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Rainfall probability analysis for contingent crop planning in Ganjam (Odisha)

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Abstract
The weather and its variability are well known to the farming community and have great impact on crop production and have great impact on crop production. Rainfall is one of the most important climatic parameter in crop planning especially in region of rainfed agriculture. In this paper, an attempt has been made to analyze 15 years of rainfall (2001–2015) in Ganjam district in Odisha whose annual normal rainfall 1296.0 mm with 95 rainy days. Probability at different probability level such as 90,75,50 percentage has been analysised. Probability of for receiving more than 100 mm rainfall is only for six months and that is too at 50 percent probability level which is leading to interpretation that rice production is a challenging task in this region. It has been found that at 75 per cent assured probability level rainfall more than 150 mm can be expcted only in August, July and September and this rainfall is hardly sufficient for meeting the water requirement in upland situation. However at 50 percent probability which is equivalent to average condition, cultivation of rice is possible under well water management Condition or else some non rice crop can be taken as an alternative.

Keywords: Probability analysis, rainfed agriculture, crop planning, Ganjam

Introduction

The primary source of water for agricultural production for most of world is rainfall. Rainfall is one of the most important factor in crop production programme, of all the climatic factors. The variation of monsoonal and annual rainfall in space and time are well known and this inter-annual variability of monsoonal rainfall has considerable impact on agricultural production, water management and energy generation. Analysis of annual, seasonal and monthly rainfall of a region is useful to design well cropping system, cropping pattern, designing drainage and water harvesting structure. Knowledge of average monthly, seasonal and annual rainfall is helpful in understanding the general picture of the particular region but the weekly rainfall data analysis gives more useful and precise information's for the rainfall based crop planning (Sharma *et al.*, 1979, Tiwari *et al.*, 1992) [6, 5].

Agriculture sector is the backbone of India as it feeds ever growing population and provides employment to about 58% of the population. Several new advanced techniques have been developed to enhance the crop productivity further. However, it is mainly dependent on monsoon rainfall and hence faces severe challenge in the form of natural disasters. This trend is clearly visible if we look in to agricultural production in good and bad monsoon years. The natural disasters like floods, drought and cyclone are primarily responsible for crop loss and low crop productivity resulting in poor socio-economic condition of the farmers.

The average annual rainfall of Odisha is 1452 mm, there are large variations in annual rainfall and these variations often result in reduced crop productivity especially rice crop. Terminal drought is a recurring feature for rice crop in this region. Also intermittent dry spells make the crop operations delayed as 80 per cent of the area in this region is under rainfed conditions. Thus, the success of rice crop depends upon not only the monsoonal rainfall but also on the October rainfall which occurs due to cyclonic activity in the Bay of Bengal. Hence, an attempt has been taken in the present study for rainfall probability analysis of Ganjam districts of Odisha, which come under North Eastern ghat agro climatic zone of Odisha, having a broad soil groups namely Saline, Lateritic, Alluvial, Red & Mixed red & Black soils. Here the prevailing climatic condition is Hot and moist, subhumid.

A number of studies have been conducted for location specific agricultural planning in general and crop planning in particular by analyzing daily, weekly, monthly, seasonal and annual rainfall data. Stern and Coe (1982) [7] analyzed daily rainfall data for crop planning in semi-arid, tropics. Similar analysis of rainfall data has been done for crop planning in coastal,

semi-arid, dry farming, sub-humid and Himalayan foothill regions (Panigrahi, 1998 and Sharda and Das, 2005) [2, 5].

Rainfall analyses are helpful for proper crop planning under changing environment in any region. Therefore, in this paper, an attempt has been made to analyze 15 years of rainfall (2001–2015) in Ganjam district in Odisha, for prediction using in complete gma distribution were the best-fit probability distribution. The earliest and most delayed week of the onset of rainy season was the 20th standard meteorological week (SMW) (14th–20th May) and 25th SMW (18th–24th June), respectively. Similarly, the earliest and most delayed week of withdrawal of rainfall was the 39th SMW (24th–30th September) and 47th SMW (19th–25th November), respectively. The longest and shortest length of rainy season was 26 and 17 weeks, respectively.

Scientific study on the quantum and distribution of rainfall if made would enable the farming community to adjust or modify the cropping programme as well as the cultural operations. An attempt has been made to understand the rainfall climatology by analysing the temporal and spatial rainfall distribution and its variability on daily, weekly, seasonal and annual basis for the last 15 years for Ganjam district of coastal Odisha.

