Indian J. Met. Geophys. (1973), 24, 2, 153-158

551.588 : 551.577.38 : 63(548.2)

Climatic factors influencing agriculture in the low rainfall tract of Bellary in Mysore State

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(Received 20 April 1970)

ABSTRACT. The general climatic features of Bellary based mainly on the data recorded at the Soil Conservation Research Farm for the period 1956-69 are presented. The short period rainfall data of the farm is compared with 100-year rainfall record of the Bellary Observatory regarding amounts, distribution and monthly probabilities of occurrence of rain of specific amount.

1. Introduction

Bellary in Mysore State lies in the low rainfall zone receiving less than 750 mm of rainfall. Though the Bellary area is situated within the influence of both monsoons, most of the annual rainfall is contributed by the northeast monsoon. The frequent failure of rains render it a problem area. Bellary is reported to have experienced severe famines in 1824, 1833, 1854, 1866-67, 1876-78, 1891-92, 1896-97, 1921 and 1923 and Subramaniam (1964) has observed a minimum of four drought years of varying intensities in a normal decade.

An attempt is made in this paper to discuss the characteristics and variations in rainfall with reference to the sowing of crops in the tract.

2. Climatic features

Average values of various meteorological parameters like temperature, low level (10 ft) wind, sunshine, evaporation, maximum daily rainfall and maximum hourly intensity, based on the data recorded at the meteorological observatory at the Soil Conservation Research Farm, Sreedharagadda (9 km north of Bellary) for the period 1956-59, are given in Table 1.

Short period data of many meteorological parameters can be averaged to represent climate of a place; however, for rainfall, because of large inter and intra-annual variations, a long series data is required for meaningful studies. Therefore, for the estimate of variability, the longer series data of the Bellary Meteorological Observatory has been used. The percentage of variability estimated after the method of Logan (1957) using the semi-intra-quartile deviation from the median expressed as a percentage, is given in Table 1.

Comparison of farm and observatory rainfall series

It is generally recognised that a month is too long a period to analyse, study and understand the features of distribution of rainfall, especially for agricultural purposes under rainfed conditions. Weekly rainfall data was readily available for the farm rainfall series. Before analysing this, it was decided to compare the same with the long series observatory data regarding fluctuations in annual rainfall, distribution and probabilities of occurrence of given amount of rainfall in a month. The following procedure was adopted.

(a) *Fluctuations in annual rainfall* — The two usual methods of obtaining the central tendency of a series of rainfall recordings are : (*i*) arithmetic mean, and (*ii*) median. Church *et al.* (1941) after critically going through both the methods, recommended the median to represent the true central tendency, while Foster (1949) suggested the use of mean as more desirable for statistical soundness. The comparative figures of mean and median rainfall both for the farm data and the Bellary Observatory data, adopting the method given by Elhance (1958) are presented in Table 2. Though the farm data do not show much difference between the mean and the median, the 100-year record for Bellary has a difference of 78·5 mm between the mean and the median being 507·9 and 429·4 mm respectively. Obviously, the wet and dry spells during the short period of observations (1956-69) at the research farm has affected the annual mean and median values as compared to the long period of records for the observatory station. The extreme fluctuations of the long series rainfall data for the 100-year period (1870-1969) about the mean and the median are illustrated in Fig. 1.

TABLE 1

Summary of meteorological observations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)												
Mean Max. (a)	30·1	33·4	36·3	38·2	38·0	34·3	32·2	32·3	32·1	31·8	30·2	29·1
Mean Min. (b)	15·7	17·5	21·1	23·7	24·2	23·3	22·6	22·2	21·8	20·9	18·1	16·1
[(a) + (b)]/2	22·9	25·4	28·7	31·0	31·2	28·1	27·4	27·2	26·9	26·3	24·0	22·6
Rainfall (mm)												
Per cent variability *	50·5	50·0	50·4	60·3	52·1	61·0	60·6	70·1	44·2	48·9	77·7	49·6
Max. (mm) in 24-hrs	14·4	1·0	28·5	34·4	60·0	72·0	57·5	81·0	61·0	96·4	130·0	48·0
Date of record.	26,1966	24,1968	25,1968	15,1962	30,1968	16,1967	7,1966	6,1958	13,1964	27,1961	30,1966	4,1962
Max. Inten./hr	56·9	Negligible	73·9	62·0	104·0	94·0	74·0	115·8	120·0	117·9	80·0	81·3
Date of record.	26, 1966	—	25, 1968	15, 1962	30, 1968	16, 1967	7, 1966	6, 1958	17, 1966	27, 1961	30, 1966	4,1962
Wind												
Mean velocity (kmph)	8·0	8·3	9·3	10·0	14·4	20·3	23·3	21·6	16·8	9·1	8·4	7·5
Evaporation												
Mean pan evaporation (mm)/day	6·5	9·0	11·5	11·9	12·5	11·0	8·8	9·0	8·4	6·9	5·9	5·5
Radiation												
Mean sunshine hr/day	9·9	10·6	10·2	9·6	9·5	7·2	4·7	5·8	6·6	7·9	8·4	9·0

