INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

www.scienceandnature.org

# SPATIAL DISTRIBUTION OF ORGANIC CARBON IN COCONUT GARDENS OF DIFFERENT AGRO-CLIMATIC ZONES OF KARNATAKA

Dinesh Kumar, M., Binny Gopal & Dhananjaya, B.C.
Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Shivamogga -577 224, Karnataka, INDIA
* Corresponding author email: dinumallige@gmail.com

**ABSTRACT**
Spatial distribution of organic carbon was studied from 99 coconut farmers covering 195 acres representing different irrigation situations in Chikkapattanagere of Chikkamagaluru district, Doddaghatta of Davangere district, Siriyur of Shivamogga district and Madhure of Chitradurga district of Karnataka. The chosen gardens were 20-25 years old with varying management levels. The standard technique of grid method with a spacing of 50x50m was employed to draw soil samples from the selected study area in 0-30 and 30-60 cm depth with geographical identity by GPS. Using these data on GIS environment mapping of each area was done. Among the areas studied, Siriyur soils are acidic while others are tending towards basisity. Generally, the soil pH was increasing with the depth supported by the increased salt accumulation. Status of organic carbon studied across different locations showed a relative tendency, in that surface layers had the status of high to medium, while at deeper layers of 30-60 cm this proportion lessened wherein largely it gloomed towards medium to low status. In order to achieve sustainability the integrated approach is must.

**KEY WORDS:** GIS, recommendation, spatial distribution, site specific management.

## INTRODUCTION

Agricultural soils have long been recognized by scientists as potential carbon reserves. Key strategies to increase the carbon content or potential of a soil includes increasing the time under which the soil is vegetated, crop rotation, reducing soil tillage, returning soil tillage, returning organic materials to soil, increasing the soil fertility and enhancing the tree species, perennial grasses and legumes etc. In the wake of eliminating hunger, soils have been put to constant usage by growing different types of crops as dictated by primary need of food and crop ecology. Hence, in a given environment of agricultural crop production, crop choices are based on wants and accordingly amount of carbon fixed do also varies. In a given system net gain in carbon sequestered in soil includes many variable factors. Knowledge of the relationship between land use type and soil carbon build up will lead to further understanding of the effect of land management practices on soil carbon fluctuations that may reduce the rate of increase of $CO_2$ concentrations in the atmosphere (Jaiarree *et al*., 2011). One of the agriculturist's major opportunities to help mitigate the effect of climate warming gases lies in the management of soil to increase OM content, thereby removing C from the atmosphere. A number of biological soil based practices employed in integrated systems have great potential to sequester C due to enhanced abundance of mycorhiza and other favourable micro climate (Clay *et al*., 2010). The perennial crop such as coconut is one of the ideal choices for carbon sequestration not only by crop itself but also for soils to improve its quality as there will be minimum cultural disturbance to soil and addition of leftover of plant waste which helps to augment the soil carbon. The coconut palm (*Cocos nucifera* Linn.), is a member of the family Palmae (palm family) grown mostly along the coastal regions and Karnataka stands third in the country in terms of coconut production (2,176 million coconuts) after Kerala and Tamil Nadu **(**Anon., 2012). Major coconut growing districts in Karnataka are Tumkur, Hassan, Dakshina Kannada, Chikkamagaluru and Chitradurga, which together account for more than 85 per cent of coconut-growing area. Hence, it is very important horticultural crop having a very high impact on the economy of farmers of Hill, Southern Transition and Central Dry Zones. By and large, the crop as it is being envisaged, grown with middle to less care. The perennial nature of crop, the tall upper canopy, unavailability of skilled labours, biotic stress etc paves way for not caring situations. As such crop is also drought tolerant, management become a secondary postponed option for growers rather than time and space need. Basically, the soils also differ with that of agro climatic situations and not possible to generalize the soil nutrient status as it is a dynamic factor. Growers need sound information to guide their management decisions. Well established coconut gardens were selected across these agro climatic situations with an objective to classify the soil organic carbon as a part of site specific management and to understand them the variability of their fields for improving the garden fertility status for sustainable yields.

