# Rainfall analysis in relation to rice crop for Jaintia Hills district of Meghalaya

**B. GOSWAMI, O. P. SINGH[1], K. K. SATAPATHI and UDAY S. SAIKIA**

*Division of Agricultural Engineering*
*ICAR Research Complex for NEH Region, Umiam 793 103, Meghalaya*
*[1]Centre for Environmental Studies*
*North Eastern Hill University, Shillong, Meghalaya*
*Email : ussaikia@yahoo.com*

## ABSTRACT

The long term rainfall data for Sali rice season (June-November) of Jaintia Hills district, Meghalaya has been analyzed to estimate expected weekly rainfall at various probability levels. Based on expected rainfall at 50 and 75% probability levels and water requirement, a crop calendar for Sali rice has been prepared for the district. The calendar is assumed to be applicable for the whole district irrespective of terrain differences as rice is mostly grown in comparatively plain lands in bunded condition. 22nd to 24th meteorological weeks have been suggested best for sowing/transplanting to avoid any kind of water stress during the critical growth periods. Amount of water required to maintain at least 5 cm of standing water in the field up to the dough stage has also been clacilated.

*Key words*: Crop calendar, probability, rice, water requirement

Jaintia Hills district is a major rice-producing belt in the state of Meghalaya. It forms the eastern part of Meghalaya and covers about 4000 sq. km area and situated between latitude of 25°5' N to 25°4' N and longitude of 91°51' E to 92°45' E. Three types of rice are grown in the district namely Sali, Ahu and Boro rice. Both area and production of Sali rice are much higher as compared to other two types of rice in the district (Anon., 2002). Sali rice is direct sown/ transplanted in the month of June-July and harvested in the month of November-December. Rice cultivation is mostly rainfed in nature and cultivated in the plateaus between the hills in bunded condition and hence, the effect of terrain difference or slope variation on soil moisture status may be neglected.

Although North Eastern region falls in very high rainfall zone with lowest rainfall variability, the amount of rainfall received over the years showed a decreasing trend with erratic distribution pattern probably under the influence of global climate change (Saikia *et al*., 2007). Information of expected rainfall during the crop season will help the farmer to take up cultural and management practices in time by minimizing associated risk factors, if any. Rainfall analysis in relation to paddy crop in coastal saline soils at Panvel, Maharastra has been done to evolve rainfall based cropping system to utilize the amount of received rainfall efficiently for improving crop production (Mahale and Dhane, 2003). Rana and Thakur (1998) have suggested rice based cropping pattern in Kulu valley, Himachal Pradesh considering the rainfall amount at different probability levels. Crop planning in relation to rainfall pattern in Paotna valley of Himachal Pradesh has been suggested by Rana and Chakor (1999). Gupta *et al.* (1975) suggested that the rainfall at 80% probability level can safely be taken as sure rainfall, while that of 50% is the medium limit for taking a dry risk. Considering decreasing pattern of rainfall over NE region this analysis is carried out to evolve a crop calendar for Sali rice at 75% probabilistic weekly rainfall for Jaintia Hills district, Meghalaya.

## MATERIALS AND METHODS

The rainfall data of Jaintia Hills District, Meghalaya for Sali rice season, for the period of 1986-2004, has been collected from IMD, Pune. Probability analysis of weekly (Meteorological Standard Week) rainfall for the probability levels of 50, 60, 75 and 90%, respectively, have been done following 'Ranking order method' (Doorenbos and Pruitt, 1984) using the formula given below. This method assumes that rainfall is more or less normally distributed.

$$Fa(m) = \frac{100m}{n+1}$$

**Table1:** Seasonal values of lysimetric evapotranspiration (ET$_1$) mesh covered pan evaporation (Eo) and estimated PET by empirical methods.