*100-year Bellary data (1870-1969): Semi interquartile deviation from the median

TABLE 2

Comparative figures of mean and median rainfall (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean													
(a)	2·2	0·1	5·0	20·8	55·5	65·0	53·0	50·7	112·5	104·5	38·7	13·9	521·9
(b)	1·8	2·8	4·2	21·0	50·3	47·6	44·4	60·1	118·4	108·5	42·1	6·7	507·9
Median													
(a)	6·4	5·4	7·0	17·5	42·5	78·1	43·8	54·2	115·0	95·8	37·5	7·5	510·7
(b)	5·5	5·4	5·9	16·6	42·1	38·5	31·7	42·8	110·6	101·0	23·4	5·9	429·4

(a) Research Farm data (1956-1969)

(b) 100-year Bellary data (1870-1969)

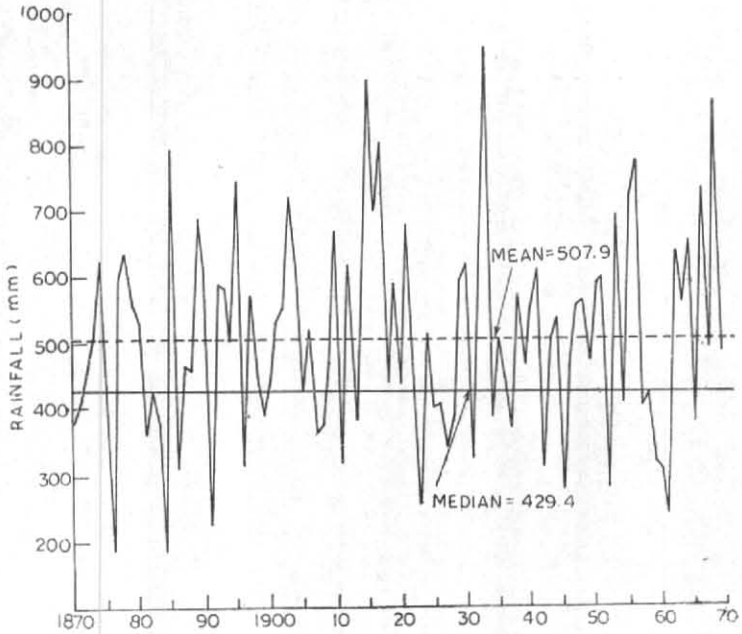

Fig. 1

Annual march of rainfall at Bellary (Mysore)

(b) *Distribution and variability*--The two months September and October account for nearly 50 per cent of the annual median rainfall while the five-month period from December to April receives only 9 per cent of the annual rains. There is a wide variation in the monthly rainfall and the recorded maximum and minimum for the different months are presented in Table 3. The percentage variability of rainfall (as given in Table 1) is observed to be lowest for September (44·2 per cent) and highest for November (77·7 per cent).

(c) *Monthly and weekly probabilities* — The expectancies of receiving monthly and weekly rainfalls of certain specified amounts have been compiled from the frequency distribution following the method adopted by Hounam (1950). The arbitrarily selected threshold figures used for monthly rainfall are 10, 25, 50, 75, 100 and 150 mm while the corresponding figures for weekly purpose are 10, 20, 30 and 40 mm only. Observatory data of 100 years and the research farm data have been respectively used for the monthly and weekly purposes. The number of years or weeks when the rainfall is greater than or equal to the indicated amount was listed out and the per cent chance of recording that amount of rainfall was arrived at by dividing this number by the number of years or weeks for which the data are available.

The monthly rainfall probabilities thus worked out for the research farm as well as the 100 years Bellary figures are presented in Table 4. The differences between the two are seen to be small for all amounts in September and October; in August and also in July, except for amounts greater than 100 mm, the values are comparable.

To pin-point the week or the period when an assured rainfall would be received, the rainfall figures of the research farm were analysed for weekly probabilities as mentioned above. These are presented in Table 5. It is seen that the probability of receiving an assured rainfall, not more than 40 mm, is highest in the meteorological weeks 38 and 39 corresponding to the period from September 17 to 30.

