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DRY AND WET ANALYSIS FOR CROP PLANNING USING MARKOV'S CHAIN MODEL FOR DAMOH DISTRICT OF MADHYA PRADESH, INDIA

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ABSTRACT

It is important to know the sequence of dry and wet period for crop planning and to carry the agriculture practices of region. An attempt has been made to analyze 21 years of rainfall (2000–2021) at the Damoh district in Madhya Pradesh, India for forecasting the probable time of onset and withdrawal of monsoon, probability of dry spells by using Markov chain model and finally crop planning for the region. The successive dry weeks indicate the need of supplemental irrigations and moisture conservation practices whereas, successive wet weeks gives an idea of excessive runoff water availability for rainwater harvesting and to take up suitable measures to control soil erosion. The average annual rainfall at Damoh district was observed as 1089.1 mm with coefficient of variation (CV) of 32.8%. The data on onset and withdrawal of rainy season indicated that the monsoon started effectively from 24th SMW (11-17th June) and remained active up to 40th SMW (22-28th October). During rainy season the probability of occurrence of wet week was observed more than 35% during 23-24th SMW (4th June–17th June) and average weekly rainfall ranged from 27.4 to 41.9 mm, this rain can be utilized for summer ploughing and initial seed bed preparations.. Results obtained through this analysis would be utilized for agricultural planning and mitigation of dry spells at the Damoh district in Madhya Pradesh, India.

Key words : Rainfall Variability and Markov's chain, Probability analysis.

Introduction

India's economy is mainly dependent on agriculture, which is based on monsoon rainfall and its distribution. Fluctuation in rainfall directly influences the growth, development and yield of crops. India ranks first among the countries that practice rainfed agriculture both in terms of extent (86 mha) and value of production (Sharma *et al*., 2010). To meet the future food demands and growing competition for water among various sectors, a more efficient use of water in rainfed agriculture will be essential. The most important factor for low yield is the lack of assured water supply (Panigrahi and Panda, 2002). Increased climate variability has made rainfall patterns more inconsistent and unpredictable (Kumar *et al*., 2005). The demand of water in other sectors especially to meet the increasing demand for rapid growing industrialization and urbanization will dwindle the share of water available for agriculture in the future. Further, depletion of groundwater and reduced stream flows (Khan *et al*., 2008) affect drinking water supplies, health and rural livelihoods (Meijer *et al*., 2006); for instance, in India, the implications for social equity for the poor and groundwater-dependent communities for drinking and irrigation are quite large (EPW, 2007). Rainwater management and its optimum utilization is a prime issue of present-day research for sustainability of rainfed agriculture. Kothari *et al*. (2007) opined that on the basis of water harvesting, water can be utilised for saving of crops during severe moisture stress. In order to address the issue, detailed knowledge of rainfall distribution can help in deciding the time of different agricultural operations and designing of water harvesting structures for providing round the year full irrigation (Srivastava, 2001; Srivastava *et al*., 2009). For sustainable crop planning, rainfall was characterised based on its variability and probability distribution by previous researchers (Mohanty *et al*., 2000; Sharda and Das, 2005; Bhakar *et al*., 2008; Jain and Kumar, 2012) for different regions of India. For successful agricultural management and planning of soil water conservation measures, information about occurrence of dry and wet periods along with onset and withdrawal of rainy season is important. Panigrahi and Panda (2002), Kar (2003) applied Markov Chain method for calculating initial and conditional probability of dry and wet spells of different duration for various climatic situations and have evaluated its practical importance in crop planning. Researchers (Pandarinath, 1991; Banik *et al*., 2002; Barron *et al*., 2003 and Deni *et al*., 2010) have used Markov chain model to study the probability of dry and wet spell analysis in terms of the shortest period like week and also demonstrated its practical utility in agricultural planning.

