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# Investigation on organ specific carbon concentration of Palmyra palm in Thoothukudi District, Tamil Nadu

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**Abstract**
An Analytical survey was conducted to record the carbon contribution of *Borassus flabellifer* L. which belongs to Arecaceae family. In this study, the species specific carbon concentration in various parts of Palmyra palm was investigated in tropical and sub-tropical regions of Thoothukudi district, Tamil Nadu. A total of 10 trees of Palmyra palm (five each in Coastal and Inland areas) were randomly selected and five replicate samples of various parts (wood, leaf, petiole, leaf scar and root) were collected for this study. The mean carbon content of Coastal and Inland area in wood sample was recorded as 48.62 ± 0.26% and mean carbon content of Coastal and Inland area in leaf sample was recorded as 47.05 ± 0.26%, the mean carbon content of Coastal and Inland area in petiole sample was recorded as 42.35 ± 0.54%, the mean carbon content of Coastal and Inland area in leaf scar sample recorded as 40.85 ± 0.35%, the mean carbon content of Coastal and Inland area in root sample was recorded as 42.00 ± 0.34%. The *Borassus flabellifer* L. was sequestrated the maximum carbon in wood and minimum carbon in leaf scar. This study revealed that Palmyra palm has sequestrated a good amount of organic carbon from the atmosphere. The cultivation and maintenance of Palmyra palm would improved the local, National and International ecosystem through carbon sequestration.

**Keywords:** carbon sequestration, inland and coastal area, Palmyra palm, Thoothukudi

## Introduction
Climate change and Global warming are the major havoc in the environment that are resulting from the accumulation of carbon dioxide ($CO_2$) and other green house gases in our atmosphere. Global environment suffered with lot of carbon concentration produced by various anthropogenic activities at the rate of 3.5 billion metric tons per annum (Jina *et al*., 2008) [7]. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide reducing global climate change. So far there is no proper mechanism was discovered to mitigate the carbon content in the atmosphere. Satellite data may eventually be developed to determine aboveground biomass directly in optical as well as radar yielded consistent results in forests with moderate to high biomass (Rignot *et al*., 1997) [18]. Whereas, the carbon stock file shows differentiation at coastal and inland areas based on the various factors especially climate change (Lal *et al*., 1998; Schimel *et al.*, 2000) [4]. Deforestation is the major factor in increasing carbon concentration from 280ppm to 368ppm in the year 2000 and 540ppm by 2100 (Houghton *et al*., 2001) [6], because the forest ecosystem acts as a source and sink of carbon (Watson *et al*., 2000) [23].
Globally, Forests play vital role in carbon sequestration (Rawat *et al*., 2003) [17], since it sequestrates and store more carbon than any other ecosystem. Since net ecosystem productivity generally reflects overall gain or loss of terrestrial carbon pools (Nair and Nair, 2003) [13]. Warmer temperatures generally accelerate litter decomposition and possible stimulatory effects of raising atmospheric $CO_2$ levels on Photosynthetic production and also associate greater litter fall production rates (Kumar *et al*., 2005) [8]. The present study focus on carbon concentration in various parts of Palmyra palm both Coastal and Inland areas of Thoothukudi District, Tamil Nadu.

## Materials and Methods
### Study area
This study was conducted in four taluks of Thoothukudi district, Tamil Nadu, two each from Coastal (Tiruchendur, Udangudi) and Inland areas (Srivaikundam, Karunkulam). Both Inland and Coastal areas are consists of tropical and sub-tropical regions. The geography of Thoothukudi district in particular areas is 470724 hectares. It lies between 8º29’ Northern latitude and 78º.07 of Eastern longitude.

