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ASSESSMENT OF DROUGHT VULNERABILITY / PROBABILITY ESTIMATES AND DECLARATION MEASURES OF DROUGHT

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ABSTRACT: The current research paper assesses the information that can be known in advance about the various aspects of the rainfall deficiency, including the extent, duration, and areas that are most likely to be impacted in Bhiwani District, Haryana by using determination of various probabilities levels at weekly rainfall periods for various stations under study.

Key words: Drought assessment, probability estimates, rainfall distribution.

1. Introduction

Due to the escalating effects of climate change, which have led to more frequent and severe drought events, drought vulnerability assessment is essential. These evaluations offer crucial information for managing resources over the long term, especially in the areas of agriculture and water distribution, as well as for ensuring food security and economic stability. Additionally, they help to identify socially vulnerable populations, protect ecosystems, and direct efforts to build resilient infrastructure. These data supported analysis help to guide policy, enhance local preparedness, and promote international cooperation to lessen the severe effects of drought on both a local and global level. The ability to predict monsoon rainfall over the long term is crucial because droughts are caused by precipitation shortages. Information on water availability, including its outlook for the near and long term, is valuable (Sivakumar, M. V. K., & Wilhite, D. A. 2002).

Though the India Meteorological department has been successful in predicting the south-west monsoon rainfall across the entire country since 1988, the long-range forecast failed in 2002, when the country experienced its worst drought. Studies on the applicability of summer monsoon rainfall forecasts across India in various regions revealed that forecasts of deficit rainfall were unreliable in most regions except north-western region. Therefore, prediction of the occurrence of droughts over smaller areas is not yet feasible. Under such circumstances, information on the probability estimates of droughts of various durations and intensity, based on long-term climatic records is the option for assessing the vulnerability of different regions for droughts (Wilhelmi, O. V., & Wilhite, D. A. 2002).

2. Study Area

The study was carried out in the Bhiwani district of Haryana state, India. The site is located at 28.19' to 29.05' N latitude and 75.28' to 76.28' E Longitude with an area of 5099 sq kms. The district of Bhiwani is an example of a semi-arid, river less ecosystem where drought is a serious problem that harms the balance of rural economy. The main crops grown in this area are bajra, jowar, wheat and gram.

3. Methodology:

Rainfall distribution over weekly periods has been done for the study to assess drought vulnerability / probability estimates. Thom (1958) found thatthe gamma distribution provides good fit to precipitation series in the United States. The method for evaluating the precipitation estimates' dependability on the number of observations available for analysis is presented in this report (Bridges, T. C., & Haan, C. T. 1972). Mooley and Crutcher (1968) showed that the monthly rainfall during the southwest monsoon season obeys the gamma distribution based on eleven representative stations in India. Mooley (1973), Krishnan and Kushwaha (1972), Bishnoi and Saxena (1978), Khambete and Biswas (1978) showed that the incomplete gamma distribution is the most suitable among Pearsonian models that show good fit to the skew data like rainfall. Thus, the gamma distribution model over the standard weeks being used by the Indian Meteorological Department has been studied on the basis of which rainfall zones can be demarcated having a direct bearing on the cropping plans.

After suitable transformations (Karl Pearson, 1946) the relative probabilities for various intervals can be calculated. Mooley (1974) prepared very suitable tables for the determination of probabilities of rainfall with gamma distribution model. These tables have been utilized here for the determination of various probabilities levels at weekly periods for various stations under study. Bishnoi and Saxena (1978) indicated that upto a cumulative period of four weeks skew ness is very high and therefore normal distribution cannot be applied. In such cases gamma distribution has been fitted and found satisfactory. By fitting gamma distribution the probabilities of weekly rainfall amounts at different levels (10 to 60 percent) have been computed. The study was conducted in six tehsils of Bhiwani district and gamma distribution was attempted on weekly rainfall data.

