Weekly rainfall variability and probability analysis for Coimbatore in respect of crop planning

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सार – परिवर्तनशीलता और घटना की संभावना के स्तर का अध्ययन करने के लिए साप्ताहिक विश्लेषण हेतु कोयंबटूर के 30 साल (1981-2010) की दैनिक वर्षा के आँकड़ों का इस्तेमाल किया गया । अध्ययन से यह पता चला है कि 40 वें से 45 वें मानक सप्ताहों में 50 प्रतिशत संभावना के साथ 25 मि.मी. वर्षा और 41 वें सप्ताह में । 4.6 मि.मी. वर्षा प्रेक्षित की गई । 50 प्रतिशत की संभावना के साथ 25 मि.मी. साप्ताहिक वर्षा 39 वें से 46 वें मानक सप्ताहों, कुल मिलाकर आठ सप्ताहों में देखी गई । साप्ताहिक वर्षा विश्लेषण के भिननता के गुणांक से 37 वें से 48 वें मानक सप्ताहों में वर्षा होने का संकेत मिला जो वर्षा की मात्रा से निरपेक्ष है । सूखा प्रतिरोधी कम अवधि में होने वाली दाल और चारा 39 वें से 46 वें मानक सप्ताहों के भीतर उगाई जा सकती है ।

ABSTRACT. Daily rainfall data of 30 years (1981-2010) of Coimbatore were used for weekly analysis to study the variability and the probability level of occurrence. The study indicated that rainfall amount of more than 25 mm under 50 per cent probability was observed in the standard weeks from 40th to 45th with 41st week being 14.6 mm. The chance of getting 25 mm weekly rainfall with 50 per cent probability was noticed from 39th to 46th standard week covering eight weeks. The CV of weekly rainfall analysis indicated dependable rainfall from 37th to 48th standard weeks irrespective of quantity of rainfall to be received. Drought resistant short duration pulses and sorghum can be grown within the growing period from 39th to 46th standard weeks.

Key words – Co-efficient of variation, Conditional probability, Initial probability, Rainfall analysis.

1. Introduction

Coimbatore is situated in the Western agro-climate zone of Tamil Nadu State and positioned at 11° N latitude and 77° E longitude with an elevation of 427 m above mean sea level. The region receives an average annual rainfall of 713 mm. It is generally a dry district apart from the Noyyal River basin and occasional over - flowing streams from the Western Ghats, which terminate at the city's large tanks. The soil is predominantly black soil, which is suitable for cotton cultivation, but it also has red loamy soil to little extent. In agricultural planning, rainfall variability analysis aids to take farm decisions on times of sowing, inter culture operations, fertilizer application etc. Many studies have reported the advantages of working out weekly rainfall probabilities for a station or for an agroclimatic region (Subbulakshmi *et al*., 2005 and Nemichandrappa *et al*., 2010). Probability analysis can be used for predicting the occurrence of future events of rainfall from the available data with the help of statistical methods (Kumar and Kumar, 1989). Chattopadhyay and Ganesan (1995) attempted to study the variability of annual and seasonal rainfall and its probability and suggested suitable cropping pattern for Tamil Nadu. Prakash and Rao (1986) have suggested use of weekly rainfall data to predict the occurrence of rainy events and its amount for crop planning in Kota. This was also suggested for Madurai and Bhavanisagar in Tamil Nadu by Subbulakshmi *et al.* (2005).

The initial and conditional probability approach would be relatively good method for rainfall analysis, especially in the regions where rainfall is erratic or where short dry periods can be expected within the wet season. Gupta *et al*. (1975) 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 dry risk.

2. Materials and methodology

The daily rainfall data from 1981-2010 (30 years) were collected from Agro Climate Research Centre, Coimbatore. The daily rainfall was aggregated into weekly and used for analysis. Two types of probabilities *i.e*., Initial and Conditional probability indices were used for the study.

2.1. *Initial probability index*

The initial probability analysis was taken up to find out the amount of rainfall anticipated at 70 per cent, 50 per cent and 30 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 (Panse and Sukhatme, 1954; Veeraputhiran *et al.*, 2003).

$$\text{IPI} = \frac{N \times P}{100}$$

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 particular quantity of rainfall for specific agricultural operations. Conditional probability is worked out from the following formula (Panse and Sukhatme, 1954; Veeraputhiran *et al.*, 2003).

$$CPI = \frac{\overline{X} - X}{\text{SD}}$$

where,

CPI = Conditional Probability Index;

X = Required rainfall; $\overline{X}$ = 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 25 mm was considered as thresholds, as they have some relevance for carrying out agricultural farm operations like sowing, fertilizer application, weeding etc. under dry land condition.

