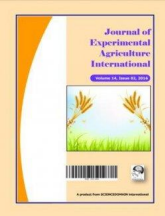

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Distribution of Weekly Rainfall and Probability Analysis for Crop Planning in Bastar Region of Chhattisgarh

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Authors' contributions

This work was carried out in collaboration between all authors. Author AP designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Authors SKN and AS managed the analyses of the study. Author SCM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Daily rainfall data of 10 years (2004-2013) of Bastar were used for weekly analysis to study the rainfall distribution and the probability of occurrence. The CV was less than 20 per cent from 10th to 22nd standard week, indicated that the rainfall is consistent during this period. The above rainfall analysis showed that the crops could be recommended under rainfed condition between 22nd to 35th standard weeks as the rainfall is more consistent during this period as compared to 36th to 52nd and 10th to 21st standard weeks for summer ploughing, which fall under Southwest monsoon. The moisture requirement of crops could be met from 26th to 38th standard week as these weeks has the probability of 50 per cent for getting 20 mm of weekly rainfall. The analysis revealed that the drought-resistant finger millet, kodo millet, niger, horsegram and drought escaping little millet can be grown. Maize may be grown with supplemental irrigation of one or two to get the best yield out of available soil moisture as rainfed farming. Drought resistant short duration pulses and oilseeds can be grown within the growing period from 39th to 46th standard weeks.

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Keywords: Rainfall variation; conditional probability; initial probability; crop planning.

1. INTRODUCTION

The kharif crops represent the main livelihood securiting foods based on rainfall (rainfed agriculture). Rainfed agriculture is the most practiced activity in rural areas, while irrigated agriculture is negligible in this region [10]. The mean average rainfall 1404 mm per annum which divides in four parts *i.e.* south western monsoon (June to September), Northeast monsoon (October to December), winter (January to March) and Summer (April to May) are 1121.5, 114.8, 45.3 and 124.8 mm, respectively with normal rainy days 55, 7, 4 and 9 in respect to dividend periods of seasons. The normal onset of monsoon is 10 June and normal cessation in 15 September. The soil is predominantly light soil, which is suitable for cultivation of upland rice, small millets, short duration pulses but it also has red loamy soil in lowland farming. In agricultural planning, rainfall distribution helps to take decisions on times of sowing, weed management, fertilizer application etc. Many researchers have reported the advantages of working out weekly rainfall probabilities for the region or an agroclimatic zone [15,8] n crop planning. Probability analysis can be used for predicting the occurrence of future events of rainfall from the available data with the help of statistical methods [7]. [1] attempted to study the variability of annual and seasonal rainfall and its probability and suggested suitable cropping pattern for Tamil Nadu. [11] have suggested the use of weekly rainfall data to predict the occurrence of rainy events and its amount for crop planning in Kota. The initial and conditional probability approach would be relatively effective method for rainfall analysis, especially in the regions where rainfall is erratic or where short dry periods likely to be expected within the wet season. It was suggested that the rainfall at 80 per cent probability can safely be taken as assured rainfall, while that of 50 per cent probability is the medium limit for taking risk of no rainfall [2,3,4]. The probability of rainfall under rainfed situation caters the business of either complete failure or success because rainfed agriculture is gamble of monsoon. This distribution pattern of rainfall is very erratic which influences the crops of the region that is why the study was undertaken to know the weekly variation and trend of distribution for crop planning.

2. MATERIALS AND METHODOLOGY

Jagdalpur is situated in the southern part of Chhattisgarh under Eastern plateau and hills region (VII) and positioned at 19°08 N latitude and 82°03 E longitude with an elevation of 553 m above mean sea level. Bastar is located in southern part of Chhattisgarh states, bordering Odissa state in east, Dantewada district in west site. The daily rainfall data from 2004-2013 (10 years) were collected from S.G. College of Agriculture & Research Station, Jagdalpur. The daily rainfall was aggregated into weekly and these primary data were used for analysis in predicting rainfall concerned events. Two types of probabilities *viz.*, Initial and Conditional probability indices were used for the study.

