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SCOPE OF POPULAR FODDER CROPS IN CARBON SEQUESTRATION FOR MITIGATING CARBON EMISSIONS

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Abstract- Cultivation study was conducted with popular fodder crops to enumerate the impact of sequestering atmospheric carbon through changing agricultural pattern in land use and management on soil. Four types of forage crops; fodder maize and fodder cowpea of annual, hedge lucerne and hybrid napier of perennial were cultivated in Srivilliputhur (Virudhunagar district, Tamilnadu, India). The experiments were conducted in triplicates, the data showed a significance ($P<0.05$) in carbon sequestered by hybrid napier (1.5 %). The rate of carbon sequestered by hybrid napier was high when compared with hedge lucerne (1.13 %), followed by fodder maize (0.99 %) and cowpea (0.92 %), (R^2=0.401) in addition with farm yard manure and fertilizers. The agricultural soils studied from the Srivilliputhur agricultural soils have the potential to sequester soil organic carbon and the adaptation of fodder crops to hedge lucerne and hybrid napier could be one of the effective strategies to improve carbon sequestration and to mitigate carbon di-oxide emissions and to provide as a fodder for the farm animals. Cultivation of crops as a whole is still a primary contributor to GHG emissions. While we must not ignore the fact, when it comes to assessing our best options for food security, in the future we cannot allow important factors like carbon sequestration to be ignored simply because they are more difficult to measure-and less likely to make the headlines.

Keywords- Agriculture, black soil, carbon, cowpea, CO_4, desmanthus, sequestration, fodder crops, maize, soil organic matter

Introduction

Acting as carbon sinks, the marine and terrestrial ecosystems have absorbed 60 per cent of carbon emissions while remaining 40 per cent has resulted in increase of atmospheric carbon dioxide concentration [1]. Increased concentration of ambient carbon dioxide tends to global warming leading to change in climatic patterns causing global concerns such as loss of biodiversity, floods, drought, and changes in land use, soil degradation and extreme weather conditions thereby limiting the capacity to sequester carbon from the soil [2]. Agriculture plays a major role in economic development and providing food security [3]. Agriculture is the most vulnerable sector to climate change and will leave its deleterious impacts on Indian agriculture in various ways. This means blow on the livelihoods of Indians dependent on agriculture and livestock farm sectors. Adoptions of improved and scientific agricultural application have enormous prospective in increasing the amount of carbon sequestered in soils by enhancing the amount of soil organic matter and to mitigate carbon dioxide emission effects on climate change [4].

Anthropogenic transformations of both land and soil can trigger alterations in soil organic matter leading to decreased soil organic matter. This dynamic process of accumulation of soil organic matter involves plant growth above the soil surface and deposition of organic carbon below the soil surface. Carbon sequestration process can continue for longer periods and eventually gets stabilized; changes in agricultural practices can bring soil organic carbon stocks to original stability. To conserve soil organic carbon resources, the modern tillage practices like no tillage, zero tillage, ridge tillage, minimal usage of inorganic fertilizers, increased usage of organic manures, farm yard manures, vermicomposts and conventional agriculture has been gaining popularity. By minimizing soil tillage, atmospheric increase of carbon dioxide can be reduced while at the same time increasing the soil carbon sequestration and improving the soil quality. Soil organic carbon is the major criterion for reporting the most important and common indicator of soil quality and sustainable agriculture [5]. Soil carbon in forests, crop land, or grazing pastures increases or decreases depending on inputs that are applied, rates of deforestation, and farming practices. Any steps taken to sequester carbon in biomass and soils will generally increase soil organic matter, which will have a productive impact on agricultural, environmental and biodiversity aspects. Therefore, management practices should focus on increasing the inputs and reducing the outputs of carbon in soils through which long-term carbon sequestration potential is determined depending on numerous factors together with typical weather, soil nature, type of crop or vegetation cover and management practices [6].

