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An Assessment of Carbon Sequestration Potential of Different Land Use Patterns in Southern Region of Kerala

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Abstract

Sequestration of atmospheric carbon is one of the mitigation measures for countering anthropogenic climate change due to excessive emission of green house gases. However soil carbon sequestration measures need to be sustainable and significant, without substantial conflict between groups with diverse priorities. Carbon sequestration potential of soils in reduced clearing of primary ecosystems has attained substantial importance in modern agricultural farming systems apart from climate change adaption. The adaption of diverse management strategies of carbon sequestration in croplands, grasslands etc., may provide potential estimation of carbon sequestration potential.The different land use patterns, such as rubber plantations, coconut plantations, oil palm, sacred groove and paddy fields soil quality parameters like p^H, electrical conductivity, moisture content, bulk density, texture and organic carbon were varying in the basis of depth. In this study ,when considered the different land use patterns in the southern region of Kerala, the p^H does not varying in the depth increases up to 100cm in rubber plantation. The electrical conductivity is slightly changed and the moisture content is approximately same. The bulk density and organic carbon content in the rubber plantation with depth up to 100cm. And the texture is sandy clay loam in nature. In the case of coconut plantation all other parameters except texture is approximately equal by the increase of size, and the texture of this plantation is sandy clay loam in 0-50cm and sandy loam in 50-100cm. Same as that all the parameters are approximately equal by the increase of depth. While comparing each of them, it may vary, that is the p^H is higher in coconut and less in mixed vegetation, the electrical conductivity is high in paddy field and less in coconut field, moisture content is high in paddy field and low in mixed vegetation, bulk density is high in coconut field and less in rubber plantation and the organic carbon content is high in mixed vegetation and low in paddy field. The carbon sequestration potential is not only improve the soil structure but also improve the biological and physical health of soil.

Introduction

The carbon cycle is a fundamental part of life on earth. Soil organic carbon – the amount of carbon stored in the soil is a component of soil organic matter-plant and animal material in the soil that are in various stages of decay. Soil organic carbon is the basis of soil fertility. It releases nutrients for plant growth, promotes the structure, biological physical health of soil and is a buffer against harmful substances. If more carbon is stored in the soil as organic carbon, it will reduces the amount present in the atmosphere and help reduce global warming. Carbon sequestration is the long term storage of carbon in ocean, soils, vegetation and geologic formations. Although oceans store most of the earth's carbon, soil contamination approximately 75% carbon pools on land. The primary way that carbon is stored in the soil is as soil organic matter (SOM). SOM is a complex mixture of carbon compounds consisting of decomposing plants and animal tissue, microbes (protozoa, nematodes, fungi and bacteria) and carbon associated with soil minerals. Carbon can remain stored in soil or be quickly released back into the atmosphere, climatic condition, natural vegetation, soil texture and drainage all affected the amount and length of time carbon is stored (ecological society of America, 2000).Soil microorganism play a crucial role in the carbon sequestration process by transforming plant residues into smaller carbon molecules that are more likely to be protected and sequested (Six et al, 2006).

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Materials and Methods

Soil samples collected from different land use patterns such as rubber plantations, coconut plantations, oil palm plantations, sacred groove and paddy fields. Around 1 kg soil samples were collected randomly from each study area at 0-50 cm and 50-100 cm depth and kept in a polythene bag for analysis. The parameters like p^H, electrical conductivity, moisture content, bulk density, texture and organic carbon were analysed by standard procedures.

Result and Discussion

In the present study, the different land- use patterns in the Southern region of Kerala were selected for carbon sequestration potential. They are rubber plantations, coconut fields, oil palm fields, mixed vegetation (sacred groove) and paddy fields. The samples were collected from the depth of 0-50 cm and 50-100 cm respectively. The parameters collected for the analysis are $p^{H,}$ electrical conductivity, bulk density, texture and organic content. This was illustrated by tables and graphs. Based on these results to assess the best carbon sequestrated land use were identified by the absorption of organic carbon.

p^H

In the present study, while considering the different land use patterns up to the depth of 0-50 cm the p^H value of each soil samples such as rubber plantations, coconut fields, oil palm fields, sacred groove and paddy fields are 6.17, 6.45, 5.99, 6.14 and 6.21 respectively. And the depth up to 50-100 cm is 6.17, 6.39, 6.03, 5.85 and 6.22. Here in the case of rubber plantations, the p^H does not vary with its depth of soil increases. Except the case of oil palm plantations and paddy fields, the other two land use patterns were showed the p^H of soil decreases by the depth of soil increases(Table 1 and figure 4) .Here the value of p^H of sacred groove up to depth 50-100cm showed very slight variation, ie, 5.85 is acidic in nature. The p^H of soil decreases by the depth soil increases, due to the soil erosion and the leaching of top soil results the nutrients of soil were leached out.

