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WET AND DRY SPELL ANALYSIS FOR AGRICULTURAL CROP PLANNING USING MARKOV CHAIN PROBABILITY MODEL AT BHAVANISAGAR

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ABSTRACT

Sequence of dry and wet periods along with onset and withdrawal of rainy season is necessary for successful agricultural crop planning and soil and water conservation measures. In the present study, Markov chain probability model to calculate the chances of occurrences of dry and wet spells was applied for Bhavanisagar using 47 years (1969 to 2015) weekly rainfall. The average annual rainfall of Bhavanisagar was found to be 677.9 mm and coefficient of variation (CV) was 28.4% which is higher than threshold limit that indicates the erratic distribution of rainfall. Monsoon starts on the 24th standard meteorological week (SMW) (11 – 17th June) and remains active up to 46th SMW (12-18th November) with a total length of 22 weeks (154 days). Initial, conditional and consecutive dry and wet week probabilities showed that chances of occurrence of a week getting dry is high during early part of the season and chances of occurrence of a week getting wet is high from 34th week onwards upto 47th week. Chances of occurrence of wet week of more than 30% at the beginning of Kharif season indicates that summer ploughing and initial seed bed preparations shall be taken up in the 20th – 22nd SMW (14th May - 3rd June) and sowing operations can be taken up since 23rd SMW (4th – 10th June). However higher values of CV showed that higher variability of rainfall during this period which questioned the success of growing of rainfed crops. During the rabi season, from 37th week to 49th week high chances of occurrence of wet week of more than 50%, high consecutive wet weeks and the values of CV less than threshold limit of 150 indicates that all agricultural operations like planting/sowing under rainfed condition can be undertaken successfully during this period. Chances of occurrence of consecutive dry weeks indicate the need of supplemental irrigations and moisture conservation. Weekly rainfall of more than 40 mm during 42nd – 45th SMW and chances of occurring consecutive wet weeks during 38th – 47th SMW intimate the potential scope of harvesting excess runoff water for future supplemental irrigations.

KEYWORDS: Markov Chain Model, Wet and Dry Week, Weekly Rainfall, Coefficient of Variation, Onset and Withdrawal of Rainy Season

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INTRODUCTION

Bhavanisagar is a revenue block in the Erode district of Tamil Nadu, India. Bhavani River, a major tributary of the Kaveri River originates from Nilgiri hills of the Western Ghats flows through this block and forms the major source of irrigation in this area. Bhavanisagar dam is located on the river Bhavani and the dam is used to divert water to the lower Bhavani Project for irrigating dry parts of the district. The major crops grown in this area are paddy, Turmeric, Maize, Sugarcane, Banana, Vegetables. Initial field preparation, planning of crop sowing/planting and carrying out all agricultural operations in an area requires the details of distribution of rainfall, onset and withdrawal of rainy season and periods of dry and wet spells. Markov chain probability model helps to study the chances of occurrences of dry and wet spells (Pandharinath, 1991). Success of rainfed

agriculture largely depends on the onset and the withdrawal of monsoon. Onset and withdrawal of rainy season for crop planning can be determined by forward and backward accumulation of daily rainfall. Crop failure and yield loss may be occurred due to late onset of monsoon and early withdrawal of rains. Many studies have been conducted using Markov chain probability model for crop planning (Pandharinath, 1991; Dash and Senapati, 1992: Panigrahi and Panda., 2002; Srinivasareddy et al., 2008; Senthilvelan et al., 2012; Mangaraj et al., 2013; Mandal et al., 2013; Admasu et al., 2014; Swetha et al., 2015; Sifer et al., 2016). With this background information, this study analyse the period of onset and withdrawal of rainy season and chances of occurrence of wet and dry periods for Bhavanisagar, Erode.

MATERIAL AND METHODS

Daily rainfall data recorded at the Meteorological Observatory of Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar for a period of 47 years (1969 – 2015) was processed and converted into weekly rainfall. Assessment of dry and wet spell has been carried out using weekly rainfall data based on Markov chain probability model. A week is considered as a dry week when rainfall is less than 20 mm in a week and when rainfall is more than 20 mm it is a wet week (Pandharinath, 1991).

