Determining Length of Growing Period forCrop Planning in East and South Eastern Coastal Plain Agroclimatic Zone of Odisha

ABSTRACT

Aim: The length of the growing period (LGP) refers to a number of days in a year during which the moisture at the root zone of crop plants is adequate to meet the crop water need. Information on LGP provides a basis for the selection of crops, cultivars (short / medium / long duration),and cropping/farming systems of a region. The study aims to estimate the length of crop growing season of the East and South Eastern Coastal Plain Agroclimatic Zone of Odisha ~~in order~~ to provide a basis for suitable crop planning for the region.

Methodology: The LGP for four districts (Jagatsinghpur, Kendrapara, Khordha, and Puri) under East and South Eastern Coastal Plain Agroclimatic Zone of Odisha wasestimated using rainfall dataof 30 years (1991 to 2020). The growing season begins when the sum of daily rainfall (forward accumulation) reaches 75 mm (28 May, 29 May…15 Oct) and ends when backward accumulation (15 Oct, 14 Oct,……, 28 May) of 20 mm reach~~es~~. The LGP was worked out by adding the duration of the rainy season with the sum of post-monsoon rainfall and the average ~~water~~ water-holding capacityof soil divided by the ~~post~~ post-monsoon PET of the district.

Results:LGPs obtained by the above method varied from 173 to 192 days in this zone withKendraparadistrict having the highest LGP (192 days) and Khordhathe shortest (173 days). ~~Date~~ The date of onset and cessation of southwest (SW) monsoon was 15-17 June and 13 October, respectively.

Conclusion: Double cropping can be followed in Jagatsinghpur, Kendrapara and Puri districts where the length of the growing period >180 days except Khordha district where paira cropping can be followed as the length of the growing period <180 days.

Keywords: Cessation, Length of Growing Period, Monsoon, Onset, Rainfall.

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1.0 Introduction

Water availability at appropriate times is the most crucial factor that limits the time and determines the type and productivity of crops (Fox and Rockstrom, 2000),particularly in rainfed agriculture.~~Growing~~ The growing season can be defined as the period during which rainfall distribution characteristics are appropriate for crop germination, establishment, growth, and ripening (Yousif et al., 2018).The length of the growing period (LGP) of a region represents the number of days in a year during which moisture stored in the root zone is sufficient to meet the crop water need. Reliable information ~~of~~ onrainfall onset and cessation times will help in planning timely land preparation, and mobilization of inputs and equipment and will also reduce the risk involved in sowing too early or too late (Omotosho et al., 2000).The rainfall and evapotranspiration of a region determine theLGP. The duration of the rainy season is the period between the onset ~~and cessation~~and cessationof monsoon rains. On the other hand, LGP takes into account the length of the rainy season, the soil moisture storage at the end of the rainy season, and the ~~post~~ post-rainy season and winter rainfall. Therefore, the LGP depends not only on the rainfall distribution but also on the type of soil, soil depth, water retention capacity, release characteristics of the soil, air temperatures, and daylight hours (Thirupathi*et al.* 2015).

Climate change can bring about changes in LGP, which dictates the type of crops and or varieties that can be cultivated in a region. Studies of climatic parameters such as rainfall, temperature, day length, etc. are thus helpful in defining the risk level of arable agriculture, ~~characterising~~characterizing crop growing season and cropping system (Kar et al. 2004).

The objective of this study is to determine the LGP of major coastal districts of Odisha which mostly suffer from natural calamities such as droughts, floods, cyclones, etc. more or less frequently. The information on LGP will help the farmers and policymakers in planning agriculture objectively for the region.

2.0 Material and methods

2.1 Study area

Four coastal districts viz. Jagatsinghpur, Kendrapara, Khordha, and Puri under the East and South Eastern Coastal Plain Agroclimatic Zone of Odisha were chosen for estimating the LGPs

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(Fig. 1). The zone is bounded by latitudes 19° 28'N to 20° 37' N and longitudes 84° 55'E to 87°01' E. The climate of the zone is hot and humid having mostly alluvial, lateritic, and saline soils. Major crops grown in this zone are rice, groundnut, greengram, blackgram, and jute.