4. Results and Discussion:

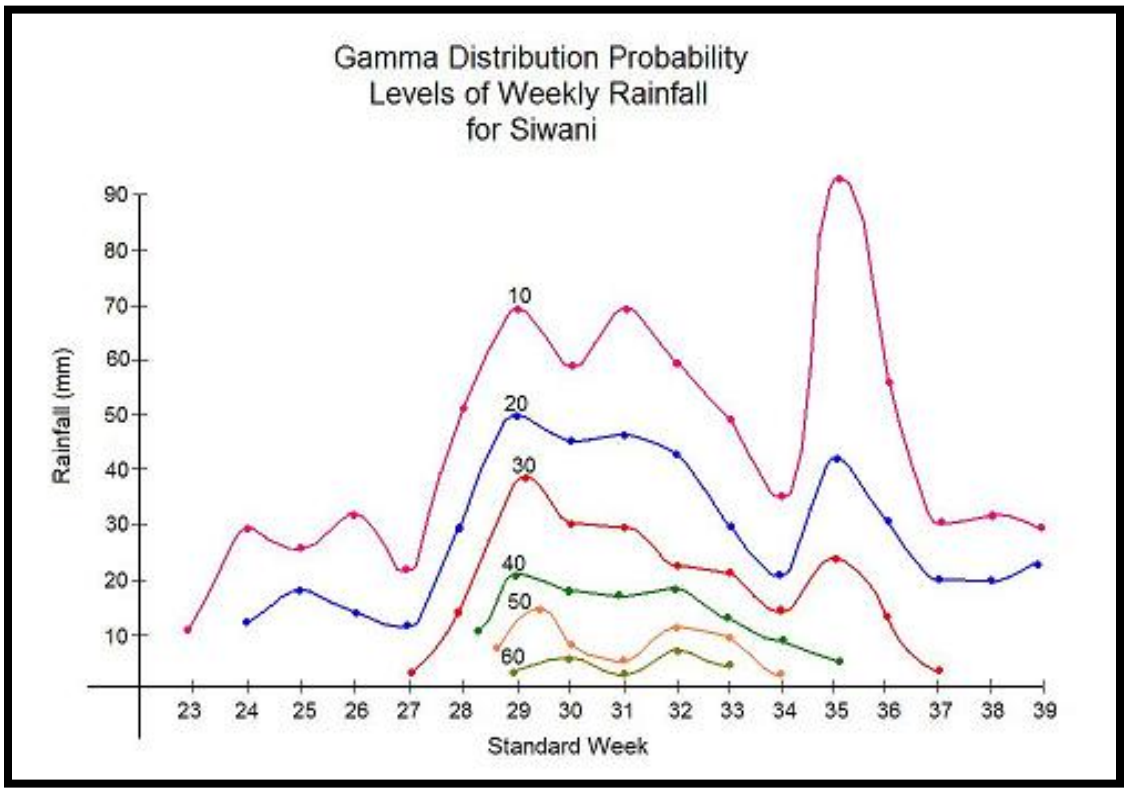
A. Weekly Rainfall Probabilities

1. Weekly Rainfall Probabilities for Siwani*Tehsil*:

The probabilities of weekly rainfall amounts at different levels for the Siwani*Tehsil* of Bhiwani district has been depicted in Fig.1. In this figure, prominent peaks in 29^{th}, 31^{st} and 35^{th} weeks are evident. In

between these peaks in 30th and 34th weeks, a decrease of rainfall is observed indicating lesser monsoonal activities.

Fig 1: Gamma Distribution Probability Levels of Weekly Rainfall for Siwani



The excess water stored during these peak periods can be stored and can be utilized during the lesser rainfall probability periods. Assured rainfall is around 10-15 mm (at 50% level) during the period from mid-29th to 33rd week. The dry period may be harmful to the crops grown in 27/28th week as the early vegetative phase will occur at this stage, and vegetative growth is retarded. In the case of crops like Moong, the critical stage for irrigation is the flowering stage which falls in Mid-August. Since 34th week is one of the stress periods, the lack of water may reduce the grain size and yields considerably. Thus, for a station like Siwani (the driest part of the whole district) short duration crops / varieties with soil conservation practices are strongly recommended.

