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Rainfall distribution pattern of Cuttack and its implication in rainfed rice and other crop planning for coastal Orissa

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ABSTRACT

Daily rainfall data of 60 years (1941–2000) recorded in the 'Agromet observatory' of the Central Rice Research Institute, Cuttack were examined for establishing the long term averages of annual and seasonal rainfall and its temporal variability. Average annual rainfall of this region was 1536 mm. Co-efficient of variability of annual rainfall (21%) indicated that the rainfall was more or less stable over the years. At 25 and 50% probabilities, the stable quantum of rainfall was observed during 24th– 41st and 25th – 38th standard meteorological week (SMW), respectively. The probabilities of receiving 10, 15 and 20 mm of average weekly rainfall exceeded 70% from 23rd – 42nd, 24th – 41st and 25th – 40th SMW, respectively. There is an ample opportunity to harvest the excess rain water during the period of July – September which can be utilized as life saving irrigation or utilized for raising a second crop of short duration pulses or oilseeds.

Key Words : Rainfall pattern, rainfed rice, crop planning

Climate variability, particularly rainfall variability is the major factor influencing the agricultural productivity and sustainability in the tropics (Viramani 1994). It is particularly true for the rainfed rice crop as it needs more water than other crops like sorghum, millets, pulses and oilseeds. The climate of Cuttack region is mostly sub-tropical, hot and humid and is 70-80 km. away from Bay of Bengal coast and is largely influenced by the sea. Rainfed rice is the main crop grown during the wet season. The productivity of the crop is largely influenced by the rainfall distribution pattern and the intensity of rainfall received during the monsoon season. Initiative was taken up at the Central Rice Research Institute (CRRI), Cuttack to study the rainfall distribution pattern and its variations over the years for suitable crop planning under rice-based cropping system.

MATERIALS AND METHODS

Data on daily rainfall events recorded at the 'Agromet Observatory', CRRI, Cuttack (20.5^0 N, 86^0 E and 23.5 m above MSL) from 1941-2000 were critically examined for establishing the monthly normals, the time of onset and withdrawal of monsoon, weekly, monthly and seasonal rainfall and its distribution pattern. The severity of aberrations in rainfall (monthly and seasonal) was adjudged by following the criteria suggested by Ahcarya and Gupta, 1990 and Sondge *et. al.*, 2000. The

co-efficient of variation, dependable and conditional probabilities (at 10, 15 and 20 mm level) of rainfall were also worked out (Munn, 1970).

RESULTS AND DISCUSSION

Annual rainfall distribution pattern

Compilation of 60 years rainfall data (1941-2000) indicated that the average annual rainfall of this region was around 1536 mm. The co-efficient of variability of annual rainfall (21%) revealed that the rainfall was more or less stable over the years. The inter year probability revealed that the chances of receiving rainfall in the normal range (1119-1645 mm) were 55% and the chances of aberrant rainfall were 45%. The break up of aberrations revealed that the chances of rainfall being deficit or surplus were 8% and 37%, respectively. The further refined picture showed that the chances of rainfall to be severe deficit (D) were nil, while it being moderately deficit (d) was 8%. Similarly, the chances of rainfall being highly surplus (H) were less (2%) than moderately surplus (35%) (Table 1).

This rainfall quantum clearly indicated the suitability of this region for rainfall rice cultivation during the wet season as the chances of receiving more than 1119 mm rainfall were 92% (Table 1) considering the water requirement of rice crop 1000 - 1200 mm for medium and late muturing variety. However, the total amount and distribution pattern of monsoon rain is the most critical weather component in rainfed rice ecologies. So, good productivity can be obtained only by adopting suitable water conservation and recycling methods and packages. Sastri *et. al.* (1999) also opined alike while studying the influences of climatic variability on the productivity of rainfall rice in Chattishgarh region.

Seasonal rainfall distribution pattern

Average seasonal rainfall and its variability are presented in Table 2. About 9% of the total annual rainfall occurred during pre-monsoon period of March – May which would be helpful for land preparation especially in the case of lowland rice field. The rainfall received during the month of March and April can be utilized for summer ploughing to make the land ready for final land preparation while the May rainfall can be utilized for final land preparation and sowing of rainfed lowland rice especially in medium deep and deep water rice ecology.