Markov chain probability model has been found suitable to describe the long-term frequency behaviour of wet or dry spells. Markov chain probability model assumes that the probability of rainfall occurring on any week depends on whether the previous week was wet or dry. Rainfall amount is involved only in the definition of occurrence or non-occurrence of rain. In the first order Markov chain the probability of an event that would occur on any single day depends only on the conditions during the preceding day and is independent of events of further preceding days. The model calculates the initial probabilities of getting a dry spell / wet spell in a given standard meteorological week. The calculation of conditional probabilities provides the information on the dry spell followed by dry spell or wet spell *vice-versa*. The calculation of initial and conditional probabilities are given below;

I. Initial Rainfall Probability (%)

Initial rainfall probability of getting less than 20 mm rainfall of week Wx

$$P_D = \frac{F_D}{N}$$

$$P_W = \frac{F_W}{N}$$

II. Conditional Rainfall Probability (%)

Conditional rainfall probability (%) of getting less than 20 mm rainfall during next week also when there was rainfall of > 20 mm during this week (x)

$$P_{DD} = \frac{F_{DD}}{F_D}$$

$$P_{WW} = \frac{F_{WW}}{F_W}$$

$$P_{DW} = 1 - P_{WW}$$

$$P_{DW} = 1 - P_{WW}$$

III. Consecutive Dry and Wet Week Probabilities

Probability of 2 consecutive dry weeks starting with the week

$$2D = P_{Dw1} P_{DDw2}$$

$$2W = P_{Ww1} P_{WWw2}$$

$$3D = P_{Dw1} P_{DDw2} P_{DDw3}$$

$$3W = P_{Ww1} P_{WWw2} P_{WWw3}$$

Where,

P_D - Probability of the week being dry

P_W - Probability of the week being wet

N - Number of years of data

F_D - Number of dry weeks

F_W - Number of wet weeks

N - Number of years of data

P_{DD} - Probability (conditional) of a dry week preceded by a dry week

P_{WW} - Probability (conditional) of a wet week preceded by a wet week

P_{WD} - Probability (conditional) of a wet week preceded by a dry week

P_{DW} - Probability (conditional) of a dry week preceded by a wet week

F_{DD} - Number of dry weeks preceded by another dry week

F_{WW} - Number of wet weeks preceded by another wet week

2D - Probability of 2 consecutive dry weeks starting with the week

2W - Probability of 2 consecutive wet weeks starting with the week

3D - Probability of 3 consecutive dry weeks starting with the week

3W - Probability of 3 consecutive wet weeks starting with the week

P_{Dw1} - Probability of the week being dry (first week)

P_{DDw2} - Probability of the second week being dry, given the preceding week dry

P_{DDw3} - Probability of the third week being dry, given the preceding week dry

P_{Ww1} - Probability of the week being wet (first week)

P_{WWw2} - Probability of the second week being wet, given the preceding week wet

P_{WWw3} - Probability of the third week being wet, given the preceding week wet

Onset and Withdrawal of Rainy Season

Forward and backward accumulation methods were used for computation of onset and withdrawal of rainy season from weekly rainfall data. In this method weekly rainfall was summed by forward accumulation (20+21+…+52 weeks) until a certain amount of rainfall was accumulated. Seventy five millimetres of rainfall accumulation has been considered as the onset time for the growing season of dry seeded crops and land preparation (Babu and Lakshminarayana, 1997; Panigrahi and Panda, 2002). The withdrawal of rainy season was determined by backward accumulation of rainfall (48+47+46+…+30 weeks) data. Twenty millimetres of rainfall accumulation was chosen for the end of rainy season, which is sufficient for ploughing of fields after harvesting the crops (Babu and Lakshminarayana, 1997).

Probabilities of Onset and Withdrawal of Rainy Season

The percent probability (P) of each rank was calculated by arranging them in ascending order and by selecting highest rank allotted for particular week. The following Weibull's formula has been used for calculating percent probability:

$$P = \frac{m}{N+1}$$

Where, m is the rank number and N is the number of years of data used.

