Journal of Agrometeorology 7 (2) : 284 - 290 (Dec 2005)

Rainfall variability and crop planning in Sabour region of Bihar

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ABSTRACT

The daily rainfall data for 29 years (1972-2000) recorded at Bihar Agriculture College, Sabour, (Bihar) were analysed for mean, annual, seasonal, monthly and weekly periods. Markov Chain probabilities (> = 20 mm rainfall / week) were also worked out. Fourteen years received above average rainfall with 41 percent chance of getting more than normal rainfall .The mean sowing rains commence around 20th June. Initial probabilities of receiving 20 mm are more than 70 percent from 26th to 34th standard meteorological week in kharif. Results indicate the rabi season rainfall to be more suitable for crops like rabi maize, oil seed or pulses.

Key words: Rainfall annual, monthly rainfall, weekly rainfall, weekly probability, trend analysis and variability

Crop productivity has increased in past four decades. The reason being use of improved seeds, fertilizers and sustainable agrotechniques. For maintaining food production in line with increasing population our agricultural research should integrate with the long-term technical policies (Parasuraman, P. 2003). Rainfall distribution varies greatly over time and space. Its analysis over a number of years helps in crop planning. This random nature of rainfall occurrence suggests need for sound statistical analysis and logical interpretation (Pimale *et al.*2001). Rainfall studies, particularly its probability analyses, are of great help in crop management practices, contingent crop planning, plant protection measures and related farm operations for sustaining crop production in the area. Sivakumar *et. al.* (1991) analysed data from Nandyal (Andhra Pradesh) and reported that rainfall from July to end of September is more assured and dependable. They also estimated trend by time series analysis. Gaikwad *et al* (1996) analysed rainfall data (1963-1992) for Solapur and showed that medium to long duration dry spells are of common occurrence during kharif season. Patil and Kale (1988) analysed rainfall data up to 1984 for Solapur and showed that rainfall is bi-model; i.e. first peak is observed in June and second in September. The rains at this time are relatively more assured. Deka *et al* (2000) analysed rainfall data for Assam and showed that this region received about 83.9 percent of annual rainfall during southwest monsoon months of June to September. Markov chain probability model is more suitable for studying the

long-term frequencies of wet and dry weather spell occurrences (Victor and Sastry 1979, Subudhi, *et al.*1996). Pandarinath, N. (1991) used the Markov chain model to identify the probability of dry and wet spell occurrences on short period basis (weekly). Rainfall probability is < 50 percent from 34th to 37th SMW indicating chances of dry spell during *kharif* season and conditional probabilities (W/D) exceeding 80 percent in standard meteorological weeks 29th showed suitability of 28th standard meteorological week for dry seeding according to Gare *et al* (2000).

Monsoon generally arrives at Sabour by 25th week. However, the earliest and latest week of start of monsoon rainfall are 23rd and 32nd weeks. The mean week of withdrawal of monsoon from Sabour is 43rd week, while the earliest and latest week of cessation of monsoon rains are 38th and 52nd week respectively. Mean duration of rainy season is 18 weeks.

MATERIALS AND METHODS

The daily rainfall data of 29 years (1972 to 2000) from the meteorological observatory of Bihar agriculture College, Sabour (Bihar) located at latitude 25°14'N, longitude 86°57'E and 49 m above mean sea level were used for analysis on probability and variability of rainfall. From the daily rainfall data annual, seasonal, monthly and weekly total rainfalls were worked out for each year following Deka *et al* (2000). Standard deviation, coefficients of variability of weekly rainfall were work out. Rainfall probability analysis was based on first order Markov chain as suggested by Virmani *et al*., (1980), Virmani *et al* (1982) and Pandarinath (1991). In this study a week is considered as dry when the rainfall is less than 20 mm.

RESULTS AND DISCUSSION

The seasonal rainfall of different years and its coefficient of variation is presented in Table1. The coefficient of variation of the seasonal rainfall indicates that in *rabi* season the rainfall was not dependable for growing any rainfed crops in this region. Rainfall above 100 mm / month may be expected from June to September. The mean annual rainfall is 1193.5 mm, of which 81 percent (966.7 mm) is received during June to September (Southwest monsoon) and 7 percent (83.5 mm) from October-November. Pre monsoon rainfall recorded in May considered useful for land preparation contributes 6 percent to the annual rainfall. The annual rainfall (Table 1) ranged from 721.1 mm (1972) to 1994. 6 mm (1999) with a mean of 1193.5 mm (CV = 27 percent). Out of 29 years, fourteen years (48 percent) recorded above average annual rainfall and in 52 percent of the years, below average rainfall.