2.1 Initial Probability Index (IPI)

The initial probability analysis was taken up to find out the amount of rainfall anticipated at 70 per cent, 50 per cent and 25 per cent probability level. For computing initial probability, the time series rainfall data were arranged in descending order. Initial probability was worked out by using the simple formula [9] and [16].

$$IPI = \frac{N * P}{100}$$

Where,

IPI = Initial probability Index;
N = Sample size and
P = Probability required.

2.2 Conditional Probability Index

Conditional probability is useful in predicting the receipt of a particular quantity of rainfall for specific agricultural operations. Conditional probability is worked out from the following formula [9] and [16].

$$CPI = \frac{X - x}{100}$$

Where,

CPI = Conditional Probability Index;
x = Required rainfall; *X*= Mean rainfall;

SD = Standard deviation. Since the resultant value does not fall under normal distribution, it has to be referred to 'Z' table and multiplied by 100 to find out the actual probability in

percentage. Two riders are to be considered. (*i*) If the resultant value of the formula given above is positive, the corresponding value may be referred to 'Z' table and multiplied by 100. This gives conditional probability in percentage. (*ii*) If the resultant value is negative, the corresponding 'Z' table value is deducted from unity (1) and multiplied by 100. This gives the conditional probability in percentage.

Weekly rainfall of 10 and 20 mm was considered as thresholds, as they have to carry out agricultural farm operations like sowing, fertilizer application, weeding etc. under rainfed condition.

3. RESULTS AND DISCUSSION

3.1 Rainfall Variability

The highest mean weekly rainfall (35.49 mm) was received during 31st standard week (Table 1). The CV was less than 20 per cent from 10th to 22nd standard week, indicated that the rainfall is consistent during this period (Fig. 1). This was also observed during 36th to 52nd standard week but the quantity of rainfall received during the above period is not sufficient to support the rainfed rice, small millets and pulses. The above rainfall analysis showed that the crop could be recommended under rainfed condition between 22nd to 35th standard weeks as the rainfall is more consistent during this period as compared to 36th to 52nd standard weeks for summer ploughing, which fall under South west monsoon. Rakhecha and Pisharoty [12] have studied the heavy rainfall events during the south-west monsoon season for some selected stations over the country [5,12]. Rakhecha and Soman, [13] reported that the annual extreme rainfall records of mostly are free from trend and persistence [13].

The Author has given a statement that, the rainfall is more consistent between 22nd to 35th standard weeks as compared to 36th to 52nd and 10th to 21st standard weeks for summer ploughing, which fall under South west monsoon which is contradictory to the statement mentioned in the paragraph No. 1 under results sub head 3.1., wherein he has mentioned that, the rainfall during 10th to 22nd standard week, and 36th to 52nd standard week was more consistent with CV < 20%.

3.2 Initial Probability Index

The initial probability index for weekly rainfall was analyzed which indicated that more than 20 mm of rainfall could be expected from 27th, 30th, 31st, 32nd, and 35th standard weeks under 25% probability index, which showed about soil moisture would support to low water demanding crops (Fig. 2), whereas 50% initial probability index was observed under 27th and 31st standard week with more than 20 mm rainfall over rest of standard week along with CV of 55.52 and 58.09% for these two standard weeks. The expected rainfall of more than 20 mm did not observe in any standard weeks from the mentioned weeks (Table 1) in 75% initial probability index as analyzed the standard week rainfall. Under rainfed agriculture much more risk is there if probability of rainfall lying below 50 per cent. Among the 25, 50 and 75% probability index was analyzed but only 25% of chance to expect more than 20 mm rainfall under limited standard weeks as compared to 50% and 75% which was comparatively lower than 25%.

