

Ecological and Biomass Study of Coconut Plantations of Puri Coast, Odisha, India

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Abstract

Coconut is the most prevalent plantation crop in India. To determine the morphological parameter, biomass and moisture content of coconut and its different components (coconut leaf, midrib of leaf, leaflet and different parts of nut), an ecological study was conducted in Puri district of Odisha. Many research works are in progress to increase the productivity of coconut palm that will be helpful to farmers to improve their socio-economic status.

Keywords: Coconut plantation, biomass, moisture content, Puri district.

Introduction

Going back to more than 3000 years, Coconut is primarily a smallholder crop. It is now cultivated throughout humid tropics (Dhanapal, 2002). It is one of the most important sources of vegetable oil in the world. The coconut palm is also known as 'wonder plant' yielding many products. The coconut is included in a member of the family Arecaceae (Palmaceae). It is only the accepted species included in the genus *Cocos* and is a large palm, grow up to 30 m tall, with pinnate leaves 4-6 m long, and pinnae 60-90 cm long, old leaves break away minimally, leaving the trunk smooth. Out of 2,700 species of palm, coconut is one of the most resourceful palm. It has versatile uses and has the large value to Indian culture. So the coconut palm is called as "The tree of heaven" or "Kalpavriksha". Coconut is a smallholder crop primarily (Dhanapal 2002). Many useful products i.e. food, fuel and timber are provided by coconut palm. Many intercropping are seen in coconut plantation in coastal Odisha such as screw pine (*Pandanus odorifer*), drumstick (*Moringa oleifera*), beefwood (*Casuarina equisetifolia*) and cashew (*Anacardium occidentale*).

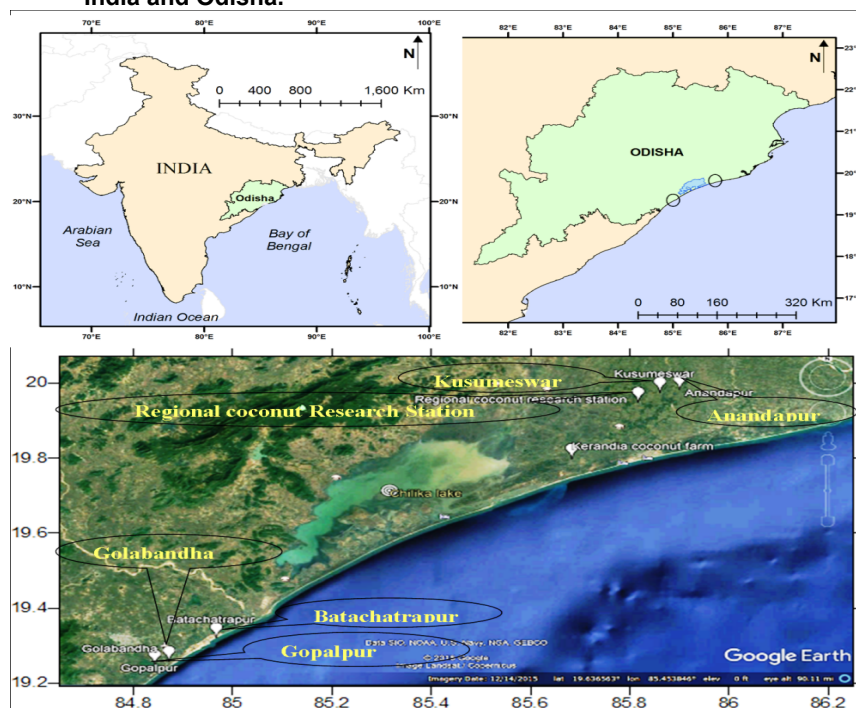
Many works have been done on coconut plantations and different parts of coconut. Through moisture conservation, drought management of coconut garden's work was done by Kumar & Rajgopal (2007). Monohar (2006) described the uses of coconut for the manufacture of ayurvedic medicine. Tender coconut water and the cardio protective effect have been elaborated by Anurag *et al.* (2007). Different varieties of tender coconut and coconut hybrids have been evaluated by Dash *et al.* (2007). Many works have been done on intercropping of different plants inside coconut gardens in different areas of the country (Ghosh *et al.* 2007; Thomas *et al.* 2007; Medda *et al.* 2008).