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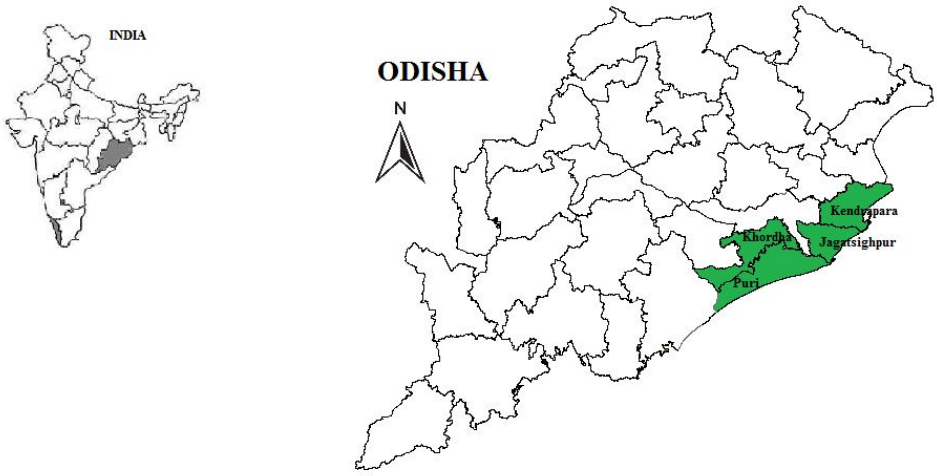

Fig 1: Map showing the study area comprising four districts.

2.2 Rainfall characteristics and rainfall variability

Daily rainfall data at the block level of each district were collected from Special Relief Commisssioner, the government of Odisha for a period of 30 years (1991-2020). ~~District~~District-wise daily rainfall datawere derived from the daily rainfall data at the block level (arithmetic mean) and wasprocessed by using the Weather cock"Rainy Day.exe" module to calculate the rainfall characteristics of the zone. Mean annual, seasonal, and monthly rainfall with standard deviation (SD) and Coefficient of variation (CV) for each data series were determined by using the following formulae.

$$\mu = \frac{Sum\ of\ all\ observations}{Number\ of\ obseravtions} \qquad \text{(Eq.1)}$$

$$\sigma = \sqrt{\frac{\sum(X-\mu)^2}{n-1}} \quad \text{(Eq. 2)}$$

$$CV = \frac{Standard\ deviation}{Mean} \times 100 \quad \text{(Eq. 3)}$$

Where μ is an arithmetic mean; σ is the Standard deviation; X is the actual value of any weather element~~;~~, and 'n' is the number of years.

2.3 Assessment of Length of Growing Period

The calculation of LGP first requires the determination of onset and cessation dates of rainfall in the rainy season. In this study, we followed the forward and backward accumulation methodfor computation of the onset and withdrawal of the rainy season from daily normal rainfall data given by *Babu and Lakshminarayana,* 1997.The daily rainfall amount was summed by forward accumulation from 28th May onwards (28 May, 29 May…15 Oct) until a certain amount of rainfall was accumulated. For forward accumulation,~~seventy five~~seventy-five millimeters of rainfall was considered as the onset time of the growing season (Morris and Zandesta, 1979; Babu and Lakshminarayana, 1997; Panigrahi and Panda, 2002). The withdrawal of the rainy season was calculated by the backward accumulation of daily rainfall amount from 15th October backward~~s~~(15 Oct, 14 Oct,……, 28 May). Twenty millimeters of rainfall was considered as the recession time for the rainy season in backward accumulation which is sufficient for ~~ploughing~~ and plowing of fields after the harvest of a crop (Babu and lakshminarayana, 1997).

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The LGP was computed by using the formula given by Sattar *et.al.,* 2013(Eq. 4). Post-monsoon rainfall was estimated from the daily normal rainfall after the recession of the rainy season (15 Oct- 31 Jan). The total ~~post~~ post-monsoon rainfall came to be around 7-8 % of the annual rainfall. The soil type determines the water retention characteristics and available water holding capacity (AWHC) of soil.~~Soil~~ The soil texture of the four districts was obtained from the book Soil Series of Orissa (Published by NBSS and LUP, ICAR). As this zone is having medium texture soil, the value of water holding capacity (field capacity - permanent wilting point x bulk density x 10) of 120 mm per meter of soil depth was considered.The average potential evapotranspiration (PET) in ~~post~~ -post-monsoon period of this zone was found to be around 3.8-

4.2 mm per day (Pasupalak, 2015).The LGP for different districts was worked out as the sum of post-monsoon rainfall and average water holding capacity divided by the ~~post -~~post-monsoon PET of the district and the total number of rainy days in the monsoon period (Eq. 4).

