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A study of the reliability, deficiencies and excesses of rainfall over the Haryana State

O. P. BISHNOI

Haryana Agricultural University, Hissar

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ABSTRACT. The maps showing the probabilities of occurrence of rainfall of less than 100, 200, 300, 400, 500 mm during the southwest monsoon season and the percentage number of years of significant excesses/deficiencies of rainfall give information regarding the rainfall distribution in the Haryana State. These maps supplement the normal rainfall and give an idea to the users of the confidence with which the certain amounts of rainfall could be expected over the different regions in the State.

1. Introduction

60 per cent of the cultivated area in Haryana State depends on the monsoon rains. The southwest monsoon season contribute nearly 75 per cent of the annual rainfall. Therefore, a, thorough knowledge of rainfall pattern and the probable departure from normal is essential for successful land use planning. Where the precipitation is periodically insufficient for crop production, the estimates of crop demand for water and water available to meet this demand are essential. The reliability of rainfall can be expressed as to indicate the probabilities of receiving over or under a specified amount of rainfall. Such maps have been given by Glover *et al.* (1954) for East Africa, Gregory (1957) for England and Sreenivasaiah *et al.* (1958) for India.

In the present study, the rainfall data of the State raingauge stations are analysed to study the reliability of rainfall on probability basis. The occurrences of deficiencies and excesses of rainfall in the various parts of the region, their magnitude and frequency of occurrence form important aspects of the rainfall pattern. Such information is very helpful for planning and designing of irrigation and drainage systems and evaluating the climatic potential for agricultural production.

2. Material and Methods

The rainfall data of the 60 raingauge stations of the State were available for 30 years. The rainfall data during the rainy season are analysed in the procedure given below :

(*i*) Using the selected minimum rainfall x, the quantity $d=(m-x)/S$ is calculated for each station, where m=average rainfall and S=standard deviation.

(*ii*) With the help of the table of probabilities of normal distribution, the probability corresponding to this difference d is found for each of the stations.

(*iii*) The percentage probabilities for all the stations are plotted on the maps and isolines have been drawn.

Though the assumption of normal distribution for seasonal rainfall may not be strictly true, but for a broad picture, such an assumption is reasonable. Pramanik and Jagannathan (1953) have studied the rainfall distribution for many stations in India and have shown that the skewness is very small except in the arid regions of Rajasthan and the semi-arid regions in the Deccan.

Walker (1914) procedure has been adopted in classifying the years of deficit rainfall in three categories, *i.e.*, years with rainfall deficiency between 30 to 45 per cent, 45 to 60 per cent and over 60 per cent of the mean annual rainfall and called them years of 'large', 'serious' and 'disastrous' deficiency. Similar maps have been prepared for depicting the excesses of 30 to 45 per cent, 45 to 60 per cent, over 60 per cent of the normal rainfall.

These maps will indicate the liability to drought or flood conditions, particularly in the regions of high rainfall.
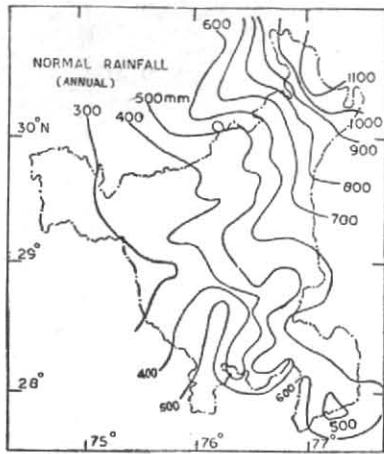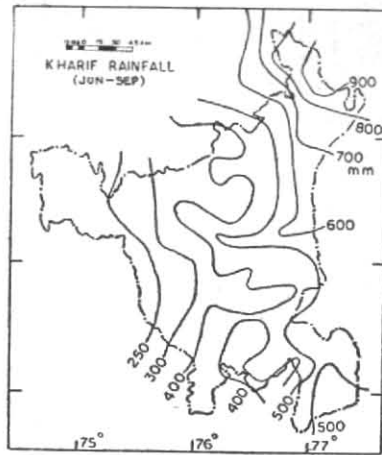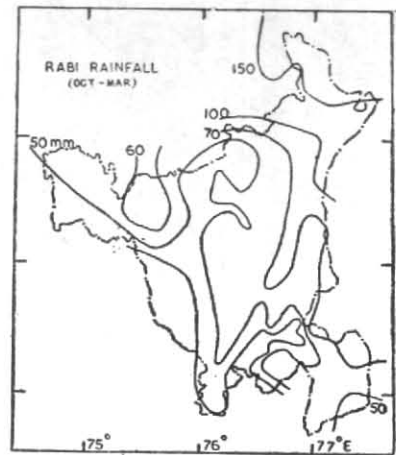
Fig. 1
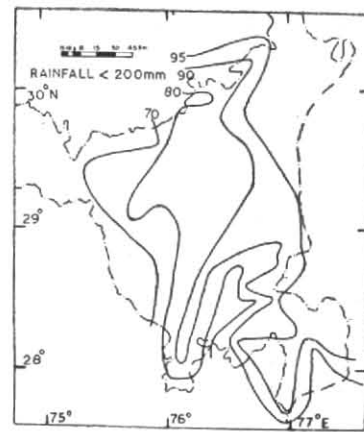
Fig. 2

