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Short communication

Weekly, monthly and seasonal rainfall at Bengaluru in Karnataka

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Rainfall is one of the major factors influencing the agricultural production stability which in turn depends on the onset and distribution of south west (SW) monsoon. There is a variation in onset of monsoon and distribution of rainfall year to year. Time of occurrence and spatial variability governs the crop production activities. Occurrence of frequent and prolonged dry spell in monsoon season is a common trend. Rainfall probability in India have been studied by many scientists (Hundal and Prabhjyot kaur 2002; Mohan Singh *et. al* 2009). The weekly distribution of rainfall and their probability is helpful in crop planning by identifying the periods of drought, normal and excess rainfall (Ray *et. al,* 1980). The Markov chain model has been extensively used to study the probability analysis of rainfall occurrence of initial wet and dry spells as well as conditional probabilities of wet followed by dry, dry followed by wet and dry followed by dry (Mahale and Dhane, 2003; Suchit and Singh, 2009).

Daily rainfall data of Agromet observatory at UAS, GKVK, Bengaluru Karnataka for the period of 1972-2009 is used for analysis. This station is located at 77° 35' E longitude, 13°05' N latitude with altitude of 924 meters above MSL. The data were systematized as annual, seasonal, monthly and weekly rainfall. Weekly, monthly and seasonal rainfall distribution pattern were critically examined and worked out by adopting procedure suggested by Panse and Sukathme (1985). The annual and seasonal rainfall was classified as per the IMD (Indian Meteorological Department) classification. The rainfall probability analysis was based on first order Markov chain as suggested by Victor and Sastry (1979). The weekly initial and conditional probabilities of rainfall were computed using Markov chain process for receiving 10 mm and 15 mm rainfall in a given week.

The mean annual rainfall of GKVK, Bengaluru is 925.8 mm (ranges from 528.0 mm to 1374.4 mm) spread over in 56 rainy days with standard deviation (SD) of 219.4 mm and coefficient of variation (CV) 23.7 per cent. The highest monthly rainfall of 204.2 mm is received during September followed by October (168.0 mm) and August (131.2 mm).

An increasing trend of annual rainfall was observed over the period between 1972 and 2009 as shown in Fig 1. During the study period there were about 58 per cent with normal annual rainfall (22 years), 21 per cent (8 years) with excess rainfall and 21 percent (8 years) with deficit rainfall.

Seasonal rainfall

Mean rainfall during south west (SW) monsoon season (June to September) is 518.4 mm which accounted 56 per cent of the total annual rainfall with a coefficient of variation 30.7 per cent. The number of rainy days in SW monsoon season was varied from 19 to 44 days with an average of 32 rainy days. During north-east monsoon period (October to December) the mean rainfall is 233.9 mm and it contributes 25 per cent to the annual rainfall with coefficient of variation of 55.7 percent and standard deviation of 130.3mm. Mean rainfall during pre-monsoon period (March to May) is 162.2 mm which accounts 18 percent of annual rainfall and winter mean rainfall is 11.3 mm which accounts 1 per cent of annual rainfall (Table 2).

The starting and ending of rains for the purpose of sowing crops and growing period has been identified as follows. The starting date has been identified as the day by which at least 25 mm of accumulated rainfall is received in 3 consecutive days followed by wet spell (no limitation of duration) or dry spell of less than 21 days. The ending of rainy period is identified as the last day by which at least 25 mm of rainfall is available in 5 consecutive days beyond which no rains up to 30 days. Therefore, the matured crop can be safely harvested.

Table 2 depicts that the sowing period during *kharif* begins from 190 Julian Days and extends even beyond 220 Julian Days. During the period of study, the crops were sown between 190 and 204 Julian days (JD) in 19 years (50 per cent) out of 38 years, between 205 and 220 Julian days in 13 years (34 per cent) and beyond 220 JD in 6 years (16 per cent). It is observed that early sown crop have the benefit of 657 mm of mean rainfall with 38 rainy days and can grow up to 125 days. Therefore, this period can be considered as optimum sowing period or normal sowing period. Any normal rainfed crops like pulses, finger millet, paddy tanked/direct sown paddy, groundnut can be comfortably grown during this period. In the late sowing period due to delayed rains, medium duration crops (groundnut, finger millet, sunflower, pulses) can be sown. In the very late rainfall situation only short duration crops have to be preferred (cowpea, green

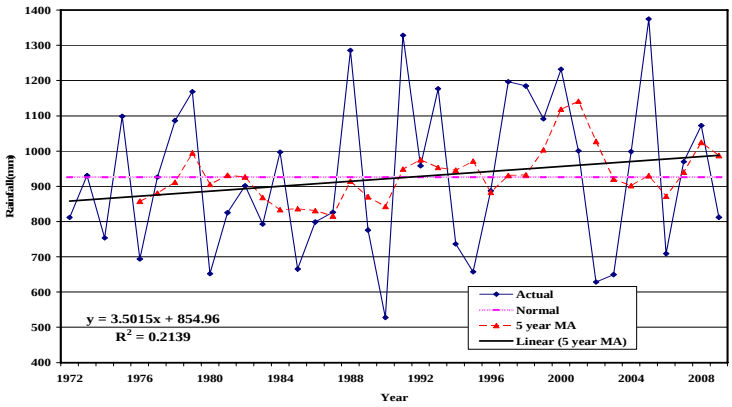

Fig 1: Annual rainfall along with 5 year moving average and its trend at GKVK, Bengaluru

