Original Research Article

THE STUDY OF DIFFERENT LAND USE SYSTEM ON THECARBON STOCK AND C-FRACTIONS UNDER VARYING SOIL DEPTH IN CHANDEL DISTRICT OF MANIPUR

ABSTRACT:

Soil nutrients play crucial roles in performing key ecological functions. Soil erosion and degradation of soil quality also caused by unscientific land use and cropping techniques. To understand the effects of land use systems, present study was carried out to quantify soil nutrients (NPK) and soil organic carbon in different land use system of Chandel district such as Forest area, Jhum after 15 years at Lamphoucharu, Jhum after 10 years at Lamphoucharu, Jhum after 10 years at Chakpikarong,Jhum after 5 years, Intermittent Jhum, Oak forest, Teak forest, Pine forest, Agri-hortijhum and Maize based cropping system. Results showed that available N was found to be significantly higher in forest soils as compared to other land use system. Similarly, available P_2O_5 andK_2O were also recorded to be significantly higher in forest soil in both the soil depths which was followed by the Jhum cultivation after 15 years in Lamphoucharu area of Chandel district. Forest soils shows significantly higher Organic carbon content than the other land use system of Chandel district. These results indicated that the land under more vegetation and less disturbed areas have higher soil nutrient and organic carbon as compared to other land use system. The variations in soil fertility parameters need immediate improvement in soil health of Jhum lands and other land use systems.

Key words: *Carbon stock;*Land use system; *Soil Depth.*

Introduction:

Land use systems involves the management and modification of natural environment or wilderness into built environment as settlements and semi natural habitats such as arable fields, pastures, and managed woodlands. Land-use and land management practices have a major impact on natural resources including water, soil nutrients, plants and animals *(Beirregaard et al., 2001).* Land use changes and management are widely recognized as the most important driving forces of global carbon cycles *(Zhang et al., 2012),* contribute 6%–39% of the growth in CO_2 emissions *(Brovkin et al., 2004)* and have profound impacts on SOC which are estimated to be one of the second largest sources of human- induced

greenhouse gas emissions (1.5 Pg C/a) after fossil fuel combustion (5.3 Pg C/a) (IPCC, 2007). SOC is influenced by dynamic interaction of various factors in the ecosystems including climate, vegetation, soil type, topography, soil texture, soil aggregations, and land use systems. The balance between the rate of decomposition and the rate of supply of organic matter is upset when land use is altered and forests are cleared (Lal, 2004).

Poor soil management and the replacement of native forests by agricultural land may compromise soil health. Soil organic carbon (SOC) is reported as a sensitive indicator of soil quality and environmental sustainability *(Lal, 2002).* To sustain fertility and productivity of a soil, SOC is considered essential to improve physical, chemical and biological properties of a soil, as well as it can be used for predicting climate change and effects on crop production. The role of Forests has a great impact on the global biogeochemical cycles and in particular in the carbon cycle. Larger parts of the global C stock are found to be stored in forest ecosystems. About 40% of the total SOC stock of the global soils lies in forest ecosystem and because of their higher organic matter content forest soils are known to be one of the major carbon sinks on earth (*Dey, 2005).*It is anticipated that the significant shifts in plant cover will alter the nitrogen cycle and soil C content, affecting sustainability and environmental equilibrium (Wilcke and Lilienfein, 2004). Conversion of natural forest to other form of land-use can aggravate soil erosion and lead to a reduction in soil organic content and there is a changed in the rates of accumulation, turnover and decomposition of SOC which make changes in SOC *(Poeplau et al., 2011).*Keeping in view, an attempt was made to study the effect of different land use system onthe carbon stock and C-fractions under varying soil depth in Chandel district of Manipur, India.

MATERIALS AND METHODS:

To accomplish the objectives of the research problem entitle "Effects of different land use system on the carbon stock and C-fractions under varying soil depth in Chandel district of Manipur" a study was conducted in Chandel district, Manipur". It is one among 16 districts ofManipur State, India. It is 66 Km north towards state capital Imphal. It liesin the south-eastern part of Manipur between 23.49 and 24.28 North latitude and94.09 to 94.31 East longitudes. Its neighbors with Myanmar on the East, Tengnoupal district on the north, Kakching district on the westand Churachandpur district to the south. Chandel district occupies an area of approximately 2100 square kilometers. The average annual temperature for Chandel district is 31˚C and experiences summer temperature to the range of 28 to 38.27˚C. The mean annual precipitation varies from 2000 to 2400 mm. The area belongs to

warm, humid agro-ecological zone with thermic ecosystem and length of growing period of 300-330 days. The vegetation is predominated by pine including woody and herbaceous species. The soil types of Chandel district are mostly coarser, varying from fine loamy, loamy to sandy in texture and deep in soil depth. Soils of the study area fall under three major soil orders: ultisol, inceptisol andalfisols.