(d) *Dry periods and their occurrence* — An analysis of the extent of dry periods and the frequency of their occurrence has been made using the short term research farm data adopting the diagrammatic form followed by Lynch (1964) and Daniel (1967) based on the criterion used by Fitzpatrick (1953), *viz.*, " a dry period as the number of at least 15 consecutive days during which either no rainfall was recorded or less than 6 mm have been recorded over two consecutive days" and the data obtained are diagrammatically presented in Fig. 2. In the lower portion, the dry periods in each year have been left blank and the wet periods have been shaded and the upper portion depicts the frequency of occurrence of a dry period on selected dates. For example 24 January falls in a dry period in 100

TABLE 3

Maximum and minimum monthly and annual rainfall (mm) with year of occurrence

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual rainfall
						Maximum							
(a)	17·3 (1966)	1·0 (1968)	30·5 (1958)	53·7 (1963)	128·3 (1962)	111·7 (1968)	164·8 (1966)	138·2 (1958)	273·8 (1960)	269·7 (1956)	160·6 (1966)	117·0 (1962)	717·0 (1962)
(b)	36·8 (1884)	90·4 (1917)	50·3 (1915)	85·9 (1907)	210·6 (1940)	172·5 (1887)	223·5 (1916)	284·2 (1938)	384·7 (1968)	403·9 (1921)	225·0 (1936)	167·0 (1962)	949·6 (1933)
						Minimum							
(a)	0 *	0 *	0 *	0 (1965) (1966)	2·3 (1964)	5·0 (1958)	6·1 (1963)	5·2 (1960)	4·0 (1961)	0 (1965)	0 (1963)	0 *	334·0 (1961)
(b)	0 *	0 *	0 *	0 *	0 (1953)	0 *	0 (1876)	0 *	0 (1961)	0 (1876) (1965)	0 *	0 *	183·7 (1876)

Note : Years of occurrence are indicated within brackets (a) Research farm data (b) 100-year Bellary data

* 0·0 mm rainfall was recorded in more than 4 years. Hence the year of occurrence has not been given

TABLE 4

Monthly rainfall probability

(Percentage chance of receiving the specified amount or more)

Rainfall amount (mm)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	(a)	15·4	0	23·1	61·5	92·3	85·7	92·9	92·9	92·9	92·9	64·3	28·6
	(b)	7·0	7·0	14·0	67·0	95·0	84·0	86·0	87·0	96·0	96·0	70·0	15·0
25	(a)	0	0	0·8	30·8	76·8	78·6	78·6	57·1	92·9	85·7	50·0	14·3
	(b)	2·0	4·0	6·0	31·0	73·0	64·0	56·0	61·0	92·0	88·0	47·0	7·0
50	(a)	0	0	0	15·4	38·5	71·4	35·7	50·0	71·4	64·4	42·9	0·7
	(b)	0	1·0	1·0	12·0	39·0	40·0	28·0	43·0	80·0	76·0	33·0	4·0
75	(a)	0	0	0	0	30·8	50·0	22·2	28·6	64·4	64·4	0·7	0·7
	(b)	0	1·0	0	3·0	19·0	22·0	20·0	32·0	69·0	61·0	20·0	2·0
100	(a)	0	0	0	0	15·4	22·2	0·7	0·7	57·1	42·9	0·7	0·7
	(b)	0	0	0	0	8·0	13·0	10·0	23·0	55·0	50·0	12·0	1·0
150	(a)	0	0	0	0	0	0	0·7	0	22·2	22·2	0·7	0
	(b)	0	0	0	0	3·0	1·0	3·0	7·0	29·0	26·0	7·0	1·0

(a) Research Farm record (b) 100-year Bellary record

TABLE 5

Weekly rainfall probability

(Percentage chance of receiving the specified amount or more)

Met. week No.	Week ending	Rainfall amount (mm)				Met. week No.	Week ending	Rainfall amount (mm)			
		10	20	30	40			10	20	30	40
1	Jan 7	0	0	0	0	27	Jul 8	35·7	21·4	14·3	7·1
2	14	7·7	0	0	0	28	15	35·7	14·3	7·1	7·1
3	21	0	0	0	0	29	22	50·0	21·4	14·3	0
4	28	7·7	0	0	0	30	29	64·3	35·7	28·6	7·1
5	Feb 4	0	0	0	0	31	Aug 5	14·3	7·1	7·1	0
6	11	0	0	0	0	32	12	28·6	21·4	14·3	14·3
7	18	0	0	0	0	33	19	42·9	28·6	0	0
8	25	0	0	0	0	34	26	14·3	14·3	7·1	0
9	Mar 4	0	0	0	0	35	Sep 2	42·9	28·6	21·4	21·4
10	11	0	0	0	0	36	9	28·6	14·3	14·3	0
11	18	7·7	7·7	0	0	37	16	28·6	14·3	7·1	7·1
12	25	7·7	7·7	7·7	0	38	23	78·6	71·4	57·1	50·0
13	Apr 1	7·7	0	0	0	39	30	57·1	50·0	35·7	35·7
14	8	0	0	0	0	40	Oct 7	64·3	35·7	21·4	21·4
15	15	23·1	15·4	15·4	15·4	41	14	42·9	35·7	28·6	21·4
16	22	23·1	7·7	0	0	42	21	35·7	28·6	21·4	21·4
17	29	38·5	7·7	0	0	43	28	35·7	35·7	35·7	35·7
18	May 6	15·4	15·4	15·4	15·4	44	Nov 4	28·6	14·3	0	0
19	13	23·1	7·7	7·7	7·7	45	11	50·0	28·6	21·4	14·3
20	20	38·5	23·1	7·7	0	46	18	7·1	7·1	7·1	7·1
21	27	38·5	30·8	7·7	7·7	47	25	7·1	7·1	7·1	7·1
22	Jun 3	38·5	38·5	23·1	15·4	48	Dec 2	14·3	7·1	7·1	7·1
23	10	42·9	28·6	21·4	14·3	49	9	14·3	7·1	7·1	7·1
24	17	50·0	21·4	14·3	14·3	50	16	14·3	7·1	0	0
25	24	21·4	21·4	14·3	14·3	51	23	7·1	0	0	0
26	Jul 1	28·6	14·3	7·1	7·1	52	31	0	0	0	0

