

## Analysis of Rainfall Probabilities for Strategic Crop Planning in Raipur District of Chhattisgarh State

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### ABSTRACT

Rainfall data of recent forty three years (1971-2013) of Labhandi station, Indira Gandhi Krishi Vishwavidhyalaya Raipur, Chhattisgarh was analysed with the method of incomplete gamma probability. The data revealed that the average rainfall of labhandi station is 1202 mm spread over 61 rainy days. Out of this 1055, 68, 53 and 27 mm received from south west monsoon (June-September), north east (October-December), summer (March-May) and winter season (January -February) respectively. Probability for receiving more than 100 mm of rainfall can be expected only at 25% probability level and that too in four weeks which is leading to the interpretation that rainfed rice production is a challenging task in this region. It has been found that at 75 per cent assured probability level rainfall of more than 200 mms can be expected only in July and August months and this rainfall is hardly sufficient for meeting the water requirement in upland situations. However at 50 per cent probability which is equivalent to average condition, cultivation of rice is possible under well water management conditions. On seasonal basis rainfall at assured probability level of 75% is not sufficient as the quantity is 795 mm rainfall in south-western monsoon season.

**Key words:** Crop planning, Rainfall probability, Chhattisgarh.

### INTRODUCTION

Rainfall is the single most important factor in crop production programme particularly under dry lands areas. Of all the climatic factors, rainfall is of greatest concern to population in rainfed agriculture. The variation of monsoonal and annual rainfall in space and time are well known and this inter-annual variability of monsoonal rainfall has considerable impact on agricultural production, water management and energy generation. Analysis of annual, seasonal and monthly rainfall of a region is useful to design water harvesting structure. Similarly weekly rainfall analysis give more useful information in crop planning (Sharma *et al.*, 1979). Earlier workers have worked out the weekly rainfall

probabilities for different agro climatic regions (Ray *et al.* 1980 and Agnihotri *et al.*, 1986). 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. According to Mulat *et al.*, 2004, the quantum of rainfall during crop growing season and temporal distribution of rainfall is a crucial factor deciding interannual fluctuations in national crop production security. On the similar lines, Von Braun (1991) also commented that a 10% decrease in monsoonal rainfall from the long-period average generally translates into a 4.4% decrease in the national food production. Rainfall in much of the country is, on the other hand, often erratic and unreliable and can be considered as gamble; and resultant droughts

due to negative departure of rainfall have historically been major causes of food shortages and famines (Wood, 1977; Pankhurst and Johnson, 1988).

There have been different techniques for determining probability distribution on rainfall analysis and best fit probability distribution function such as normal, log-normal, gumbel, weibull and Pearson type distribution have been identified as per different research studies. Fisher (1924) studied the influence of rainfall on the yield of wheat in Rothamsted and concluded that distribution of rainfall during a season is determining factor rather than total amount of rainfall which influences the crop yield. Another useful line of work relating to the study of rainfall distribution was introduced by Manning (1950) and a transformation of the skew frequency distribution of rainfall was performed to close down to the theoretical normal distribution.

Bhargava *et al.* (1971) also showed that for a number of crops under Indian situation the distribution of rainfall over the season has a great influence on the yield. Ramana Rao *et al.* (1975) analyzed the daily rainfall data of Bijapur for the

period 1921 - 1970. Biswas and Khambete (1989) computed the lowest amount of rainfall at different probability levels by fitting gamma distribution probability model on weekly basis of 82 stations in dry farming tract of Maharashtra. Upadhaya and Singh (1998) stated that it is possible to predict rainfall fairly accurately using various probability distributions for certain returns periods although the rainfall has inconsistent nature both spatially and temporarily.

In Chhattisgarh state, there are large variations in annual rainfall and these variations often result in reduced crop productivity especially rice crop. Rice is grown in approximately 3.6 million hectares area and farmers take tall and photo-sensitive varieties for some reasons which flower by mid-October and mature by mid-November. Terminal drought is a recurring feature for rice crop in this region. Also intermittent dry spells make the crop operations delayed as 80 per cent of the area in this region is under rainfed conditions. Thus, the success of rice crop depends upon not only the monsoonal rainfall but also on the October rainfall which occurs due to cyclonic activity in the Bay of

**Table 1: Monthly and seasonal expected rainfall amount (mm) at different probability levels at Labhandi station, Raipur**

Months	Probability levels			
	90 %	75%	50%	25%
January	0	0	6	26
February	0	1	11	23
March	0	0	10	19
April	0	3	12	20
May	2	9	16	36
June	76	101	144	221
July	136	214	321	451
August	160	228	349	457
September	62	100	192	232
October	1	14	34	68
November	0	0	0	16
December	0	0	0	4
Season				
Winter (Jan-Feb)	0	8	19	40
Summer (Mar-May)	16	25	40	70
Southwest monsoon (Jun-Sep)	702	795	1040	1207
Northeast monsoon (Oct-Dec)	8	23	52	120

Bengal. As the Chhatisgarh plains in central India are mainly dependant on monsoon rains (south-west), the precise knowledge of amount of rainfall that can be expected at different probability levels will go a long way in helping farmers to plan their agricultural operations (Rao *et al.* 1968). Therefore, an attempt has been made for probability analysis of long term rainfall data of Labandi station for developing risk proof technologies for rainfed agriculture of Raipur district.

