*Journal of Agrometeorology* 2 (1) : 47-53 (June 2000)

# Rainfall analysis for rainfed crop planning in the upper Brahmaputra valley zone of Assam

R.L. DEKA AND K.K. NATH

Department of Agrometeorology
Assam Agricultural University, Jorhat - 785 013, Assam

## ABSTRACT

Daily rainfall data for 25 years (1974 - 98) as recorded at Agromet Observatory of Assam Agricultural University, Jorhat, were analysed to suggest rainfall based cropping system for Upper Brahmaputra Valley Zone of Assam. The probability of 10, 20 and 40 mm rainfall per week exceeds 70 per cent values between 13th to 41st, 15th to 39th and 25th to 37th standard meteorological weeks, respectively. Summer crops are suggested to be sown from 11th week onwards in rainfed uplands. In the medium and lowlands, sowing can be started from 13th week to accommodate *sali* rice timely. The period from July to August is regarded suitable for transplanting of sali rice. In the upland situation, where a three crop sequence is followed, the third crop should be sown within October. In the flood prone lowland situation, the second crop of rice should be grown from 37th week onwards.

***Key words :*** Rainfall, Probability, Crop planning.

For better crop planning under rainfed condition detailed analysis of rainfall data is vital. In Assam, rainfed cropping system is prevalent and farmers are totally dependent on rainfall for water supply. In order to stabilize crop yields at reasonable levels in rainfed situation, it is essential to plan rainfed crops and their management practices in consonance with the rainfall pattern prevalent in the region. Analysis of rainfall data on weekly basis gives more information for rainfed crop planning. Rainfall probability profiles could be made use of in selection of cropping system (Jadav *et al.*, 1999). Such analysis has been reported from various parts of the country (Sahoo *et al.*,1991; Prasad *et al.*, 1995; Sarma *et al.*, 1996). Presently, such information is lacking in this region. So, an attempt has been made to analyse the rainfall data of Jorhat station located in the Upper Brahmaputra Valley Zone of Assam. In this preliminary analysis, rainfall data of Jorhat has been taken as the representative of the entire zone.

## MATERIALS AND METHODS

Daily rainfall data for the past 25 years (1974-98) recorded at the Agromet Observatory, Assam Agricultural University, Jorhat ($26^0 47^1$ N, $94^0 12^1$ E, 87 m AMSL), were used for the study. Data were analysed for annual, seasonal, monthly and weekly values following Panse and Sukhatme (1985).

i) Standard deviation ($\sigma$) = $(d^2/N)^{0.5}$, where,
d= deviation of each observation from

mean and N= number of observations.

ii) Standard error (S.Em ±) = $\sigma / (N)^{0.5}$

iii) Co-efficient of variation (CV) = $\sigma/\mu \times 100$, where $\mu$ = mean of n observations.

iv) Probability (%) was calculated as follows:

a) Calculation of normal = $x-\mu/\sigma$, where x is given observation,

b) The table value of ½ $(1+\alpha)$ corresponding to the value of normal deviate was computed. When these differed by 0.1, intermediate values of normal deviate were obtained by interpolation.

c) Probability (%) = [1-table value of ½ $(1+\alpha)$] x 100

## RESULTS AND DISCUSSION

### *Annual rainfall*

The overall mean total annual rainfall of Jorhat for the past 25 years was found to be 1931.2 mm spread over 157 rainy days (Fig 1) with a coefficient of variation (CV) of 13.06 %. The maximum rainfall (2675.4 mm), recorded in 1977 was 39 percent above normal and occurred on 167 rainy days. The lowest rainfall of 1507.4 mm was recorded in 1979 in 137 rainy days and was 22 per cent below normal. During the reported period, in 12 years the rainfall was above normal and in 13 years it was below normal. The number of rainy days per year ranged within 137-170 days (CV 6%).

