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USE OF RAINFALL ANALYSIS IN THE PLANNING AND MANAGEMENT OF RAINFED COTTON

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INTRODUCTION

The yearly rainfall pattern over 72 years (1916-87) shown in Figure 1. does not have any perceptible pattern of the rainfall trend over the years and clearly, the fluctuations are randomly distributed around the normal rainfall. However, it is not necessary that a year receiving low (or below normal) rainfall results in a low crop output and an year receiving high rainfall is a better crop year. Well distributed rainfall is an important factor determining yield.

A detailed knowledge of the rainfall regime at a place is an important prerequisite for agricultural planning and management. More so for rainfed agriculture, rainfall is the single most important agro-meterological variable influencing crop production. In the absence of reliable, physically based seasonal forecasts, crop management decisions and planning have to rely on statistical assessment based on the analysis of historical rainfall records. The rainfall-based information generated by this study is expected to be of considerable agronomic importance for the efficient planning and management of rainfed cotton based cropping system.

Some important aspects of rainfall, yielding information of potential agronomic importance are:

(i) the chance of rain,
(ii) the start, end and length of the rainy season,
(iii) amounts of rain that can be expected at specified probability levels
(iv) the risk of dry spells.

A simple statistical methodology employing a distribution free approach, for the analysis of daily rainfall data has been followed.

DATA BASE

Daily historical data on rainfall for 72 years (1916-87), collected from the Regional Meterological Department, Nagpur was used for this study.

The chance of rain

For each day of the growing season, the chance of rain was estimated by the frequency approach. For convenience, computations were aggregated over consecutive 5-day period units. The general trend observed during the crop growing season was as follows: the chance of rain rose sharply during the month of June, reached a peak in July and was more or less maintained till August and then started decreasing gradually during September.

Probable rainfall and Cotton agriculture

In the rainfed conditions of Central India, the sowing of cotton crop is generally taken up immediately following the receipt of monsoon rains. Since the time of sowing is an important agricultural operation depending on the commencement of rains, it is important to evolve an objective and scientific criteria to determine the start of rains. Also since crop production crucially depends on the length of the growing season, it follows that the end of the rainy season and hence the length of the rainy season have also to be determined by employing suitable criteria. In the following, these eatures of rainfall are described.

Start of the rains

Criteria

(a) The start of the season is not considered before June 1,
(b) A date after June 1 indicates a potential start date, defined as the first occurrence of at least 70 mm of rain totaled over at least 2 consecutive days and,

(c) The potential start could be a false start if a dry spell of 10 or more days occurs in the next 30 days.

End of rains

Criteria: The first occurrence of a long dry spell of atleast 15 days, after September 15.

Length of rains

The length of the rainy season is calculated by subtracting, for each year, the date at which rain begins from the date at which it ends.

Table 1. Gives the percentage points of the distribution of the start, end and length of rains.

Table: 1 Distribution of the Start, End and Length of Rains

	Percentage points			
	20	40	60	80
Start	June 16	June 24	June 30	July 6
End	September 23	September 28	October 4	October 12
Length	85 days	95 days	102 days	111 days

Amounts of rain within a decade

Dependable amounts of water-availability during the critical stages of crop growth periods are more importantly required over shorter periods. The rainfall amounts have therefore been considered over ten-day periods (decades).

The decade rainfall amounts for the period from June 1 to September 30 over the 72-year data base were statistically analyzed to estimate the amounts of rain that can be expected at given probability levels. Percentage points of decade rainfall amounts alongwith approximate 95% confidence limits have been estimated and these are given in Table 2.

Table: 2 Percentage Points and 95% Confidence Limits for Decade Rainfall Amounts

Years used	Month	Decade	Percentage Point	Amount (mm)	Confidence Limits
1916-87 (72 years)	June	I	25%	0.0	(0.0 ,3.0)
			50%	11.2	(5.3, 14.0)
			75%	29.8	(17.8,71.9)
		II	25%	19.0	(10.2, 29.1)
			50%	50.5	(32.0, 61.8)
			75%	77.4	(64.3, 120.9)
		III	25%	42.0	(21.1, 56.3)
			50%	92.6	(62.4,112.7)
			75%	135.1	(121.2,160.1)
	July	I	25%	53.4	(43.8, 71.1)
			50%	96.2	(84.3, 117.5)
			75%	143.2	(131.5, 169.4)
		II	25%	66.6	(44.4, 75.8)
			50%	104.1	(85.1, 131.6)
			75%	176.9	(135.0, 215.3)