Fig. 3

Figs. 1-3. Distribution of rainfall in Haryana
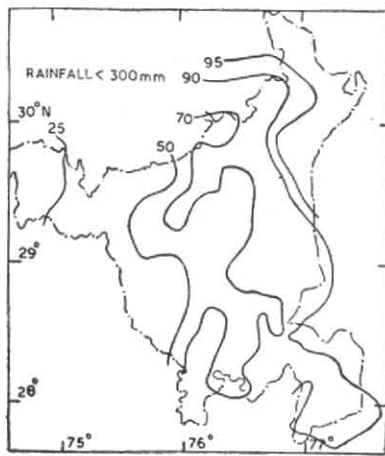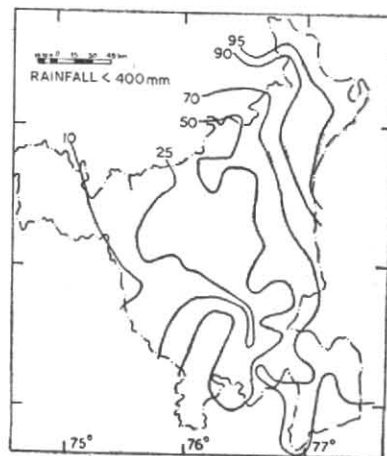
Fig. 4
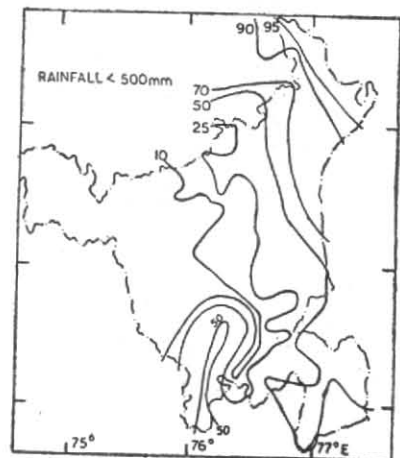
Fig. 5

Fig. 6

Fig. 7

Fig. 8

Figs. 4-8. Percentage probability of monsoon rainfall in Haryana
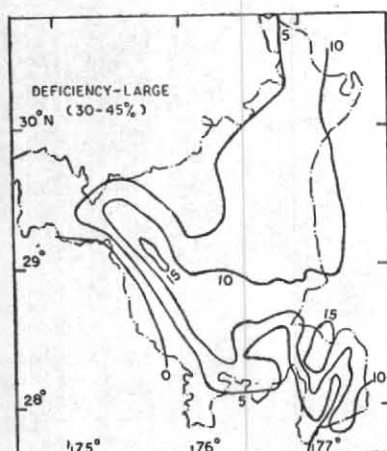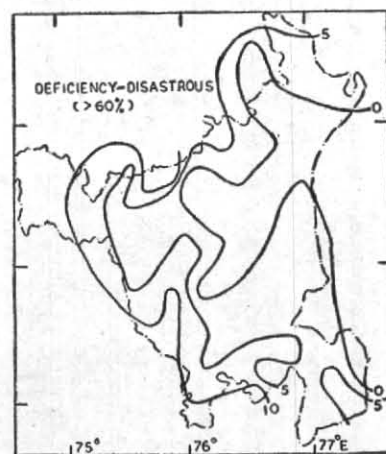
Fig. 9   Fig. 10   Fig. 11

Figs. 9-11. Percentage number of years of deficient rainfall in Haryana (annual normal)

3. Reliability of rainfall

Figs. 1, 2 and 3 show the normal annual rainfall, rainfall during the Kharif season (June to September) and the rainfall during the Rabi season (October to March) respectively. These diagrams indicate the spatial distribution of rainfall in the State. Northern regions are wettest, whereas the southwestern portions receive scanty rainfall. The seasonal rainfall indicate only the amount of average rainfall expected in the different parts of the State. But, this information is not sufficient. It would be appropriate to study the reliability on probability pattern than to assess it from the average picture.