Enhancement of verifiable carbon pool in terrestrial (soils and vegetation) and aquatic (wetlands) ecosystems can have both economic and environmental benefits. Soil carbon sequestration helps offset emissions from fossil fuel combustion and further carbon-emitting actions though enhancing soil quality, water-holding capacity, and long-term agronomic productivity. Carbon appropriation can be achieved through modern farming practices and land management systems that add high amounts of biomass to soil while enhancing soil fauna activity. Various technologies have been developed in recent years to measure, monitor, and verify carbon content and sequestration in agricultural land. Contribution towards environmental sustainability depends upon the different methods focused in the storing of soil carbon in soil as a sink in agricultural lands. Enhanced soil's agronomic capabilities increases the organic matter content of soil, which in return produces better soil and better crops, improves water conservation and reduces erosion. Hence, in the present study cultivation of fodder crops like cowpea, maize, hybrid napier and hedge lucerne was assessed for soil carbon sequestration in black soil of Srivilliputhur (Virudhunagar district, Tamilnadu, India).

Materials and Methods

Srivilliputhur is located in Virudhunagar district of Tamilnadu in India located at an altitude of 41m, 08° 46.006 ' N and 77° 41.011 ' E and the study was conducted during 2010-12. The field site was divided into 12 blocks (100 m^2) with 3 replicates as a randomized complete block design. Field plots measuring 1200 m^2 were used. Regular agronomic practices including farm yard manure and fertilizers were followed in cultivation of these crops [7]. Crops were harvested at random periodically up to 240 days to study biomass accumulation pattern and for carbon and nitrogen estimation. Forage crops of hedge lucerne and hybrid napier were classified under perennial group and fodder maize and fodder cowpea under annual crops. Finally, the crops along with roots were harvested as: one harvest of fodder maize (50 days); fodder cowpea (55 days); hedge lucerne (60 days) and hybrid napier (first cut at 90 days and 60 days consecutively for second cutting). The soil samples were collected from the depth of 30 cm. Soil samples were dried in oven (at 80°C) overnight. The dried soil samples were grounded to surpass throughout 0.2 mm sieve mesh and were estimated for carbon and nitrogen content using Analytikjena multi N/C 2100S carbon analyzer, with ignition temperature of 950°C, non-dispersive infrared detector and oxygen as supportive gas. The results of the analysis are represented as per cent age. The total carbon present pre cultivation and amount of carbon captured at the time of final harvest was calculated and organic carbon content in the fodder samples was also estimated. One-way ANOVA (multiple comparison tests) was performed to analyze significant difference in rate of sequestered carbon. Bulk Density of the soil (Mg/m^3) was calculated by dividing the dry weight with the quantity of the soil.

Tonnes carbon per hectare was calculated by the following formula:

$$\text{Tones carbon per he (t C/h)} = \text{SOC (\%)} \times \text{Soil Bulk Density (Mg/m3)} \times \text{Soil Sampling Depth (cm)}$$

One-way ANOVA was performed using Graphpad Prism Version 5, cluster diagrams, PC analysis, draftsman plot and link tree analysis was carried out using Primer 5.

Results and Discussion

The soil organic carbon is a food source for most soil fauna, so as it is utilized, the carbon in the soil organic carbon is emitted as carbon dioxide and returns into the atmosphere. The total organic carbon present in the soil of Srivilliputhur ranged from 0.71 to 0.75 per cent before cultivation was started, i.e. 46.01 to 50.21tonnes of carbon per ha. The amount of carbon sequestered in the soil varied from 54.43 t C/h by fodder maize, 46.01 t C/h by fodder cowpea, 67.39 t C/h by hedge lucerne and 79.70 t C/h by hybrid napier after harvest was accomplished [Fig-1].

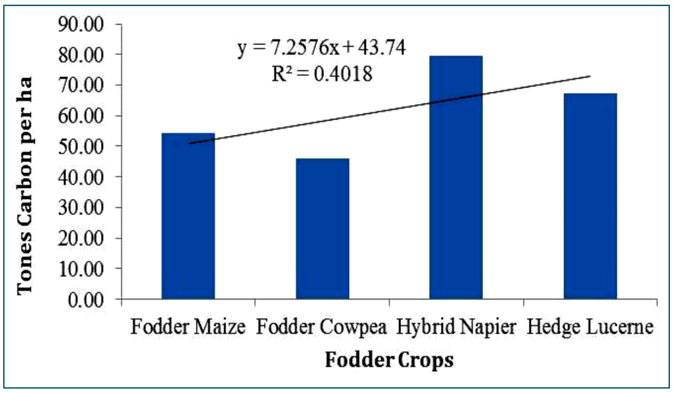

Fig. 1- Comparison between the carbons sequestered by forage crops in the soil

The organic carbon content in hybrid napier had a higher percentage (54.08), followed by hedge lucerne (52.13), fodder maize (50.78) and fodder cowpea (43.90) respectively. The soil bulk density ranged from 1.44 to 1.56 mg/m3, the calculated soil bulk density showed positive correlation with the soil organic carbon and soil dept had a positive correlation and similarity between them [Fig-2].