		III	25%	56.1	(37.3, 78.7)
			50%	114.8	(91.5, 134.9)
			75%	173.2	(144.3, 210.8)
	August	I	25%	45.5	(29.5, 58.9)
			50%	99.4	(70.1, 114.5)
			75%	123.6	(117.2,157.5)
		II	25%	34.2	(20.6, 44.5)
			50%	65.9	(49.7, 96.8)
			75%	129.1	(107.9, 152.0)
		III	25%	28.9	(13.8, 50.6)
			50%	79.6	(54.8, 101.5)
			75%	130.0	(112.8, 164.3)
	September	I	25%	36.6	(23.1, 45.5)
			50%	71.8	(51.6,84.9)
			75%	111.8	(97.6, 143.6)
		II	25%	14.8	(7.6, 22.4)
			50%	39.5	(27.3, 54.2)
			75%	76.2	(58.2, 85.8)
		III	25%	7.1	(2.6, 10.5)
			50%	32.1	(15.7, 43.0)
			75%	84.8	(57.3, 94.8)

Dry spells

The analysis of dry spells is useful to agricultural planners in determining the most appropriate crop or variety and in selecting the best cropping practices. To assess the risk of dry spells, the probability distribution of dry spells of different duration have been derived and presented in Table 3.

Table: 3 Probability of a dry spell of 'n' or more days by dates shown

Date By which started		**Probability of dry spell lengths (days) ≥5**	**≥7**	**≥10**
June	1	0.597	0.486	0.319
	6	0.514	0.306	0.236
	11	0.347	0.208	0.056
	16	0.222	0.111	0.056
	21	0.111	0.069	0.000
	26	0.042	0.042	0.014
July	1	0.056	0.028	0.000
	6	0.042	0.028	0.000
	11	0.056	0.042	0.014
	16	0.111	0.042	0.028
	21	0.097	0.028	0.028
	26	0.097	0.056	0.028

Aug	1	0.097	0.056	0.028
	6	0.083	0.056	0.028
	11	0.167	0.097	0.042
	16	0.181	0.069	0.028
	21	0.208	0.153	0.083
	26	0.250	0.167	0.069
Sep	1	0.097	0.056	0.028
	6	0.167	0.097	0.042
	11	0.222	0.181	0.097
	16	0.306	0.181	0.083
	21	0.292	0.194	0.153
	26	0.458		

Applications to Cotton-based cropping systems

The information generated by the rainfall analysis could find useful application in crop planning and management, in optimum pesticide use for the control of insect pests and diseases, in crop modeling etc. Some of the applications of this analysis is discussed below.

Decision on the sowing date

Cotton crop is sown on receipt of a good rain spell at the beginning of the monsoon season, indicating the start of the rains. Timely sowing is a most important criteria for achieving high cotton yields. A reference to Table 1. shows that the start of the rains occurs during the period from 3rd decade of June to 1st decade of July corresponding to the 60th to 80th percentage points. The sowings can therefore be safely taken up during this period. This is also borne out from Table 2., which shows that the rainfall amount during this period is sufficient for sowing purposes during 3rd decade of June/ 1st decade of July.

Interculture operations and fertilizer application

Wet spells are predominant during early July as it can be seen from Table 3. Interculture during this time is very difficult due to the sticky nature of vertisols. Use of herbicides is recommended. During July 16-21, probability of a dry spell of length 5 or more is higher and this period, can therefore be used to advantage by carrying out interculture operations and formation of ridges, toward off the ill effects of excessive drainage. Fertilizer top dressing needs to be done when the soil is sufficiently moist and this period (July 16-21) is ideal.

Utilisation of excess rainfall occurring in July

Research at the Institute has shown that excess rain water received during early July and August can be harvested and later used as a life saving irrigation at times when prolonged dry spells occur.

Plant protection

Probability of prolonged dry spell duration increases towards the end of August and throughout September, as can be seen from Table 3. Spraying against boll worm complex, which does require dry period for maximum effectiveness, can therefore be taken up during this period quite safely.

Harvesting

From Table 1, it can be inferred that the 80 to 90 percentage points of end of rains occur towards the end of October. If the crop has been sown at the normal date, i.e., 3rd decade of June / 1st decade of July and is short duration variety/ hybrid, then the boll bursting and 1st picking are expected to occur by the 1st decade of November, more or less coinciding with the end of the rains as determined above and the harvest is expected to be good.

Suggestions for dry sowing, in the light of the findings of the rainfall analysis

The rainfall analysis has shown (Table 3) that prolonged dry spells occur during the 2nd decade of September onwards. The normal sown crop will therefore experience severe water stress (deficit) during this critical period which corresponds to flowering and boll formation stages. From Table 2 it is seen that about 64 to 120 mm of rain can be expected during the 2nd decade of June corresponding to the 75th percentage point. By taking up sowing around June 15, the critical period of water stress can be overcome.

Suggestions to plant breeders

Varieties should be developed which have the ability to have a profuse but short fruiting time commencing in mid August and the life span does not extend beyond December, so that maximum utilization of rainfall is ensured.

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