### *Seasonal rainfall*

For seasonal rainfall analysis, three distinct crop seasons have been identified. These are summer (March to May), *kharif* (June to September) and *rabi* (October to February). The region enjoys a well defined pattern of seasonal rainfall. The highest rainfall occurs during *kharif* season (1232.2 mm) followed by summer (478.6 mm) and *rabi* (220.4 mm) seasons (Table 1). The per cent contribution to total rainfall is 64.8, 24.8 and 11.4 for *kharif*, summer and *rabi*, respectively, with the lowest CV in *kharif* followed by summer and *rabi*. During the reported period, in 14 years *kharif* rainfall was above normal and 11 in years below normal. Likewise, in 13 years summer rainfall and in 10 years *rabi* rainfall was found to be above normal. The number of rainy days per season also followed a similar trend as that of rainfall with 54 per cent occurring in *kharif* season followed by summer (28%) and *rabi* (18 %).

### *Monthly rainfall*

From Table 1 it is seen that rainfall in this region increases from January onwards, attains a flat peak during July and August and then falls reaching the lowest value (15.4 mm) in December. Mean monthly rainfall is the highest in July (394.5 mm). Assam as a whole comes under south-west monsoon from 1st week of June which continues up to the end of September. However, pre-monsoon showers normally start from mid-April itself. Very often the transition from pre-monsoon to monsoon season is not well defined. During the months of June to September the CV of mean monthly rainfall is the least (16 to 20 %).

### *Weekly rainfall*

The average weekly rainfall of

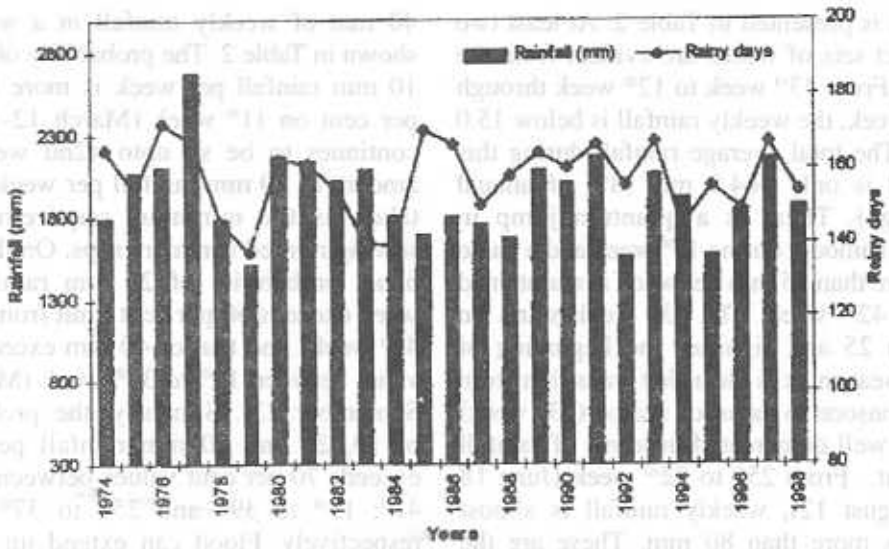


Fig.1 Annual rainfall and rainy days at Jorhat (1974-98)