Materials and Methods

Study area and data collection of data

The study was conducted in the Krishi Vigyan Kendra, Damoh, JNKVV, Jabalpur, Madhya Pradesh, India situated at 23^0 09' N latitude and 79^0 52' E longitude with an elevation of 359.5m amsl. The Damoh has uneven, erratic rainfall. Daily rainfall data recorded at the meteorological observatory, Collectorate office of Damoh, Madhya Pradesh, India for 21 year (2000-2021) has been used in this analysis. The daily data in a particular year has been converted to weekly data.

Rainfall data were categorised into four seasons, *viz*. pre-monsoon (March–May), monsoon (June–September), post-monsoon (October–December) and winter (January–February) season. Monthly effective rainfall was calculated using Eqs. 1 and 2 following the USDA Soil Conservation Service method. This method is being widely used in India for calculation of monthly effective rainfall. The same method has been used for calculation of effective rainfall for rainfed districts of India by Sharma *et al*. (2010).

$$P_e = P_t\,(125 - 0.2P_t)/125 \quad (\text{When } P_t < 250 \text{ mm}) \qquad (1)$$

$$P_e = (125 + 0.1P_t)/125 \quad (\text{When } P_t \geq 250 \text{ mm}) \qquad (2)$$

Where, P_e = Monthly effective rainfall (millimetres) and P_t = total monthly rainfall (millimetres).

Computation of dry and wet spells using Markov's chain probability models

The dry and wet spell analysis was carried out using weekly rainfall based on Markov Chain Model considering less than 20 mm rainfall in a week as a dry week and 20 mm or more as a wet week (Pandharinath, 1991). Markov chain is a stochastic process to predict the succeeding situation of day solely based on situation of previous day. The different notations followed in this analysis are given below.

a) Initial probability

$$P_D = F_D/N \qquad (4)$$

$$P_W = F_W/N \qquad (5)$$

Where, P_D = probability of the week being dry, F_D = frequency of dry weeks, P_W = probability of the week being wet, F_W = frequency of wet weeks and N = total number of years of data being used.

b) Conditional probabilities

$$P_{DD} = F_{DD}/F_D \qquad (6)$$

$$P_{WW} = F_{WW}/F_W \qquad (7)$$

$$P_{WD} = 1 - P_{DD} \qquad (8)$$

$$P_{DW} = 1 - P_{WW} \qquad (9)$$

Where, P_{DD} = probability of a week being dry preceded by another dry week, F_{DD} = frequency of dry week preceded by another dry week, P_{WW} = probability of a week being wet preceded by another wet week, F_{WW} = frequency of wet week preceded by another wet week, P_{WD} = probability of a wet week preceded by a dry week and P_{DW} = probability of a dry week preceded by a wet week.

c) Consecutive dry and wet week probabilities

$$P_{2D} = P_{DW1} \times P_{DDW2} \qquad (10)$$

$$P_{3D} = P_{DW1} \times P_{DDW2} \times P_{DDW3} \qquad (11)$$

$$P_{2W} = P_{WW1} \times P_{WWW2} \qquad (12)$$

$$P_{3W} = P_{WW1} \times P_{WWW2} \times P_{WWW3} \qquad (13)$$

Where, P_{2D} = probability of two consecutive dry weeks starting with the week; P_{DW1} = probability of the first week being dry; P_{DDW2} = probability of the second week being dry, given the preceding week being dry; P_{3D} = probability of three consecutive dry weeks starting with the week; P_{DDW3} = probability of the third week being dry, given the preceding week dry; P_{2W} = probability of two consecutive dry weeks starting with the week; P_{WW1} = probability of the first week being wet; P_{WWW2} = probability of the second week being wet, given the preceding week being wet; P_{3W} = probability of three consecutive wet weeks starting with the week and P_{WWW3} = probability of the third week being wet, given the preceding week wet.