## MATERIALS & METHODS

The study was undertaken during 2014 and area included Chikkapattanagere of Chikkamagaluru district, Chitradurga district (Fig. 1). The study was undertaken during 2014-15. A total of 195 acre representing 45-50 acre at a stretch aged about 20-25 years coconut gardens in each location was chosen which included 99 farmers in

total (Tab. 1). In the context of study, Chikkapattangere is a dry place, where tank fed irrigation during summer is prominent or otherwise tube well irrigation by few farmers.

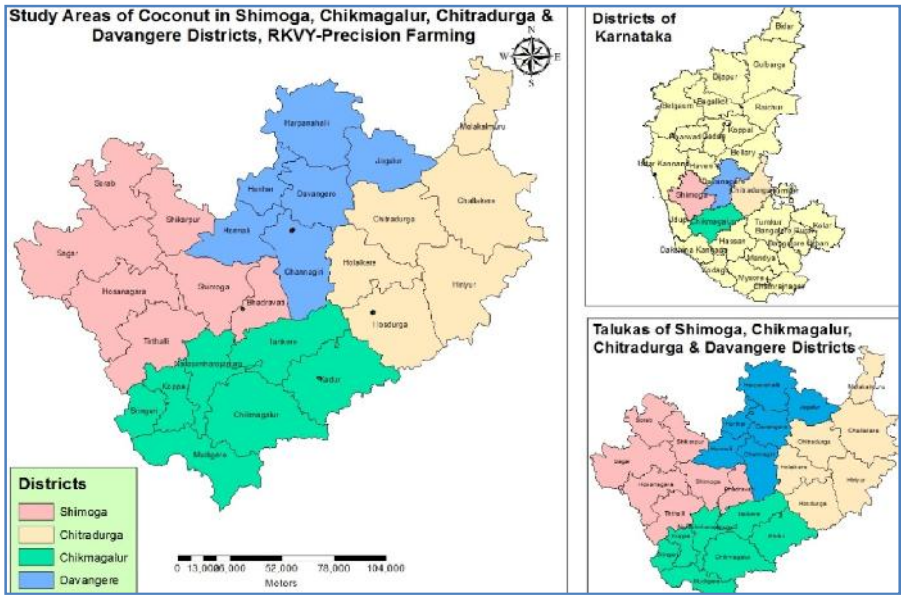
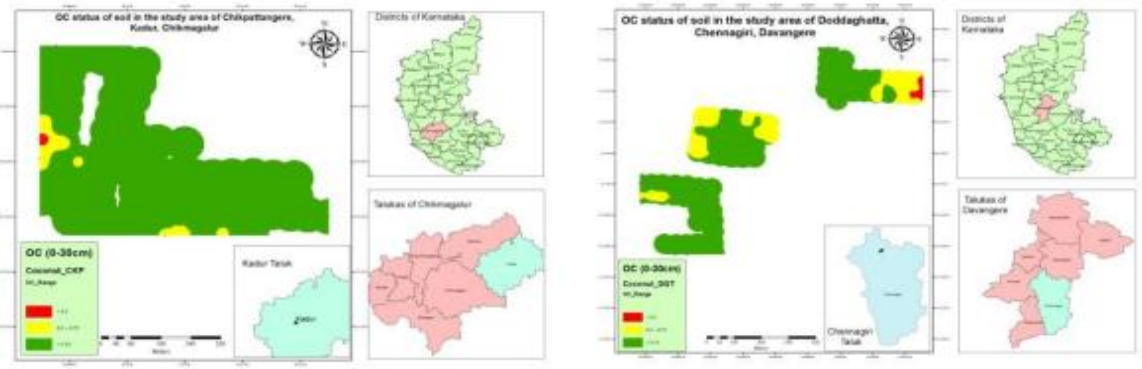