TABLE 1

**Co-efficient of variation and initial probability index
for weekly rainfall**

Std. week	Period	CV %	75 %	50 %	30 %
1	Jan 1-7	351	0	0	0
2	8 - 14	476	0	0	0
3	15 - 21	364	0	0	0
4	22 - 28	537	0	0	0
5	29 - Feb 4	381	0	0	0
6	5 - 11	360	0	0	0
7	12 - 18	347	0	0	0
8	19 - 25	291	0	0	0
9	26 - Mar 4	272	0	0	0
10	5 - 11	281	0	0	0
11	12 - 18	192	0	0	5.0
12	19 - 25	273	0	0	0
13	26 - Apr 1	254	0	0	0.5
14	Apr 2 - 8	175	0	0	15
15	9 - 15	196	0	2.2	10.0
16	16 - 22	140	0	7.5	16.2
17	23 -29	155	0	2.2	10.5
18	30 - May 6	123	1.5	14.5	24.5
19	7 - 13	146	0	4.3	14.6
20	14 - 20	133	0	5.6	18.0
21	21 - 27	128	0	4.0	15
22	28 - Jun 3	133	0	4.3	10.8
23	4 - 10	114	0	2.5	8.6
24	11 - 17	147	1	3.4	9.0
25	18 - 24	138	0.5	3.8	8.6
26	25 - July 1	128	0	4.5	17.5
27	Jul 2 - 8	145	0	3.7	11.5
28	9 - 15	163	0.7	6.2	12.5
29	16 - 22	121	1	6.5	16.4
30	23 - 29	119	0	3.4	13.2
31	30 - Aug 5	124	1.3	5.5	9.2
32	6 - 12	129	0	3.0	9.8
33	13 - 19	200	0.2	2.5	10.5
34	20 - 26	147	0.2	6.3	13.1
35	27 - Sep 2	152	0	1	13.9
36	Sep 3- 9	168	0	2.0	11.0
37	10 - 16	122	2	8.8	16.5
38	17 - 23	152	0	6.5	14
39	24 - 30	127	1	9.8	38.5
40	Oct 1 - 7	105	2	28.8	42.5
41	8 - 14	111	6.21	14.6	43.4
42	15 - 21	118	3	27.2	61.4
43	22 - 28	89	19.3	39.4	66.0
44	29 - Nov 4	93	14	44.2	83.8
45	5 - 11	89	30.5	50.2	69.2
46	12 - 18	143	1.2	17.2	26.5
47	19 - 25	137	0	3.3	35.0
48	26 - Dec 2	129	0	3.2	21.8
49	3 - 9	167	0	1.5	8.8
50	10 - 16	296	0	0.2	3.0
51	17 - 23	260	0	0	4.0
52	24 - 31	380	0	0	0