**Table 1:** Mean monthly and seasonal rainfall and rainy days at Jorhat (1974-98).

| Months/ Seasons | Rainfall (mm) | Contribution to total (%) | SEm ± | CV (%) | Rainy days | Contribution to total (%) | SEm ± | CV (%) |
|---|---|---|---|---|---|---|---|---|
| March | 66.8 | 3.4 | 8.56 | 64.1 | 10.6 | 6.7 | 0.82 | 38.6 |
| April | 182.8 | 9.5 | 17.69 | 48.4 | 15.8 | 10.0 | 0.80 | 25.5 |
| May | 229.0 | 11.9 | 20.41 | 44.6 | 18.0 | 11.5 | 0.74 | 20.5 |
| Total summer | 478.6 | 24.8 | 31.96 | 33.4 | 44.4 | 28.2 | 1.07 | 12.1 |
| June | 284.6 | 14.7 | 20.48 | 36.0 | 21.0 | 13.4 | 0.63 | 15.1 |
| July | 394.5 | 20.4 | 17.02 | 21.6 | 24.9 | 15.9 | 0.58 | 11.7 |
| Aug | 295.5 | 15.3 | 15.55 | 26.3 | 20.4 | 13.0 | 0.66 | 16.3 |
| Sept | 257.6 | 13.4 | 18.59 | 36.1 | 18.6 | 1.8 | 0.67 | 18.1 |
| Total *kharif* | 1232.2 | 63.8 | 34.72 | 14.1 | 84.9 | 54.1 | 1.30 | 7.7 |
| Oct | 120.9 | 6.3 | 14.85 | 61.4 | 9.4 | 6.0 | 0.59 | 31.4 |
| Nov | 26.6 | 1.4 | 4.77 | 89.9 | 3.9 | 2.5 | 0.51 | 65.3 |
| Dec | 15.4 | 0.7 | 3.06 | 99.1 | 3.0 | 1.9 | 0.43 | 71.8 |
| Jan | 18.7 | 1.0 | 2.98 | 79.7 | 3.9 | 2.5 | 0.43 | 55.4 |
| Feb | 38.8 | 2.0 | 5.20 | 67.1 | 7.5 | 4.8 | 0.71 | 47.3 |
| Total *rabi* | 220.4 | 11.4 | 16.75 | 38.02 | 27.7 | 17.7 | 1.16 | 20.9 |
| Grand Total | 1931.2 | 100 | 50.46 | 13.06 | 157.0 | 100 | 2.00 | 6.4 |

Jorhat is presented in Table 2. At least two distinct sets of weeks are evident from the table. From 43rd week to 12th week through 52nd week, the weekly rainfall is below 15.0 mm. The total average rainfall during this period is only 164.0 mm (8% of annual average). There is a quantum jump in rainfall amount during 13th week and a value of more than 25 mm per week is maintained up to 42nd week. The 13th week starts on March 25 and signifies the beginning of rainy season. It is clear that transition from pre-monsoon to monsoon season (23rd week) is not well demarcated in terms of rainfall amount. From 25th to 32nd week (June 18 to August 12), weekly rainfall is almost always more than 80 mm. These are the weeks having higher probabilities for occurrence of flood. The rainy season ceases from 43rd week (October 22-28) when weekly rainfall drops below 15 mm.

Predictably, the CV of weekly rainfall is more than 100 per cent during the post-monsoon i.e., from 39th to 12th week (September 24 to March 25) through the 52nd week. From 13th to 38th week, CV is less than 100 per cent, the lowest value being 44 per cent (29th week). The isolated highest CV (128 %) during 22nd week indicates the transitional nature of pre monsoon to monsoon conditions which is distinct and highly variable.

The highest number of rainy days per week are 6.00 (28thh week) and are at least 3.5 days per week between 14th and 39th week. The values are more stable during 25th and 31st week (CV less than 30%) .

***Weekly rainfall probability***

Probabilities of getting 10, 20 and 40 mm of weekly rainfall in a week are shown in Table 2. The probability of getting 10 mm rainfall per week is more than 60 per cent on 11th week (March 12-18) and continues to be so upto 42nd week. An amount of 10 mm rainfall per week can be taken as the minimum requirement for sowing rainfed summer crops. On the other hand, probability of 20 mm rainfall per week exceeds 60 per cent limit from 13th to 41st weeks and that of 40 mm exceeds this value between 19th to 38th week (May 7 to September 23). Similarly, the probability of 10, 20 and 40 mm rainfall per week exceeds 70 per cent values between 13th to 41st; 15th to 39th and 25th to 37th week, respectively. Flood can extend up to 34th week (August 20-26) from 25th week because higher rainfall in the preceding weeks will contribute to flood water.

