



Curtailing Crop Production Risk in Dry Lands of Coimbatore District, Tamil Nadu

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A systematic study was made to assess the variability and probability occurrence (initial and conditional) of rainfall at Coimbatore. Length of Growing Period (LGP) was also computed to plan dry land crop cultivation with minimum risk. LGP was computed by two different methods viz., weekly Moisture Availability Index (MAI) and weekly Rainfall /Potential Evaporation (R/PE) ratio. The mean weekly rainfall and PET data from 1961-2010 were used to compute LGP. The results indicated that for getting more than 25 mm with 50 per cent probability was possible from 42nd to 45th Standard Meteorological Week (SMW). The chance of receiving 20 mm rainfall per week with 50 per cent probability was observed from 39th to 49th week except in 48th week. The coefficient of variation was below 150 per cent from 16th to 23rd week and from 37th to 45th week. It showed that weekly rainfall during pre-monsoon and post monsoon season is highly dependable. LGP analysis shows that 77 days (37th to 47th week) was available as per MAI method and 91 days (37th to 49th week) period as per R/PE ratio.

Key words: Co-efficient of variation, Conditional probability, Initial probability, LGP, Rainfall analysis

The information on seasonal and annual rainfall in a region is useful to design weather sensitive crop operations. The geo location of Coimbatore is 11° N latitude and 77° E longitude with an elevation of 427 m above mean sea level. The region receives 701.8 mm of annual rainfall with 45 rainy days.

Many studies have reported the advantages of working out weekly rainfall probabilities for an agro-climatic 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. 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 dryland risk.

Length of the growing period is defined as the period during which the availability of moisture in the root zone of a crop is adequate to meet the water needs. Therefore, at a given location, the amount and distribution of rainfall, moisture storage capacity and the rate of evapo-transpiration determines the length and characteristics of the growing period. In dry farming areas, where rainfall is the sources of water for crops, changes in both quantity and distribution of rainfall during the year could affect the economy an area. Proper understanding of rainfall climatology is very important to determine the success of the rainfed farming. Taking into account this climatic situation and

probability factor, the rainfall analysis and length of growing period was computed for Coimbatore district.

Materials and Methods

The weekly rainfall data from 1961-2010 were collected from Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore. Initial and Conditional probabilities of rainfall were worked out to know the expectancy with different probability and to see the receipt of rainfall with diverse possibility. Mean, standard deviation and co-efficient of variation has been calculated to discern the fidelity of the rainfall. Length of growing period was worked out through two different methods viz., Sarkar and Biswas (1988) and Jeevananda Reddy method (1983).

Coefficient of variation (CV)

It measures the variability and gives the indication of rainfall dependability and expressed in percentage. The threshold limit for daily, weekly, monthly, seasonal and annual rainfall is less than 250, 150, 100, 50 and 25 per cent, respectively.

Initial probability

The initial probability analysis was taken up to find out the amount of rainfall anticipated at different probability level viz., 75, 50 and 30 per cent, respectively.

$$IP = N \times P/100$$

Where;

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

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Conditional probability

Conditional probability is useful in predicting the receipt of particular quantity of rainfall for specific agricultural operations (Veeraputhiran *et al.*, 2003).

$$CP = \text{Mean-X/SD}$$

Where;

CP = Conditional Probability;

X = Required 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.

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

Sarkar and Biswas method (1988)

Weekly Moisture Availability Index (MAI)

Assured weekly rainfall (mm)

$$\text{MAI} = \frac{\text{Assured weekly rainfall (mm)}}{\text{PET (weekly)}}$$

PET (weekly)

Weekly probable rainfall @ 50 per cent (annual rainfall > 400 mm) and @ 30 per cent (annual rainfall < 400 mm) should be considered for computation (Table 1).

Jeevananda Reddy method(1983)

R/PE is worked out in which R is the mean weekly rainfall (mm) and PE is weekly Potential Evaporation (mm). As the growing season is limited to less than

90 days in drylands, 14 weeks moving average has been suggested and based on this R/PE ratio, the following six climatic variables have been identified.