LGP = Duration of the rainy season in days + [(Post monsoon rainfall, mm + AWHC, mm) / Average evaporative demand of atmosphere] (Eq. 4)

Where AWHC is available water holding capacity.

2.4 Crop planning based on LGP

The choice of cropping system isdecided ~~on the basis of~~based on based onthe distribution of rainfall (Table 1).Mono cropping is only possible where the LGP is less than 140 days. In regions where the LGP ranges from 140-180 days, intercropping can be ~~practised~~ practiced whereas in regions having an LGP of more than 180 days, double cropping can be accommodated.

Table 1. LGP and cropping system

LGP (Days)	Cropping system
<140 days	Mono cropping
140-180 days	Inter cropping
>180 days	Double cropping

3.0 Results and discussion

3.1 Rainfall characteristics and rainfall variability

3.1.1 Annual Rainfall

Kendrapara districtreceives the maximum rainfall of 1561mm while Khordhadistrict receives the lowest (1446mm). The mean annual rainfall of the zone ranges from 1446 to 1561

mm with a variability of18 to 21 % **(Table 2)**. The co-efficient of variation (CV) of rainfall of all the fourdistrictsis less than 25% which indicates that the rainfall is highly dependable.

Table 2: DistrictDistrict-wise mean annual rainfall with standard deviation and CV (%)

District	MEAN(mm)	SD	CV (%)
Jagatsinghpur	1501	275	18
Kendrapara	1561	299	19
Khordha	1446	269	18
Puri	1533	335	21
Mean	**1510**	**295**	**19**

3.1.2 Monthly Rainfall

The mean monthly rainfall (367 mm) is the highest in the month of August followed by July with 320 mm and September (269 mm) while December receives the lowest amount of rainfall (6 mm)**(Table 3)**. The months of December and Marchshowed high variability (>20%) of rainfall as compared to other months.

Table 3: Mean monthly rainfall (mm) with standard deviation (mm) and CV (%)

District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jagatsinghpur	8	9	9	25	96	161	318	372	273	190	36	5
Kendrapara	6	10	18	24	98	188	310	368	278	221	37	4
Khordha	10	13	15	29	89	169	320	338	252	182	29	5
Puri	8	10	11	20	87	156	331	390	272	196	41	8
District Mean	8	11	13	25	93	169	320	367	269	197	36	6
SD	2	2	4	4	5	14	9	22	11	17	5	2
CV (%)	20	16	30	15	6	8	3	6	4	9	14	31

3.1.3 Seasonal Rainfall

The average SW monsoon rainfall in this zone is 1124 mm withPuri district having the maximum amount (1149 mm)**(Table 4)**. All ~~the~~ fourdistrictsreceive almost 74% of the mean annual rainfall during SW monsoon**.**The percentage contribution of SW monsoon towards total annual rainfall ishighest in Jagatsinghpur and Puri districts (75%). It is thus clear that SW monsoon accounts for a major part of rainfall distribution out of all the seasons. The ~~post-~~post-monsoon rainfall contributes ~~on an~~ average 15% to the mean annual rainfall for this zone.

Table 4: Mean seasonal rainfall with percentage contribution to annual rainfall

District	Monsoon (mm)	% contribution to annual rainfall	Post-Monsoon (mm)	% contribution to annual rainfall	Summer (mm)	% contribution to annual rainfall	Winter (mm)	% contribution to annual rainfall
Jagatsinghpur	1124	75	226	15	129	9	22	1
Kendrapara	1144	73	257	16	140	9	20	1
Khordha	1079	74	211	15	133	9	27	2
Puri	1149	75	238	16	118	8	27	2
Mean	1124	74	233	15	130	7	24	2

3.2 Length of Growing Period

3.2.1 Start of growing season

~~Onset~~ The onset of the monsoon is considered ~~as~~ the start~~ing~~ of the growing season. The onset date of the monsoon was calculated by the forward accumulation of rainfall. ~~Early~~ The early onset of the monsoon was in Kendrapara district (15 June). Jagatsinghpur and khordha districts had the commencement of monsoon after 16 June. Puri district received the rainfall late (17 June) than other districts of this zone (Table 5).