McCauley et al, 2009; were pointed out that the factors influenced soil p^H include organic matter decomposition, NH_4^+, fertilizers, weathering of minerals and parent material and the soil p^H levels near 7 are optimal for overall nutrients availability, crop tolerance and soil microorganisms activity. Brogan, 1966; studied that p^H have significant effect on soil organic carbon content.

Electrical Conductivity

The different land use patterns up to depth 0-50 cm the electrical conductivity of rubber plantations, coconut fields, oil palm fields, sacred groove and paddy fields are 204.4µs, 155µs, 174µs, 223.8µs and 251.5µs and the depth up to 50-100 cm is 193.2µs, 183.3µs, 218.8µs, 191.7µs and 231.9µs respectively. Except the case of coconut and oil palm plantations, the others were shows the electrical conductivity of soils were decreases by the depth of soil increases. The coconut plantations up to depth 0-50 cm shows the lower electrical conductivity, ie, 155µs and the paddy fields up to depth 0-50 cm have the higher electrical conductivity, ie, 251.5µs (Table 1 and figure 4). In this study, the paddy fields up to depth 0-100 cm have the higher electrical conductivity, ie, 251.5µs and 231.9µs and the coconut fields have lower electrical conductivity, ie, 155µs and 183.3µs. Because of the sandy nature of sandy nature of soil in coconut plantations, it shows low electrical conductivity. It indicates that it does not affect the salinity. Soil electrical conductivity is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity, drainage conditions, organic matter levels, salinity and sub soils varies depending on the amount of moisture held by soil particles.

Grisso et al, 2009; made a study about soil electrical conductivity and carbon sequestration. They found that inadequate sampling density and the high cost of conventional soil sampling and analysis may prevent soil property segregation and classification. Benbi and Brar, 2009; found evidence that low electrical conductivity values indicate that soils in the state do not suffer from salinity.

Moisture Content

The present investigations shows that the different land use patterns up to depth 0-50 cm, the moisture content of rubber plantations, coconut fields, oil palm fields, sacred groove and paddy fields are 8.8%, 3.7%, 5.48%, 3.4% and 19.8% respectively. The depth up to 50-100 cm is 8.48%, 3.04%, 4.32%, 2.8% and 17.8% respectively. In moisture content, the depth of soil increases, the moisture content also increases (Table 1 and figure 4). The percentage of moisture content is higher in paddy fields and lower in the sacred groove, ie, 2.8% and 19.8%. The percentage moisture content is high in 0-50 cm in paddy fields. That is the paddy has the high ability to hold water.Hugar et al, 2012; reported that soil hydraulic property governs soil metabolism and greatly affects the soil management; hence an optimum level of soil organic carbon is required to hold water and nutrients which decrease the risks of erosion and degradation.

Bulk Density

This study revealed that, the bulk density of different land use patterns such as rubber plantations, coconut plantations, oil palm fields, sacred groove and paddy fields up to depth 0-50 cm are 1.27gcm^{-3}, 1.44gcm^{-3}, 1.28gcm^{-3}, 1.32gcm^{-3} and 1.32gcm^{-3} and in the case of 50-100cm depth are 1.32gcm^{-3}, 1.46gcm^{-3}, 1.40gcm^{-3}, 1.32gcm^{-3} and 1.30gcm^{-3} (Table 1 and figure 4). In the case of sacred groove, the bulk density does not change when the depth of soil increases. The bulk density value up to depth 0-100cm is 1.32gcm^{-3}. The paddy field up to depth 0-50cm and rubber plantation up to depth 50-100cm also shows the same result. The bulk density is very lower in the rubber and oil palm plantations up to depth 0-50cm are 1.27gcm^{-3} and 1.28gcm^{-3} respectively. The bulk density is higher in coconut plantations, ie, 1.44 and 1.46 gcm^{-3} of depth at 0-50 and 50- 100cm. This result shows that the size of soil particles of coconut plantations are very low so that they require more space to occupy and bulk density is also increases. Except in the case of paddy fields, the other land use patterns show that when the depth soil increases, the bulk density also increases. Bulk density increases with compaction and tends to increase with depth. Sandy soils are more prone to high bulk density. It is an important parameter in its own right, influencing water infiltration and plant root health.Han et al, 2010; found that the soil bulk density plays a very important role in the assessment of soil organic carbon content and it affected by land use and soil types. Chaudhari et al, 2013; showed that the bulk density is increases with profile depth, due to changes in organic matter content, porosity and compaction.