### Study area (inland & coastal area)

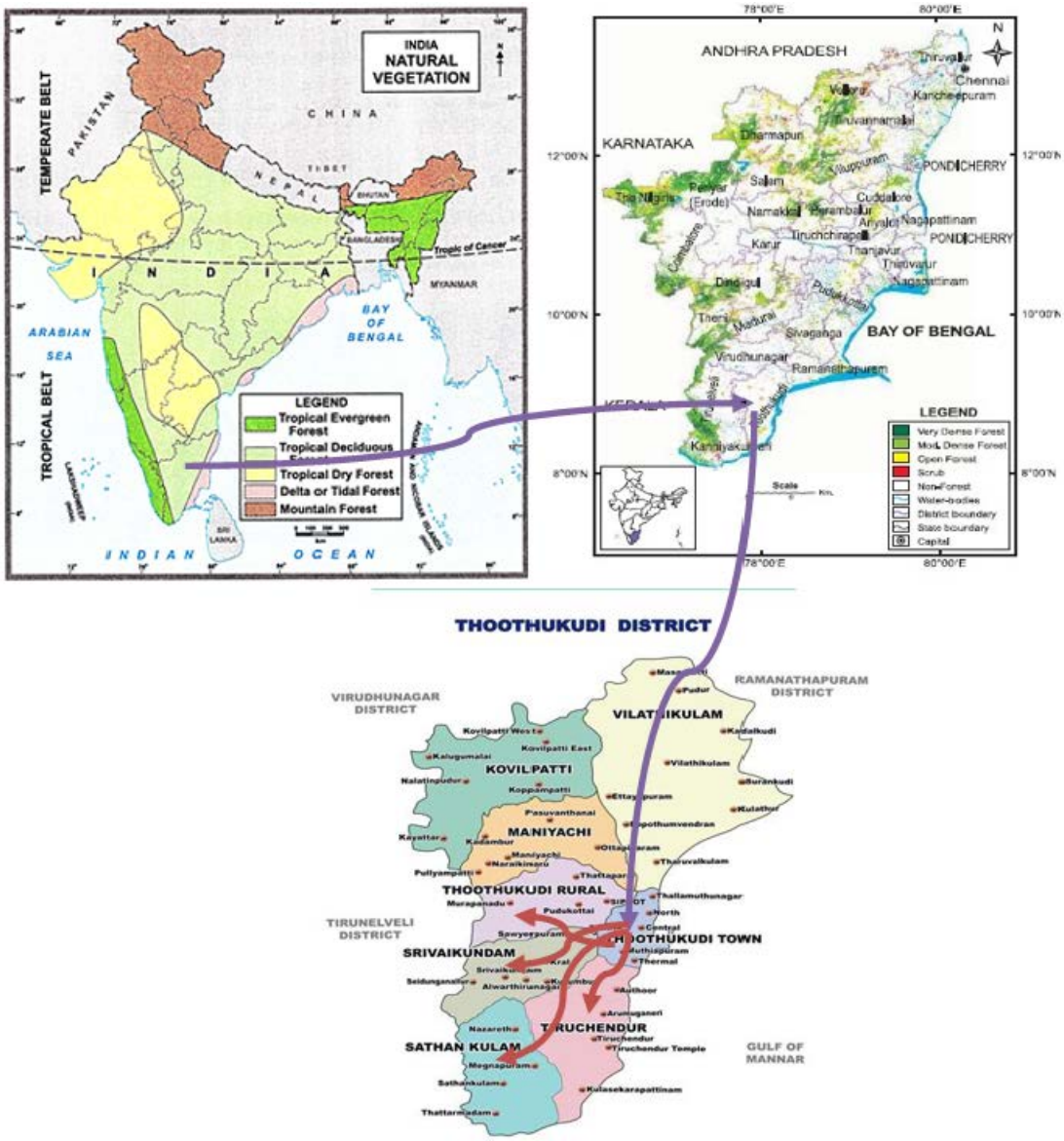



**Fig 1:** Forest type of Thoothukudi

### Sample Collection

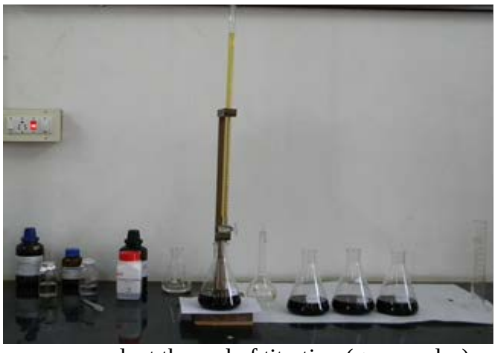
This study was conducted from January to December, 2019. The data were collected from the field by direct field visits, simultaneous observation and measurements. Five places were randomly selected for this study from each Coastal and Inland areas, in each place five replicate samples were collected from various parts (wood, leaf, petiole, leaf scar and root) of the Palmyra palm. Samples sans visible symptoms and damage were collected by sharp knife and digger from each part of Palmyra palm.

### Estimation of carbon

The carbon content of each part in Palmyra palm was estimated by using the methodology of (Nelson *et al*., 1982) [14]. The samples were placed in hot air-oven 75ºC for 48 hours after the dried samples were kept in oil-bath at 135ºC for 40 minutes. Dried samples were made into fine powder by a mixer grinder. Powdered samples were mixed thoroughly before carbon concentration estimation (Walkley, 1934; Peech *et al*., 1947; Greweling and Peech, 1960) [22, 15, 5].

a. Wood Sample B. Wood Powder

c. Titration



d. at the end of titration (green color)

**Fig 2:** Estimation of Carbon

**Calculation**

Organic carbon, = $\frac{(Vb-Vs)\times N\times 0.39}{Ws}$

Organic matter, % = Organic carbon × 1.724

Where *Vb* is the Mohr's salt reagent used for the blank titration in milliliters (ml) *Vs* are the Mohr's salt reagent used for the blank titration in milliliters (ml) *N* is the normality of Mohr's salt reagent *Ws* are the weight of air-dried sample used in grams