**MATERIALS AND METHODS**

Daily rainfall data of the recent past 43 years (1971-2013) of Labhandi station, Indira Gandhi Krishi Vishwavidhyalaya Raipur, Chhattisgarh has been scrutinized for correctness of data and converted into weekly, monthly, seasonal and annual format using weathercock software. The weekly rainfall data then analyzed with the help of Weibulls formula as followed by Jadav *et al.* 1999

$$P = \{(m/n+1)/100\}$$

Where, P is plotting position in percentage, m is the rank of magnitude and n is number of year for which the data are taken. Rainfall at various probability levels (25, 50, 75 and 90 percent) for

weekly, monthly, seasonal and annual basis has been worked out and are presented in Table 1 and 2.

**RESULTS AND DISCUSSION**

Analysis of rainfall data showed that on an annual basis, rainfall of the Labhandi station is 1202 mm received in 61 rainy days. The mean monthly rainfall of labhandi is 189, 337, 337 and 191 mm in the month of June, July, August and September, respectively with a total monsoon rainfall of 1054 mm on the data base of 1971-2013.

However when the monthly statistics has been put to probability analysis the rainfall quantity comes down drastically at 90%. 90 per cent probability means that we can expect this rainfall quantity in 9 out of 10 years. However, the assured probability level of 75% which is considered as assured rainfall in 3 out of 4 years. On annual basis, this quantity 1023.2 mm, at 50 probability annual rainfall quantity is 1231.8 mm and at 25% probability, annual rainfall quantity is 1397.5 mm. Moreover, August happens to be wettest month with rainfall quantity of 160, 228, 349, 457 mm at 90%, 75%, 50%

**Table 2: Expected weekly rainfall amount (mm) at different probability levels**

Standard week	Probability levels			
	90 %	75%	50%	25%
23 (4 <sup>th</sup> to 10 June)	0	0	6	32
24 (11 <sup>th</sup> to 17 <sup>th</sup> June)	1	7	28	64
25 (18 <sup>th</sup> to 24 <sup>th</sup> June)	5	17	46	80
26 (25 <sup>th</sup> to 1 <sup>st</sup> July)	11	19	54	98
27 (2 <sup>nd</sup> to 8 <sup>th</sup> July)	10	24	53	78
28(9 <sup>th</sup> to 15 <sup>th</sup> July)	14	43	74	99
29(16 <sup>th</sup> to 22 <sup>nd</sup> July)	17	38	58	111
30(23 <sup>rd</sup> to 29 <sup>th</sup> July)	6	23	60	95
31(30 <sup>th</sup> to 5 <sup>th</sup> August)	10	35	62	110
32(6 <sup>th</sup> to 12 <sup>th</sup> August)	16	36	71	104
33(13 <sup>th</sup> to 19 <sup>th</sup> August)	9	27	77	126
34(20 <sup>th</sup> to 26 <sup>th</sup> August)	6	26	47	84
35(27 <sup>th</sup> to 2 <sup>nd</sup> September)	4	23	56	93
36(3 <sup>rd</sup> to 9 <sup>th</sup> September)	3	22	45	82
37(10 <sup>th</sup> to 16 <sup>th</sup> September)	11	19	29	61
38(17 <sup>th</sup> to 23 <sup>rd</sup> September)	0	1	12	61
39(24 <sup>th</sup> to 30 <sup>th</sup> September)	0	3	13	47

and 25% probability level and its quantity is more than July month. It leads to conclusion that there is need of more preparedness on part of the farmers to go for water management practices (conservation & harvesting) in the months of July and August. Moreover, there is water conservation scope in the month of August which can later be utilized for rice crop at reproductive phase in the month of October. Rainfall quantity is falling drastically in the month of October and at 50 per cent probability, the expected rainfall is 34 mm only.

Similarly seasonal basis analysis has been carried out at different probability levels. At 50 per cent probability, there is expected rainfall of 1040 mm in south-western monsoon season while at 75% probability level assured rainfall of 795 mm which is not sufficient for meeting the water requirement of long duration rice variety and even medium duration rice variety. Therefore, here lies risk in rainfed rice production as well a need for water harvesting

in On Farm Reservoirs (OFRs) farm ponds and other harvesting structures as per farming situation basis.

However, it is the distribution of rainfall on weekly basis which is very important and rainfall quantity expected at 75% probability is less than 50 mms in almost all the weeks during south west monsoon period which adds uncertainty factor in rainfed rice production. Standard week number 28 is receiving highest rainfall quantity of 43 mm which can satisfy minimum water requirement of percolation and ET losses for rice crop. However at 50% probability which means on every alternate year basis, there is definite rainfall receipt of more than 45 mm per week during the period between 25 and 36 standard weeks and this period is in between 18 June and 9 September. Agricultural strategies, farming operations need to be based on this type of analysis and advisories should be planned accordingly.

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