Texture

In the present study the texture of different land use patterns such as rubber, coconut, oil palm, sacred groove and paddy fields shows sandy clay loam in nature up to depth 0-100cm (Table 1). Most of the land use patterns show sandy clay loam in nature. Except in the case of coconut plantations up to depth 50-100cm, all others show the sandy clay loam in nature and coconut plantations. Islam *et al.* (2014); proposed that the soil in northeast Thailand shows loamy sand to sandy loam texture and the percentage of silt and clay had a positive correlation with carbon sequestration. Also the amount of finer soil particles was lower in the soil surface (0-15cm) and steadily increased with increasing depth to the highest content at a depth between 45 and 60cm. Fullen et al, 2007; studied that the most of the regions of the Lithuania were contains clay, sandy loam, silty clay loams, loamy soils respectively and the soil organic matter content depends on climatic conditions, land use and texture of soil.

Organic Carbon

In the present study, while considering the different land use patterns up to depth o-50cm, the organic carbon content of rubber, coconut, oil palm, sacred groove and paddy fields are 0.624%, 0.39%, 0.429%, 1.599% and 0.526% respectively. And the depth up to 50-100cm is 0.487%, 0.35%, 0.39%, 1.248% and 0.292% respectively (Table 1 and figure 4). While assessing the carbon sequestration potential of different land use patterns, the percentage of organic carbon content is the very important parameter for the analysis. This study shows that the sacred groove or the mixed vegetation have the more organic carbon content up to depth 0-50cm and, ie, 1.599% and 1.248%. And the paddy fields have less organic carbon content, ie 0.526% and 0.292% up to depth 0-50cm and 50-100cm.

Organic carbon content is helps to identify the carbon sequestration potential. The assessment of carbon sequestration potential o f all these five landuse patterns, this result shows that because of the accumulation of organic matter on soil, the sacred groove have high organic carbon content and they have the capacity to sequester more carbon in the soil. The paddy fields consists of highly clay contents so that the capacity of sequester carbon in soil is low and the carbon storage ability is also low. The total soil organic carbon content is increased with precipitation and clay content and decreased with temperature. The importance of this controls switched with depth, climate dominating in shallow layers and clay content dominating in deeper layer, possibly due to increasing percentage of slowly cycling soil organic carbon fraction at depth. The sacred grooves are the best land use patterns for carbon sequestration potential.

Vashum *et al.* (2016) reported that measurement of SOC will not only help us to assess the productivity and the sustainable fertility of the soil but will also give an idea about the potentials of the soil for sequestering carbon from the atmosphere or the emission potential when the soil is disturbed. Parajuli and Duffy (2013) shows that carbon amount is not influenced by soil organic matter but soil organic matter could be influenced by soil organic carbon.

Table 1: Chemical analysis of different land use patterns of southern region of Kerala

Land Use Patterns	Depth (cm)	pH	Electrical Conductivity (µs)	Moisture Content (%)	Bulk Density (gcm^{-3})	Texture	Organic Carbon (%)
Rubber	0-50	6.17	204.4	8.8	1.27	Sandy clay loam	0.624
	50-100	6.17	193.2	8.48	1.32	Sandy clay loam	0.487
Coconut	0-50	6.43	155.0	3.7	1.44	Sandy clay loam	0.39
	50-100	6.39	183.3	3.04	1.46	Sandy loam	0.35
Oil Palm	0-50	5.99	174.0	5.48	1.28	Sandy clay loam	0.429
	50-100	6.03	218.8	4.32	1.40	Sandy clay loam	0.39
Sacred groove	0-50	6.14	223.8	3.4	1.32	Sandy clay loam	1.599
	50-100	5.85	191.7	2.8	1.32	Sandy clay loam	1.248
Paddy	0-50	6.21	251.5	19.8	1.32	Sandy clay loam	0.526
	50-100	6.22	231.9	17.8	1.30	Sandy clay loam	0.292