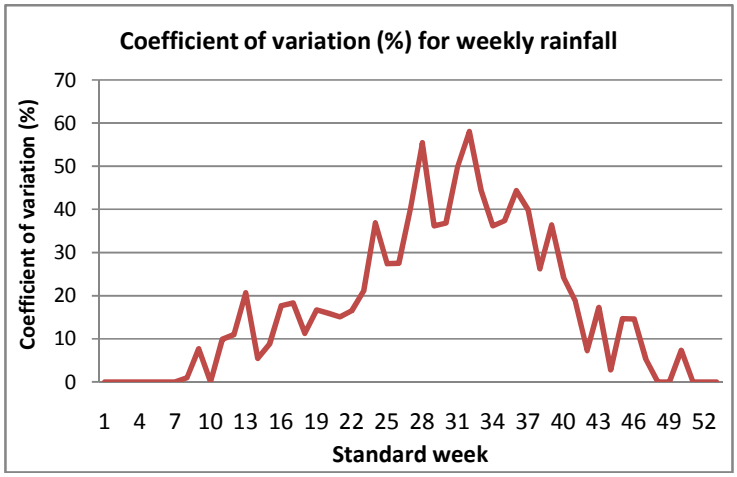

Fig. 1. Co-efficient of variation (%) for weekly rainfall over Bastar

Table 1. Initial probability index for weekly rainfall

Std. week	Period	Mean actual rainfall (mm)	CV%	Initial probability index		
				75%	50%	25%
1	1Jan-7Jan	0.0	0.00	0.00	0.00	0.00
2	8Jan-14 Jan	0.0	0.00	0.00	0.00	0.00
3	15 Jan-21 Jan	0.0	0.00	0.00	0.00	0.00
4	22 Jan-28 Jan	0.0	0.00	0.00	0.00	0.00
5	29 Jan-4 Feb	0.0	0.00	0.00	0.00	0.00
6	5 Feb - 11 Feb	0.0	0.00	0.00	0.00	0.00
7	12 Feb - 18 Feb	0.0	0.95	0.03	0.09	0.13
8	19 Feb - 25 Feb	3.6	7.71	0.19	0.50	0.75
9	26 Feb - 4 March	10.2	0.00	0.00	0.00	0.00
10	5 Mar - 11 Mar	10.6	9.83	0.28	0.76	1.14
11	12 Mar - 18 Mar	6.9	10.98	0.35	0.92	1.39
12	19 Mar - 25 Mar	2.0	20.68	1.15	3.07	4.61
13	26 Mar - 1 April	9.1	5.47	0.11	0.29	0.44
14	2 April - 8 April	0.5	8.78	0.23	0.62	0.93
15	9 April -15 April	8.8	17.68	0.85	2.26	3.40
16	16 April -22 April	11.4	18.33	0.91	2.43	3.64
17	23 April -29 April	16.1	11.22	0.36	0.96	1.44
18	30 April -6 May	26.2	16.68	0.76	2.03	3.04
19	7 May -13 May	16.2	15.92	0.69	1.85	2.78
20	14 May -20 May	6.3	15.09	0.63	1.67	2.51
21	21 May -27 May	6.6	16.48	0.74	1.98	2.97
22	28 May-3 June	20.2	21.07	1.19	3.18	4.77
23	4 June -10 June	39.5	36.90	3.60	9.59	14.39
24	11 June -17 June	58.5	27.39	2.00	5.33	7.99
25	18 June -24 June	57.0	27.52	2.02	5.37	8.06
26	25 June -1 July	85.2	40.31	4.29	11.43	17.15
27	2 July -8 July	44.7	55.52	8.11	21.62	32.43
28	9 July -15 July	89.5	36.22	3.47	9.25	13.87
29	16 July -22 July	62.6	36.84	3.59	9.56	14.35
30	23 July -29 July	35.6	49.93	6.56	17.50	26.25
31	30 July -5 Aug	61.6	58.09	8.87	23.66	35.49
32	6 Aug -12 Aug	57.6	44.43	5.20	13.87	20.81
33	13 Aug -19 Aug	56.9	36.23	3.47	9.25	13.88
34	20 Aug -26 Aug	17.1	37.40	3.70	9.86	14.78
35	27 Aug-2 Sep	127.3	44.38	5.19	13.84	20.76
36	3 Sep -9 Sep	16.6	39.92	4.21	11.22	16.83
37	10 Sep -16 Sep	111.2	26.24	1.83	4.89	7.34
38	17 Sep -23 Sep	17.6	36.39	3.50	9.34	14.00
39	24 Sep -30 Sep	81.4	24.17	1.56	4.16	6.25
40	1 Oct -7 Oct	62.1	18.68	0.95	2.52	3.78
41	8 Oct -14 Oct	49.5	7.24	0.17	0.45	0.67
42	15 Oct -21 Oct	22.4	17.27	0.81	2.17	3.25
43	22 Oct -28 Oct	1.9	2.77	0.05	0.14	0.20
44	29 Oct-4 Nov	3.0	14.69	0.60	1.59	2.38
45	5 Nov -11 Nov	2.0	14.62	0.59	1.58	2.36
46	12 Nov -18 Nov	1.3	5.25	0.10	0.27	0.41
47	19 Nov -25 Nov	0.0	0.00	0.02	0.06	0.08
48	26 Nov-2 Dec	0.0	0.00	0.00	0.00	0.00
49	3 Dec -9 Dec	3.0	7.37	0.17	0.46	0.69
50	10 Dec -16 Dec	1.0	0.00	0.01	0.04	0.06
51	17 Dec -23 Dec	0.0	0.00	0.00	0.00	0.00
52	24 Dec -31 Dec	0.0	0.00	0.00	0.00	0.00