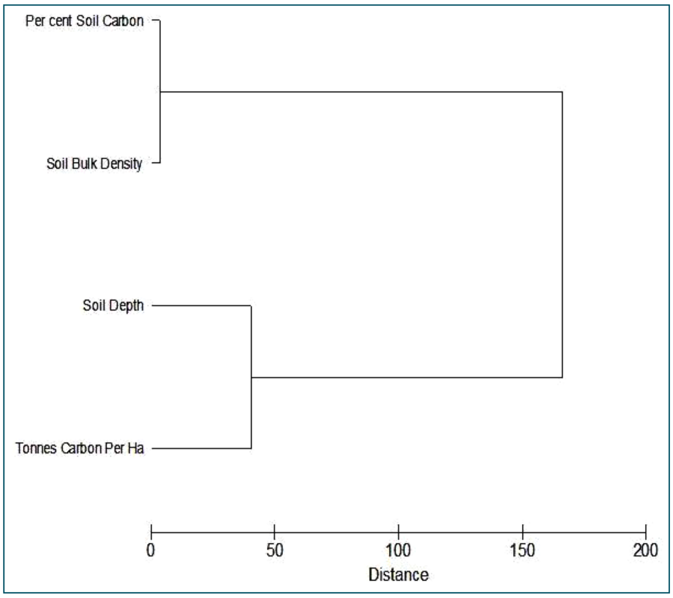

Fig. 2- Elucidan distance method calculated through primer (group average) for the parameters connected with soil carbon sequestration.

The impact created by the bulk density of the soil, depth of soil sample collection, percent soil carbon and total carbon sequestered in respect to the plots were significant ($P<0.05$) (P1, P2, P4, P5 and P9), this was due to application of conventional agriculture (farm yard manure, minimal usage of fertilizers and reduced tillage) have been represented by principal component analysis [Fig-3]. It is evidently clear that hybrid napier and hedge lucerne has the maximum potential of sequestering carbon in the soil followed by fodder maize and fodder cowpea in respect to the depth of the soil samples collected [Fig-4], plays a major role in accumulating the higher amounts of carbon through the underground biomass of the fodder crops in correlation with the increased root density of the fodder crops (hybrid napier>hedge lucerne>fodder maize> fodder cowpea). Carbon sequestration in agriculture is typically linked to sustainability outcomes to significant tool in mitigating global warming.