Materials and Methods

Ganjam district is one of the coastal districts of Odisha and lies between 19º 04' and 20º 17' N. latitude and between 84º 07' and 85º 12' E. longitudes. The climate of Orissa falls under the category of tropical monsoon type of climate and in this, Orissa is not different from the rest of the country. Orissa receives an annual average rainfall of about 145 cm. The rainfall has a key role to play in the climate of Orissa. Copious rainfall or absence of it directly affects the crop production in Orissa. Rainfall of about 140 cm is considered heavy and anything less than 120 cm is counted as low though it is helpful for paddy harvest. Rainfall in the winter months are also welcomed in Orissa as it gives a fillip to the growth of second crop in the state.

It is situated partly in the Agro Climatic Zone of North Eastern Ghat and East and South Eastern Costal Plain zone. Net cultivated area 375thousand hectare. Soil type of Ganjam is Laterite Soils, Deep Alluvial soils, Coastal saline soils sandy loam to clay loam. Normal rainfall 1296.0 mm and rainy days 95(Number).Block wise daily rainfall data were collected from Special Relief Commissioner (SRC), Government of Odisha for the period from 2001 to 2015 (15 years) and processed by using Statistical Analysis Software (SAS, 2014). By using WEATHER COCK software which is developed by CRIDA, Hyderabad for weather data analysis. Weather Cock contain 26 nos. of modules which are related to agroclimatic parameters out of which 8 to 10 modules were used in this study for weather data analysis.

Monthly rainfall probability is calculated through the module named as "Incomplete Gamma Probabilities.exe". Rainfall data of twelve months of the Ganjam district is used as inputs for determining monthly probability of rainfall at a level of 90%, 75% and 50%. The amount of rainfall at three probability level has been computed for each standard month by fitting Incomplete Gamma Distribution model.

Seasonal rainfall data of the three districts are used as input to determine seasonal probability of rainfall of each districts. It is calculated through the module named as "Incomplete Gamma Probabilities.exe". The whole year was categorised into four major season namely Monsoon, Post-monsoon, summer and winter according to the Odisha condition. Monsoon season consist of four months namely June, July, August and September. Post-monsoon consist of two months namely October and November. Likewise December, January and February are under winter season and March, April and May are under summer season.

Results and Discussion

The data presented in Table 1 demonstrates that the At 75% probability level during monsoon season Ganjam district received about 707.5 mm rainfall. It is distributed, with the period from 25th to 40th weeks giving rise to or length of growing season 112 days or 16 weeks. So the non paddy crops like groundnut, sunflower, short duration arhar of 120 days can be taken is upland during kharif season. The rainfall at 75% assured level should be utilized for growing rainy-season crops like maize, cowpea, groundnut, blackgram and direct-seeded rice in second fortnight of June with the commencement of monsoon. Senapati *et al*. (2009), revealed that the duration of monsoon period is 92 days and short duration crops of 90 - 95 days should be preferred to be grown in rainfed uplahds. In medium land rice can be taken with a duration of maximum upto 130 days or short duration rice of 100 to 120 days can be taken to accommodate vegetables like cole crops as a second crops, sowing of which can be made early to best utilize the soil moisture. In low land, long duration rice of 150 days may be grown as the altitude of the coastal district like Jagatsinghpur is low.

During the winter season (40th week onwards), negligible rainfall is recorded at 75% probability level. So the surface soil would become dry with rare chances of getting adequate soil-moisture in the seeding zone. Hence, surface moisture conservation would be essential for germination of seed and plant establishment and, if possible, water harvesting should be done to ensure a pre-sowing irrigation. It was also revealed that the rabi crops have to be raised under moisture stress conditions. The crops should be able to use residual soil profile moisture more judiciously as reliability of getting adequate weekly rainfall is low. If irrigation facilities are available, then early sown varieties may be grown with the application of pre- sowing irrigation. Bhadoria et al. (2013) [1] analysed the rainfall in the rainy season, August was the highest rainfall contributing month (33.4%) followed by July (28.9%) mean weakly, precipitation amount and its assurance reaches the peak (>50mm/week) during 26th SMW (Standard Meteorological Week) to 38th SMW and again declined thereafter. The earliest onset of rainy season occurred in 24th SMW. The normal onset of rainy season was observed as 26th SMW with CV of 5.8 per cent. There is an ample scope for rain water harvesting from July to September which can be utilized as crop saving irrigation as well as pre-sowing irrigation for succeeding Rabi crops which are generally sown on residual soil moisture.