| Meteorological week No | Mean rainfall (mm) | Weekly rainfall (mm) at probability levels (%) | | | |
|---|---|---|---|---|---|
| | | 50 | 60 | 75 | 90 |
| 16 | 61.9 | 36.6 | 31.4 | 10.5 | 5.3 |
| 17 | 52.1 | 19.5 | 9.4 | 4.3 | 2.1 |
| 18 | 65.3 | 32.9 | 30.7 | 14.8 | 5.3 |
| 19 | 90.3 | 48.8 | 36.8 | 23.0 | 7.1 |
| 20 | 53.8 | 41.0 | 32.5 | 14.8 | 0 |
| 21 | 50.2 | 54.1 | 51.3 | 0 | 0 |
| 22 | 91.8 | 74.0 | 48.7 | 31.4 | 0 |
| 23 | 88.3 | 77.2 | 52.5 | 31.1 | 0 |
| 24 | 78.7 | 56.9 | 50.8 | 29.1 | 2.2 |
| 25 | 140.8 | 80.5 | 69.8 | 24.4 | 0.7 |
| 26 | 83.9 | 43.8 | 36.9 | 23.2 | 9.3 |
| 27 | 62.9 | 54.6 | 28.1 | 23.3 | 0 |
| 28 | 83.8 | 68.7 | 65.2 | 36.1 | 13.4 |
| 29 | 59.9 | 40.5 | 35.4 | 32.5 | 13.6 |
| 30 | 64.2 | 63.7 | 54.3 | 30.3 | 4.1 |
| 31 | 40.3 | 23.2 | 21.2 | 16.4 | 0 |
| 32 | 50.0 | 36.3 | 30.4 | 17.1 | 0 |
| 33 | 52.1 | 28.4 | 18.7 | 15.5 | 0 |
| 34 | 38.1 | 38.8 | 37.9 | 20.6 | 0 |
| 35 | 63.9 | 48.7 | 43.8 | 19.0 | 2.6 |
| 36 | 47.9 | 26.7 | 24.3 | 15.7 | 4.2 |
| 37 | 33.1 | 24.0 | 22 | 9.6 | 4.2 |
| 38 | 62.5 | 25.0 | 10.3 | 5.2 | 5.1 |
| 39 | 60.8 | 31.3 | 29.8 | 14.6 | 0 |
| 40 | 41.7 | 30.8 | 25.4 | 3.6 | 0 |
| 41 | 36.5 | 9.2 | 6.3 | 0 | 0 |
| 42 | 4.8 | 0 | 0 | 0 | 0 |
| 43 | 26.4 | 2.1 | 0 | 0 | 0 |
| 44 | 12.1 | 0 | 0 | 0 | 0 |
| 45 | 21.3 | 5.2 | 2.1 | 0 | 0 |
| 46 | 11.3 | 0 | 0 | 0 | 0 |
| 47 | 2.8 | 0 | 0 | 0 | 0 |
| 48 | 7.9 | 0 | 0 | 0 | 0 |
| 49 | 1.1 | 0 | 0 | 0 | 0 |
| 50 | 1.7 | 0 | 0 | 0 | 0 |
| 51 | 0.0 | 0 | 0 | 0 | 0 |
| 52 | 2.2 | 0 | 0 | 0 | 0 |