**FIGURE 1:** Different study area of coconut

The crop management level is almost medium range wherein farmers use to get per palm around 50-60 nuts per year. Doddaghatta farmers enjoy the supply of tank irrigation around the year and higher middle to high level of management is seen with 60-80 nuts per palm per year. Siriyur also enjoys the Bhadhra river water supply almost year around and farmer's justice the crop with middle level of management as the palm yield levels around 60-70 nuts per year. On the other hand, among the places chosen, Madhure is a driest place and irrigation is also scarce; only those farmers with success tube wells irrigate less frequently their gardens as it depends on water quantity they got. Likewise, level of management is also relatively poor as they get yield around 40-50 nuts per palm per year. The standard technique of grid (50x50 m) method was employed to draw soil samples from the selected study area in 0-30 and 30-60 cm depth. Each grid is recognised by its own co-ordinates by GPS to make area geo-referencing. Further, using co-ordinates, the base maps of the study area was developed with the help of GIS software. Soil samples from each grid was dried, powdered, sieved with 2 mm mesh and analyzed by following the standard methods of analysis. The pH and EC was measured with glass electrode in a 1:2.5 soil/water suspension (Jackson, 1973) and organic carbon by rapid titration method (Walkely and Black, 1934). Also with the help of soil analysis for various elements on grid basis, the delineation maps of the area were developed for selected nutrient that can also be a managemental zone for its applicability. For each location depending on sufficiency (>0.6) and deficiency (<0.6) classification criteria, organic carbon maps were prepared on base map of each study area separately with the help of GIS.

## RESULTS & DISCUSSION

The location wise compiled soil analytical results are accomplished in Table 2. Soil variability map of organic carbon for the study area is accomplished in Figure 2. The location wise discussions are indicated in the following paragraphs.



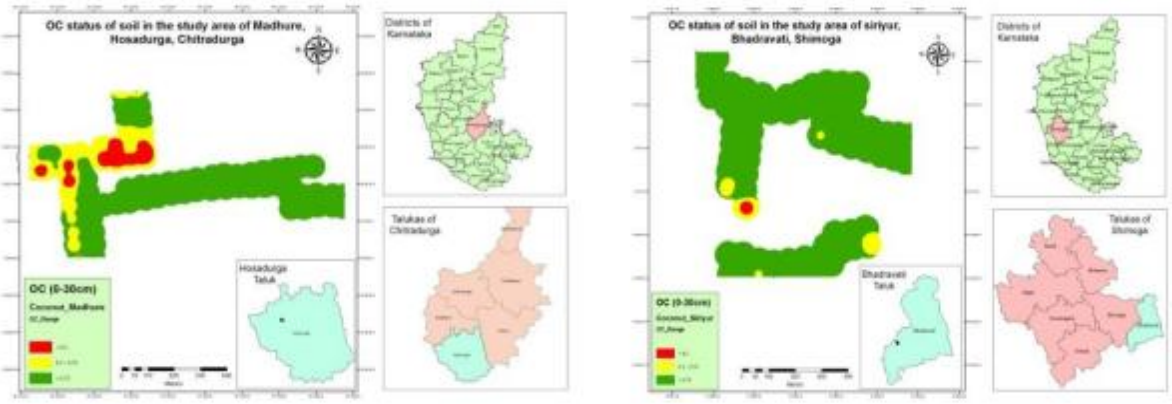



**FIGURE 2:** Organic carbon content for 0-30 cm depth of study area

**TABLE 1:** Details of different sites of the study area

| | Chikkapattangere | Doddaghatta | Siriyur | Madhure |
|---|---|---|---|---|
| No. of farmers | 37 | 7 | 24 | 31 |
| Area (Acres) | 160 | 160 | 160 | 144 |
| No. of samples | 50 acre | 50 acre | 50 acre | 45 acre |

**TABLE 2:** Location wise soil nutrient parameters

| | Chikkapattangere | | | | | |
|---|---|---|---|---|---|---|
| | 0-30 cm | | | 30-60 cm | | |
| | pH | EC (dS/m) | OC (%) | pH | EC (dS/m) | OC (%) |
| Maximum | 8.80 | 1.77 | 3.70 | 8.90 | 1.97 | 3.04 |
| Minimum | 8.10 | 0.31 | 0.33 | 8.10 | 0.36 | 0.24 |
| Average | 8.46 | 0.61 | 1.15 | 8.50 | 0.70 | 0.97 |
| Standard deviation | 0.35 | 0.77 | 1.71 | 0.28 | 0.77 | 0.91 |
| Standard error | 0.98 | 0.19 | 0.41 | 0.99 | 0.22 | 0.34 |
| Ratings | Acidic=0 | Low=56 | Low =01 | Acidic=00 | Low=42 | Low=14 |
| out of 80 | Neutral=00 | Medium=24 | Medium=17 | Neutral=00 | Medium=38 | Medium=44 |
| samples | Basic=80 | High=00 | High=62 | Basic=80 | High=00 | High=22 |