Figure 4-8: Graphical representation showing the chemical parameters of different land use patterns of southern region of Kerala

Fig 4

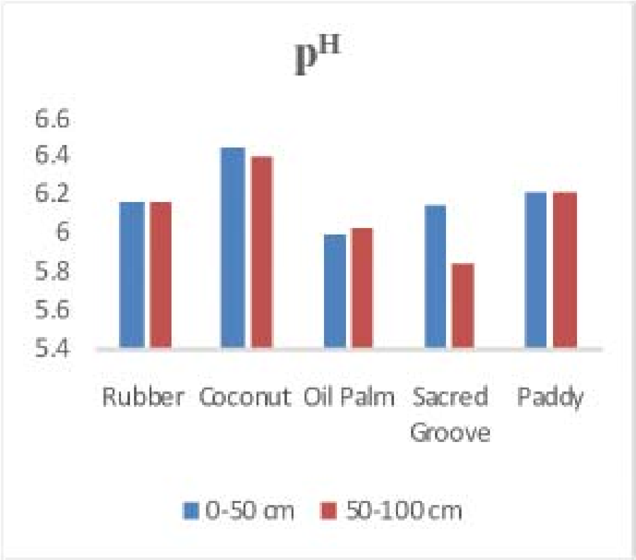


Fig 5

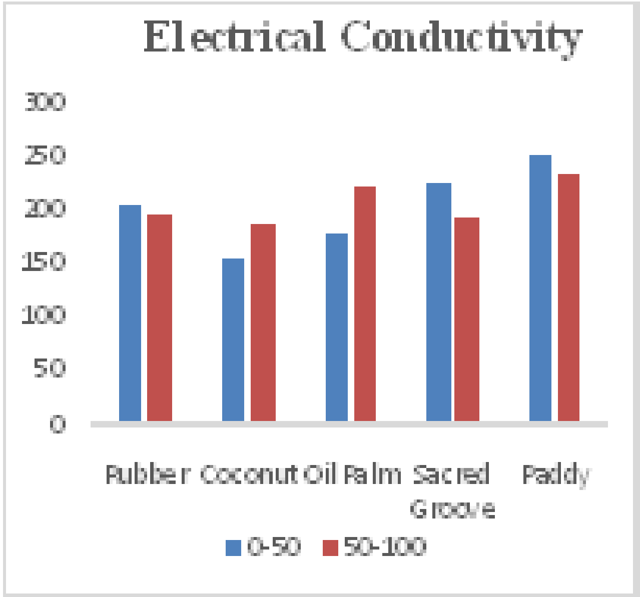


Fig 6

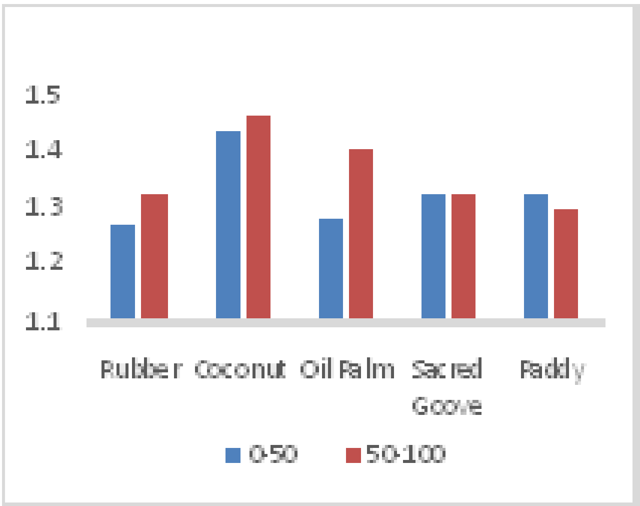


Fig 7

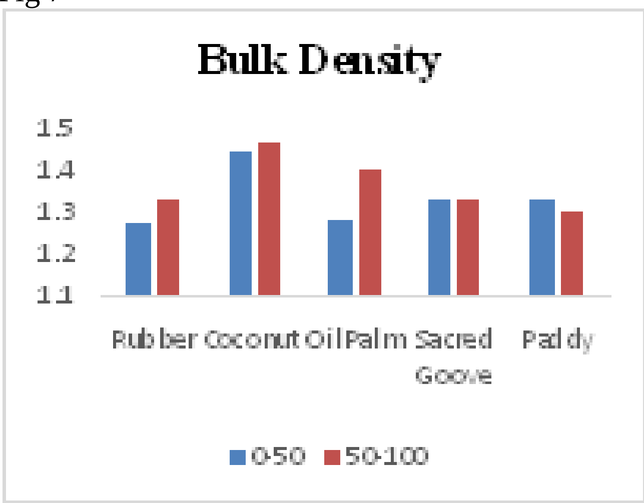
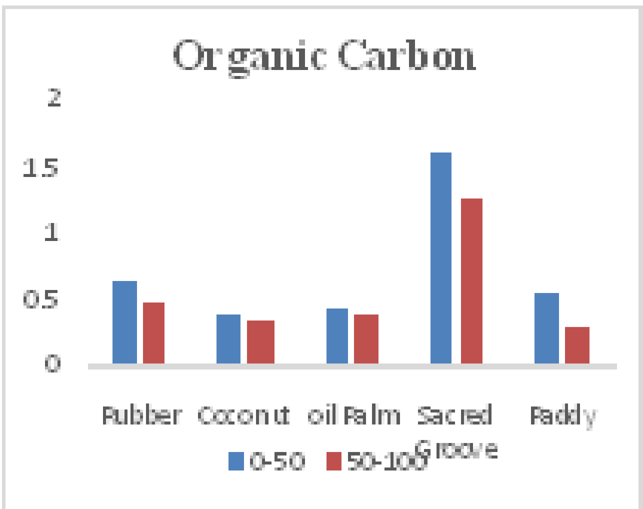


Fig 8



Sequestration of atmospheric carbon is one of the mitigation measures for countering anthropogenic climate change due to excessive emission of green house gases. The adaption of diverse management strategies of carbon sequestration in croplands, grasslands etc., may provide potential estimation of carbon sequestration potential (Wani *et al*., 2015). The rate of soil organic carbon sequestration with adoption of recommenced technologies depends on soil texture and structure, rainfall, temperature, farming systems and soil management. Soil carbon sequestration is a strategy to achieve food security through improvement in soil quality. While reducing the rate of enrichment of atmospheric concentration of carbon dioxide, soil carbon sequestration improves and sustain biomass or agronomic productivity (Lal, 2004).Increase in carbon content in the soil, through better management practices, produce a number of benefits in terms of soil biodiversity, fertility and water storage capacity and hence productivity (FAO, 2008).

Summary and Conclusion