Available effective rainy period (G)

The number of consecutive weeks in which the 14 weeks moving average of R/PE ratio is ≥ 0.75 the initial week of this effective rainy period should be with simple R/PE ratio of ≥ 0.5

Sowing rain (S)

The week before the beginning of the available effective rainy period is taken as the week of commencement of sowing rain. Here, the simple R/PE ratio should be ≥ 0.5 .

Presowing cultivation (Ps)

Pre sowing cultivation and seed bed preparation (Ps) are started when the 14 week moving average curve for R/PE ratio crosses 0.5 limits and when the particular week has simple R/PE ratio of ≥ 0.25

Wet spell (W)

Within G, if the simple R/PE ratio is ≥ 1.5 , the week is called as wet spell.

Dry spell (D)

Within the growing period, if the simple R/PE ratio is < 0.5, the week is said to be called as dry spell.

Crop failure (A)

If the 'G' period (in any year) is ≤ 5 weeks, the possibility of growing any crop is limited.

Results and Discussion

Standard Meteorological Week (SMW) rainfall of Coimbatore from 1961 to 2010 have been presented in Fig. 1. It was noted that mean weekly rainfall

Table 1. Rainfall vs Potential Evaporation based classification of cropping area.

Zone	MAI (weeks)		Area
	0.3	0.7	
D	<10	<1	Crop production without irrigation is almost in speculation
E	>10	>1	Crop production is not very high. However a short/ medium duration crop may be raised
F	>11	>4	Medium duration crop may be raised
G	>14	>7	A crop of 13-18 weeks duration may be raised once in two years
H	> 18	>9	Medium duration crop may be raised
I	>20	>10	A crop can thrive for 4-6 weeks on stored soil moisture after the termination of second rainfall.
J	>24	12	Stored moisture is available at the end of rainy season

ranged from 0.3 mm (4th SMW) to 49.9mm (49th SMW). It is interesting to note that from 41st SMW onward, the mean weekly rainfall is above 30 mm up to 46th SMW. The coefficient of variation was below 150% during 16th to 23rd SMW and again from 37th to 45th SMW. It showed that that weekly rainfall during Pre-monsoon (April 16th to June 10th) season and Post monsoon season (September 10th to November

11th) rainfall is highly dependable. In consideration to remaining SMW, the mean weekly rainfall is not dependable as CV is very high (>150%). Though, the SMW rainfall is reliable during the 16th to 23rd SMW (105.1 mm) period, the quantum of rainfall received is not sufficient to support the crop. Under dry land condition, the short duration pulses could be recommended from 37th to 45th SMW (299.7 mm)

for reliable cultivation (Table 2). A similar finding was reported by Manikandan *et al.*, 2014.

Table 2. SD and CV for Standard Meteorological Week rainfall at Coimbatore (1961-2010)

SMW No	Period	Rainfall(mm)	
		SD	C V (%)
1	Jan 1-7	10.9	419.6
2	8-14	5.2	323.4
3	15-21	11.5	428.8
4	22-28	1.5	464.4
5	29-Feb 4	2.8	347.5
6	5-11	7.4	422.6
7	12-18	7.8	333.9
8	19-25	8.4	285.3
9	26- Mar4	13.7	320.6
10	5-11	22.3	316.7
11	12-18	15.9	211.3
12	19-25	10.2	329.1
13	26- Apr1	6.7	255.1
14	2-8	14.8	178.0
15	9-15	24.1	231.3
16	16-22	22.9	135.0
17	23-29	14.8	141.2
18	30- May6	23.1	117.2
19	7-13	23.8	137.8
20	14-20	17.0	117.9
21	21-27	16.6	135.5
22	28- Jun 3	11.0	134.2
23	4-10	8.3	144.9
24	11-17	11.9	155.9
25	18-24	12.6	137.7
26	25-July 1	16.9	158.0
27	2-8	17.6	138.8
28	9-15	20.7	150.3
29	16-22	10.5	129.2
30	23-29	18.7	169.2
31	30-Aug 5	9.8	123.4
32	6-12	14.8	200.7
33	13-19	13.9	174.7