Table 2. Conditional probability index for weekly rainfall

Week no.	Std. week	10 mm	20 mm
1	1Jan-7Jan	0.00	0.00
2	8Jan-14 Jan	0.00	0.00
3	15 Jan-21 Jan	0.00	0.00
4	22 Jan-28 Jan	0.00	0.00
5	29 Jan-4 Feb	0.00	0.00
6	5 Feb - 11 Feb	0.00	0.00
7	12 Feb - 18 Feb	0.40	0.70
8	19 Feb - 25 Feb	2.26	3.96
9	26 Feb - 4 March	0.00	0.00
10	**5 Mar - 11 Mar**	3.44	6.02
11	12 Mar - 18 Mar	4.20	7.35
12	19 Mar - 25 Mar	13.95	24.41
13	**26 Mar - 1 April**	1.32	2.31
14	2 April - 8 April	2.82	4.93
15	**9 April -15 April**	10.29	18.00
16	16 April -22 April	11.03	19.31
17	23 April -29 April	4.37	7.65
18	30 April -6 May	9.21	16.11
19	7 May -13 May	8.41	14.72
20	14 May -20 May	7.60	13.30
21	21 May -27 May	8.99	15.73
22	28 May-3 June	14.46	25.30
23	4 June -10 June	43.58	76.27
24	11 June -17 June	24.19	42.33
25	18 June -24 June	24.41	42.72
26	25 June -1 July	51.93	90.89
27	2 July -8 July	98.20	98.04
28	9 July -15 July	42.00	73.50
29	16 July -22 July	43.44	76.02
30	23 July -29 July	79.50	95.67
31	30 July -5 Aug	97.80	97.05
32	6 Aug -12 Aug	63.02	96.50
33	13 Aug -19 Aug	42.02	73.54
34	20 Aug -26 Aug	44.77	78.35
35	27 Aug-2 Sep	62.88	91.94
36	3 Sep -9 Sep	50.95	89.16
37	10 Sep -16 Sep	22.22	38.88
38	17 Sep -23 Sep	42.40	74.21
39	24 Sep -30 Sep	18.91	33.10
40	1 Oct -7 Oct	11.45	20.03
41	8 Oct -14 Oct	2.04	3.57
42	15 Oct -21 Oct	9.84	17.22
43	22 Oct -28 Oct	0.62	1.08
44	29 Oct-4 Nov	7.22	12.64
45	5 Nov -11 Nov	7.15	12.52
46	12 Nov -18 Nov	1.25	2.18
47	19 Nov -25 Nov	0.26	0.45
48	26 Nov-2 Dec	0.00	0.00
49	3 Dec -9 Dec	2.10	3.67
50	10 Dec -16 Dec	0.17	0.29
51	17 Dec -23 Dec	0.00	0.00
52	24 Dec -31 Dec	0.00	0.00