Study Site and Climate

Study area

The coastline of India stretches over a length of 7,500km (Banerjee *et al.* 2002), of which, Odisha comprises 481km. Out of the six coastal districts of Odisha, Puri coast extends over 138km along the Bay of Bengal. The coast is mainly sandy and devoid of any rocky substratum. Parallel sand dunes and beach ridges of 10 -15m high are present in Puri coast. The width of the sandy coastal belt ranged from 100 to 1000 m from the seawater (drift line) to the interior. The coastal plant community is divided into two distinct types – dry coastal plant community and wet coastal plant community. The former comprises strand flora whereas the later comprises mangroves. The vegetation of the coastal belt is influenced and determined largely by the estuaries and creeks formed by the rivers such as Mahanadi, Brahmani, Baitarani, Budhabalanga and others.

Fig 1. Map showing the study sites of coastal Puri district of Odisha. Insets are India and Odisha.



In Orissa, The rivers such as Subarnarekha, Budhabalanga, Dhamra, Baitarani, Brahmani, Mahanadi, Devi and Rushikulya from north to south fall in the Bay of Bengal forming the major deltaic regions. Coconut palm is one of the major vegetation in coastal belt of Odisha. Many people of the coastal belt are dependent on coconut palm because every part of this palm is useful and has economic value, medicinal value etc.

For the present work Puri coastal district of Odisha is selected. Four plantation sites were selected in the Puri coast i. e., Kusumeswar, Anandapur, Kerandia coconut farm and Regional coconut research centre. In Puri namely Kusumeswar, Anandapur, Kerandia coconut farm and Regional coconut research station that are situated about 19.95 km, 21.51 km, 16.09 km and 17.10 km from Puri sea beach.

Soil

Soil samples have collected from different sites. The pH of soil ranges from 7.2-8.7, organic carbon varied from 0.60-1.20%, water holding capacity from 21%-35% and the soil temperature 20 °C to 34 °C. The soil texture showed that the soil was silt-clay-loam and silt-sandy-loam. Coconut palm grows on sandy, saline, wastelands and marshy land on the bounds.

Table 1. Average annual rainfall at Puri districts of Odisha during 2020.

Month 2020	Average Rainfall (mm)
Feb	21.6
Mar	25.8
Apr	67.2
May	131.3
June	103.6
July	110.4
Aug	435.9
Sept	92.0
Oct	295.1
Nov	3.3
Dec	0
Total rainfall	1286.22

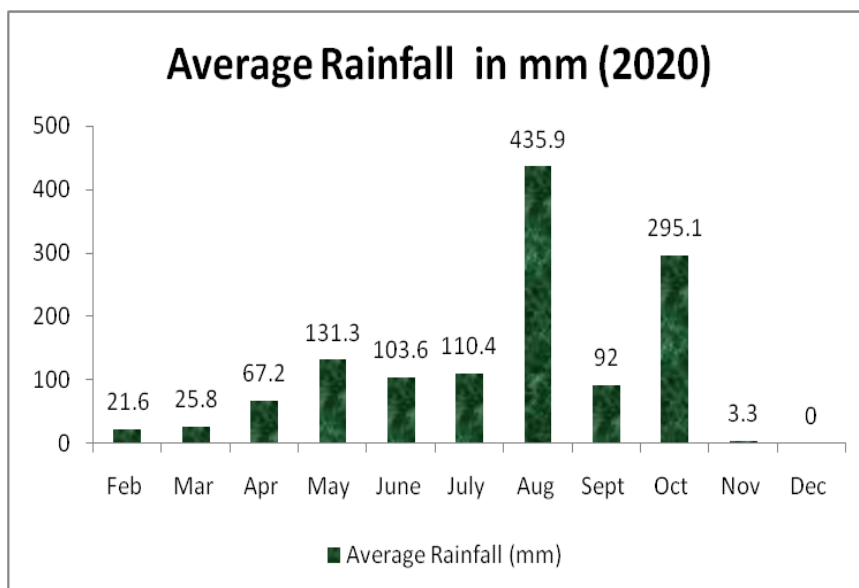


Fig.1. Average Annual Rainfall at Puri Districts of Odisha during 2020.