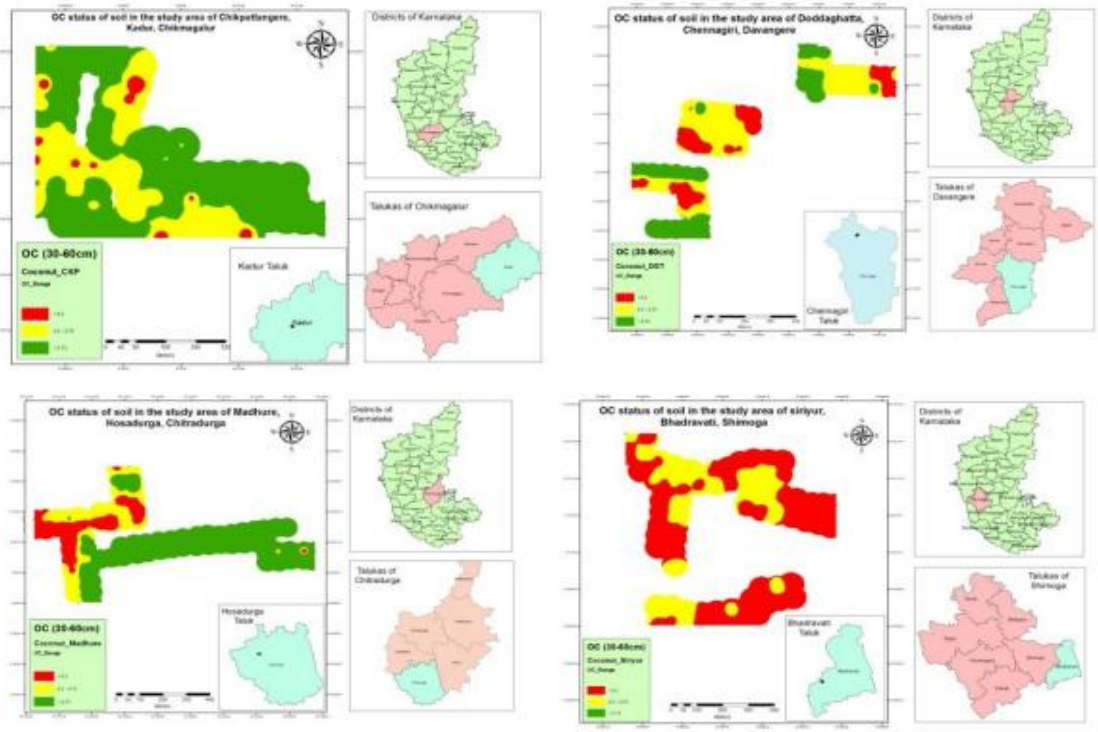



**FIGURE 3:** Organic carbon content for 30-60 cm depth of study area

**Chikkapatttangere**

The place is a border village cluster of hilly zone. Being a shadow area of hilly zone, the rainfall of study area is around 600 mm. The nature of soil is basic in reaction with very low salt accumulation in both the depths studied. Status of organic carbon remained high with 77 per cent for 0-30 cm while at 30-60 cm depth it showed 27 and 55 per cent high and low status respectively. Increasing soil organic matter is a key component of any productive system of plants. It appears that management of crop with different approaches by farming community dictated the top layer nutrient status.

**Doddaghatta**

This village is blessed with year around water supply through canal and tank. Hence crop is fed with irrigation frequently or when it is required. Depth wise no perceptible variation with respect to soil reaction is observed. Among the soils analysed 43 per cent of them showed neutral tendency while 28 per cent remained basic in reaction and depth wise also remained static. Others show marginal level of acidity. Depth wise distribution of salt remained same. At 0-30 cm, organic carbon was found high with 63 per cent of samples while 32 per cent of samples had medium status. At 30-60 cm depth, the proportion of high organic carbon status was limited to 37 per cent wherein low status also occupied with same margin leaving others in medium status. These unique minor variations are due to relevant cultural practises with good management where bearing ability of gardens are in higher order as compared to other places in the study.