Results and Discussion

Average rainfall, effective rainfall, distribution over seasons and analysis of rainy days

Total annual rainfall in the Damoh district ranged between 681.7 mm (the lowest during the year 2021) and 1721.9 mm (the highest during the year 2013). The average annual rainfall is around 1089.1 mm with 45 rainy days (14.9% coefficient of variation). If rainfall received in a year was equal to or more than the average rainfall plus standard deviation for 22 years of rainfall (*i.e.* 1089.1+308.6=1397.7 mm), it was considered as excess rainfall year (Sharma and Kumar, 2003). During eight years *i.e.* 2003, 2005, 2011, 2013, 2016 and 2019, this region received rainfall of more than 1233 mm and considered as excess rainfall years. Only 19% of total years of analyses under this study received rainfall of more than 1233 mm. Out of 22 years, 9 years recorded annual rainfall in excess of average or normal (1089.1 mm) while 13 years (*i.e.* 59% of the total years of rainfall record) recorded below normal rainfall (Fig. 1). Monthly average and effective rainfall of the Damoh district for 22 years are presented in Fig. 2.

Considering monthly rainfall distribution, it was revealed that mean rainfall of July was 379.2 mm, which was the highest and its contribution was 25.4% annual average rainfall. July rainfall was slightly lower than that in August (*i.e.* 23.4% of annual average rainfall). December was the lowest rainfall month. Total annual effective rainfall (ER) was 668.6 mm which was 72.0% of the total annual rainfall. It was also observed that 259.8 mm of rainfall water was lost in the form of surface runoff, deep percolation and evaporation.

The distribution of rainfall for different seasons showed that the normal southwest monsoon, which delivered 83.6% of annual rainfall, extended from June to September (Table 1).

This is also the main season (rainy season) for cultivation of rainfed crops. Winter season contributes only 2% of the total annual rainfall; 1.8 and 2.6% of the total annual rainfall occurred during pre- and post-monsoon season, respectively with the lowest coefficient of variation during monsoon (31.4%) followed by post-monsoon (138.9%), pre-monsoon (155.8%) and winter (119.6%). The occurrence of rainy days were categorized into four groups viz. 0-40, 41-50, 51-60 and 61-70 days (Table 2). The analysis showed that maximum numbers of rainy days were observed under 41-50 days category followed by 0-40 and 51-60 days. Numbers of rainy days under 61-70 days category were found only 7.1%.

The weekly rainfall attributes showing mean, maximum, minimum, standard deviation, coefficient of variation and percentage of weekly rainfall contribution towards annual rainfall are presented in Table 3. Data revealed that, there were total of 16 weeks (24^{th} to 38^{th} SMW) where rainfall exceeded more than 20 mm. During rainy season the mean weekly rainfall was found to be more than 40 mm during 25^{th} -37^{th} SMW and found to be less than 20 mm during 39^{th}–40^{th} SMW. The coefficient of variation during rainy season varied from 125.3% (24^{th} SMW) to 210.4% (40^{th} SMW).

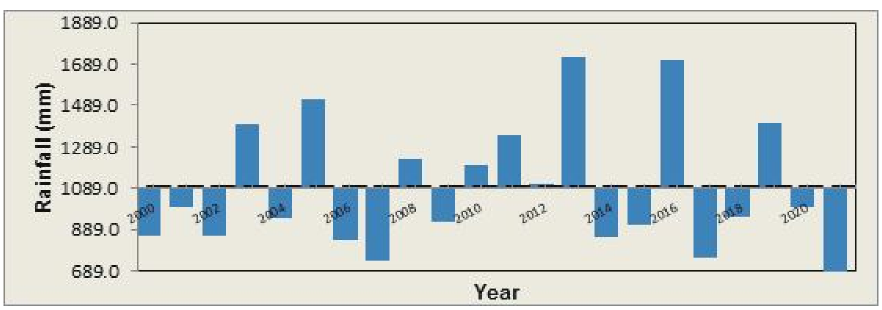

Fig. 1 : Annual variability of annual rainfall over normal at Damoh (2000-2021).