RESULTS AND DISCUSSIONS

Rainfall Characteristics

The mean annual rainfall at Bhavanisagar (Figure 1) was found to be 677.9 mm and it varied from 362.7 (lowest in 1990) to 1169.36 mm (highest in 1987) with standard deviation (SD) of 192.5 mm. The average annual rainy days was 42 which were between 24 days (1982) and 64 days (2008). It was also observed that over the study period, 22 years (47%) received rainfall above annual average. Analysis of seasonal rainfall showed that the rainfall contributed to the annual rainfall during the winter (Jan-Feb), summer (March-May), southwest (Jun-Sep) and northeast monsoon (Oct-Dec) were 2.6, 21, 28 and 48.4 per cent respectively.

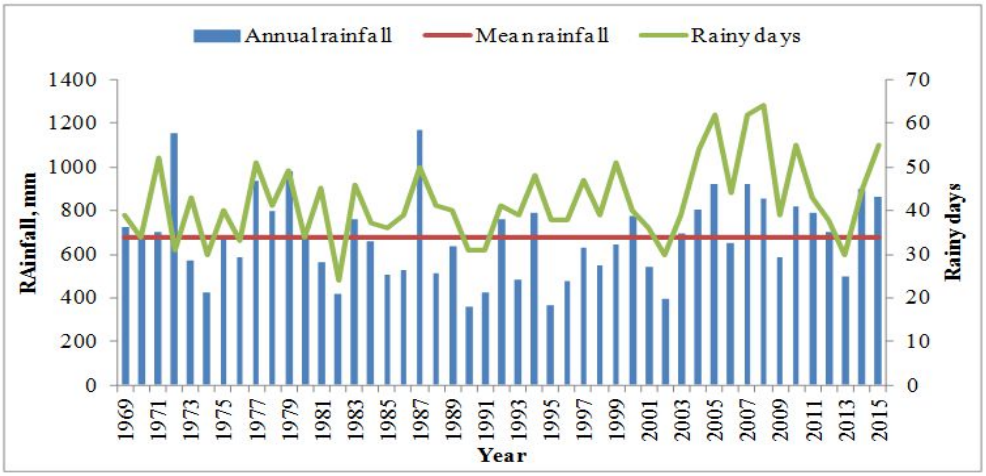

Figure 1: Mean Annual Rainfall (mm) and Rainy Days for the Period of 1969 – 2015

The highest mean monthly rainfall (Figure 2) was received during October (161.8 mm) followed by November (129.56 mm), September (90.88 mm), May (71.7 mm) and August (44.4 mm). The minimum rainfall of 6.17 mm was received in the month of January, it was followed by February (11.6 mm). The average monthly rainy days was 4 and only four months experienced more than the average rainy days. The maximum rainy days were in the month of October (9 days) followed by November (7 days), September (6 days) and the minimum rainy days were in the month of January followed by February.

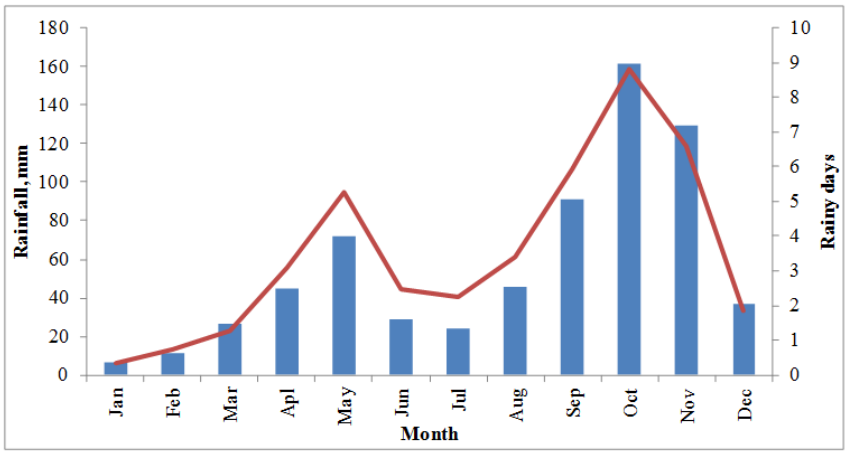

Figure 2: Mean Monthly Rainfall (mm) and Rainy Days for the Period of 1969 – 2015

The weekly mean rainfall, rainy days and coefficient of variation were also computed and tabulated (Table 1). The maximum weekly rainfall was recorded in the 45th week (45.1 mm) followed by 42th week (43 mm). Thirty two weeks (62 per cent) received a rainfall less than the average weekly rainfall of 13 mm. The maximum number of weekly rainy days (more than 2 days per week) was recorded from 42nd to 45th week.