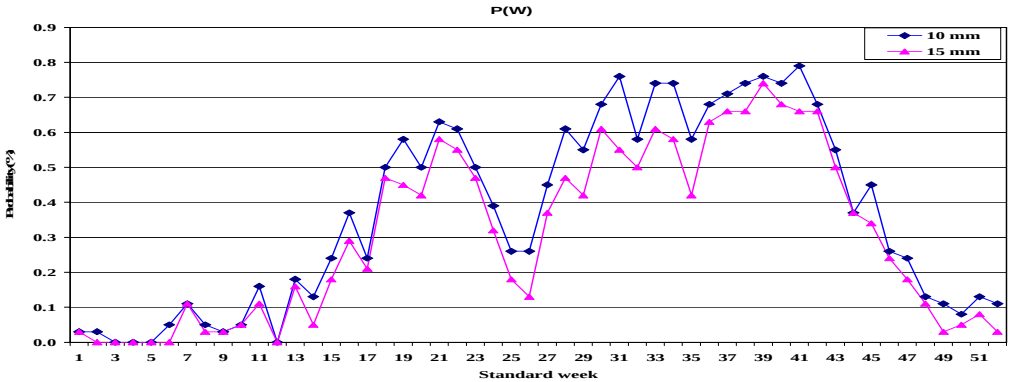

Fig. 2a) : Initial P(W) probability at different limit of rainfall at GKVK, Bengaluru

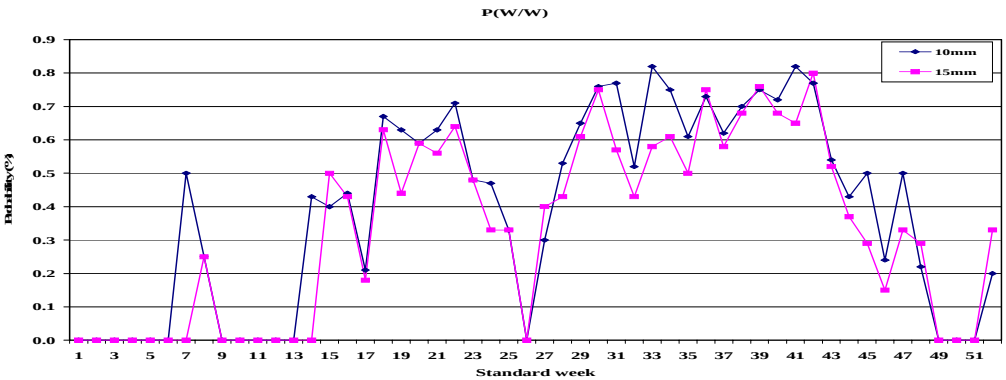

Fig. 2b) : Conditional P(W/W) probability at different limit of rainfall at GKVK, Bengaluru

gram, horse gram, field bean, vegetables).

Weekly rainfall and probability

Mean weekly rainfall during 28th to 43rd standard meteorological week (SMW) varied from 23.8 mm (28th SMW) to 62.2 mm (43rd SMW). The highest peak appeared during 40th SMW with rainfall of 62.2 mm and second highest peak during 38th SMW with rainfall of 56.7mm. In this period coefficient of variation varies from 113 % (28th SMW) to 162 % (43rd SMW). Lowest variability (88%) is observed in 30th and 34th SMW. The mean weekly rainfall shows that 28th to 43rd SMW considered as assured rainfall period since mean weekly rainfall is greater than 20 mm.

The initial P (W) and conditional P(W/W) probabilities have worked out using Markov chain method and shown in Fig. 2. Study of probability of wet week P(W) reveals that

Table 1: Characteristics of seasonal rainfall at GKVK, Bengaluru

Season	Particulars	Mean (mm)	Highest (mm)	Lowest (mm)
Winter (Jan-Feb)	Rainfall	11.3	133.2	0.0
	Rainy day	1	4	0
Pre-monsoon (Mar-May)	Rainfall	162.2	255.1	52.6
	Rainy day	10	18	4
SW Monsoon (Jun-Sep)	Rainfall	518.4	841.9	252.5
	Rainy day	32	44	19
NE Monsoon (Oct-Dec)	Rainfall	233.9	693.1	100.8
	Rainy day	14	22	7
Annual	Rainfall	925.8	1374.4	528.0
	Rainy day	56	71	36

Table 2: Optimum sowing period based on occurrence of rainfall, corresponding events, duration, mean rainfall and rainy days from 1972 -2009 at GKVK, Bengaluru

Optimum Sowing period	Range (Julian days)	Number of events	Crop growing period (days)	Mean amount of rainfall(mm)	Rainy days
Normal	190-204 (9^{th} July to July 23^{rd})	19	125	657	38
Late	205-219 (24^{th} July to Aug 7^{th})	13	117	550	33
Very Late	≥220 (8^{th} Aug onwards)	6	92	462	25

from 18 to 43^{rd} SMW, except 24 to 27^{th} SMW, there is more than 50 per cent probability of getting 10 mm rainfall. From 21^{st} to 43^{rd} SMW, except 24 to 29^{th} SMW and 35^{th} SMW, there is more than 50 per cent probability of getting more than 15 mm rainfall and hence they are considered as wet weeks and this is shown in Fig. 2a. This implies that after the receipt of rains from 21^{st} SMW, there will be a dry spell for 4 weeks in the beginning. Early showers will helpful for land preparations.

The conditional probability of wet week preceded by wet week, P (W/W) for both 10 and 15 mm rainfall exceeds 50 per cent in each week (Fig. 2b) during 18^{th} to 43^{rd} SMW, except 24 to 28^{th} SMW and 32^{nd} SMW.

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