2. Weekly Rainfall Probabilities for BawaniKhera*Tehsil*:

The graphical picture of probabilities of weekly rainfall amounts at different levels for the BawaniKhera*Tehsil* in the north-eastern part of Bhiwani is given in Fig. 2.In this figure, three prominent peaks in 28th, 31st and 37th weeks and a secondary peak in 34th week are featured.

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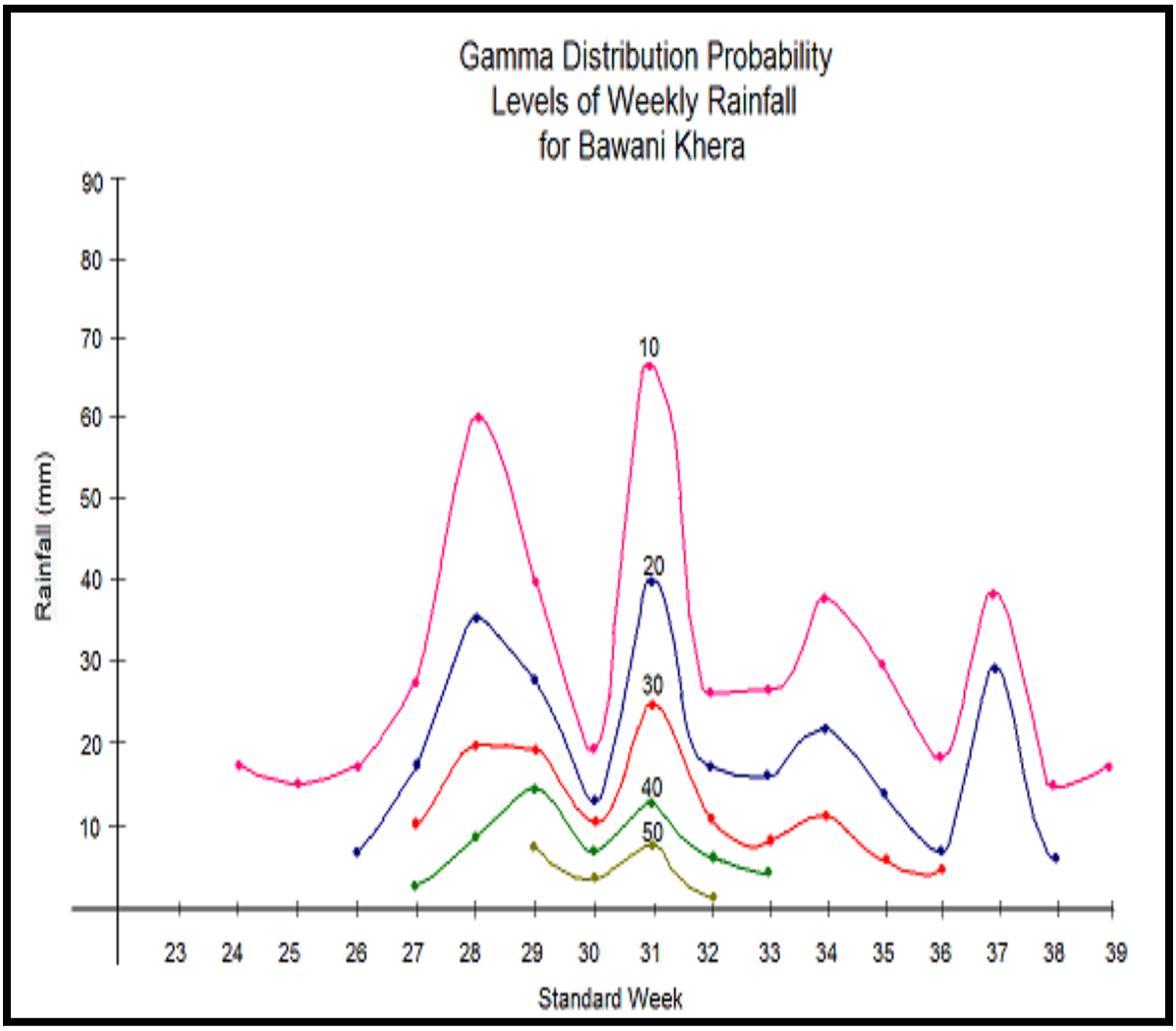
Fig 2: Gamma Distribution Probability Levels of Weekly Rainfall for BawaniKhera