Table 1: Weekly Rainfall, Rainy Days and Coefficient of Variation of Rainfall at Bhavanisagar (1969 - 2015)

SMW	Average Rainfall (mm)	Rainy Days	CV of Rainfall (%)	SMW	Average Rainfall (mm)	Rainy Days	CV of Rainfall (%)
1	2.59	0.09	437.30	27	5.07	0.49	224.48
2	0.83	0.09	398.79	28	5.80	0.47	178.69
3	1.40	0.06	481.83	29	5.17	0.51	196.44
4	0.96	0.04	466.53	30	6.98	0.60	281.30
5	1.01	0.11	335.75	31	8.33	0.60	244.37
6	2.04	0.17	417.38	32	5.07	0.47	173.84
7	2.98	0.15	364.92	33	15.06	0.87	173.15
8	4.99	0.26	240.38	34	13.02	1.00	163.91
9	2.70	0.28	217.46	35	8.64	0.83	168.35
10	7.80	0.36	299.30	36	12.12	1.04	139.85
11	10.36	0.32	326.79	37	17.64	1.38	135.28
12	4.85	0.19	364.94	38	29.65	1.49	126.41
13	1.61	0.21	251.98	39	28.02	1.79	143.69
14	8.05	0.57	186.79	40	29.74	1.53	131.59
15	10.24	0.72	191.70	41	26.99	1.87	100.21
16	11.17	0.77	157.52	42	42.95	2.32	114.23
17	12.89	0.91	181.27	43	41.98	2.36	105.30
18	14.54	1.04	124.49	44	42.22	2.04	105.64

Table 1: Contd.,							
19	17.88	1.19	136.91	45	45.09	2.04	119.89
20	13.82	1.17	122.72	46	26.27	1.51	155.26
21	18.59	1.32	104.50	47	26.37	1.32	166.83
22	17.77	1.28	123.00	48	13.26	0.64	188.03
23	9.18	0.83	125.57	49	17.09	0.62	444.06
24	6.19	0.51	179.11	50	9.36	0.49	261.83
25	3.43	0.28	241.36	51	3.50	0.26	361.67
26	1.58	0.26	191.86	52	3.06	0.23	266.29

The coefficient of variation (CV) in percentage is an indicative of dependability of rainfall. The threshold levels for CV for any interpretation are < 25, < 50, < 100 and < 150 per cent for annual, seasonal, monthly and weekly rainfall respectively (Manorama et al*.,* 2007). If the CV is within the threshold limit of variability, it is considered that the rainfall is highly dependable and *vice-versa.* At Bhavanisagar, CV of annual rainfall was found to be 28.4% which is higher than threshold limit, so it indicates that the mean annual rainfall amount is not highly dependable.

The CV of winter, summer, southwest and northeast monsoon was found to be 150, 49.5, 49.3 and 47.8 per cent respectively. The CV of seasonal rainfall except winter season was found to be lower than the threshold limits (50% for seasonal rainfall) which indicates rainfall is much dependable around mean seasonal rainfall. The monthly rainfall CV varied from 64.9% in October to 254 % in December. The CV of April to June and September to November was well within the threshold limits (< 100%) which shows dependable rainfall around the mean monthly rainfall at Bhavanisagar station.

Onset and Withdrawal of Rainy Season

The data on onset, withdrawal and duration of the rainy season (difference between onset and withdrawal time) and its variability in Bhavanisagar are presented in Table 2. Weekly rainfall data of 47 years (1969 – 2015) indicated that the monsoon starts effectively from 24th standard meteorological week (SMW) (11 – 17th June) and remains active up to 46th SMW (12-18th November). Therefore, mean length of rainy season was found to be 22 weeks (154 days) which include rainfall of both south west and north east monsoon.