**Results and Discussion**

**Carbon content of Palmyra palm wood**

The maximum carbon concentration was recorded in wood sample of Palmyra palm in both Coastal and Inland areas, the values are 49.82 ± 0.28% and 47.45 ± 0.24% respectively.

**Carbon content of Palmyra palm petiole**

Palmyra palm petiole stored 43.83 ± 0.53% of carbon in Coastal area and 45.84 ± 0.36% of carbon content in Inland area.

**Carbon content of Palmyra palm leaf**

The carbon content in leaf sample was 48.35 ± 0.31% found in Coastal area, subsequently 45.75 ± 0.22% was found in inland area. The difference of carbon concentration in Coastal and Inland Palmyra palm was nearly 2.5%.

**Carbon content of Palmyra palm root**

The root of Palmyra palm recorded lowest carbon concentration (42.35 ± 0.32%) when compared to other parts in Coastal region. In Inland area, Palmyra palm root stored (41.65 ± 0.24%).

**Carbon content of Palmyra palm leaf scar**

The Coastal area leaf scar stored 43.25 ± 0.28% of carbon content in Inland area 38.56 ± 0.42% of carbon content was stored in leaf scar.

The carbon content of various parts in Palmyra palm of each area (Coastal and Inland) was tabulated in table 1.

**Table 1:** The carbon content of various parts in Palmyra palm of each area (Coastal and Inland)

| S.No. | Name of Parts | Carbon content (%) | |
|---|---|---|---|
| | | Coastal | Inland |
| 1. | Wood | 49.82 ± 0.28 | 47.45 ± 0.24 |
| 2. | Leaf | 48.35 ± 0.31 | 45.75 ± 0.22 |
| 3. | Petiole | 43.86 ± 0.53 | 40.84 ± 0.36 |
| 4. | Leaf scar | 43.25 ± 0.28 | 38.56 ± 0.42 |
| 5. | Root | 42.35 ± 0.32 | 41.65 ± 0.24 |