Sample collection and preparation:

The soil samples were collected from the different land use system namely Forest area, Jhum area after 15 years at Lamphoucharu, Jhum area after 10 years at Lamphoucharu, Jhum area after 10 years at Chakpikarong,Jhum after 5 years, Intermittent Jhum area, Oak forest, Teak forest, Pine forest, Agri-hortijhum and Maize based cropping. For each land uses soil samples were collected from different reaches of the hillock (upper, middle and lower reaches). The soils were collected from two depths (0-15 cm and 30-45 cm) for each reaches. The soils were taken from 3 spots of each reach and depth, and finally collected soils were composited. The soil samples were air dried, crushed and grounded to pass through a 2 mm sieve and then analyzed for different chemical properties of the soil. Standard procedures were followed to estimate all the soil fertilityparameters.

Statistical Analysis:

The collected data were analyzed by Randomized Block Design (RBD).

RESULTS AND DISCUSSION:

Table 1.*Available N and P_2O_5 present in soils of different land use system*

Different land use system	N (Kg/ha)		P_2O_5(Kg/ha)	
	0-15 cm	30-45 cm	0-15 cm	30-45 cm
Forest	533.49	475.14	10.92	9.97
Jhum after 15yrs of Lamphoucharu	512.54	468.49	10.22	9.07
Jhum after 10yrs of Lamphoucharu	486.62	454.24	9.55	8.42
Jhum at 10yrs of Chakpikarong	461.56	439.30	9.15	8.20
Jhum after 5yrs	427.01	408.88	8.24	7.13
Intermittent jhum	410.56	396.95	7.58	6.16
Oak	373.08	348.32	6.10	5.10
Teak	345.73	327.83	5.98	4.70
Pine	277.31	253.16	5.19	3.94
Agri-hortijhum	379.27	363.43	6.39	5.50

Maize	296.03	275.37	5.44	4.11
C.D.	**34.27**	**8.70**	**0.60**	**0.80**

Table 2.*Available $K_2O$and OC (%) present in soils of different land use system*

Different soil samples of Jhum land	**K_2O (Kg/ha)**		**OC (%)**	
	0-15 cm	**30-45 cm**	**0-15 cm**	**30-45 cm**
Forest	278.08	266.11	2.73	2.04
Jhum after 15yrs of Lamphoucharu	264.33	253.59	2.42	1.86
Jhum after 10yrs of Lamphoucharu	250.56	242.66	1.86	1.35
Jhum at 10yrs of Chakpikarong	241.84	232.00	1.69	1.09
Jhum after 5yrs	210.14	201.90	1.38	1.03
Intermittent jhum	186.88	176.71	1.26	0.95
Oak	128.58	120.41	0.96	0.73
Teak	126.83	114.22	0.85	0.60
Pine	106.98	94.27	0.54	0.34
Agri-horti jhum	144.00	133.31	1.05	0.76
Maize	113.16	101.01	0.75	0.48
C.D.	**2.13**	**2.92**	**0.19**	**0.24**

EXPERIMENTAL FINDINGS:

Data on available N, P_2O_5 and K_2O in the soil at different depths as affected by different land use system are presented in table 1 and table 2 and it was observed that forest area showed significantly the highest available N (533.49 Kg/ha and 475.14 Kg/ha) in both the soil depths i.e. 0-15 cm and 30-45 cmrespectively followed by Jhum cultivation after 10 years at Lamphoucharu area of Chandel district.

Similarly, in the case of available P_2O_5 in the soil as affected by different land use system was observed highest in forest areas (10.92 kg/ha) in 0-15 cm depth and 9.97 kg/ha in 30-45 cm soil depth followed by Jhum cultivation after 10 years at Lamphoucharu area of Chandel district (10.22 kg/ha) in 0-15 cm soil and 9.07 kg/ha in 30-45 cm soil depth. The lowest available P_2O_5 in the soil was recorded from pine forest with 5.19 Kg/ha and 3.94 kg/ha P_2O_5 in 0-15 cm and 30-45 cm soil depth respectively. Also available K_2Oas influenced by different land use system was observed highest inforest soil and lowest was

recorded from pine forest in both the soil depth. The primary reason for higher available soil nutrients could be due to higher tree density and litter inputs in the forest which shows positive impact on the soil nutrient content in the forest. The findings were in close conformity with the findings of Kharal et al. (2018).