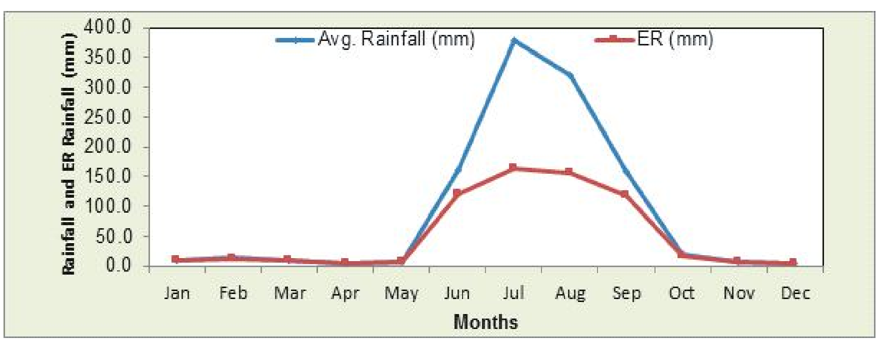

Fig. 2 : Average monthly rainfall and effective rainfall for the study area, Damoh; ER is the effective rainfall.

Markov's chain model

The results of initial and conditional probabilities of dry and wet weeks and consecutive dry and wet weeks are presented in Tables 4 and 5, respectively for all the 52 standard meteorological weeks. The results showed that the probability of occurrence of dry week was high until the end of the 23^{rd} SMW. The initial probability of dry week (P_D) and conditional probability of dry week preceded by another dry week (P_{DD}) varied between 9.1 -100% and 0.0–100%, respectively during 1^{st}–52^{nd} SMW. Similarly the initial probability of wet week (P_W) and conditional probability of wet week preceded by another wet week (P_{WW})

Table 1 : Rainfall distribution in the Damoh region over different seasons (data of 21 years for the period 2000–2021.

Seasons	Average Rainfall	Percentage of total rainfall	SD	CV
Northeast monsoon	29.0	2.6	40.3	138.9
Southwest monsoon	1018.7	93.4	320.2	31.4
Summer	19.9	1.8	31.0	155.8
Winter	21.4	2	25.6	119.6

Table 2 : Rainy days distribution in the Damoh region over different seasons (data of 21 years for the period 2000–2021).

Seasons	Average rainy days	Percentage of total rainy days	SD	CV
Northeast monsoon	2	4.4	1.5	89.8
Southwest monsoon	40	88.9	6.6	16.6
Summer	2	4.4	2.2	134.0
Winter	1	2.2	1.6	104.4

Table 3 : Weekly rainfall attributes at Damoh (2000–2021).

Week No.	Mean	Maxi	Mini	SD	CV	% of MAR	Week No.	Mean	Maxi	Mini	SD	CV	% of MAR
1	2.9	25.7	0	6.5	224.6	0.3	27	107.2	587.7	0	169.6	158.2	9.8
2	0.5	10.6	0	2.3	456.3	0.0	28	75.6	200.8	0	56.4	74.6	6.9
3	2.3	27.5	0	7.3	319.0	0.2	29	85.2	188.6	0	56.4	66.2	7.8
4	1.7	17.5	0	4.4	258.9	0.2	30	85.1	218	0	61.2	71.9	7.8
5	5.5	73.6	0	16.2	293.8	0.5	31	62.8	136.9	0	39.8	63.4	5.8
6	1.4	19.5	0	4.4	308.5	0.1	32	82.9	216	0	56.4	68.1	7.6
7	4.2	30	0	7.1	168.8	0.4	33	77.4	299.7	0	66.4	85.7	7.1
8	1.1	6.9	0	2.3	202.6	0.1	34	68.7	210.4	0	59.1	86.0	6.3
9	4.0	45.1	0	11.3	282.9	0.4	35	59.5	174.1	0	49.8	83.7	5.5
10	3.1	39	0	9.5	304.1	0.3	36	50.6	154.5	0	46.7	92.3	4.6
11	3.0	22.8	0	6.6	222.0	0.3	37	44.3	136.4	0	44.2	99.7	4.1
12	0.1	2.4	0	0.5	442.5	0.0	38	28.9	114.1	0	33.5	116.0	2.6
13	0.1	1	0	0.2	255.4	0.0	39	18.4	117.5	0	34.3	186.8	1.7
14	0.1	1	0	0.3	323.7	0.0	40	10.3	83.1	0	21.2	206.5	0.9
15	2.6	44.7	0	9.5	366.2	0.2	41	3.1	25.1	0	6.2	202.4	0.3
16	2.1	10.7	0	5.2	249.1	0.2	42	3.5	62.5	0	13.2	383.1	0.3
17	0.3	6.9	0	1.5	449.9	0.0	43	0.2	5.1	0	1.1	469.0	0.0
18	0.0	0	0	0.0	0.0	0.0	44	2.4	34.8	0	8.0	333.5	0.2
19	0.7	6.7	0	1.9	273.9	0.1	45	0.3	2.9	0	0.9	323.7	0.0
20	4.2	75.2	0	16.0	383.3	0.4	46	4.4	83.9	0	18.0	406.9	0.4
21	0.7	4.1	0	1.2	168.2	0.1	47	0.2	2.1	0	0.6	323.7	0.0
22	3.0	25.2	0	6.1	203.8	0.3	48	0.0	0	0	0.0	0.0	0.0
23	12.8	75.5	0	22.3	173.2	1.2	49	0.0	0	0	0.1	469.0	0.0
24	29.1	106.9	0	36.5	125.3	2.7	50	2.4	13.3	0	4.5	191.5	0.2
25	61.8	367.5	0	101.5	164.1	5.7	51	0.6	7.6	0	2.0	319.0	0.1
26	66.4	298	0	66.2	99.6	6.1	52	1.7	16.3	0	4.3	255.3	0.2