Table 2: Characterization of the Rainy Season at Bhavanisagar (1969 – 2015)

Sl. No.	Particulars	Std Week	Date
I	**Onset of Rainy Season**		
1	Mean week	24	11 to 17th Jun
2	Earliest week	20	14 to 20th May
3	Delayed week	29	16 to 22nd Jul
II	**Withdrawal of Rainy season**		
1	Mean week	46	12 to 18th Nov
2	Earliest week	43	22 to 28th Oct
3	Delayed week	49	03 to 09th Dec
III	**Duration of Rainy Season**		
1	Longest duration of rainy season	31	
2	Shortest duration of rainy season	15	

The earliest and delayed week of onset of rainy season was 20th SMW (14 – 20th May) and 29th SMW (16 – 22nd July) respectively. Similarly the earliest and delayed week of termination of rainy season was 43rd SMW (22 – 28th October) and 49th SMW (03rd – 09th December) respectively. The longest (subtraction of earliest rainy season and delayed withdrawal of rainy week) and shortest length of rainy season was 31 and 15 weeks respectively.

Probabilities of Onset and Withdrawal of Rainy Season

The probabilities of onset and withdrawal of rainy season was calculated by Weibull's formula and results are presented in Table 3. The results reveal that there is a 75 % chance that the onset of rainy season and termination of rainy season will occur during 23rd and 45th SMW respectively.

Table 3: Probability of Onset and Withdrawal of Rainy Season at Bhavanisagar

STD week	20	21	22	23	24	25	26	27	28	29
Probability (%)	89	84	79	74	68	63	58	53	47	42
Std week	43	44	45	46	47	48	49	50	51	52
Probability (%)	91	82	73	64	55	45	36	27	18	9

Table 4: Initial, Conditional Probabilities and Consecutive Dry and Wet Week Probabilities of Rainfall at Bhavanisagar

Standard Week	Initial Probabilities (%)		Conditional Probabilities (%)				Consecutive Dry and Wet Week Probabilities			
	PD	PW	PDD	PWW	PWD	PDW	2D	2W	3D	3W
1	94	6	91	0	9	100	85	0	77	0
2	100	0	98	0	2	100	98	0	96	0
3	98	2	96	0	4	100	94	0	89	0
4	96	4	93	0	7	100	89	0	85	0
5	100	0	98	0	2	100	98	0	96	0
6	98	2	96	0	4	100	94	0	89	0
7	96	4	93	0	7	100	89	0	83	0
8	89	11	88	20	12	80	79	2	70	0
9	98	2	96	0	4	100	94	0	89	0
10	89	11	88	0	12	100	79	0	68	0
11	87	13	85	17	15	83	74	2	64	0
12	91	9	91	0	9	100	83	0	74	0
13	100	0	98	0	2	100	98	0	96	0
14	83	17	79	0	21	100	66	0	53	0
15	83	17	77	0	23	100	64	0	49	0
16	81	19	76	11	24	89	62	2	45	0
17	83	17	85	25	15	75	70	4	57	0
18	72	28	68	23	32	77	49	6	32	2
19	66	34	61	25	39	75	40	9	26	2
20	68	32	69	33	31	67	47	11	32	2
21	66	34	55	19	45	81	36	6	19	0
22	64	36	70	47	30	53	45	17	34	6
23	87	13	85	17	15	83	74	2	66	0
24	91	9	88	0	12	100	81	0	70	0
25	96	4	93	0	7	100	89	0	83	0
26	100	0	98	0	2	100	98	0	96	0
27	94	6	91	0	9	100	85	0	77	0
28	94	6	91	0	9	100	85	0	79	0
29	94	6	93	33	7	67	87	2	81	0
30	91	9	88	0	12	100	81	0	74	0
31	89	11	90	20	10	80	81	2	74	0
32	91	9	88	0	12	100	81	0	70	0
33	79	21	78	10	22	90	62	2	51	0
34	77	23	75	18	25	82	57	4	47	0
35	83	17	85	38	15	63	70	6	57	4
36	77	23	81	45	19	55	62	11	47	4
37	74	26	74	33	26	67	55	9	43	4