***Existing and proposed cropping pattern***

Rice is the staple crop in the Jorhat region and therefore, the cropping system is rice based. Many farmers raise only sali rice as monocrop. The second/third crop grown by a farmer is selected on the basis of two parameters: (a) the type of land (b) amount of rainfall that may occur during the season. The land types commonly available in the zone are upland, medium land (flood free and flood prone), lowland (flood free and flood prone) and deep water land. The farmers do not follow a definite cropping pattern. Rice is invariably grown by the farmers and subsequent crop (s) is not mandatory rather is optional. In the upland areas, rice/maize/summer vegetables followed by toria/potato/wheat in *rabi* is a common cropping pattern. In the medium land situations, *ahu* rice (March-June)-*sali*

Table 2: Mean weekly rainfall (mm), rainy days and rainfall probability at Jorhat (1974-98)

| Standard week | Month and date | Rainfall 1(mm) | S.Em± | CV (%) | Rainfall probability(%) 10mm | 20mm | 40mm | Rainy days | S.Em± | CV (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 1-7 | 5.3 | 2.06 | 196 | 32.2 | 7.5 | - | 0.6 | 0.20 | 163 |
| 2 | 8-14 | 3.3 | 1.62 | 246 | 20.9 | 1.9 | - | 0.6 | 0.19 | 136 |
| 3 | 15-21 | 4.1 | 1.29 | 158 | 17.8 | 0.6 | - | 1.0 | 0.29 | 107 |
| 4 | 22-28 | 4.1 | 1.54 | 189 | 22.5 | 1.9 | - | 0.8 | 0.24 | 133 |
| 5 | Feb 29-4 | 7.1 | 2.71 | 191 | 41.4 | 17.0 | 0.7 | 1.8 | 0.29 | 79 |
| 6 | 5-11 | 8.6 | 1.66 | 96 | 43.4 | 8.5 | - | 1.6 | 0.27 | 84 |
| 7 | 12-18 | 13.0 | 3.48 | 133 | 56.9 | 34.4 | 6.0 | 2.3 | 0.37 | 78 |
| 8 | 19-25 | 8.9 | 2.32 | 130 | 46.1 | 16.8 | 0.3 | 1.7 | 0.29 | 84 |
| 9 | Mar 26-4 | 8.7 | 1.92 | 110 | 44.5 | 12.0 | - | 1.6 | 0.31 | 93 |
| 10 | 5-11 | 10.4 | 3.05 | 140 | 47.6 | 27.5 | 2.5 | 1.8 | 0.34 | 90 |
| 11 | 12-18 | 14.6 | 3.57 | 121 | 60.2 | 38.1 | 7.7 | 2.2 | 0.36 | 80 |
| 12 | 19-25 | 14.1 | 3.61 | 127 | 59.0 | 37.2 | 7.6 | 2.6 | 0.39 | 69 |
| 13 | 26-1 | 28.4 | 5.65 | 99 | 74.2 | 61.6 | 34.0 | 3.0 | 0.30 | 38 |
| 14 | Apr 2-8 | 35.2 | 6.18 | 87 | 78.6 | 57.2 | 40.7 | 3.6 | 0.29 | 40 |
| 15 | 9-15 | 42.3 | 7.43 | 87 | 80.5 | 72.6 | 52.4 | 3.5 | 0.37 | 52 |
| 16 | 16-22 | 41.4 | 6.63 | 80 | 81.7 | 74.0 | 51.6 | 3.7 | 0.36 | 48 |
| 17 | 23-29 | 50.4 | 8.90 | 88 | 81.8 | 75.2 | 59.2 | 3.8 | 0.41 | 53 |
| 18 | May 30-6 | 38.9 | 5.23 | 67 | 85.5 | 76.3 | 48.3 | 4.3 | 0.33 | 36 |