In between the main peaks a decrease of rainfall depicting water stress are also featured during 30th, 32-33rd and 36th weeks. These alternative increasing and decreasing features at particular periods again necessitates the importance of managing the water received due to higher intensity of rainfall at the peak periods. With the better management of the available water resources in the area, crops can be grown with a better output. Assured rainfall is less than 10 mm at 50 percent level during a small period from 30th to 32nd week. Although mainly low water requirement crops are grown but even they suffer due to lesser available water both at the early vegetative as well as the pod development and flowering stages.

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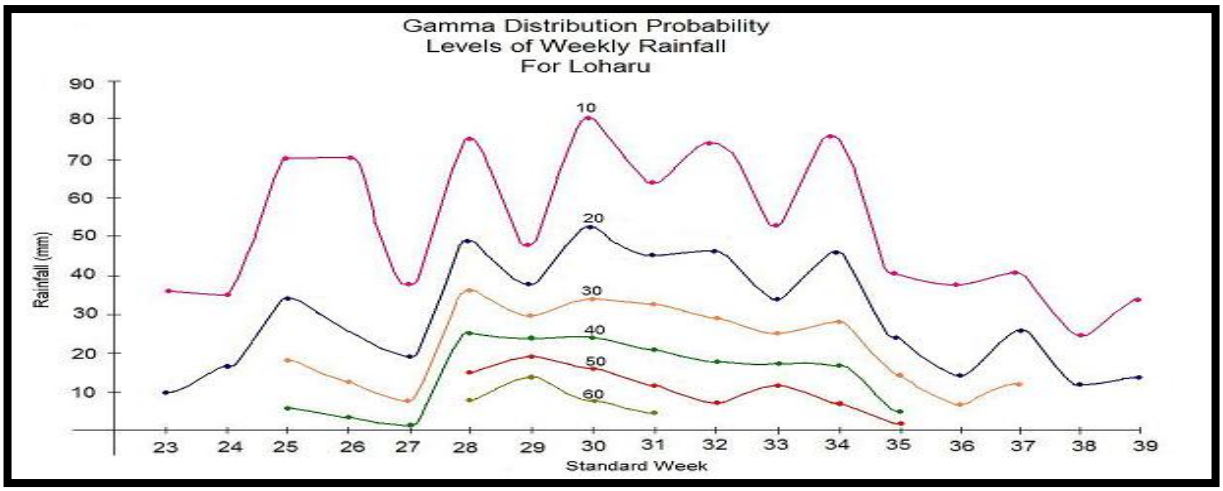
3. **Weekly Rainfall Probabilities for Loharu *Tehsil*:**

The weekly probabilities of rainfall amount at different levels for the *Tehsil* of Loharu is shown by the Fig 3. The probability analysis of the station reveals the depiction of prominent peaks of rainfall during 25th, 28th, 30th and 34thweeks and a secondary peak at 32nd week.

Fig. 3 Gamma distribution probability levels of weekly rainfall for Loharu.

