

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

ABSTRACT

Aim: The length of growing period (LGP) refers to 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 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 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 was estimated using rainfall data of 30 years (1991 to 2020). The growing season begins when 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 reaches. The LGP was worked out by adding the duration of rainy season with the sum of post-monsoon rainfall and average water holding capacity of soil divided by the post monsoon PET of the district.

Results: LGPs obtained by the above method varied from 173 to 192 days in this zone with Kendrapara district having the highest LGP (192 days) and Khordha the shortest (173 days). Date of onset and cessation of south west (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 growing period >180 days except Khordha district where paira cropping can be followed as the length of growing period <180 days.

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

1.0 Introduction

Water availability at appropriate times is the most crucial factor that limits the time and determine the type and productivity of crops (Fox and Rockstrom, 2000), particularly in rainfed agriculture. 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 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 rainfall onset and cessation times will help in planning timely land preparation, 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 the LGP. The duration of the rainy season is the period between the onset and cessation of 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 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 risk level of arable agriculture, characterising 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 policy makers 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 East and South Eastern Coastal Plain Agroclimatic Zone of Odisha were chosen for estimating the LGPs (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.

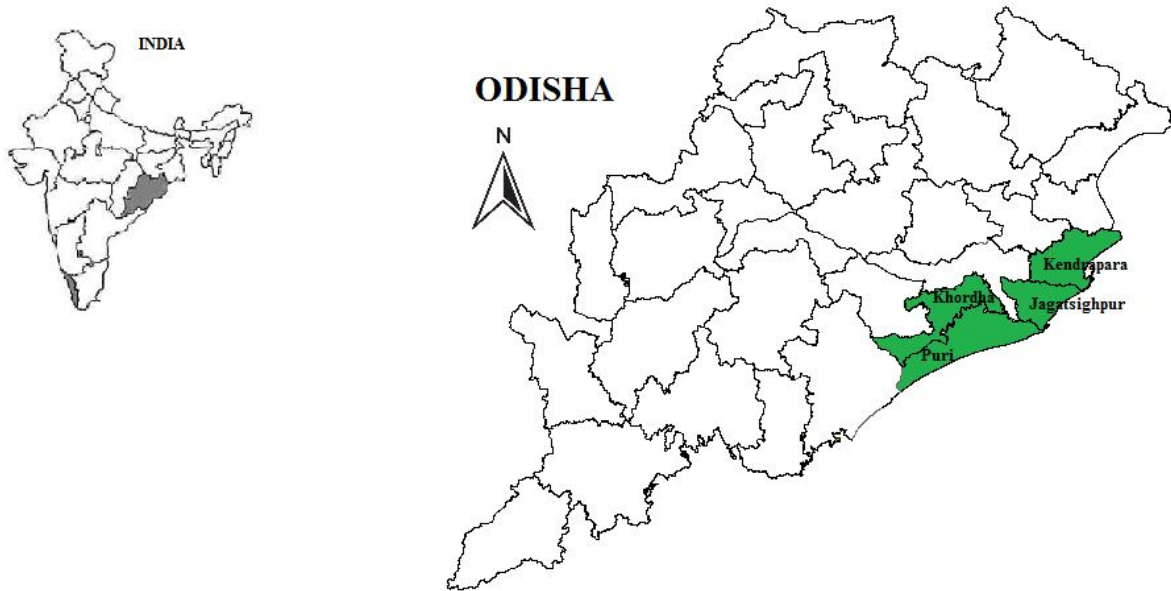


Fig 1: Map showing the study area comprising four districts.

2.2 Rainfall characteristics and rainfall variability

Daily rainfall data at block level of each district were collected from Special Relief Commissioner, government of Odisha for a period of 30 years (1991-2020). District wise daily rainfall data were derived from the daily rainfall data at block level (arithmetic mean) and was processed by using 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.

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

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

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

Where μ is arithmetic mean; σ is Standard deviation; X is actual value of any weather element; and 'n' is 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 method for computation of onset and withdrawal of 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 certain amount of rainfall was accumulated. For forward accumulation seventy five millimeters of rainfall was considered as the onset time of growing season (Morris and Zandesta, 1979; Babu and Lakshminarayana, 1997; Panigrahi and Panda, 2002). The withdrawal of rainy season was calculated by backward accumulation of daily rainfall amount from 15th October backwards (15 Oct, 14 Oct,....., 28 May). Twenty millimeters of rainfall was considered as the recession time for rainy season in backward accumulation which is sufficient for ploughing of fields after the harvest of a crop (Babu and lakshminarayana, 1997).

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 rainy season (15 Oct- 31 Jan). The total 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 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 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 monsoon PET of the district and the total number of rainy days in the monsoon period (Eq. 4).

$$LGP = \text{Duration of rainy season in days} + [(\text{Post monsoon rainfall, mm} + \text{AWHC, mm}) / \text{Average evaporative demand of atmosphere}] \quad (\text{Eq. 4})$$

Where AWHC is available water holding capacity.

2.4 Crop planning based on LGP

The choice of cropping system is decided on the basis of 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 whereas regions having LGP 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 district receives the maximum rainfall of 1561mm while Khordha district receives the lowest (1446mm). The mean annual rainfall of the zone ranges from 1446 to 1561 mm with variability of 18 to 21 % (**Table 2**). The co-efficient of variation (CV) of rainfall of all the four districts is less than 25% which indicates that the rainfall is highly dependable.

Table 2: District 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 December and March showed 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 with Puri district having the maximum amount (1149 mm) (Table 4). All the four districts receive almost 74% of mean annual rainfall during SW monsoon. The percentage contribution of SW monsoon towards total annual rainfall is highest in Jagatsinghpur and Puri district (75%). It is thus clear that SW monsoon accounts a major part of rainfall distribution out of all the seasons. The post monsoon rainfall contributes on an average 15% to 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 of monsoon is considered as the starting of the growing season. The onset date of monsoon was calculated by forward accumulation of rainfall. Early onset of monsoon was in Kendrapara district (15 June). Jagatsinghpur and khordha ditrict had 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 recession of monsoon. The growing season terminated at around 13 October (41st SMW) in all district 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 Puri district (119 days).

Table 5. District wise onset and cessation of monsoon

Blocks	Onset date	Cessation date	Wet Days
Jagatsinghpur	16 June	13 Oct	120
Kendrapara	15 June	13 Oct	121
Khordha	16 June	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 districts have LGP >180 days but Khordha district has 173 days.

Table 6. Length of Growing Period (Days)

District	SW Monsoon Period (days)	Post monsoon Rainfall (mm) (Oct-Jan)	AWHC (mm)	Average evaporation during 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 east and south eastern coastal plain zone and remain active up to 41st week (13th October) Therefore, we expected good monsoon shower for about 17 weeks (24 to 41 SMW) in the region. Thus, medium duration rice of about 120 – 135 days can easily be grown in the region with little fear of drought. The 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 for raising another 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 growing period >180 days except Khordha district where paira cropping can be followed as the length of growing period <180 days (Tab 6). In assured irrigated situation double cropping can also be practiced in Khordha district.

4.0 Summary and conclusion

This study reveals that the east and south eastern coastal plain zone receives 1510 mm of rainfall on an average annually, out of which monsoon rainfall contributes 74%. Length of growing period is 170-180 days for Khordha district and > 180 days for Jagatsinghpur, 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 east and south eastern coastal plain zone is Rice based cropping system. In rainfed situation, medium duration (120-130 days) rice varieties like Bina 11, Pratibha, Pratikshya, Manaswini, Naveen, Lalat and MTU 1001 can be taken up by 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.

6.0 References

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