per cent of years, while 6 September has fallen in a dry period in 54 per cent chances only.

3. Effect of climate on cropping

Bellary taluk has black clayey soils and light textured red soils in the proportion of 80 and 20 respectively (Anonymous 1949). Dryland farming in the black soils in the *kharif* season does not have a chance to be successful due to lack of assured rainfall and high evaporation. Similarly dry farming in the red soils in the *rabi* season is not possible due to poor retention of moisture by soil and receding rains.

(a) *Probable sowing periods for red soils* — From Table 5 and Fig. 2, it can be seen that the period around 3 June has a probability of receiving greater than or equal to 20 mm of rainfall in 38·5 per cent of years and the dry period occurrence is also the least, being about 22 per cent only. Crops sown around this period will have to tide over low rainfall (10 mm per week) period upto 22 July when the rainfall greater or equal to 20 mm is again probable

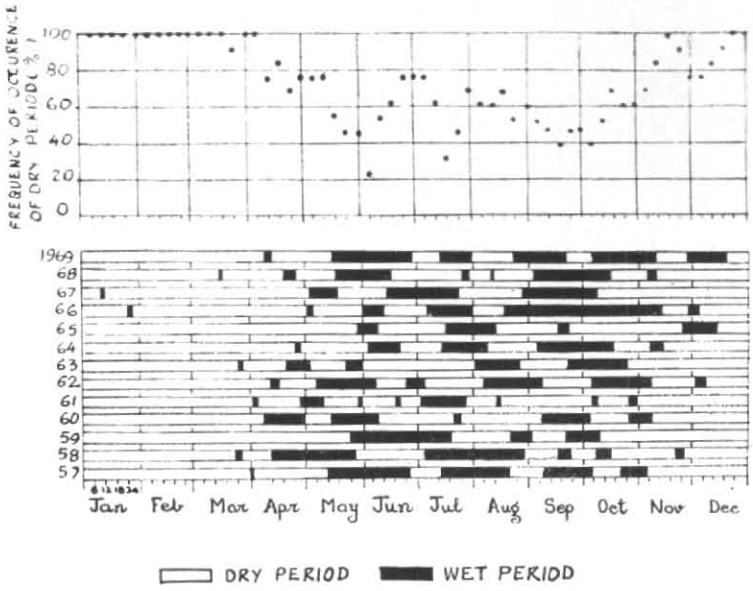

Fig. 2

Extent of dry periods and frequency of occurrence on selected data

in about 35 per cent of years. Alternatively, the period around 29 July is suitable for sowings, which have a follow up of better and assured rainfall.

(b) *Probable sowing periods for black soils* — The rainfall greater than or equal to 20 mm per week in the period from 16 to 30 September is almost assured being 71 and 50 per cent and hence this period as well as a few days ahead of it are most suitable for sowing the *rabi* crops in the black soils. Crops sown prior to this period, in years when such sowing is possible, would be most successful receiving assured rainfall between 16 to 30 September.

4. Concluding remarks

The months of September and October record reliable rainfall and the meteorological weeks 38 and 39 receive almost assured rainfall. While dryland farming in red soils is possible with certain amount of risk during the *kharif* season, there is a least chance of *kharif* cropping being successful in the black cotton soils. Based on the weekly rainfall probability and the dry periods, the suggested dates for sowing for successful crop production are around 3 June and 29 July for the red soils and second fortnight of September for black cotton soils.

Acknowledgement

The authors are thankful to the Director of Agricultural Meteorology, Poona for supplying part of the rainfall data and to Shri B. Ayyappa, Observer, and Shri B. S. Thippannavar, Junior Scientific Assistant for assisting in compilation of the data.

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