Organic carbon in the soil due to different land use system was found to be significant in both the soil depth in all the different land use systems. Significantly the highest organic carbon content was recorded in forest soils in both the soil depths of 0-15 cm and 30-45 cm sowing the data of 2.73 and 2.04 % respectively followed by Jhum cultivation after 10 years at Lamphoucharu area of Chandel district (2.42%) in 0-15 cm soil and 1.86 % in 30-45 cm soil depth. The least organic carbon content in both the soil depths of 0-15 cm and 30-45 cm was 0.54 % and 0.34% respectively was observed from pine forest of Chandel. The high organic carbon content in the forestland could be as a result of tree leaves, stems, barks, ˆflowers, logs, and fruits. In addition, microorganisms, animals, and roots contribute to the increased of organic carbon. The findings are similar with the findings of Nanganoa, et al. (2019).

CONCLUSIONS:

Land use change influences a number of biological and physiological processes of the soil. Poor soil health and land degradation can result from poor land use decisions.Based on the study area of different land use system, it was found that areas with less disturbed have significant amount of higher soil nutrients and soil organic carbon in both the different soil depths. Soils of Chandel district are varied in soil fertility status. The soils collected from different land use systems of Chandel district are high in organic carbon content, however amelioration of soil acidity and external inputs of essential nutrients is necessary for successful crop production. The status of available nutrients provides the basis for soil and crop specific mineral nutrition recommendation in all the land uses in order to maintain soil nutrient balance and also to enhance higher crop production and productivity.

REFERENCES:

Bierregaard, Richard, CaludeGascon, Thomass, E., Lovejoy, Rita Mesquita, eds. (2001). Lessons from Amazonia.The Ecology and conservation of a Fragmented Forest.ISBN 0-300-08483-8.

Brovkin, V., Stich, S., von Bloh, W., Claussen, M., Bauer, E., Cramer, W., 2004. Role of land cover changes for atmospheric CO2 increase and climate change during the

last 150 years. Global Change Biology **10**, 1253–1266.

Dey, S.K., 2005. A preliminary estimation of carbon stock sequestrated through rubber (Heveabrasiliensis) plantation in North Eastern regional of India. Indian Forester **131**(11), 1429–1435.

IPCC, 2007. Climate Change 2007: Mitigation of Climate Change. Cambridge University Press, Cambridge. Available from: http://www.ipcc.ch/publications_and_ data/ar4/wg3/en/content s.html (verified 3 January 2012).

Kharal, S., Khanal, B.R., and Panday, D. 2018.Assessment of Soil Fertility under Different Land-Use Systems in Dhading District of Nepal. Soil Syst. **2,**57. doi:10.3390/soilsystems2040057.

Lal, R., 2002. Soil carbon dynamics in cropland and rangeland. Environmental Pollution **116**(3), 353–362.

Lal, R., 2004. Soil carbon sequestration impacts on global climate change and food security. Science **304**, 1623– 1627.

Nanganoa, L.T., Okolle, J. N., Missi, V., Tueche, J.R., Levai , L.D., and Njukeng J.N. 2019. Impact of Different Land-Use Systems on Soil Physicochemical Properties and Macrofauna Abundance in the Humid Tropics of Cameroon.Applied and Environmental Soil Science Volume, Article ID 5701278, 9.https://doi.org/10.1155/2019/5701278.

Poeplau, C., Don, A., Vesterdal, L., Leifeld, J., Van Wesemael, B.A.S., Schumacher, J., Gensior, A., 2011. Temporal dynamics of soil organic carbon after land-use change in the temperate zone-carbon response functions as a model approach. Global Change Biology **17**, 2415–2427.

Wilcke, W., Lilienfein, J., 2004.Soil 13C natural abundance under native and managed vegetation in Brazil. Soil Science Society of America Journal **68**, 827–832.

Zhang, L., Xie, Z., Zhao, R.F., Wang, Y.J., 2012. The impact of land use change on soil organic carbon and labile organic carbon stocks in the Longzhong region of Loess Plateau. Journal of Arid Land **4**(3), 241–250.