During summer season Ganjam likely to get 106.2 mm rainfall at 75% probability so that cash crop like jute can be taken in low land during April that is on 17th week onwards and will be harvested within 30 to 31 week so that rice crop of medium duration can be taken as second crop. During post monsoon (October, November) season, Ganjam district likely get 91.1 mm rainfall at 75% probability level. The pre rabi crops like green gram, black gram, hors gram and sesame can be taken in upland and vegetables like cucurbits, lady's finger, cowpea, cole crops can be grow in medium land as second crop. Probability analysis of weekly rainfall can be

taken or may be considered as a base for caring out of agricultural operations throughout the year. Ganjam district received 18.3mm rainfall on 25th SMW. With this amount of rainfall the farmers can go for summer ploughing to control weeds, soil borne pathogens and hibernated larvae. However from 23rd week onwards farmers can go for summer ploughing as the districts may receive rainfall of 6.4 mm. So summer ploughing can be continued from 23rd to 25th week. The monsoon may be onset 26th or 27th week. So prior to monsoon onset sowing of direct seeded rice in medium and low land can be carried out within 24 to 25th week to have better germination after the first shower of monsoon. From 31st to 33rd week, district is going to receive more than 100 mm rainfall so that beushining of direct seeded rice can be carried out. After the onset of monsoon during 26-27 week nursery raising of rice can be started in dry bed nursery so that transplanting may be made in 31st- 33rd week. Rai *et al.* (2014) [3] found that the Initial and conditional rainfall probability analysis at Damoh reinforced that Initial probabilities {P (W)} of getting 10 mm rainfall per week was 76% during 25th (18-24 June) SMW. Thus, the seed bed preparation could be initiated during this week. Initial as well as conditional probability of wet week followed by wet week {P(W/W} of getting 20 mm rainfall was more than 80% during 27th SMW (2-7 July) in Sagar district. Therefore, this week is most suitable for sowing operation in this district. After harvest of medium duration rice in medium land non paddy short duration crops like pulses such as green gram, black gram, lathyrus, oilseeds like sesame can be grown for effective utilisation of soil moisture recharge by predicted post monsoon rainfall. Wheat, potato, mustard, lentil, chickpea, onion, cabbage, cauliflower etc. Jute, ladies finger can also be taken after harvesting of the transplanted rice at the beginning of October. The cropping patterns are based on rice. Farmers can grow those crops provided the stored moisture after rice is utilized through immediate land preparation (by the middle of October).

As there is very little chances of rainfall occurrence after 47th week, no crop is advised to take up after 48th week in upland and medium land unless there is provision of irrigation facilities. There was continuous dry spell at the end of October which could be utilized for harvesting of rainy season crops and field preparations for winter season. High value winter crops could be grown only with supplemental irrigation during winter season, starting from November.

Table 1: Monthly Rainfall Probability of Ganajam

Month		Probability		
	90%	75%	50%	Mean
January	0.6	2.2	6.5	5.6
February	0.5	2.1	6.5	10.0
March	2.9	7.9	19.1	15.0
April	22.5	37.2	60.3	19.6
May	41.5	61.1	89.5	116.1
June	86.5	136.7	191.5	171.8
July	136	186.3	241.1	259.0
August	155.6	208.7	266.6	410.7
September	132.5	175.8	234.3	251.2
October	40.6	82.2	157.2	180.2
November	2.7	8.1	21.2	47.8
December	0.1	0.8	4.2	24.4

Table 2: District Seasonal Rainfall Probability

District	Season	Probability		
		90%	75%	50%
Ganjam	Monsoon	510.6	707.5	933.5
	Post monsoon	43.4	91.1	182.6
	summer	66.9	106.2	168.9
	Winter	1.1	4.3	13

Table 3: District Annual and Weekly Rainfall Probability of Ganjam

WEEK	Probability			
	90%	75%	50%	Mean(mm)
1	0.2	0.7	2.3	3.2
2	0.2	0.8	3.2	5.3
3	0.5	0.8	1.3	0.5
4	0.4	1.1	2.4	2.3
5	0.3	0.9	2.4	2.9
6	0	0.1	1.2	1.2
7	0	0.4	1.9	1.9
8	0	0	1.7	1.7
9	0.3	0.9	2.4	2.9
10	0.3	1.2	3.2	4.2
11	0.3	1	3.1	4.3
12	0.3	1	2.7	3.1
13	0.3	1.1	3.3	4.4
14	0.8	2.1	4.8	5.7
15	0.6	1.6	3.8	4.4
16	0.5	1.9	5.3	7.5
17	0.8	2.7	7.6	11.2
18	1.9	3.8	7.2	7.9
19	1	3	7.7	10.5
20	1.5	4.5	11.7	16.9
21	1.8	5.8	16.1	24.3
22	1.6	4.5	11.3	15.7
23	6.5	11.7	20.5	23.4
24	6.5	14.9	31.2	40.3
25	8.3	18.9	39.5	51.1
26	13.7	24.2	41.4	47.7
27	10.6	23	46.6	59.4
28	8.7	19.4	40.2	51.8
29	18.3	31.2	52	59.5
30	17.8	28.5	44.9	49.9
31	22.8	37.2	59.5	66.8
32	10.7	23.1	46.4	58.9
33	11.3	21.4	38.7	46
34	23.6	33.1	46.5	49
35	21.8	34.8	54.8	61
36	24.9	37.7	56.6	61.7
37	17.7	30.9	52.6	60.9
38	16.3	29.6	52	61.2
39	4.3	11.9	29.1	41.2
40	6.6	18.9	47.3	68.9
41	2.2	8.9	28.8	49.4
42	1.3	5.1	16	26.5
43	0.1	2.1	15.6	49.1
44	0.3	2.5	12.3	27.9
45	0.2	1.4	7.2	16.2
46	0.1	0.9	4.2	8.6
47	0.2	0.6	1.7	1.7
48	0.5	0.7	0.9	0
49	0.1	0.5	2.3	4.1
50	0.2	0.7	1.9	1.9
51	0.1	0.6	2.2	3.2
52	0.5	0.8	1.4	0.6
Annual	989.5	1118.8	1275.3	1289.7