Table 4: Contd.,										
38	55	45	42	33	58	67	23	15	13	4
39	62	38	59	33	41	67	36	13	23	2
40	60	40	54	26	46	74	32	11	19	0
41	49	51	48	46	52	54	23	23	9	11
42	38	62	39	59	61	41	15	36	6	26
43	43	57	35	52	65	48	15	30	4	17
44	38	62	50	66	50	34	19	40	9	21
45	45	55	57	65	43	35	26	36	13	21
46	62	38	55	33	45	67	34	13	21	4
47	57	43	70	55	30	45	40	23	30	11
48	77	23	75	9	25	91	57	2	43	0
49	89	11	88	20	12	80	79	2	70	0
50	89	11	90	20	10	80	81	2	74	0
51	96	4	96	0	4	100	91	0	87	0
52	96	4	93	0	7	100	89	0	83	0

Initial, Conditional Probabilities and Consecutive Dry and Wet Week Probabilities of Rainfall at Bhavanisagar

Initial, conditional probabilities and consecutive dry and wet week probabilities calculated for Bhavanisagar are presented in Table 4 for all the 52 standard meteorological weeks. The results in relevance with rainy season starts from the first week of June and ends during the last week of November (20^{th} SMW – 48^{th} SMW) only are discussed. From the Table, initial probabilities showed that chances of occurrence of a week getting dry is high during early part of the season and the probability decreases with the progress of rainy season from 34^{th} week onwards. Subsequently chance of occurrence of a week getting wet is high upto 47^{th} week due to heavy downpour during north east monsoon.

Parallel patterns are followed for conditional probabilities and consecutive dry and wet week probabilities. The chances of occurrence of dry week preceded by another dry week (P_{DD}) are less during monsoon periods particularly from 38 to 46^{th} SMW. The chances of occurrence of wet week preceded by another wet week (P_{WW}) are high during rainy season. Chances of occurrence of wet week preceded by another dry week (P_{WD}) are very limited whereas chances of occurrence of dry week preceded by another wet week (P_{DW}) are very high throughout the year.

Results of analysis of consecutive dry and wet week during rainy season showed that the chances of occurrence of 2 or 3 consecutive dry weeks starting with the week (2D and 3D) are high throughout the year except rainy season. But the chances of occurrence of 2 or 3 consecutive wet weeks starting with the week (2W and 3W) are high during rainy season.

Planning of Agricultural Crops-Applications

Proper planning of agricultural crops and water management requires the knowledge of chances of occurrence of wet and dry spells during the monsoon period and co-efficient of variation (CV) of rainfall. Some of the applications towards agricultural planning are presented below.

Usually, in a calendar year, water is released from Bhavanisagar dam, from 16^{th} December to 15^{th} April for raising irrigated dry crop of groundnut and 15^{th} of August to 15^{th} of December for wet crop of rice. Threshold limit of 20 mm per week at more than 50% of initial probability during the rainy season is adequate for crop activities like land preparation and the conditional probability of occurrence of rainfall at 20mm per week above 50% is the right week for sowing/planting. The estimation of co-efficient of variation (CV) of rainfall is more suited for agricultural purposes. The higher the CV, the lesser the dependability of rainfall and *vice-versa*. The threshold limit for CV for weekly rainfall should be less than 150% (Senthilvelen et al., 2012).

Major crops cultivated during *kharif* season under irrigated conditions are rice and maize. *Kharif* irrigated rice crop will be taken up from 3rd week of August to 1st week of September and Maize may be taken up from 3rd week of September to 2nd week of October when water is released from reservoir. Definite dates of opening and closing of Bhavanisagar Dam water for irrigation are based on the water availability in the reservoir. This reflects in planning cropping sequence of farmer's choice. This constraint not only affects *kharif* and *rabi* crop growing seasons, but also has an impact on the growing of the summer season crops.

During the *kharif* season under rainfed condition, crops cultivated are sorghum, finger millet, maize, chickpea, greengram, horsegram, cowpea, groundnut, castor, sesame and cotton. Land preparation and sowing/planting is done in the month of May/June/July which falls in the 20th – 30th SMW. Summer ploughing and initial seed bed preparations shall be taken up by utilizing pre-monsoon rain during 20th – 22nd standard week (14th May - 3rd June). Average weekly rainfall received during this period ranges from 15 to 19 mm and chances of occurrence of wet week are more than 30%. The sowing operations can be taken up since 23rd SMW (4th – 10th June). Also the mean onset of rainy season is found to be 24th SMW (11th – 17th June). Average weekly rainfall received from 23rd to 36th week (03rd – 09th Sep) ranges from 2 to 15 mm.