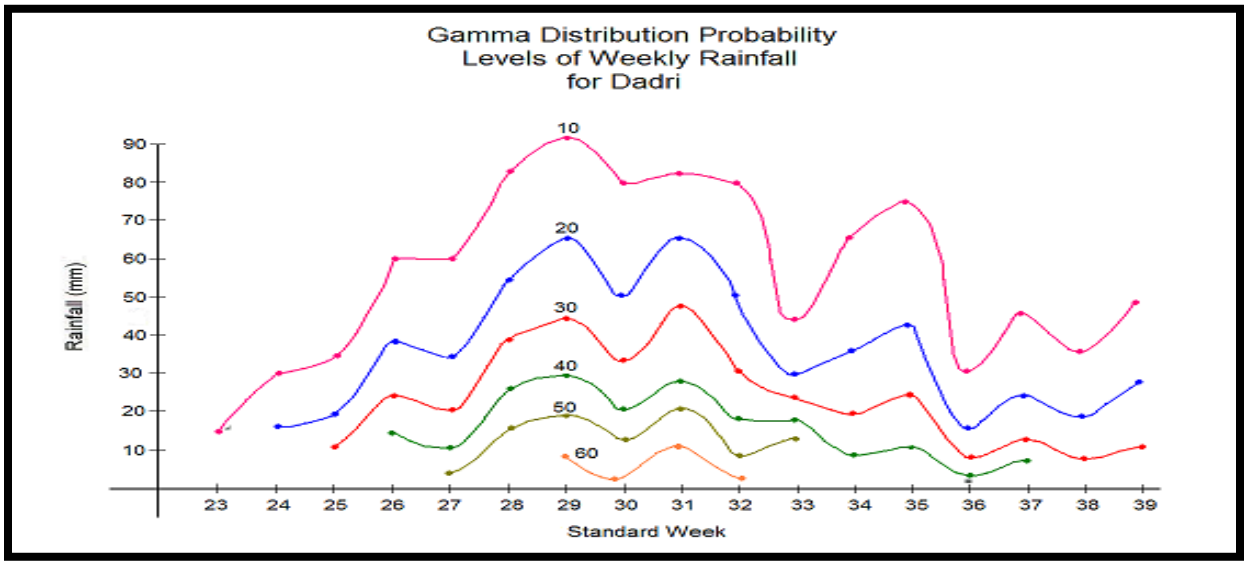


A decrease of rainfall is also featured in between the main peaks during 27th, 29th31st, 33rd and 35th to 36th weeks indicating poor monsoonal activity. The assured rainfall at 50 percent probability level is likely to be occurred during 29th to 34th weeks with 10 to 20 mm amount of rainfall. The maximum amount of probable rainfall at 50 percent level of about 20 mm is in the 29th week. Thus, this pattern again necessitates the importance of drought resistant and short duration crops / varieties like Moong, Bajra, etc.

4. Weekly Rainfall Probabilities forDadri *Tehsil*:

The graphical picture of probabilities of weekly rainfall amounts at different levels for the Dadri *Tehsil* in the south-eastern part of Bhiwani is given in Fig.4. Prominent peaks during 29th, 31st and 35th weeks are the rainfall characteristics in this zone. A decrease of rainfall is also featured during 30th, 33rd and 36th weeks in between the main peaks.

Fig. 4 Gamma distribution probability levels of weekly rainfall for Dadri.