| 19 | 7-13 | 62.1 | 10.26 | 82 | 84.4 | 78.8 | 66.6 | 3.9 | 0.30 | 38 |
| 20 | 14-20 | 54.4 | 7.17 | 85 | 89.2 | 83.1 | 85.6 | 4.3 | 0.31 | 36 |
| 21 | 21-27 | 44.5 | 8.52 | 95 | 78.5 | 71.7 | 54.4 | 3.3 | 0.37 | 55 |
| 22 | Jun 28-3 | 52.8 | 13.59 | 128 | 72.5 | 68.5 | 57.4 | 4.0 | 0.34 | 42 |
| 23 | 4-10 | 61.3 | 8.89 | 72 | 85.2 | 82.3 | 68.4 | 4.5 | 0.29 | 31 |
| 24 | 11-17 | 56.6 | 8.73 | 77 | 85.7 | 79.4 | 64.8 | 4.8 | 0.30 | 31 |
| 25 | 18-24 | 85.2 | 11.23 | 65 | 90.9 | 87.7 | 78.3 | 5.3 | 0.26 | 25 |
| 26 | 25-1 | 69.3 | 8.77 | 63 | 91.1 | 86.9 | 74.9 | 5.4 | 0.27 | 24 |
| 27 | July 2-8 | 102.8 | 11.58 | 56 | 94.5 | 92.3 | 84.3 | 5.9 | 0.19 | 16 |
| 28 | 9-15 | 106.0 | 9.95 | 46 | 97.9 | 96.0 | 90.3 | 6.0 | 0.27 | 22 |
| 29 | 16-22 | 76.1 | 6.78 | 44 | 97.4 | 95.1 | 85.8 | 5.4 | 0.20 | 16 |
| 30 | 23-29 | 81.3 | 12.42 | 76 | 87.4 | 83.8 | 74.7 | 5.7 | 0.22 | 19 |
| 31 | Aug 30-5 | 52.9 | 7.80 | 68 | 88.4 | 82.6 | 66.5 | 4.6 | 0.28 | 29 |
| 32 | 6-12 | 83.1 | 13.65 | 82 | 85.7 | 82.2 | 73.6 | 4.5 | 0.33 | 36 |
| 33 | 13-19 | 58.3 | 7.48 | 64 | 90.1 | 84.7 | 68.8 | 4.4 | 0.32 | 35 |
| 34 | 20-26 | 69.6 | 6.94 | 49 | 95.6 | 92.3 | 79.9 | 4.8 | 0.24 | 25 |
| 35 | Sep 27-2 | 60.2 | 7.97 | 66 | 89.5 | 84.3 | 69.4 | 4.2 | 0.34 | 40 |
| 36 | 3-9 | 78.7 | 11.14 | 70 | 89.0 | 85.3 | 75.5 | 4.5 | 0.29 | 32 |
| 37 | 10-16 | 75.5 | 9.62 | 63 | 91.2 | 87.5 | 76.6 | 4.6 | 0.34 | 36 |
| 38 | 17-23 | 51.2 | 7.64 | 74 | 85.8 | 78.6 | 61.4 | 3.8 | 0.37 | 48 |
| 39 | 24-30 | 48.3 | 9.65 | 106 | 76.5 | 69.9 | 54.3 | 4.2 | 0.36 | 42 |
| 40 | Oct 1-7 | 41.7 | 8.68 | 104 | 76.4 | 69.1 | 51.5 | 3.4 | 0.38 | 56 |
| 41 | 8-14 | 31.4 | 7.26 | 115 | 72.2 | 62.3 | 40.6 | 2.7 | 0.31 | 56 |
| 42 | 15-21 | 26.5 | 7.58 | 143 | 66.7 | 56.7 | 36.0 | 1.8 | 0.31 | 85 |
| 43 | 22-28 | 13.0 | 4.77 | 184 | 54.9 | 38.5 | 12.8 | 1.2 | 0.26 | 112 |
| 44 | Nov 29-4 | 10.3 | 6.61 | 319 | 54.2 | 38.5 | 18.5 | 0.8 | 0.21 | 124 |
| 45 | 5-11 | 14.4 | 3.84 | 168 | 52.9 | 32.7 | 6.8 | 1.1 | 0.21 | 90 |
| 46 | 12-18 | 4.2 | 1.88 | 223 | 26.7 | 4.6 | - | 0.7 | 0.20 | 136 |
| 47 | 19-25 | 3.3 | 1.31 | 195 | 15.5 | 0.5 | - | 0.7 | 0.20 | 130 |
| 48 | Dec 26-2 | 6.3 | 2.53 | 199 | 38.5 | 13.9 | 0.3 | 1.0 | 0.31 | 147 |
| 49 | 3-9 | 1.7 | 0.73 | 220 | 0.6 | - | - | 0.4 | 0.15 | 171 |
| 50 | 10-16 | 5.3 | 2.36 | 222 | 34.5 | 10.6 | 0.1 | 0.8 | 0.24 | 145 |
| 51 | 17-23 | 1.0 | 0.47 | 237 | - | - | - | 0.4 | 0.16 | 171 |
| 52 | 24-31 | 3.8 | 1.25 | 162 | 16.1 | 0.4 | - | 0.9 | 0.29 | 148 |