TABLE 2

Conditional Probability Index for weekly rainfall

Std. week	Jan 1-7	10 mm	25 mm
1	8 - 14	33.36	6.55
2	15 - 21	4.18	0
3	22 - 28	34.46	7.78
4	29 - Feb 4	0	0
5	5 - 11	0	0
6	12 - 18	21.77	0.91
7	19 - 25	15.15	0.13
8	26 - Mar 4	4.36	0
9	5 - 11	40.52	12.51
10	12 - 18	47.21	23.89
11	19 - 25	50.4	22.06
12	26 - Apr 1	33.72	5.48
13	Apr 2 -8	26.11	1.46
14	9 - 15	49.6	18.67
15	16 - 22	57.14	37.07
16	23 - 29	58.32	29.12
17	30 - May 6	50.8	18.14
18	7 - 13	65.91	42.47
19	14 - 20	54.38	22.66
20	21 - 27	52.79	16.85
21	28 - Jun 3	49.2	11.31
22	4 - 10	47.21	9.51
23	11 - 17	20.33	0.03
24	18 - 24	49.6	41.69
25	25 - Jul 1	46.81	9.85
26	Jul 2 - 8	50.8	12.92
27	9 - 15	46.41	10.38
28	16 - 22	57.93	33.72
29	23 - 29	48.8	9.34
30	30 - Aug 5	37.83	2.07
31	6 - 12	44.04	5.59
32	13 - 19	36.69	2.22
33	20 - 26	46.02	15.87
34	27 - Sep 2	57.53	29.12
35	Sep 3- 9	48.8	14.23
36	10 - 16	40.52	6.68
37	17 - 23	59.87	27.09
38	24 - 30	55.17	25.46
39	Oct 1 - 7	68.44	50.8
40	8 - 14	73.89	56.75
41	15 - 21	73.57	58.71
42	22 - 28	74.54	64.43
43	29 - Nov 4	82.12	72.57
44	5 - 11	81.06	72.24
45	12 - 18	82.38	74.22
46	19 - 25	67	52.39
47	26 - Dec 2	65.17	45.62
48	3 - 9	54.38	18.41
49	10 - 16	46.81	13.57
50	17 - 23	47.61	25.46
51	24 - 31	44	24.83
52	Jan 1-7	38.21	12.71
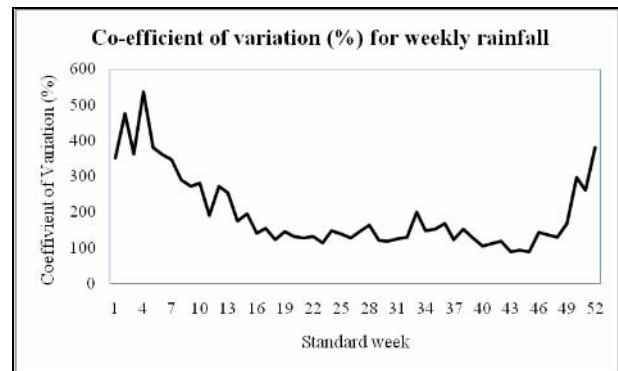
Fig. 1. Co-efficient of variation (%) for weekly rainfall over Coimbatore
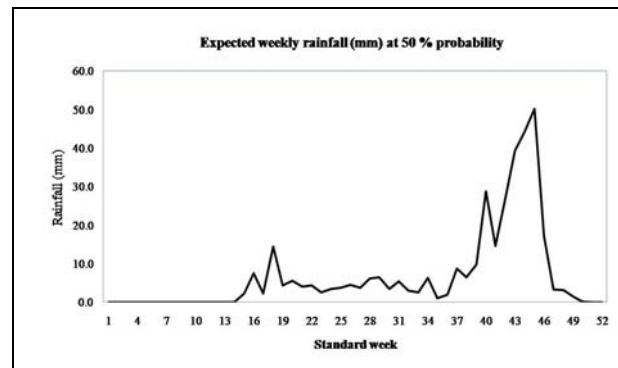
Fig. 2. Expected weekly rainfall (mm) at 50% probability level over Coimbatore
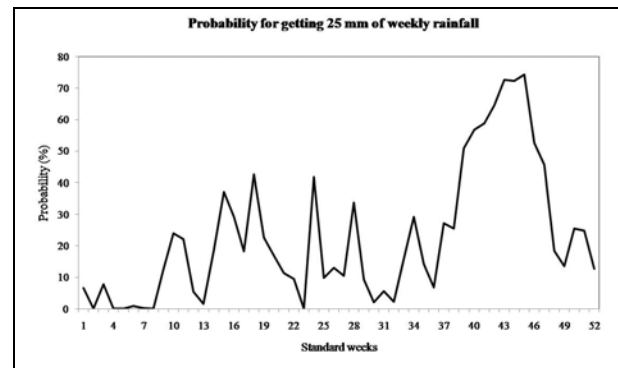
Fig. 3. Probability for getting 25 mm weekly rainfall over Coimbatore

3. Results and discussion

3.1. *Rainfall variability*

The highest mean weekly rainfall (58.8 mm) was received during 45th standard week (Table 1). The CV was less than 150 per cent from 37th to 48th standard week,

indicated that the rainfall is consistent during this period (Fig. 1). This was also observed during 18th to 27th standard week but the quantity of rainfall received during the above period is not sufficient to support the crop. The above rainfall analysis showed that the crop could be recommended under dry land between 37th to 48th standard weeks as the rainfall is more consistent during this period as compared to 18th to 27th standard weeks, which fall under South west monsoon.

3.2. *Initial probability index*

The initial probability analysis for weekly rainfall indicated that more than 25 mm of rainfall could be expected from 40th to 45th standard week with 50 per cent probability, except 41st standard week, where the rainfall is only 14 mm (Fig. 2). Whereas, with 30 per cent probability, the expected rainfall of more than 25 mm was observed from 39th to 47th standard weeks (Table 1). Sarkar and Biswass (1988) 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. But, in current study 50 per cent probability was considered.

3.3. *Conditional probability index*

The chance of getting weekly rainfall of 25 mm with more than 50 per cent probability was observed during 39th to 46th 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 50 mm rainfall during the week (Table 2).

From the above rainfall analysis it has been noted that the major cropping period under dry land condition is only during north east monsoon season. But within the cropping season, dry spells are expected limiting the crop production. Even during North east monsoon season, supplemental irrigations during 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, the crop water requirement could be met from 39th to 46th standard week as these weeks has the probability of 50 per cent for getting 25 mm of weekly rainfall. The analysis revealed that the drought resistant short duration crops like pulses and sorghum can be grown. Maize may be grown with supplemental irrigation of one or two to get the best yield out of available soil moisture.

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