The values are average of five samples Mean ± SE

The tree components of plant system can significantly act as sink of atmospheric carbon because of their high productivity and fast growth. The present study revealed that the atmospheric carbon was stored in various parts Palmyra palm. The highest carbon concentration was found in the parts of wood in both Inland and Coastal area, the similar work was observed in pine trees by (Cheng et al., 2014) [3]. Next to the wood the maximum carbon concentration was stored in parts of leaf, the leaves are high primary productivity centre it can stored the excess carbon concentration in their leaf vacuoles, this result was consistent with previous findings in leaves, roots, and reproductive organs of various plant parts (Savidge, 2000; Lamlon and Savidge, 2003; Bert and Danjon, 2006; Martin and Thomas, 2011) [20, 10, 12].

The carbon content in root was lower than that other parts of plant, it showed significant latitudinal trends introduced by climatic factors and life forms, our results was co-inside with the findings of (Ma *et al*., 2018). Earlier investigations concentrated on wood primarily as an energy resources and stored more carbon content within them, it is probably observed soft wood contains higher carbon content than hardwood in 41 North American plant species (Lamlon and Savidge, 2003) [10]. The Palmyra palm stored good amount of carbon content in the parts of wood and leaf like that Albizia saman species stored atmospheric carbon in Chennai metropolitan (Udayakumar *et al*, 2018) [21].

The carbon sequestration rates in Coastal and Inland Palmyra palm wood ranged from 49.82% to 47.45%. The mean carbon sequestration rates were higher in Coastal sites of Palmyra palm wood as compared to Inland sites. The carbon sequestration rate was higher in Coastal sites of Palmyra palm leaf (48.35%) than in Inland sites (45.75%). Actually the Coastal sites Palmyra palm sequestrated more atmospheric carbon than in Inland sites; it may due to the moisture content and nature of Coastal soil. Due to harder nature of Palmyra palm petiole, its stored applicable amount of carbon content in both Coastal and Inland sites, immediately after the reached storage carbon content it may transfer the carbon to the wood, hence, the petiole act as carrier of carbon between leaf and wood. Likewise, mean value of Palmyra palm leaf carbon was 47.05%, earliest study was recorded in *Eugenia caryophyllata* leaf carbon concentration was 51.66 % (Rodriquez *et al*., 2015) The leaf scar was also sequestrated good amount of carbon content 43.25% and 38.56% in Coastal and Inland sites respectively even after the death of leaf. Moreover, Palmyra palm root stored little amount of atmospheric carbon because the wood stored the maximum quantity of carbon it may not transfer the carbon to the root, the similar result observed by (Ma *et al*., 2018).

The variation of plant carbon content among organs was associated with differences in their chemical composition, plant organs are composed with different carbon content such as lignin, cellulose and non structural carbohydrate, (Alder, 1977; Poorter and Bergkotte, 1992) [16]. Our findings was consistent with the previous findings of the carbon content in various plants (Savidge, 2000; Lamlon and Savidge, 2003; Bert and Danjon, 2006; Martin and Thomas, 2011) [20, 10, 12].

## Conclusion

The potential of carbon sequestration is determined by the age, height, girth size, biomass accumulation capacity, canopy diameter and most important wood specific density. In this study, the highest carbon concentration was observed in the wood while the lowest level of carbon content stored in root. Our result highlight the importance of considering carbon sequestration by Palmyra palm tree, approximately 65% of total carbon was stored in the wood. The overall study showed that through the study area the Palmyra palm were significantly ensured carbon sequestrations, hence, Palmyra palm has potential role in conservation of an ecosystem as well as one step forward to climate change mitigation. So, the Palmyra palm to be chosen for sequestering maximum amount of atmospheric carbon in the scenario of climate change, with the properties of highest specific density and also should have better climate adoptability, disease resistant capacity in tropical and sub-tropical regions of Coastal and Inland sites.

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