The monthly rainfall of 318.3 mm is the highest in the month of July and 7.2 mm received in the month of December is the lowest (Table 1). The highest monthly rainfall ranges between 40.2 to 962.6 mm and the lowest, between 0 to 77.6 mm. Rainfall received from July to September has less coefficient of variation (39-62

Table 1: Mean monthly rainfall and other statistics at Sabour, Bhagalpur district

Monthly	Mean rainfall (mm)	Extremes		CV (%)	Percent of Annual rainfall
		Highest rainfall (mm)	Lowest rainfall (mm)		
January	14.8	55.3	0	112.1	1.2
February	12.7	40.2	0	101.4	1.1
March	10.9	66.4	0	134.1	0.9
April	19.5	95.2	0	127.6	1.6
May	76.3	282.6	0	81.8	6.4
June	184.9	598.2	2.0	66.3	15.5
July	318.3	536.9	57.8	39.1	26.7
August	262.7	926.6	77.6	58.3	22.0
September	197.6	530.3	42.7	62.5	16.6
October	78.3	362.9	0	123.6	6.6
November	10.2	116.2	0	229.0	0.9
December	7.2	50.5	0	198.3	0.6

percent) as compared to the rest of the months (Table 1). Weekly rainfall variability was relatively less with coefficient of variation of 83.3 to 95 percent in standard meteorological weeks from 32nd to 35th during *kharif* season (Table 2). Sowing of *kharif* crops are, therefore, undertaken during this period. The rabi crop could be sown in standard meteorological week of 37th as the variation in weekly rainfall is less (CV 89 %) at this time. From the above it is inferred that kharif (June to September) is the only season for growing a successful rainfed crop in the area. Mean rainfall of different weeks, its extremes and coefficient of variation have also been worked out (Table 2). It is observed that the quantum of rainfall received during 24th to 38th standard meteorological week were sufficient to sustain any kharif crop within that period. But the coefficient of variation values depict that rainfall in 25th to 29th standard meteorological week was dependable. The highest values of weekly rainfall show that there was always some amount of rainfall in 25th to 29th standard meteorological week. It is also seen that an average rainfall of 76.3 mm is received during 31st standard meteorological week. Thus the 31st and 32nd standard meteorological week are the critical weeks for the reproductive phase of the *kharif* crops.

Initial and conditional probability of receiving >20 mm rainfall per week is presented in Table 3. Initial rainfall probabilities are absolute probabilities and the conditional probabilities depend upon a previous week to be dry or wet. These probabilities indicate that more than 75 percent probability could be expected from standard meteorological week 26th to 28th

Table 2: Mean weekly rainfall and other statistics at Sabour

Week No.	Mean rainfall (mm)	CV (%)	Highest rainfall (mm)	Week No.	Mean rainfall (mm)	CV (%)	Highest rainfall (mm)
1	1.1	264	7.8	27	79.0	98	243.5
2	3.4	298	49.6	28	82.2	90	322.9
3	5.1	227	41.3	29	51.1	90	231.1
4	3.0	311	44.6	30	72.2	100	363.2
5	3.8	167	19.6	31	76.3	144	585.7
6	2.8	175	18.6	32	50.3	87	140.8
7	4.0	177	27.8	33	53.7	95	206.2
8	2.9	187	22.0	34	74.0	87	206.4
9	3.5	167	19.2	35	38.3	83	122.5
10	2.0	201	14.2	36	43.1	109	235.6
11	1.3	323	21.8	37	51.6	89	135.3
12	2.8	170	15.5	38	44.8	181	407.6
13	3.6	199	26.0	39	48.2	117	256.9
14	0.6	301	7.6	40	34.1	142	167.8
15	3.1	226	26.6	41	25.8	140	128.7
16	4.7	325	80.0	42	17.4	240	175.3
17	10.2	166	65.4	43	3.0	349	56.4
18	11.4	159	76.6	44	4.6	246	44.7
19	14.8	145	7.2	45	4.8	454	116.2
20	20.7	193	16.4	46	0.5	301	5.2
21	20.1	115	79.6	47	0.6	485	14.9
22	20.9	159	131	48	1.6	288	20.6
23	29.7	138	176.3	49	0.0	00	0.0
24	39.2	114	160.3	50	2.9	360	48.4
25	39.9	89	115.6	51	0.6	321	7.4
26	78.4	86	271.8	52	4.6	268	47.7