Total annual rainfall of the area was 1286.22 mm during 2020 (Table 1). No rainfall was observed in December 2020. In the month of August 2020 highest rainfall (435.9) was observed, while the minimum rainfall (3.3 mm) was received in December, 2011.

Aim of the Study

The paper is designed to study the ecology of coconut palm and plantations and detailed study of morphology of coconut palm and to study the biomass of coconut palm's part in Puri coastal district of Odisha for which only few literature is available.

Review of literature

Coconut is the economic crop which is mostly cultivated in tropical area, it is a great source of drink, food, medicine and sometimes used for the construction of houses and other purposes (Athauda *et al.* 2015; Ghosh *et al.* 2007; Edison *et al.* 2006; Medda *et al.* 2008). Some work has been done on Performance of local germplasm of coconut of Odisha (Beura *et al.* 2020). Based on an agroforestry system in coastal Odisha, the species diversity of coconut has been elaborated by Sarangi *et al.* 2020. Coconut is one of the significant economic crops which has significant value but there are less research papers available on ecology and biomass study.

Methods

Cocos nucifera (Coconut) placed under the family Arecaceae. Its local name in Odisha is 'nadia', in West Bengal is 'Narikel', and in Hindi is 'nariyal', in Tamil Nadu, the local name of coconut is called as 'Kbhri chettu' or 'Narikelumu' or 'Tenkaya'.

For the present study 28-60 age old coconut plantations were selected in the Puri coastal area. The coconut variety under study that is planted in coastal Puri is *East coast tall (ECT)*. The method includes both survey and experiment. Survey was done in the field with the help of a special questionnaire to the coconut farmer and the experiment includes collections of different samples from the coconut field and processed in the laboratory. Biomass (dry weight) of different parts of the coconut leaves and nuts were measured by the help of hot air oven by keeping the sample for a minimum of 48 hours.

Results

Morphology parameter

For the measurement of coconut leaf lengthwise and widthwise measurement is done.

Table 2. Total number of plants per acre in different sites of coastal Puri district of Odisha.

District	Total number of plants per hectare			
	Site 1	Site 2	Site 3	Site 4
Puri	104	112	145	63

Table 2 shows the number of coconut palm in different studied sites of coastal Puri district of Odisha.

Table 3. Length of coconut leaf (cm) in different sites of Puri district of coastal Odisha. Mean±SD.

	Length of coconut leaf (cm)				
District	Site 1	Site 2	Site 3	Site 4	LSD _(0.05p)
Puri	575.27 ±10.52	552.43 ±9.40	571.20 ±18.54	571.87 ±11.12	24.34

Table 3 depicted the length of coconut leaf where in site 1 has maximum length 575.27 cm and the minimum length was 552.43 cm in site 2 and the least significant difference between sites is 24.34 at 0.05p value.

Table 4. Leaf length without mid-rib in different sites of Puri district of Odisha. Mean ± SD.

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Table 5. Width of the Mid-rib (cm). Mean±SD.

	Width of the Mid-rib (cm)					
District	Region of mid-rib	Site 1	Site 2	Site 3	Site 4	LSD _(0.05p)
Puri	Base	39.06 ±2.90	44.4 ±2.99	39.5 ±3.15	37.3 ±2.51	5.472
	Middle	13.7 ±1.44	20.2 ±1.21	7.7 ±0.11	12.7 ±0.91	1.979
	Top	2.9 ±0.65	4.9 ±0.45	1.1 ±0.10	2.6 ±0.45	0.868

Table 5 reveals the width of the mid-rib of three different regions of the leaf i.e., Base, middle and top region of the leaf.

Table 6. Width of the leaf (cm). Mean±SD.