varied between 0.0 – 90.9% and 0.0–100%, respectively during1st–52nd SMW.

For main rainy season (25th - 40rd week), the initial probability of dry week (P_D) and conditional probability of dry week preceded by another dry week (P_{DD}) ranged from 9.1–86.4% and 0.0–91.7%, respectively. At the first week of main rainy season *i.e.* 24th week, the chance of occurrence of dry week (P_D) and conditional probability of dry week preceded by another dry week (P_{DD}) were 54.6 and 66.7% respectively, similarly at the end of main rainy season (40rd week), dry week (P_D) and conditional probability of dry week preceded by another dry week (P_{DD}) had chance of 86.4 and 81.3% occurrences, respectively.

For main rainy season, the initial probability of wet week (P_W) and conditional probability of wet week

Table 4 : Initial and conditional probabilities of dry and wet spells of rainfall at the study site, Damoh region.

Weeks	Initial probabilities		Conditional probabilities					Initial probabilities		Conditional probabilities			
	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)	Week	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	4.8	95.2	0.0	0.0	95.2	4.8	27	81.8	18.2	88.2	11.8	40.0	60.0
2	0.0	100.0	0.0	100.0	100.0	0.0	28	77.3	22.7	83.3	16.7	50.0	50.0
3	9.1	90.9	0.0	0.0	90.9	9.1	29	90.9	9.1	94.1	5.9	20.0	80.0
4	0.0	100.0	0.0	100.0	100.0	0.0	30	90.9	9.1	95.0	5.0	50.0	50.0
5	9.1	90.9	0.0	0.0	90.9	9.1	31	86.4	13.6	90.0	10.0	50.0	50.0
6	0.0	100.0	0.0	100.0	100.0	0.0	32	90.9	9.1	89.5	10.5	0.0	100.0
7	4.6	95.5	0.0	0.0	95.5	4.6	33	81.8	18.2	80.0	20.0	0.0	100.0
8	0.0	100.0	0.0	100.0	100.0	0.0	34	81.8	18.2	94.4	5.6	75.0	25.0
9	9.1	90.9	0.0	0.0	90.9	9.1	35	72.7	27.3	77.8	22.2	50.0	50.0
10	9.1	90.9	0.0	100.0	90.0	10.0	36	59.1	40.9	62.5	37.5	50.0	50.0
11	9.1	90.9	0.0	100.0	90.0	10.0	37	54.6	45.5	69.2	30.8	66.7	33.3
12	0.0	100.0	0.0	100.0	100.0	0.0	38	45.5	54.6	50.0	50.0	60.0	40.0
13	0.0	100.0	0.0	0.0	100.0	0.0	39	27.3	72.7	50.0	50.0	91.7	8.3
14	0.0	100.0	0.0	0.0	100.0	0.0	40	13.6	86.4	0.0	100.0	81.3	18.8
15	4.6	95.5	0.0	0.0	95.5	4.6	41	4.6	95.5	33.3	66.7	100.0	0.0
16	4.6	95.5	0.0	100.0	95.2	4.8	42	4.6	95.5	0.0	100.0	95.2	4.8
17	0.0	100.0	0.0	100.0	100.0	0.0	43	0.0	100.0	0.0	100.0	100.0	0.0
18	0.0	100.0	0.0	0.0	100.0	0.0	44	4.6	95.5	0.0	0.0	95.5	4.6
19	0.0	100.0	0.0	0.0	100.0	0.0	45	0.0	100.0	0.0	100.0	100.0	0.0
20	4.6	95.5	0.0	0.0	95.5	4.6	46	4.6	95.5	0.0	0.0	95.5	4.6