The average rainfall during the monsoon month (June – September) at Cuttack was 1134 mm, 74% of the average annual rainfall (Table- 2). A major part of this rain is generally lost through run off which can be stored through the construction of water harvesting structure as on-farm reservoir. It can be utilized as life saving irrigation particularly in the years when rain during post monsoon season is low or also for growing short duration pulses like green gram, black gram and oilseeds like mustard, castor, sunflower, linseed and groundnut in rainfed lowlands during winter/summer season. A very good amount of rainfall (219.9 mm) is also received during post- monsoon season of October-November which is helpful for rainfed rice in the lowlands because most of the long duration photo-sensitive rice varieties viz- Gayatri, Savitri, Durga and Sarala etc, grown in such areas generally

Table 1 : Standard meteorological schemes for delineating the rainfall aberration (annual)

Sr.No.	Threshold criteria of schemes	Scale of severity	Symbol	% of Year
1.	(-) < 0.59 (562 mm)from normal	Severely deficit	D	Nil
2.	(-) 0.19 to (-) 0.59 from normal (567 – 1119 mm)	Moderately deficit	D	8
3.	± 0.19 from normal (1119 – 1645 mm)	Normal range	N	55
4.	+ 0.19 to 0.59 from normal (1645 – 2197 mm)	Moderately surplus	H	35
5.	+ > 0.59 from normal (> 2197 mm)	Highly surplus	H	2

Table 2 : Seasonal rainfall distribution pattern at Cuttack and its variability parameters

Particulars	Premonsoon (Mar-May)	Monsoon (June-Sept)	Post monsoon (Oct-Nov)	Winter (Dec –Feb)	Total
Average (mm)	138.1	1134.0	219.9	43.8	1535.8
Std. Dev.	327.4	272.9	629.8	350.2	327.57
CV (%)	369.6	157.6	50.7	134.1	21.3
% of total	9	74	14	3	100

Table 3 : Monthly average rainfall at Cuttack (mm) and its variability parameters.

Particular	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Average	12.4	26.0	25.3	35.4	77.4	188.2	336.8	356.3	252.7	179.6	40.3	5.4	1535.8
Std. Dev	21.0	37.2	30.2	33.5	87.4	103.1	119.7	120	101.8	139	59.3	16.3	
CV (%)	170	143	119	95	113	55	36	34	40	77	148	301	

flowered during late October or early November. These varieties can be safely grown in this region. However, the grain filling and ultimate yield of lowland rice is largely influenced by this rain. So any deficit of rainfall during this period influences the final yield of rainfed lowland rice. The winter rain is meager (only 3%) and crops like linseed, lathyrus, blackgram and field pea can be grown by utilizing the residual soil moisture in rainfed shallow lowlands.

Monthly rainfall distribution pattern

The monthly averages increased from 188.2 mm in June to 356.3 mm in August

and then it declined to 252.7 mm in September and 179.6 mm in October (post-monsoon period) with a unimodal distribution pattern contributing 12 to 23% during June to October. July and September has low coefficient of variability.

According to the monthly rainfall distribution pattern, the Cuttack region falls under A_2 B_1C_2 category (where rainfall > 300 mm in two months of July and August i.e., A_2; 200 – 300 mm in one month of September i.e., B_1 and 100 – 200 mm in June and October i.e., C_2) which indicates that this region is suitable for rainfed rice cultivation. There may be chances of initial drought during June or terminal drought during October end in case of direct seeded rainfed rice in the lowlands. Excess rain water received during the monsoon month can be utilized during post flowering stage (late October - November) by storing it as harvested rain water.

Rainfall received during May can be utilized for land preparation and sowing of rainfed rice in medium deep and deep water rice fields, while short duration pulses like greengram can be taken during the period of May – June in shallow rainfed lowlands where transplanted rice crop generally raises during July – November. Farmers can also sow the direct seeded rice crop during late May or early June in the shallow lowlands. In the upland, farmers can sow the crop during middle of June after receiving the early monsoon rain. Transplanting in the shallow land can be done during early July before the peak monsoon rain starts. There is an ample opportunity to harvest the excess rain water which can be utilized for raising a second crop of short duration pulses like black gram or green gram or oilseeds like mustard, sunflower or groundnut during the winter/summer season with limited irrigation.