3.2.2 End of growing season

Backward accumulation of rainfall from 15 October was done to determine the date of the recession of monsoon. The growing season terminated at around 13 October (41st SMW) in all districts of this zone (Table 5). The period of wet days during monsoon was highest in

Kendrapara district (121 days) followed by Jagatsinghpur and Khordha district (120 days). The lowest wet days were in the Puri district (119 days).

Table 5.~~District~~ District-wise onset and cessation of monsoon

Blocks	Onset date	Cessation date	Wet Days
Jagatsinghpur	16June	13 Oct	120
Kendrapara	15 June	13 Oct	121
Khordha	16June	13 Oct	120
Puri	17 June	13 Oct	119

3.3 Total Annual Wet Period

The total wet period in a year was calculated by using LGP formula given by Sattar et.al. 2013. Jagatsinghpur, Kendrapara, and Puri districtshave LGP>180 days butKhordha district has173 days.

Table 6. Length of Growing Period (Days)

District	SW Monsoon Period (days)	~~Post~~ Post-monsoon Rainfall (mm) (Oct-Jan)	AWHC (mm)	Average evaporation during ~~post~~ the post-monsoon period (mm/day)	LGP Duration (days)
Jagatsinghpur	120	128.2	120	4.1	181
Kendrapara	121	151.6	120	3.8	192
Khordha	120	92.9	120	4.0	173
Puri	119	148.3	120	4.2	183

The analysis revealed that the monsoon starts effectively from 24th week (15th June to 17th June) in the east and southeastern coastal plain zone and remain active up to the 41st week (13th October) Therefore, we expected good monsoon shower for about 17 weeks (24 to 41 SMW) in the region. Thus, ~~medium~~ medium-duration rice of about 120 – 135 days can easily be grown in the region with little fear of drought. The ~~medium~~ medium-duration rice can be harvested before the monsoon terminates from the region and so the chances of reduction of the

yield of rice due to water stress will be low. Moreover, the residual soil moisture after the harvest of rice can be effectively ~~utilised~~utilized for raising another ~~short~~ short-duration crop like green gram and black gram in winter.

3.4 Crop planning based on LGP

Double cropping can be followed in Jagatsinghpur, Kendrapara, and Puri districts where the length of the growing period >180 days except Khordha district where paira cropping can be followed as the length of the growing period <180 days (Tab 6). In assured irrigated situations double cropping can also be practiced in Khordha district.

4.0 Summary and conclusion

This study reveals that the east and southeastern coastal plain zone receives 1510 mm of rainfall on ~~an~~ average annually, out of which monsoon rainfall contributes 74%.~~Length~~ The length of the growing period is 170-180 days for Khordha district and > 180 days forJagatsinghpur, Kendrapara, and Puri districts. There is maximum scope for utilization of residual soil moisture in these districts by sowing of pulses in rice-fallow during 41-42 SMW in medium land by zero till method and 41-43 SMW in low land by paira method. Depending upon the LGP available for cropping in this zone rice varieties of specific duration have been selected for medium and low lands. Mostly rice varieties of 120-135 days were selected for medium lands and of 145-155 days for low lands.The important cropping sequence followed in the east and southeastern coastal plain zoneis Rice based cropping system.In rainfed situations, medium duration (120-130 days) rice varieties like Bina 11, Pratibha, Pratikshya, Manaswini, Naveen, Lalat, and MTU 1001 can be taken up by the 15th of June. This should be followed by Zero till pulses (60-65 days) like green gram, black gram, and oil seeds like Toria (70 days) by 1st week of November. Whenever possible paira crop should be promoted.The districts like Jagatsinghpur, Kendrapara, and Puri have LGP >180days where the area under rabi pulses and oilseeds can be increased.

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6.0 References

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