21	0.0	100.0	0.0	100.0	100.0	0.0	47	0.0	100.0	0.0	100.0	100.0	0.0
22	4.6	95.5	0.0	0.0	95.5	4.6	48	0.0	100.0	0.0	0.0	100.0	0.0
23	18.2	81.8	100.0	0.0	85.7	14.3	49	0.0	100.0	0.0	0.0	100.0	0.0
24	45.5	54.6	100.0	0.0	66.7	33.3	50	0.0	100.0	0.0	0.0	100.0	0.0
25	63.6	36.4	80.0	20.0	50.0	50.0	51	0.0	100.0	0.0	0.0	100.0	0.0
26	77.3	22.7	64.3	35.7	0.0	100.0	52	0.0	100.0	0.0	0.0	100.0	0.0

preceded by another wet week (P_{WW}) varied from 13.6–90.9% and 33.3–100% respectively. At the first week of main rainy season, the chance of occurrence of wet week (P_W) and conditional probability of wet week preceded by another wet week (P_{WW}) were 45.5 and 100% respectively, similarly at the end of main rainy season, wet week (P_W) and conditional probability of wet week preceded by another wet week (P_{WW}) had chance of 13.6 and 33.3% occurrences, respectively. It is clear from results that, probability of occurrence of wet week is more than 35% during 24-25th SMW (5th June–18th June) and average weekly rainfall ranges from 29.1 to 61.8 mm, this rain can be utilized for summer ploughing and initial seed bed preparations. The mean onset of rainy season was found to be 25th SMW. So, during 25th SMW (12th June–18th June), the sowing operations can be taken up since, the probability of wet week is more than 50% and average weekly rainfall is 61.8 mm. Sowing operations taken at 25th SMW helps for good germination of seeds and helps in avoiding moisture stress for germination period during 25th –28th SMW. In the event of delayed start of rainy season, the sowing operations can be taken up latest by 27th SMW (2nd July–8th July) and further delay in sowing may cause very low productivity and crop failure. Since, mean length of rainy season was observed to be 16-17 weeks (96-120 days), during *kharif*, short duration crops of groundnut, pigeon pea, maize, sorghum, green gram, soybean, sunflower, field bean, cowpea and other low water required crops which have high return value can be taken up. Another advantage of growing short duration cereals, pulses and oilseeds in first fortnight of June is that these can be harvested by the end of September (38th SMW) and short duration *rabi* crops can be sown during 39th-41rd SMW (1st-28th October). Since, winter rainfall is uncertain and erratic than south west monsoon also it contribute only

Table 5 : Analyses of consecutive dry and wet week probabilities of rainfall at the study site, Damoh.