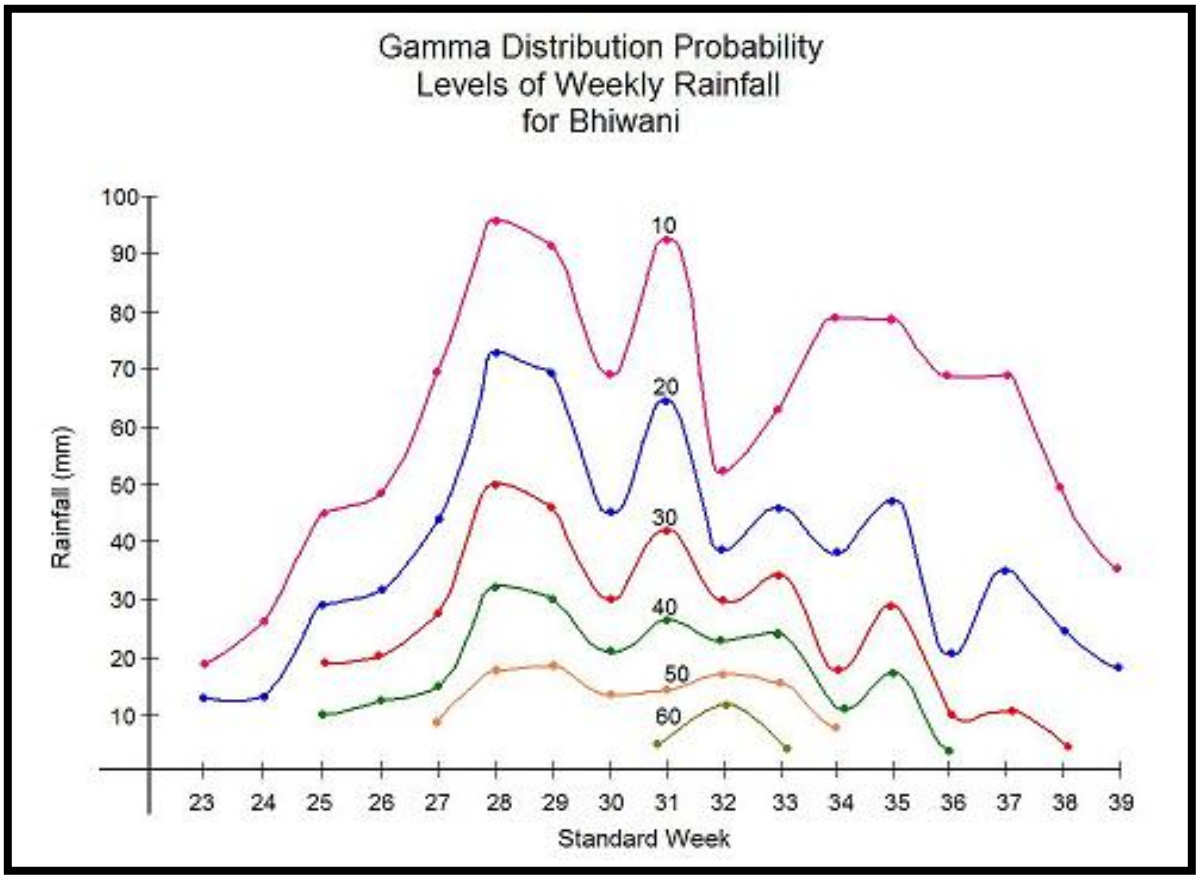


The assured rainfall at 50 percent probability level is expected during 28th to 32nd weeks with 10 to 20 mm amount of rainfall. The decrease in rainfall from 31st to 33rd weeks may be harmful to the crops grown as the vegetative growth may be retarded leading to drying of crops. With the better management of water resources and conserving the water from peak periods in the stress period may be helpful in mitigating the effects of dry periods

5. Weekly Rainfall Probabilities for Bhiwani *Tehsil*:

The probabilities of weekly rainfall amounts at different levels for the Bhiwani *Tehsil* of Bhiwani district has been depicted in Fig. 5.Compared to other *Tehsil*s, a slightly good amount of rainfall with prominent peaks during 28th, 31st and 35th weeks is featured in the figure. In between the first two peaks in the 30th week and in 36th week, a decrease of rainfall is observed indicating lesser monsoonal activity.

Fig. 5: Gamma distribution probability levels of weekly rainfall for Bhiwani.