In this study it, concluded that when considered the different land use patterns in the southern region of Kerala, the p^H does not varying in the depth increases up to 100cm in rubber plantation. The electrical conductivity is slightly changed and the moisture content is approximately same. The bulk density and organic carbon content in the rubber plantation with depth up to 100cm. And the texture is sandy clay loam in nature. In the case of coconut plantation all other parameters except texture is approximately equal by the increase of size, and the texture of this plantation is sandy clay loam in 0-50cm and sandy loam in 50-100cm. Same as that all the parameters are approximately equal by the increase of depth. While comparing each of them, it may vary, that is the p^H is higher in coconut and less in mixed vegetation, the electrical conductivity is high in paddy field and less in coconut field, moisture content is high in paddy field and low in mixed vegetation, bulk density is high in coconut field and less in rubber plantation and the organic carbon content is high in mixed vegetation and low in paddy field.

Thus it can be concluded that the carbon sequestration potential is not only improve the soil structure but also improve the biological and physical health of soil. And also the major benefits of carbon sequestration methods are reduced plant water stress, increased nutrient retention and availability, enriched species diversity of soil biota, increased germination and water filtration capacity and reduction in surface runoff, reduced risk of soil erosion, increased agronomic yield of crop and the mitigation of climate change by offsetting anthropogenic emissions through carbon sequestration in trees and soils

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