rice (July-November), *sali* rice - pea/toria/potato/winter vegetables are the common cropping patterns. In addition to these, *sali* rice as monocrop, *ahu* rice (direct seeded or transplanted) - *sali* rice (normal/late) are also some common patterns followed in low land areas.

Based on present study, the following recommendations could be made to increase production per unit area under rainfed condition. The sowing of summer crop in the existing cropping pattern is done in the month of March/April. It is suggested to sow the summer crops like rainfed blackgram, green gram and sesamum from 11th week onwards with a 10 mm rainfall probability 59 per cent. Since the water requirements of these crops are less, they could be grown successfully in uplands. On the otherhand, sowing of direct seeded rice and maize may be started from 13th week onwards as the probable rainfall is 74 and 61 per cent up to 10 mm and 20 mm, respectively. In flood free medium and lowland areas, transplanting of *sali* rice should be completed within July to August as CV values indicate 82 - 44 per cent rainfall from 23rd to 35th week In medium land areas; a third crop with wheat/pea/niger/oat as fodder could be grown successfully under rainfed conditions. Sowings of these crop should be completed within November. In flood prone medium and lowland situations, the period from 25th to 37th week should be avoided as rainfall probability is high (66 to 90% up to 40 mm). Under this situation, rice/jute could be followed by late *sali* either by transplanting of rice varieties having wide flexibility in respect of seedling age and transplanting or by direct seeding of sprouted seeds of extra early photoperiod insensitive varieties from 37th week onwards (September 10-16).

In upland situations, where rice/maize/sesame (summer) - toria/potato/wheat (*rabi*) pattern is followed, the sowings of *rabi* crops should be completed within October (Table 1). During 40 to 43rd week though the CV of rainfall is very high (104 to 184%) still the probability of 10 mm rainfall in these weeks is more than 70%. Therefore, farmers can take to sowing of *rabi* crops in these weeks with minimum risk.

## ACKNOWLEDGEMENT

The authors acknowledge the suggestions received from Dr. J. Deka, Associate Professor, Department of Agronomy, Assam Agricultural University, Jorhat .

## REFERENCES

Jadav, J.D., Mokashi, D.D., Shewale, M.R. and Patil, J.D. 1999. Rainfall probability analysis for crop planning in scarcity zone of Maharastra. Journal of Agrometeorology, 1 (1) :59-64

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi.

Prasad, R., Acharya, C.L. and Angiras, N.N. 1995. Rainfall analysis of mid-hills region of Himachal Pradesh with reference to rainfed farming. Indian Journal of Agricultural Sciences, 65 (11): 826-829.

Sahoo, B.K., Mishra, T.K. and Sahu, P.N. 1991. Rainfall based cropping system in upland conditions of Ganjam. Orissa. Madras Agricultural Journal, 78:439-442

Sarma, N.N., Paul, S.R. and Sarma, D. 1996. Rainfall pattern and rainfall-based cropping system for the Hill zone of Assam. Annals of Agricultural Research, 17:223-229.