During the *kharif* season, the co-efficient of variation of rainfall ranges from 105% to 281%. The CV is less than threshold limit of 150 percent at the beginning of *kharif* season. This indicates higher dependability of rainfall during this period. Hence, agricultural operations like planting/sowing can be undertaken successfully during this period. Higher variability of CV during later part of *kharif* season reflects the higher variability of rainfall during this period. Therefore successful growing of rainfed crops during this period is very limited.

Major crops cultivated during *rabi* season under irrigated conditions are rice and maize/groundnut. Under rainfed conditions crops cultivated are blackgram, greegram, horsegram, cowpea. The planting/sowing *rabi* crop under irrigated condition starts in the month of August/September/October. It mainly depends on the release of water from Bhavanisagar Dam for irrigation. From 37th week to 49th week average rainfall ranges are between 12 to 45 mm. During this period chances of occurrence of wet week are more than 50% and consecutive wet weeks are high. The CV of rainfall during the sowing period of *rabi* crop varies from 100% to 188%. During this crop season the CV is less than threshold limit of 150 percent (except beginning of week). This indicates higher dependability of rainfall during this period. Hence, agricultural operations like planting/sowing under rainfed condition can be undertaken successfully during this period.

Post monsoon period, crops such as groundnut will be 1st week of December to 1st week of January; rice will be taken up from 1st week of January to 4th week of January; maize will be 2nd week of January to 2nd week of February; sesame will be 2nd week of February to 2nd week of March taken up. These crops will be taken up when water is released from reservoir for irrigated dry crops. But release of water from reservoir mainly depends on previous year monsoon rainfall. During these periods, the chance of occurrences of week become dry is high. Also the CV is more than the threshold limit which indicates the dependability of rainfall is very less. So precautionary measures may be taken up for supplementary irrigation.

Delay in the start of rainy season delays the time of sowing/planting under rainfed conditions. In the case of two to four weeks delay in start of monsoon, groundnut + blackgram/greengram/cowpea or six week delay, Sorguam + blackgram/greengram/cowpea may be taken up. Due to delay in start of monsoon and high chances of occurrence of dry weeks increases the chances of poor germination of seeds and severe moisture stress. Further delay in

sowing due to start of monsoon or low rainfall during monsoon may cause very low productivity and crop failure.

Since the mean length of rainy season is observed to be 22 weeks (154 days), during *kharif* and *rabi,* short duration crops of Sorghum, Finger millet, maize, chickpea, greengram, horsegram, cowpea, groundnut, and sesame 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 (39^{th} SMW) and short duration *rabi* crops can be sown during 40^{th} to 43^{rd} SMW (1^{st} Oct – 28^{th} October). Since, winter rainfall is uncertain and erratic than south west and north east monsoon, growing of high value *rabi* crops without supplementary irrigation would be highly risky.

The significant contribution of weekly rainfall of more than 40 mm during 42^{nd} – 45^{th} SMW and chances of occurring initial, conditional consecutive wet weeks during the period from 37^{th} – 46^{th} SMW intimate the potential scope of harvesting excess runoff water for future supplemental irrigations. It also drives attention towards soil erosion measures to be taken up for soil erosion control. In the same way, chances of occurrence of high consecutive dry week after 46^{th} SMW, provides information about the need for supplementary irrigations and moisture conservation practices to be taken up. Even in the happening of mid season dry weeks, mulching and other water conservation practices will help in reducing soil evaporation and conserve moisture in top layers of the soil.

CONCLUSIONS

This study found out the chances of occurrences of dry and wet weeks for appropriate crop planning and water management. A mean of 154 rainy days with a commencement of rainfall from 26^{th} SMW and 40^{th} week as termination of rainy season will occur. Land preparation and sowing could be taken up between 26 to 28 weeks for main rainy season crop cultivation. Supplementary irrigation and moisture conservation practice need to be practiced during 38^{th} week to 40^{th} week for short duration crops and supplementary irrigation and moisture conservation could be extended if the crop is long duration. Harvesting runoff water and construction of soil erosion measures need to be practices during 28^{th} to 33 week for better water management.

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