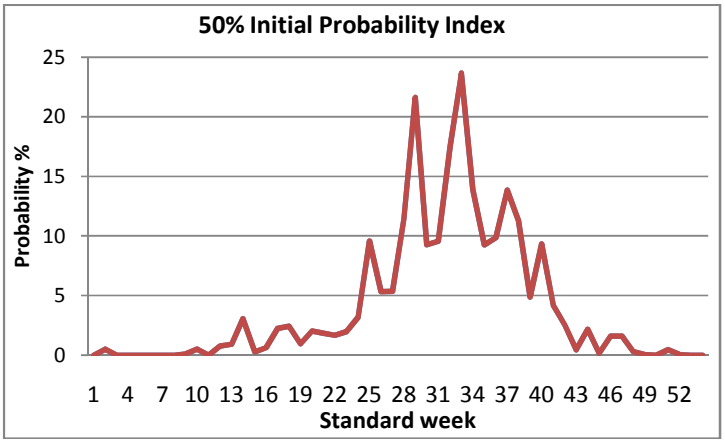

Fig. 2. Expected probability of rain at 50% initial probability index

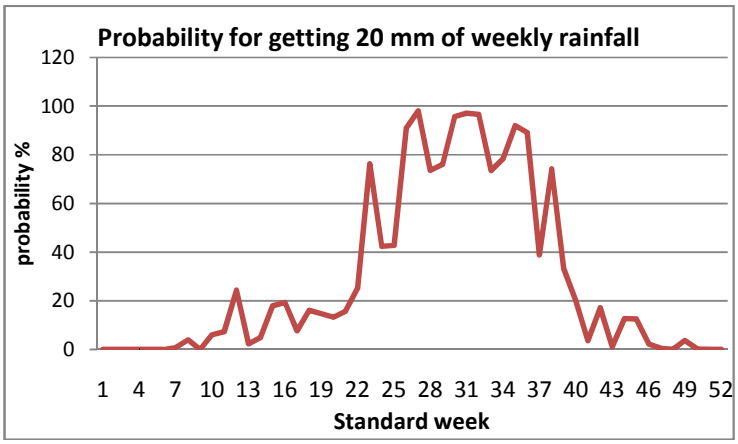

Fig. 3. Probability for 20 mm weekly rainfall over Bastar

Sarkar and Biswass [14] reported that even 30 per cent probability rainfall can be taken as weekly assured rainfall for computing moisture index if the annual rainfall is less than 400 mm [14]. But, in current study 50 per cent probability level was considered, which is critically desirable in the region due to more annual precipitation [6].

3.3 Conditional Probability Index

The chance of getting weekly rainfall of 20 mm with more than 50 per cent probability was observed during 27th and 31st standard week (Fig. 3). It also indicated that, none of the weeks has more than 60 per cent probability for the chance of getting more than 20 mm rainfall during the week (Table 2).

4. CONCLUSION

From the above rainfall analysis it has been concluded that the major cropping period under rainfed condition is only during south west east monsoon season. But within the cropping season, dry spells are expected limiting the crop production. Even during monsoon season, supplemental irrigations while early stages of the crop growth and during maturity stages can alleviate the problem of shortening length of growing period due to early and terminal droughts. Generally, moisture requirement of crops could be met from 26th to 38th standard week as these weeks has the probability of 50 per cent for getting 20 mm of weekly rainfall. The analysis revealed that the drought resistant finger millet, kodo millet and drought escaping little millet, niger, horsegram can be grown. Maize may be grown with supplemental irrigation of one or two to get the best yield out of available soil moisture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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