		Width of the leaf (cm)				
District	Region of leaf	Site 1	Site 2	Site 3	Site 4	LSD _(0.05p)
Puri	Base	223.1 ±4.36	166.5 ±6.04	168.5 ±10.57	221.8 ±3.45	12.627
	Middle	243.0 ±9.02	264.5 ±5.35	260.8 ±10.80	243.7 ±9.99	17.043
	Top	85.7 ±7.00	108.3 ±5.00	76.1 ±8.07	83.1 ±9.50	14.290

Table 6 reveals the width of the leaf in the studied sites. The width of the leaf ranged between 168.5 cm (site 3) to 223.1 cm (site 1) in the base region. In the middle region of the leaf it varied from 243.0 cm (site 1) to 264.5 cm (site 2). Top region leaf width is ranged between 76.1 cm to 108.3 cm in site 1 and site 2 respectively.

Biomass

Table 7. Dry Weight of Different Components of a Coconut Leaf at Different Sites of Puri Coast Mean±SD.

Sites	Dry weight of one leaf (kg)				
	Mid-rib	Leaflet			Grant Total
		Khadika	Rachis	Total	
Site 1	1.762 ±0.071	0.226 ±0.031	0.939 ±0.021	1.165 ±0.052	2.927
Site 2	1.405 ±0.073	0.269 ±0.036	1.102 ±0.307	1.377 ±0.304	2.782
Site 3	2.014 ±0.132	0.577 ±0.053	0.444 ±0.043	1.021 ±0.068	3.035
Site 4	1.716 ±0.129	0.232 ±0.024	0.978 ±0.041	1.210 ±0.058	2.926

The above table shows the average biomass (dry weight) of different components of a coconut leaf in the coastal district of Puri. The biomass of the rachis without midrib ranged between 0.444 kg (site 3) to 01.102 kg (site 2), the biomass of stiff leaflet midribs (*khadika*) varied between 0.226 to 0.577 kg in site 1 and site 3, respectively. The minimum biomass of leaf midrib was 1.405 kg in site 2, while the highest biomass was 2.014 kg in site 2 & 3. The total biomass of a coconut leaf ranged between 2.927 kg to 3.035 kg in the sites studied.

Table 8. Average biomass moisture content (%) of different components of a coconut leaf at different sites of Puri coast. Mean ± SD.

Sites	Moisture content (%)		
	Mid-rib	Leaflet	
		Khadika	Rachis
Site 1	65.9 ±2.3	52.5 ±2.0	54.8 ±2.1
Site 2	71.1 ±2.0	55.7 ±1.8	51.8 ±2.1
Site 3	73.1 ±0.9	46.5 ±2.7	66.0 ±1.2
Site 4	67.3 ±1.6	48.0 ±2.2	52.9 ±0.6

Table 8, the moisture content of *khadika* (stiff leaves with midrib) ranged from 46.5 % to 55.7 % in site 3 and site 2, respectively. The highest moisture content of rachis (stiff leaves without midrib) was 51.8 % (site 2) and the lowest moisture content of rachis was 66.0 % (site 3).

Table 9. Average moisture content (%) of different components of a mature coconut at different sites of Puri coast. Mean ±SD.

Sites	Moisture content (%)		
	Copra	Shell	Coir
Site 1	70.2 ±2.5	32.1 ±3.1	56.9 ±3.2
Site 2	73.8 ±0.2	33.2 ±1.7	60.5 ±3.4
Site 3	67.4 ±3.9	32.3 ±5.3	57.3 ±3.3
Site 4	68.9 ±1.5	25.6 ±6.7	73.8 ±2.8

Table 9 depicted the average moisture content of different components of mature coconut in all sites of the coastal district of Puri. The moisture content of copra of mature coconut ranged between, 67.4 % to 73.8 % in site 3 and site 2, respectively. The moisture content of the shell varied between 25.6 % (site 4) to 33.2 % (site 2). The measured moisture content of coir ranged from 56.9 % (site 1) to 73.8 % (site 4) in sites studied in Puri coast of Odisha.

Table 10. Average biomass (dry weight) of different components of a mature coconut at different sites of Puri coast. Mean \pm SD.