Week	Consecutive Dry Probability		Consecutive Wet Probability			Consecutive Dry Probability		Consecutive Wet Probability	
	Two days	Three days	Two days	Three days	Week	Two days	Three days	Two days	Three days
1	95.2	86.6	0	0	27	9.1	1.8	68.2	64.2
2	90.9	90.9	0	0	28	4.6	2.3	72.7	69.1
3	90.9	82.6	0	0	29	4.6	2.3	86.4	77.7
4	90.9	90.9	0	0	30	4.6	0	81.8	73.2
5	90.9	86.8	0	0	31	0	0	77.3	61.8
6	95.5	95.5	0	0	32	0	0	72.7	68.7
7	95.5	86.8	0	0	33	13.6	6.8	77.3	60.1
8	90.9	81.8	0	0	34	9.1	4.6	63.6	39.8
9	81.8	73.6	0	0	35	13.6	9.1	45.5	31.5
10	81.8	81.8	0	0	36	27.3	16.4	40.9	20.5
11	90.9	90.9	0	0	37	27.3	25	27.3	13.6
12	100	100	0	0	38	50	40.6	22.7	0
13	100	95.5	0	0	39	59.1	59.1	0	0
14	95.5	90.9	0	0	40	86.4	82.3	4.6	0
15	90.9	90.9	0	0	41	90.9	90.9	0	0
16	95.5	95.5	0	0	42	95.5	91.1	0	0
17	100	100	0	0	43	95.5	95.5	0	0
18	100	95.5	0	0	44	95.5	91.1	0	0
19	95.5	95.5	0	0	45	95.5	95.5	0	0
20	95.5	91.1	0	0	46	95.5	95.5	0	0
21	95.5	81.8	0	0	47	100	100	0	0
22	81.8	54.6	4.6	4.6	48	100	100	0	0
23	54.6	27.3	18.2	14.6	49	100	100	0	0
24	27.3	0	36.4	23.4	50	100	100	0	0
25	0	0	40.9	36.1	51	100	0	0	0
26	9.1	4.6	68.2	56.8	52	9.1	1.8	68.2	64.2

2% of total rainfall. Therefore growing of high value *rabi* crops without supplementary irrigation would be very high risky during *rabi* season.

During main rainy season, the probability of dry week (P_D) being more than 50% were observed during 25th, 26th and 38th to 40rd SMW and also chance of dry week preceded by another dry week (P_{DD}) were more than 50% during 25th, 28th, 30th, 31th and 34th to 40rd SMW. Therefore during those dry weeks especially at the end of main rainy season, supplementary irrigation and moisture conservation practice need to be undertaken. The significant contribution of weekly rainfall *i.e.* 47.8% of total annual rainfall during 29th–35th SMW and high consecutive wet week probability during 29th–34th SMW, indication for potential scope of harvesting excess runoff water for future supplemental irrigations and also drives attention towards soil erosion measures to be taken up for soil erosion control. The analyses of consecutive dry and wet spells (Table 5) revealed that there were 54.6 to 100% chances that two consecutive dry weeks (P_{2D}) would occur within the first 23 weeks of the year.

Similarly, the probabilities of occurrence of three consecutive dry weeks (P_{3D}) were also very high (27.3–100%) in the first 23 weeks of the year. The corresponding values of two and three consecutive wet weeks (*i.e.* P_{2W} and P_{3W}) from the 1st to 23rd SMW were very low with values ranging from 0 to 18.2% and 0 to 14.6%, respectively. From the 25th to 37th SMW, the chances of occurrence of two and three consecutive dry weeks were only within 0 to 27.3% and 0 to 25.0%, and 0 to 20.0%, respectively. Similarly, there were chances of 36.4 to 86.4% and 23.4 to 77.7% that the weeks from the 24th to 37th SMW would be getting sufficient rain with two and three consecutive wet weeks, respectively.

Conclusion

During rainy season, the probability of dry week (P_D) being more than 50% were observed during 25th, 26th and 38th to 40rd SMW Therefore during those dry weeks especially at the end of main rainy season, supplementary irrigation and moisture conservation practice need to be undertaken. The significant contribution of weekly rainfall *i.e.* 47.8% of total annual rainfall during 29th–35th SMW, hints for potential scope of harvesting excess runoff water for future supplemental irrigations.

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Competing interests

Authors have declared that no competing interest exits.

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