**Table 2:** Estimated water requirement for Sali rice at Jaintia Hills district, Meghalaya

| Met week No | Pan evaporation (mm) | Kc | WR* (mm) | WR+50 mm standing water | Expected rainfall (mm) at | | Water needs to be irrigated (mm) at | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50% Probability | 75% Probability | 50% Probability | 75% Probability |
| 16 | 35.7 | 1.25 | 44.6 | 94.6 | 36.6 | 10.5 | 58.0 | 84.1 |
| 17 | 29.5 | 1.25 | 36.9 | 86.9 | 19.5 | 4.3 | 67.4 | 82.6 |
| 18 | 25.3 | 1.25 | 31.7 | 81.7 | 32.9 | 14.8 | 48.8 | 66.9 |
| 19 | 27.5 | 1.25 | 34.3 | 84.3 | 48.8 | 23.0 | 35.5 | 61.3 |
| 20 | 25.4 | 1.25 | 31.8 | 81.8 | 41.0 | 14.8 | 40.8 | 67.0 |
| 21 | 24.3 | 1.25 | 30.4 | 80.4 | 54.1 | 0.0 | 26.3 | 80.4 |
| 22 | 23.9 | 1.10 | 26.3 | 76.3 | 74.0 | 31.4 | 2.3 | 44.9 |
| 23 | 23.9 | 1.10 | 26.3 | 76.3 | 77.2 | 31.1 | -0.9 | 45.2 |
| 24 | 22.3 | 1.10 | 24.5 | 74.5 | 56.9 | 29.1 | 17.6 | 45.4 |
| 25 | 20.5 | 1.10 | 22.5 | 72.5 | 80.5 | 24.4 | -8.0 | 48.1 |
| 26 | 20.5 | 1.10 | 22.5 | 72.5 | 43.8 | 23.2 | 28.7 | 49.3 |
| 27 | 19.2 | 1.10 | 21.1 | 71.1 | 54.6 | 23.3 | 16.5 | 47.8 |
| 28 | 18.9 | 1.10 | 20.8 | 70.8 | 68.7 | 36.1 | 2.1 | 34.7 |
| 29 | 20.3 | 1.10 | 22.3 | 72.3 | 40.5 | 32.5 | 31.8 | 39.8 |
| 30 | 19.2 | 1.10 | 21.1 | 71.1 | 63.7 | 30.3 | 7.4 | 40.8 |
| 31 | 20.5 | 1.05 | 21.5 | 71.5 | 23.2 | 16.4 | 48.3 | 55.1 |
| 32 | 19.9 | 1.05 | 20.9 | 70.9 | 36.3 | 17.1 | 34.6 | 53.8 |
| 33 | 17.9 | 1.05 | 18.8 | 68.8 | 28.4 | 15.5 | 40.4 | 53.3 |
| 34 | 18.6 | 1.05 | 19.5 | 69.5 | 38.8 | 20.6 | 30.7 | 48.9 |
| 35 | 18.0 | 1.05 | 18.9 | 68.9 | 48.7 | 19.0 | 20.2 | 49.9 |
| 36 | 18.0 | 1.05 | 18.9 | 68.9 | 26.7 | 15.7 | 42.2 | 53.2 |
| 37 | 19.2 | 1.05 | 20.2 | 70.2 | 24.0 | 9.6 | 46.2 | 60.6 |
| 38 | 18.3 | 1.05 | 19.2 | 69.2 | 25.0 | 5.2 | ---** | --- |
| 39 | 16.0 | 1.05 | 16.8 | 66.8 | 31.3 | 14.6 | --- | --- |
| 40 | 16.0 | 1.05 | 16.8 | 66.8 | 30.8 | 3.6 | --- | --- |
| 41 | 17.5 | 1.05 | 18.4 | 68.4 | 9.2 | 0.0 | --- | --- |
| 42 | 16.6 | 1.05 | 17.5 | 67.5 | 0.0 | 0.0 | --- | --- |
| 43 | 19.5 | 1.05 | 20.5 | 70.5 | 2.1 | 0.0 | --- | --- |
| 44 | 17.8 | 1.05 | 18.7 | 68.7 | 0.0 | 0.0 | --- | --- |
| 45 | 17.9 | 1.05 | 18.8 | 68.8 | 5.2 | 0.0 | --- | --- |
| 46 | 16.1 | 1.05 | 16.9 | 66.9 | 0.0 | 0.0 | --- | --- |

*WR: Water requirement; ** —: Not required

Where, n = number of records

m = rank number

In rainy season, pan evaporation can directly be multiplied with crop coefficients (Kc) to determine weekly crop water requirement (ETcrop). Rice crop coefficients were used for dry and wet seasons in 'light to moderate wind' conditions as suggested by Doorenbos and Pruitt (1977).

The water requirement to maintain 5 cm of standing water in the rice paddy fields, from transplanting to the dough stage, has been determined by adding 50 mm of water to the crop water requirement. It is done for both 50 and 75% of probabilities.

Based on water requirement and probabilistic rainfall at 50 and 75%, a Sali rice calendar has been prepared for Jaintia Hills District for optimization of cultural and management practices.