and 30th during *Kharif*. Similarly > 65 percent initial probability of rains is expected during standard meteorological week 28th to 31st in *kharif* season. Rainfall probability is < 50 percent during 38th and 40th to 43rd standard meteorological week, which indicates the chance of dry spell during this period at Sabour to be high.

Conditional probabilities (W/W) exceeding 75 percent (> = 20 mm rainfall week) are observed in standard meteorological week 24th, 26th and 29th to 33rd in *kharif* while conditional probabilities (W/D) exceeding 80 percent are expected in 26th to 27th standard meteorological week, which shows the suitability of 26th standard

Table 3: Weekly Markov chain probabilities (20 mm) at Sabour

Weeks	P (W)	P (D)	P (W / W)	P (D / W)	P (D / D)	P (W / D)
1	0	100	0	100	100	0
2	7	93	0	0	93	7
3	17	83	0	100	81	19
4	7	93	0	100	92	8
5	0	100	0	100	100	0
6	0	100	0	0	100	0
7	3	97	0	0	97	3
8	3	97	0	100	96	4
9	0	100	0	100	100	0
10	0	100	0	0	100	0
11	3	97	0	0	97	3
12	0	100	0	100	100	0
13	7	93	0	0	93	7
14	0	100	0	100	100	0
15	7	93	0	0	93	7
16	7	93	0	100	93	7
17	21	79	0	100	78	22
18	28	72	33	67	74	26
19	24	76	38	63	81	19
20	3	79	43	57	86	14
21	41	59	67	33	65	35
22	31	69	42	58	76	24
23	34	66	44	56	70	30
24	52	48	80	20	63	37
25	59	41	67	33	50	50
26	79	21	76	24	17	83
27	79	21	74	26	0	100
28	76	24	74	26	17	83
29	72	28	77	23	43	57
30	83	17	86	14	25	75
31	69	31	75	25	60	40
32	72	28	80	20	44	56
33	76	24	76	24	25	75
34	72	28	68	32	14	86
35	66	34	71	29	50	50
36	59	41	63	37	50	50
37	69	31	71	29	33	67
38	48	52	40	60	33	67
39	66	34	57	43	27	73
40	38	62	42	58	70	30
41	38	62	36	64	61	39
42	17	83	36	64	94	6
43	3	97	0	100	96	4

meteorological week for dry seeding in Sabour area of Bhagalpur district.

The probability of occurrence of dry week is high (59 to 100 percent) in 1st to 23rd week (Table 3) and from the 40th to 52nd week (62 to 100 percent). The conditional probability of dry week preceded by a dry week is also high upto 24th week and from 40th to 52nd week.

Crop planning

The major crop of the region is paddy in kharif season, which is of about 120-125 days duration. Lowland of the region is characterised by better moisture holding capacity and fertility. The crop planning of this area can be done at 50 percent probability level as early sowing of paddy crop for nursery in 24th and 25th week for better germination. The transplanting of paddy crop should be completed by July. Paddy varieties Tulsi and the local mature by the end of September and can be safely harvested at the end of October or 1st week of November. There is scope for water harvesting in on farm reservoir during 25th to 34th week. To make use of residual moisture, direct sowing of *rabi* crop immediately after the harvest of kharif crop could be tried upon. However, the rainfall received is considered sufficient to sustain healthy crops of maize, oil seed and pulses in place of paddy.

ACKNOWLEDGEMENT

The authors are grateful to Drs. Y.S.Ramakrishna, G.G.S.N.Rao, U.S.Victor, N.N.Srivastava and P.Vijaya Kumar, CRIDA, Hyderabad for their valuable encouragement and guidance. The author is grateful thanks to Dr. S.D.Lal who has provided to me Agrometeorological data of B.A.C., Sabour

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