Sites	Dry weight (g)					Grant Total
	Copra	Shell	Coir	Total	Coconut water	
Site 1	36.75 \pm 2.58	87.12 \pm 3.88	827 \pm 61	950.87 \pm 67.46	116 \pm 4	1066.87
Site 2	35.19 \pm 2.21	97.47 \pm 7.83	773 \pm 67	905.66 \pm 77.04	127 \pm 10	1032.66
Site 3	40.58 \pm 5.37	87.55 \pm 9.29	803 \pm 59	931.13 \pm 73.66	122 \pm 9	1053.13
Site 4	38.07 \pm 4.70	93.66 \pm 5.08	501 \pm 78	632.73 \pm 87.78	121 \pm 6	753.73

Table 10 reveals the average biomass (dry weight) of different components (Plate VI) of one mature coconut in all studied sites of Puri coast. The minimum water content of mature coconut was 116 g (site 1) while the maximum water content was 127 g (site 2). The biomass (dry weight) of the shell varied between 87.12 g to 97.47 in site 1 and site 2, respectively.

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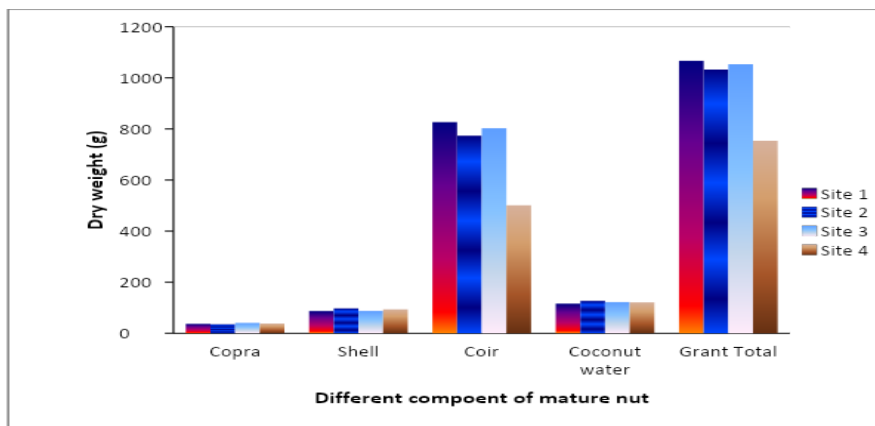
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Discussion



Coconut is a perennial palm offering a multitude of uses for mankind and therefore is important for many in the Asia and Pacific region. This crop provides food and beverage and numerous other raw materials to coconut based industries. The coconut palm has about 60 years of economic life span and has been recognized as a crop with tremendous potential for alleviating poverty in the third world (Everard *et al.*, 2000). Therefore, conservation of coconut is of primary importance in the world. Most of the coconut plantations in the coastal Puri districts belong to private farmers. The plantations are not managed well and except few they are left as such. In many of the plantations, death of plants/ saplings are observed. Coconut has been an integral part of the South Indian diets. The results indicate that per capita consumption patterns of coconut oil and coconut have not changed from 1961-2005 (Athauda *et al.* 2015).

There is a saying that there are many coconut trees in Puri and Puri stars in the sky! Every part of the coconut tree is useful. Coconut water a refreshing drink, is directly sipped from the unripe fruit, the grated and dried copra is used to thicken sauces, and the oil extracted from the fruit is a popular frying medium, palm sugar or jaggery is made from the juice extracted by cutting young stem of the palm. The coconut sap can be also fermented to yield toddy, an alcoholic beverage. The shells are used to make handicrafts objects, spoons and ladles, leaves are dried to remove their veins for making brooms, and the jute-like material from the nodes is used as material for lining.

The trend of biomass of mature coconut in Puri coast are site 1 (Kusumeswar) > site 3 (Kerandia coconut farm) > site 2 (Anandapur) > site 4 (Regional coconut research centre) whereas the tender coconut trend are site 3 (Kerandia coconut farm) > site 2 (Anandapur) > site 1 (Kusumeswar) > site 4 (Regional coconut research centre). In Puri, the leaf length (575.27 cm) observed in this study is higher than the length (388 cm) reported by Medda *et al.* (2008).

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