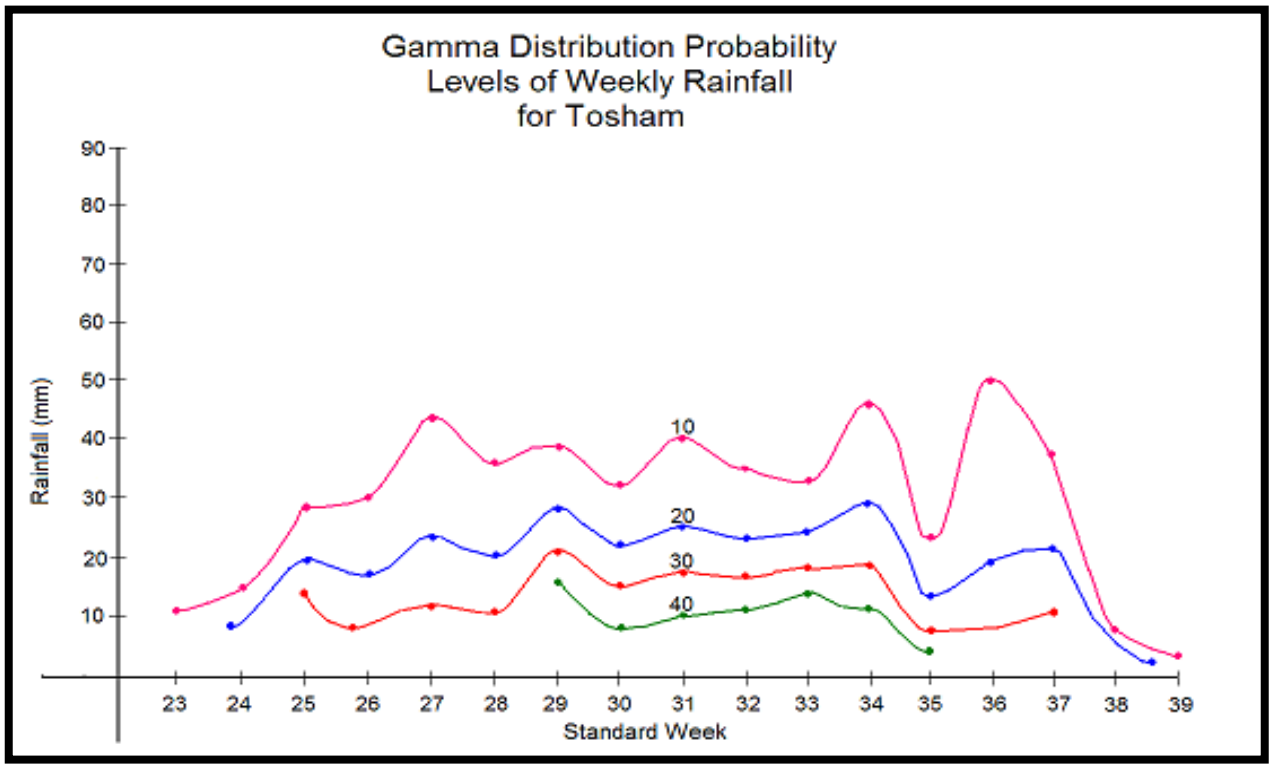
Thus, in spite of good rainfall, these prominent features of higher and lower rainfalls play very important role in day to day agricultural activities at various crop growth stages. Around 10 to 20 mm of assured rainfall is received (at 50 percent probability level) from 28th to 33rd weeks. Thus, it becomes very essential to manage the excess water for its proper utilization during the stress periods. A sudden decrease of rainfall probabilities in the 30th and 32ndweeks may cause harm to the crops which may require water in their flowering stages during that period. Thus, adopting the dry farming techniques for short duration kharif crops may be beneficial for the farmers in this region.

6. Weekly Rainfall Probabilities for Tosham*Tehsil*:

The rainfall probabilities for Tosham are depicted in Fig.6. The rainfall at this station is low adjoining to the Rajasthan. However, uniform low rainfall probabilities exist from 27th to 33rd weeks followed by peak

rainfall probabilities during 34th and 36th weeks. Decrease of rainfall probabilities are featured during 35th standard week and a sharp withdrawal of south-west monsoon after 37th week.