**Madhure**

The place is one of the driest tract wherein rainfall is less than 500 mm with improper distribution. Generally, soils of dry tract do possess neutral to slightly alkaline in reaction with poor in N content. In the studies also bulk of samples analyzed showed the tendency of neutral (around 30 %) to slightly alkaline (around 60 per cent) in both depths. It is supported by medium status of salt accumulation evenly in both the depths. As high as 66 per cent of samples in 0-30 cm depth were high in organic carbon status leaving rest of the area equally distributed to other two statuses. At 30-60 cm depth, 55 per cent of area shown high status wherein 28 and 16 per cent of area marked as low and medium status respectively.

| | Doddaghatta | | | | | |
|---|---|---|---|---|---|---|
| | 0-30 cm | | | 30-60 cm | | |
| | pH | EC (dS/m) | OC (%) | pH | EC (dS/m) | OC (%) |
| Maximum | 8.19 | 2.79 | 2.34 | 7.96 | 1.90 | 1.65 |
| Minimum | 6.07 | 0.11 | 0.35 | 6.01 | 0.10 | 0.05 |
| Average | 7.06 | 0.70 | 0.99 | 7.07 | 0.63 | 0.67 |
| Standard deviation | 0.54 | 0.54 | 0.41 | 0.56 | 0.42 | 0.34 |
| Standard error | 0.06 | 0.06 | 0.05 | 0.06 | 0.05 | 0.04 |
| Ratings out of 80 samples | Acidic=16<br>Neutral=35<br>Basic=27 | Low=58<br>Medium=18<br>High=02 | Low=01<br>Medium=26<br>High=51 | Acidic=15<br>Neutral=39<br>Basic=24 | Low=64<br>Medium=14<br>High=00 | Low=31<br>Medium=17<br>High=30 |

| | Madhure | | | | | |
|---|---|---|---|---|---|---|
| | 0-30 cm | | | 30-60 cm | | |
| | pH | EC (dS/m) | OC (%) | pH | EC (dS/m) | OC (%) |
| Maximum | 9.40 | 2.10 | 2.70 | 9.30 | 1.60 | 2.30 |
| Minimum | 5.90 | 0.10 | 0.10 | 5.60 | 0.10 | 0.10 |
| Average | 7.60 | 0.50 | 1.10 | 7.70 | 0.50 | 1.00 |
| Standard deviation | 0.67 | 0.34 | 0.60 | 0.66 | 0.31 | 0.61 |
| Standard error | 0.07 | 0.04 | 0.07 | 0.07 | 0.03 | 0.07 |
| Ratings out of 80 samples | Acidic=05<br>Neutral=27<br>Basic=48 | Low=06<br>Medium =73<br>High=01 | Low=14<br>Medium=13<br>High=53 | Acidic=07<br>Neutral=26<br>Basic=47 | Low=04<br>Medium=76<br>High=00 | Low=23<br>Medium=13<br>High=44 |
| | Siriyur | | | | | |
| | 0-30 cm | | | 30-60 cm | | |
| | pH | EC (dS/m) | OC (%) | pH | EC (dS/m) | OC (%) |
| Maximum | 7.64 | 0.95 | 2.49 | 7.38 | 0.85 | 0.76 |
| Minimum | 4.52 | 0.15 | 0.28 | 4.60 | 0.11 | 0.28 |
| Average | 5.61 | 0.36 | 1.15 | 5.60 | 0.31 | 0.49 |
| Standard Deviation | 0.71 | 0.19 | 0.47 | 0.68 | 0.16 | 0.09 |
| Standard error | 0.08 | 0.02 | 0.05 | 0.08 | 0.02 | 0.01 |
| Ratings out of 80 samples | Acidic=64<br>Neutral=06<br>Basic=02 | Low=72<br>Medium=00<br>High=00 | Low=02<br>Medium=02<br>High=68 | Acidic=65<br>Neutral=7<br>Basic=00 | Low=72<br>Medium=00<br>High=00 | Low=51<br>Medium=14<br>High=07 |

**Siriyur**

The palms here has medium management with availability of summer irrigation through Bhadra command. The soils of this transitional tract are found to be acidic in nature with few exceptions having very low salt accumulation in both the depths studied. Typically soils are oxisols. In top layer organic carbon has shown high (around 85 %) status

and nullified at deeper layer with low (around 63%) to medium (around 18 %) status.