34	20-26	16.2	166.3
35	27- Sep 2	11.8	151.4
36	3-9	11.8	172.0
37	10-16	19.8	142.1
38	17-23	21.9	138.2
39	24-30	31.0	142.8
40	Oct 1- 7	31.0	116.8
41	8-14	39.0	112.0
42	15-21	52.9	113.3
43	22-28	47.3	94.9
44	29- Nov 4	45.5	101.0
45	5-11	47.8	105.7
46	12-18	51.7	157.0
47	19-25	49.2	165.2
48	26- Dec 2	18.1	146.9
49	3-9	36.9	184.5
50	10-16	26.2	258.3
51	17-23	18.8	253.2
52	24-31	16.1	308.5

SD- Standard Deviation; CV- Co-efficient of Variation

The initial probability analysis for weekly rainfall indicated that more than 25 mm of rainfall could be expected from 42nd to 45th SMW with 50 per cent probability. Whereas, with 30 per cent probability, the expected rainfall of more than 25 mm was observed from 40th to 47th SMW. The chance of getting weekly rainfall of 20 mm (sowing rain) with more than 50 per cent probability was observed during 39th to 49th SMW except 48th SMW (Table 3). This suggests that the farmers of Coimbatore district can able to take up pre monsoon sowing to utilize the first drop of rain water for efficient crop planning.

A continuous period of MAI value (> 0.3) was observed from 37th to 47th SMW limiting the length of growing period to 11 weeks. Within this period, a MAI of > 0.7 was noticed from 40th to 46th SMW (Fig 2). Hence, crop duration of about 77 days may be considered for crop planning. The stored soil moisture at the end of the season also supports the crop if the crop needs moisture for a week time. Based on the analysis, Coimbatore district can be classified under 'F' zone (Table.1 and Fig 2). Medium duration(70 to 90 days) crops like sorghum, bajra, ragi, maize, sunflower, soybean, groundnut, gingelly, pulses like green gram, cowpea to reap high yield of the crops.

The available effective rainy period (G) starts from 37th to 49th reference standard week (Table 4). This shows that Coimbatore has a potential to grow 13 weeks (91 days) duration crop. Within 'G' period, wet spell occurred from 42nd to 45th SMW as simple R/PE ratio was ≥ 1.5 . Since consecutive four weeks are under saturated condition, effective drainage in

Table 3. Initial and conditional probability for Coimbatore (1961-2010)