Fig. 6 Gamma distribution probability levels of weekly rainfall for Tosham.



10mm of assured rainfall is available during 25th to 37th standard weeks in 3 out of 10 years. Thus, 7 out of every 10 years are assumed drought years in the region. Cropping plans are not sure in this region. It would be better if the area is exploited for natural vegetation grasses and low water requirement crops like moong, moth and bajra as green fodder. Assured cropping plans are not feasible.

B. Rainfall availability in relation to crop water requirement:

Variations in weather systems and orographic influences result in a variety of rainfall patterns (Anonymous, 1995). Rainfall measurements were available over the study region and being measured, data can be relied upon for its exploitation. National Commission on Agriculture (1976) used the rainfall data in relation to water need of crops for their utility in better crop planning as:

Table 1 Crop Feasibility in relation to Rainfall Availability

Rainfall Pattern	**Kharif Crops Feasibility**
30 cm per month during SW monsoon rainy season of three months	Rice –high water requirement crop (not feasible in the area)
20 to 30 cm per month for three months of rainy season.	Maize, Arhar, Urd-high water requirement (not feasible in the area without irrigation)
10 to 20 cm per month for three months of rainy season	Jowar, Bajra, Cowpeas-medium water requirement crops feasible in the normal rainfall years
5 to 10 cm per month for three months of rainy season	Moong, Moth, Ephemeral grasses, minor millets (Ragi)—feasible
Less than 5 cm per month for three months of rainy season	Grasses, Shrubs, Bajra as fodder – just meeting the water demand of atmosphere

On analyzing the existing rainfall data of *Tehsil*s under study, the rainfall pattern was assessed. Therefore, keeping in view the water needs of crop and rainfall availability during the monsoon rainy season, Bajra, cowpea, moong, moth, grasses; Jowar / Bajra as fodder are feasible in the region. It is advantageous to use new fertilizer responsive hybrid varieties of these crops and vegetations during the rainy season.

References:

- Sivakumar, M. V. K., & Wilhite, D. A. (2002). Drought preparedness and drought management. *Drought Mitigation and Prevention of Land Desertification, University of Ljubljana, Slovenia*, 21-25.
- Wilhelmi, O. V., & Wilhite, D. A. (2002). Assessing vulnerability to agricultural drought: a Nebraska case study. *Natural Hazards*, *25*, 37-58.
- Thom, H. C. (1958). A note on the gamma distribution. *Monthly weather review*, *86*(4), 117-122.

- Mooley, D. A., and Crutcher, Harold L., "An Application of theGamma Distribution Function to Indian Rainfail," ESSA Technical Report EDS 5, U.S. Department of Commerce, Environmental Data Service, Silver Spring, Md., July 1968, 47 pp
- Bridges, T. C., & Haan, C. T. (1972). Reliability of precipitation probabilities estimated from the gamma distribution. *Monthly Weather Review*, *100*(8), 607-611.
- Mooley, D. A. (1973). Gamma distribution probability model for Asian summer monsoon monthly rainfall. *Monthly Weather Review*, *101*(2), 160-176.
- Krishnan, A. and R.S. Kushwaha. (1972). Mathematical distribution of rainfall in arid and semi arid zones of Rajashthan.Indian J. Met.Geophy. Vol. 23(2), pp. 153-160
- Anonymous. (1995). Weekly Rainfall Probability.In "Weekly Rainfall Probability for selected stations of India".Vol.I, pub.by Additional Director General of Meteorology, IMD, Pune-5, pp. i-viii.
- Khambete, N.N. and B.C. Biswas. (1978). Characteristics of short period rainfall in Gujarat.Indian J. Met.Hydrol.Geophy. Vol. 29(3), pp. 521- 527
- Bishnoi, O. P., & Saxena, K. K. (1978). Statistical distribution of different cumulative periods of rainfall in Haryana. *MAUSAM*, *29*(3), 528-534.