Among the areas studied, Siriyur soils are acidic while others are tending towards basisity. The variation in pH across the study area may be due to the inherent heterogeneity of soil occurrence of various soil types like red and mixed red within the region and to some extent due to influence of parent material and resource region specific differences in the cultural and the fertilizer management practices of the growers (Dhanashekan Pandian and Harron, 2014). The pH values of Chikkapattanagere, Doddaghatta and Madhure are generally tending towards higher due to the fineness of texture, aridity, may be occurrence of poor quality ground water responsible for making surface soil slightly saline as it is marked by proportion of medium soil EC values due to its capillary rise during drought conditions. Generally, the soil pH was increasing with the depth due to the solubility of salts moving with water as regulated by clay distributed pattern and compaction in different sub horizons. It confirms the reports of Vijaya kumar (2015).

Temporal and spatial relationships between best cultural practices to that of net amount of carbon retained in any ecosystem is always a matter of interest. In any agricultural system soil and crop management affects the yield and also soil organic carbon. Status of organic carbon showed a relative tendency across the study area, in that surface layers had the status of high to medium. At deeper layers of 30-60 cm as expected this proportion lessened wherein largely it gloomed towards medium to low status. It is evident that management of the crop with organic residues vary from farm to farm chiefly determined by irrigation and other resource availability. Since in these perennial crops, the tillage practices followed are rather less specially it is true in established gardens, soil loss from the location is also less hence soils are tuned for variations in resource management to that of variations (Blanco and Lal, 2008). It reflects on sustained carbon status round the year apart from other essentialities like favourable nutrient uptake from plants and losses due to practices followed in the garden as well season and water. The soil type, bulk density, temperature, soil micro climate of the individual gardens, rate of decomposition as influenced by temperature and micro climate and other such factors influence upon the retention of organic carbon below the top layers (Sharma and Singh, 2001; Binita *et al.* 2009). Since gardens are of older once,

## CONCLUSION

Observations on organic carbon in different study areas of coconut tend to infer that in that surface layers had the status of high to medium, while at deeper layers of 30-60 cm this proportion lessened towards medium to low status.

## REFERENCES

Anonymous (2012) Area, production and productivity of areca nut. Indiastat.com

Binita, N.K., Dasog, G.S. and Patil, P.L. (2009) Soil fertility mapping in Ghataprabha left bank canal command area of north Karnataka by GIS. *KJAS* **22(1)**:73-76.

Blanco, C.K. and Lal. R. (2008) No tillage and soil profile carbon sequestration-on farm assessment. *Soil Sci. Soc. American J.* **72**:693-701.

Clay, D.E., Carlson, C.G., Clay, S.A. Owens, T.E., Schumar and Mamani, F. (2010) Biomass estimation approach impact on calculated SOC maintenance, requirement and associated mineralization rate constants. *J. Environ. Quality*, **39:**784-790.

Dhanashekaran Pandiyan, R. and Mohamed Harron, A.R. (2014) Soil nutrient status mapping through GIS technique of direct seeding rice cultivating area of Ramnad district. *Trends in biosci.* **7(2)**:3722-3726.

Jackson M.L. (1973) Soil Chemical Analysis, prentice Hall of India Private Limited, New Delhi.

Jaiarree, S., A. Chidthiasong, N.Tangthan, C. Polprasert, E. Sairobol and C. Tylar (2011) Soil organic carbon loss and turn over resulting from forest to maize fields in eastern Thailand. *Pedosphere* **21**:580-590.

Sharma, R.P. and A.K. Singh (2001) Characterization and properties of soil under two dominant land use systems in western Rajasthan. *J. Ind. Soc. Soil Sci.* **49(3)**:373-377.

Vijaya Kumar M., B. Bakiyathu Saliha, P. Kannan and P.P. Mahendran (2015) Delineation and GIS mapping of soil nutrient status of sugarcane growing tracts of Theni district, Tamil Nadu. *African J. Agric. Res.* **10(3)**:3281-3291.

Walkely A. and C.A. Black (1934) An estimation of methods of determining organic carbon and nitrogen in soils. *J. Agric. Sci.* **25**:598-609.