4. The probability maps

The maps indicating the probabilities of rainfall less than 100, 200, 300, 400 and 500 mm during the rainy season (SW monsoon) have been shown in Figs. 4 to 8. The probability maps for increasing amounts of rainfall show a progressive diminution in the area with cent per cent probability and the corresponding increase in the area with lesser probability.

(i) *100 mm probability map* — When this map is compared with Fig. 2, the similarity becomes obvious. The regions of higher rainfall coincide with the regions of higher probability of rainfall. The whole of the State is seen with more than 90 per cent probability at this 100 mm of assured rainfall.

(ii) *200 mm probability map* — The area with 100 per cent probability is reduced. A sufficient area has come under the grip of 70 to 90 per cent probability of rainfall. The northern region has still assured rainfall with 100 per cent probability of 200 mm, whereas the southwestern region receives

rainfall with less than 70 per cent probability. The major tract of the State is under 80 to 95 per cent probability level.

(iii) *300 mm probability map* — A sharp drop in the probability level all over the State is noticed. The area with 100 per cent probability of receiving 300 mm rainfall is considerably less. Dabawali and Rania zone in Hissar district receive 300 mm of rainfall only once in 4 years during the SW monsoon season. Most of the portion of the State comes under the grip of 50 to 90 per cent probability level. Hissar and Bhiwani districts receive 50 per cent probability of rainfall and at this level of moisture, State irrigation facilities are highly desirable in these areas.

(iv) *400 mm probability map* — The area with 100 per cent probability confines to Kalka, Naraingarh, Dadupur and Jagadhari tehsils only. The major portion of the State lies between 25 to 70 per cent probability level. The southwestern regions of the State receive only 25 per cent probability of rainfall. Sirsa tehsil in Hissar district attains 10 per cent probability level. Thus, the agricultural production becomes a limiting factor without the irrigation facilities.

(v) *500 mm probability map* — The area with cent per cent probability is very small confining to northern edge of the State. Major tract of the State is under 25 to 70 per cent probability level. Southwestern tract comprising of Hissar and Bhiwani districts receives only 10 per cent probability of rainfall.

5. Deficiencies of rainfall

The percentage number of years of deficient rainfall termed as 'large', 'serious' and 'disastrous' deficiencies have been shown in Figs. 9
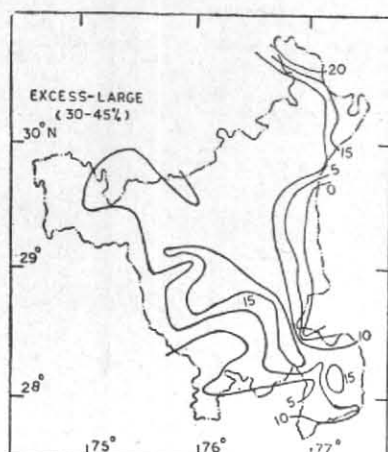
Fig. 12   Fig. 13   Fig. 14

Figs. 12-14. Percentage number of years of excess rainfall in Haryana (annual normal)

to 11. On comparing these maps with the annual rainfall map, it may be seen that the regions of lesser rainfall also happen to be the regions where frequency of occurrence of deficiencies of rainfall is larger. The frequencies of the three grades of deficiencies have indicated the different degrees of liability to drought. On comparing these maps it is worth noting that the regions with greater number of years of large deficiency receive less number of years of serious and disastrous deficiencies. The southwestern portion is under serious and disastrous deficiency, whereas the eastern and northern tracts are lesser under the grip. Southeastern tract is under large deficiency only. It indicates that the regions of higher rainfall have less variation.

6. Excesses of rainfall

The percentage number of years of excess rainfall termed as 'large', 'serious' and 'disastrous' is shown in Figs. 12 to 14 respectively. On comparing these maps, it is observed that the regions with greater number of 'large excess situation', receive less number of years under serious and

disastrous excess situation. On comparing the 'large excess' map with Fig. 2 it is indicated that the regions of higher rainfall also happens to be the regions of higher frequency of occurrence of 30 to 45 per cent excess of annual rainfall. The disastrous excess conditions exist in the medium rainfall area. Floods may be caused by the heavy rainfall in the upper reaches of the rivers flowing through these areas. The 'large' excess situation has been found to exist all over the State. The frequency is greater in high rainfall area. The percentage number of years under 'large' excess conditions is greater than under the 'serious and disastrous' conditions.

7. Results

The diagrams indicating the probabilities of different areas of Haryana State receiving less than 100, 200, 300, 400 and 500 mm of rainfall during the rainy season and the diagrams of percentage number of years of significant excesses or deficiencies of rainfall indicated the reliability of rainfall patterns in the State.

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