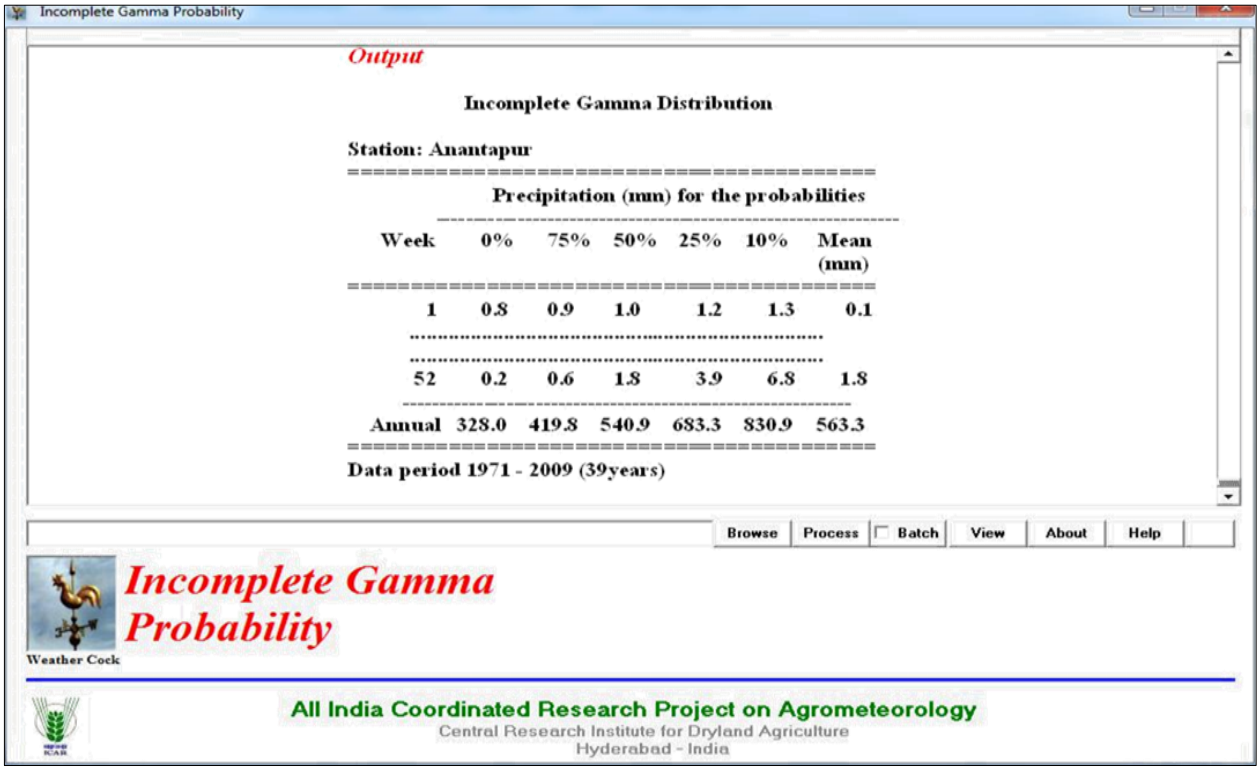

Fig 1: Rainfall Probability Output

Conclusion

Under the uncertain with delaying trend of rainfall and reduced duration of crop growing season, long duration rice are needed to be replaced by other short duration in medium land. Under the uncertain with delaying trend of rainfall and reduced duration of crop growing season, long duration rice are needed to be replaced by other short duration in medium land.

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