SMW No	Period	Probability level (%)			Expected rainfall (mm)	
		75	50	30	10 mm	20 mm
1	Jan 1-7	0.0	0.0	0.0	25	6
2	8-14	0.0	0.0	0.0	5	0
3	15-21	0.0	0.0	0.0	26	7
4	22-28	0.0	0.0	0.0	0	0
5	29-Feb 4	0.0	0.0	0.0	0	0
6	5-11	0.0	0.0	0.0	13	1
7	12-18	0.0	0.0	0.0	16	1
8	19-25	0.0	0.0	0.0	20	2
9	26- Mar4	0.0	0.0	0.0	34	13
10	5-11	0.0	0.0	0.0	45	28
11	12-18	0.0	0.0	1.1	44	21
12	19-25	0.0	0.0	0.0	25	5
13	26- Apr1	0.0	0.0	0.5	14	0
14	2-8	0.0	0.3	3.3	46	21
15	9-15	0.0	1.5	6.8	51	34
16	16-22	0.5	8.7	16.9	62	45
17	23-29	0.0	2.2	15.6	51	26
18	30- May6	0.8	14.5	26.7	66	50
19	7-13	0.0	7.6	18.8	62	47
20	14-20	1.0	7.1	18.0	60	37
21	21-27	0.0	5.8	16.0	55	32
22	28- Jun 3	0.0	3.5	10.5	44	14
23	4-10	0.0	2.0	8.6	31	4
24	11-17	0.5	3.2	7.0	42	15
25	18-24	0.3	3.7	10.0	47	19
26	25-July 1	0.5	3.6	13.5	56	29
27	2-8	0.6	4.6	13.9	56	34
28	9-15	1.0	6.2	12.5	57	38
29	16-22	1.0	3.0	11.8	43	13
30	23-29	0.8	3.8	10.0	52	32
31	30-Aug 5	0.3	4.0	9.4	42	11
32	6-12	0.0	2.8	7.2	43	20
33	13-19	0.5	3.8	10.5	44	19
34	20-26	0.2	3.0	8.1	49	26
35	27- Sep 2	0.0	2.5	10.4	42	15
36	3-9	0.0	0.3	5.0	40	13
37	10-16	0.4	8.0	14.5	58	38
38	17-23	1.0	6.8	15.2	61	42
39	24-30	1.0	8.3	19.3	65	52
40	Oct 1- 7	1.3	17.5	39.4	70	58
41	8-14	6.1	19.4	48.1	74	65
42	15-21	3.4	27.9	61.4	75	69
43	22-28	9.7	39.4	62.8	80	74
44	29- Nov 4	9.5	28.2	60.2	78	71
45	5-11	5.0	40.9	64.2	77	70
46	12-18	0.5	17.2	42.9	67	60
47	19-25	0.0	14.0	35.0	66	58
48	26- Dec 2	0.0	3.0	16.2	55	34
49	3-9	0.0	4.0	15.3	61	50
50	10-16	0.0	0.2	4.1	50	35
51	17-23	0.0	0.0	4.3	44	25
52	24-31	0.0	0.0	0.4	38	18

the field should be assured. Pre-monsoon sowing can be taken from 34th to 36th reference standard week as this period meets the criteria when the 14 week moving average curve for R/PE ratio crosses

0.5 limits and when the particular week has simple R/PE ratio of ≥ 0.25 . Since the following period supports sufficient moisture to the crops sown, it is advisable to sow during this period.

Table 4. Moving average of Jeevananda Reddy method

Reference Std week	Simple R/PE	14 Week Moving Average	Reference Std week	Simple R/PE	14 Week Moving Average
7	0.08	0.11	33	0.28	0.49
8	0.09	0.13	34	0.35	0.57
9	0.13	0.16	35	0.26	0.68
10	0.21	0.18	36	0.24	0.81
11	0.22	0.22	37	0.54	0.95
12	0.09	0.25	38	0.59	1.06
13	0.07	0.27	39	0.82	1.13
14	0.23	0.29	40	1.04	1.17
15	0.30	0.30	41	1.32	1.20
16	0.46	0.30	42	1.78	1.24
17	0.29	0.31	43	2.25	1.24
18	0.58	0.33	44	2.16	1.22
19	0.51	0.35	45	2.33	1.18
20	0.43	0.37	46	1.35	1.12
21	0.36	0.38	47	1.24	1.04
22	0.28	0.38	48	0.55	0.94
23	0.21	0.38	49	1.01	0.79
24	0.30	0.37	50	0.47	0.64
25	0.32	0.35	51	0.34	0.49
26	0.39	0.34	52	0.24	0.36
27	0.43	0.34	1	0.11	0.27
28	0.52	0.33	2	0.07	0.22
29	0.32	0.34	3	0.11	0.18
30	0.44	0.37	4	0.01	0.14
31	0.30	0.39	5	0.03	0.12
32	0.30	0.43	6	0.06	0.11

Effective growing period(G)

Wet spell

Conclusion

From the above rainfall analysis, it has been noted that the major cropping period under dry land condition in Coimbatore district of Tamil Nadu is only during north east monsoon season. But within the cropping season, dry spells are expected, which limits the crop production. 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. Hence, based on the analysis, it is recommended that the above growing period can be chosen for raising medium duration crops like sorghum, bajra, ragi, maize, sunflower, soybean, groundnut, gingelly, pulses like green gram, cowpea to reap high yield of the crops.

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