Weekly rainfall distribution pattern

Weekly precipitation amount and its assurance during rainy season are quite important for crops like rice which requires moisture and water throughout the growing period. Mean weekly rainfall received during the first 16 standard meteorological week (SMW) is low (<10 mm/week). However, a rainfall in the range of 10 – 25 mm/week is generally obtained during April 23 - June 03. The rainfall intensity (about 80mm/week) reaches the peak during 30th - 33rd SMW (July 23 – August 19). Again a good amount of rainfall in the range of 15 – 25 mm/week is also obtained during 43rd to 46th SMW (October 22 – November 18). Rainfall is mearge during rest of the period.

Mean weekly rainfall shows June 18 – September 30 as a stable rainfall period when the mean weekly average rainfall is >50 mm and corresponding cv is less than 100%. The total growing period is 133 days (Table 4).

The stable quantum of rainfall was observed during 24th to 41st (June 11 – October 14) and 25th to 38th (June 18 – September 23) SMW at 25% and 50% probabilities, respectively. The conditional probability of receiving 10, 15 and 20 mm mean weekly rainfall exceedded 70% from 23rd to 42nd, 24th – 41st SMW and 25th to 40th SMW, respectively (Table 4).

The long duration photo sensitive rice varieties like Sarala, Durga, Sabitri and Gayatri can be sown in lowlands by direct

Table 4 : Weekly average rainfall (mm) during monsoon season and its variability parameters

Std. Week	Average rainfall (mm)	S.d.	CV (%)	Probability (%) of getting rainfall			expend rainfall (mm) at probability	
				10mm	15mm	20mm	25%	50%
23	35.7	43.9	123	72	68	64	37.8	20.9
24	43.9	45.3	103	77	74	70	54.8	32.5
25	58.2	53.9	75	86	84	81	72.6	49.8
26	57.9	51.0	88	83	80	77	66.9	52.5
27	71.8	59.6	83	85	83	81	76.0	53.0
28	79.6	64.8	81	86	84	82	91.5	61.8
29	68.9	51.1	74	88	85	83	76.5	53.2
30	79.1	61.7	78	87	85	83	85.2	69.9
31	88.9	76.1	85	85	83	82	116.6	68.4
32	87.1	63.4	73	89	87	86	93.6	84.0
33	83.0	63.7	77	88	86	84	97.3	64.8
34	68.3	51.9	76	87	85	82	83.3	52.9
35	69.1	51.6	75	88	85	83	82.1	53.2
36	67.6	75.1	111	78	76	74	82.1	49.8
37	66.6	48.7	73	88	85	83	79.0	57.7
38	57.1	48.0	84	84	81	78	71.7	50.4
39	48.8	45.2	93	81	77	74	64.3	34.8
40	56.9	67.0	118	76	74	70	62.4	28.2
41	41.9	43.5	104	77	73	69	65.8	35.2
42	42.6	65.5	153	74	66	63	49.1	14.6

seeding during 21st to 22nd SMW (May 20 – 30) as rain received during this period is sufficient for land preparation and sowing of rice crop. While, the sowing of upland rice varieties of 90 – 105 days duration like Vandana, Annada and Kalinga III can be done during 24th SMW (middle of June) as early monsoon rain may help for quick establishment of rice crop. Intercropping of rice + pigeonpea and groundnut + pigeonpea etc. in the uplands can also be done during this period. A second crop of horsegram or mustard can be taken immediately after the harvest of upland rice during second fortnight of October. While, the transplanting of rice crop under favourable shallow lowland should be furnished before middle of July because of high intensity of rain generally occurs afterwards from 30th to 33rd SMW which may hinder the establishment of rice crop (Table 4).

The weekly rainfall data indicated that high intensity of rainfall (in the range of 65 – 85 mm/week) was occurred during 27th to 37th SMW (July 02 – September 16) (Table 4). In the medium deep and deep water ecology, there is an opportunity to utilize the excess rain water by adopting

an integrated rice – fish integrated farming system model through *in situ* water harvesting (Shinhababu, 1997). This system integrates different compartible components like improved rice, fish, prawn, different crops like rice in the main fish field and vegetable and crops on basis of utilizing the harvested rain water stored in the refuge tank.

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