI values greater than 0.34 can be taken as a minimum threshold value for meeting the climatic water requirement of dry land crops. Using this criteria at 50 per cent probability level, it is seen that the length of the dependable rainfall period in the Delhi region is of 11 weeks (from 2nd to 12th week) duration. This indicates that a crop which completes its grain setting stage in about 11 weeks could be successfully grown under rainfed conditions once in two years.

The MAI, being based on simple parameters and easily measurable quantities, has potential applications for planning cultural practices such as sowing dates, estimating periods available for seed bed preparation etc by making suitable choice of dependable rainfall value and the probability level which are essential in determining the land use pattern.

References

Hargreaves, G. H., 1975, *Trans. ASAE*, **18** (5), pp. 980-984.

Mooley, D. A., 1973, *Mon. Weath. Rev.*, **101** (2), pp. 160-176.

Sharma, R.G. and Dastane, N. G., 1966, Proc. Symp. water management. Ind. Soc. Agron., New Delhi, pp. 66 -75.

Stanhill, G., 1962, *Israel J. Agric. Res.*, **12** (2), pp. 51-62.

Thom, H. C. S., 1966, W.M.O. Tech. Note, 82, pp. 20-22.

Div. of Agric. Phys.,

Indian Agric. Research Institute, New Delhi

17 February 1981

U. S. VICTOR

P. S. N. SASTRY