**RESULTS AND DISCUSSION**

Weekly rainfall at different probability levels (Table 1) showed that from 22nd week onwards more than 30 mm rainfall per week is expected except at 90% level. This is corresponding to the time for onset of summer monsoon in the North Eastern region. At 75% probability level rainfall is expected in the range of 20-40 mm per week up to 30th week. A decrease of

**Table 3:** Crop calendar of Sali rice for Jaintia Hills district, Meghalaya

| Agronomic practices | Suitable meteorological standard weeks | Expected rainfall (mm) at 50% probability | Expected rainfall (mm) at 75% probability |
|---|---|---|---|
| Nursery raising | 16, 17, 18, 19, 20 | 36.6, 19.5, 32.9, 48.8 | 10.5, 4.3, 14.8, 23.0, 14.8 |
| Direct seed sowing/ transplanting | 22, 23, 24 | 74.0, 77.2, 56.9 | 31.4, 31.1, 29.1 |
| Apply irrigation, where there is provision | 31, 32, 33 | 23.2, 36.3, 28.4 | 16.4, 17.1, 15.5 |
| Harvesting of matured crop | 40th week onward (medium duration variety) | 30.8, 9.2, 0.0, 0.0 | 3.6, 0, 0, 0 |
|  | 44th week onward (long duration variety) | 0, 0, 0, 0 | 0, 0, 0, 0 |

probabilistic rainfall is observed between 31st and 33rd week comprising 21 days duration. Again from 37th week onward expected rainfall decreases with every succeeding week.

In case of rice paddy, usually 5 cm of standing water is recommended up to the heading stage when the grains start hardening. This practice helps the crop to avoid any kind of water stress and thereby to meet the total water requirement in its growth and development periods. This task is a easy one in places with irrigation facilities. But in Meghalaya the extent of irrigation coverage is very poor and performance of rice crop is purely dependent on monsoon rainfall. During this season, due to abundance of rainwater, rice often avoids water stress and bunded condition ensures sufficient standing water during the lean periods.

From the analysis (Table 2) it was found that at 50% probability level, weekly irrigation water requirement may vary between 0-50 mm between 22nd (transplanting) and 36th (dough stage) weeks to manage crop water requirement as well as 5 cm of standing water in the field. At 75% probability level the range is 30-60 mm for the same period.

### Rice crop calendar

Weekly water requirement for Sali rice has been estimated and it was found to be between 89-94 mm per week from vegetative to fruit development stages (Table 2). During the active vegetative stage the water requirement is high owing to high temperature during late May and June. Pan evaporation shows a deep from 27th week (1st week of July) to 30th Week (last week of July) due to continuous cloudiness and heavy rainfall during this period. But no change in water demand during this period has been observed. Again, in 31st and 32nd weeks we observe high values of pan evaporation with low probable rainfall amount at 75%. These 15 days is much of significance with respect to the panicle initiation (PI) stage of rice. Hence, planning should be made so that critical PI stage can avoid this low rainfall period. Again, 36th week onward (1st week of September) the expected rainfall at 75% probability starts decreasing with every succeeding week owing to start of retreating phenomenon of monsoon from Indian land mass.

Considering all of the above factors a crop calendar for Sali rice has been prepared at 75% probability level of rainfall (Table 3). It is suggested that most optimum period to transplant or direct seed the crop is in between 22-24th weeks so as to avoid falling of PI stage during the lean period of 31-33rd weeks. In any case, transplanting can be done up to 28th week (Mid July) but due to reduced rainfall and lowering of air temperature during September and October may hamper proper fruit setting, development and yield. Irrigation facility should be built up to irrigate the crop at least during 31-33rd weeks period, to meet the challenge of any eventual drought which will prove to be life saving.

Crop Calendar for rice will help in taking up

timely management and cultural practices in relation to weather conditions as agriculture in Meghalaya is rainfed in nature. Cropping intensity can also be increased by incorporation of more crops in a year if crop calendar is followed properly. Appropriate irrigation facilities should be created to avoid any kind of uncertainties in relation to water availability under the changing scenario of global climate change.

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