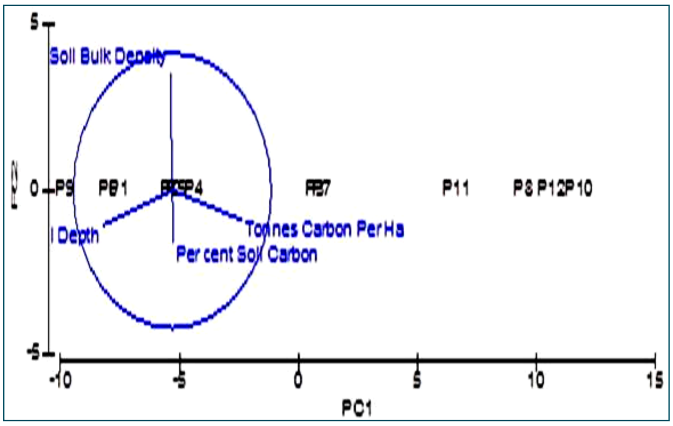

Fig. 3- Principal component analysis between the parameters and 12 field plots

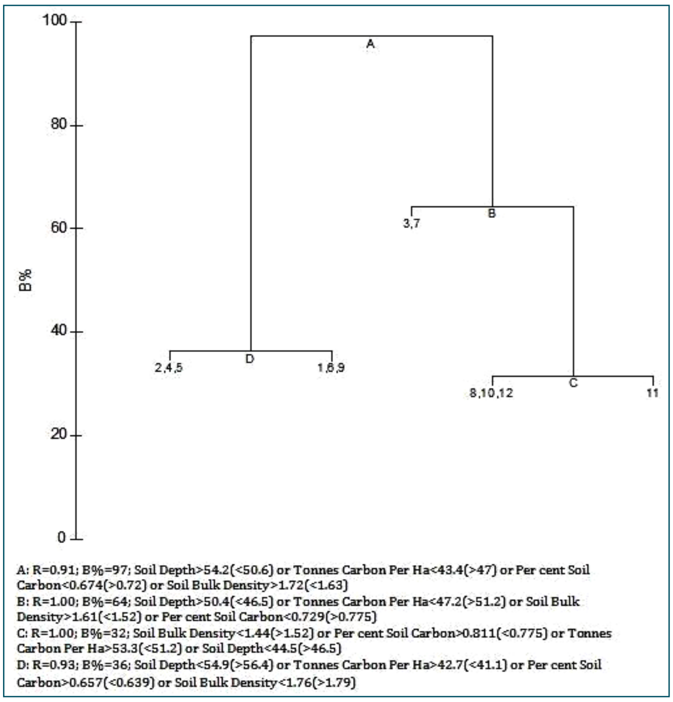

Fig. 4- Link tree Depth of the soil in terms of carbon sequestration

According to Ravindranath, et al. [8] the floral biomass in India is estimated to be 8,375 million tons during 1986, and stored carbon might be 4,178 million tones. Increasing soil organic carbon is a good idea in any situation to generate or maintain good quality soils [9]. It will profit the farming community in terms of economy for those farmers who sequester the carbon, and anyone can participate without a district prejudice. Adoption of recommended technologies in agriculture for carbon sequestration depends on soil texture and arrangement, precipitation, minimum and maximum temperature, farming system, and management of soil. Policies to augment the top soil carbon pool consist of reduced tillage farming, nutrient management, manuring, efficient irrigation and growing energy crops on barren lands. An raise of one ton of soil carbon pool of degraded cropland soils may increase crop yield by 20 to 40 kg/ha for wheat, 10 to 20 kg/ha for maize, and 0.5 to 1 kg/ha for cowpeas [9]. Estimates of the total potential of carbon sequestration in world soils vary widely from a low of 0.4 to 0.6Gt C/ year [10] to a high of 0.6 to 1.2Gt C/ year [11].

Substantiation on long-standing experimentation unveiled that soil carbon losses as a result of oxidation and erosion can be reversed through improved soil management such as reduced tillage [12]. Therefore, improved land-management practices to improve carbon in soils encompass a viable way to reduce atmospheric carbon content significantly [13]. In recent years, mounting up verification research documents advocate that definite fractions of soil organic carbon are likely to respond more rapidly than total soil carbon to land use change and management. It has been shown that carbon presented in particulate organic matter can accumulate rapidly under land management systems that minimize soil disturbance and may also provide an early indicator of changes in total soil carbon under different land use and management practices [14]. Significant differences in soil organic carbon between land-use treatments indicate that soil carbon can increase by converting annual crops to permanent forages. Articles have proposed that land use can have a wide range of effects on soil carbon but will be biased by weather, soil consistency, nutrient grade, and the occasion [15]. The differences in soil carbon between land uses treatments divided by duration of land use conversion can serve as an indicator of carbon sequestration rate [16]. Agricultural lands can potentially sequester carbon and mitigate greenhouse gas emissions through adoption of reduced and reduced tillage management, utilization of elevated carbon contribution in rotations to facilitate include silage, legumes, meadow, cover crops, irrigation or organic modifications, surroundings lands beginning cropland production, and throughout cropping escalation.

The booklet of practices recognized and implemented in the present study presumes that the objective of farmers is to increase both carbon sequestration and income. However, farmers practices can be flexible in order to minimize risk by showing opportunistic responses to the changing environmental conditions [17]. Soil carbon sinks resulting from sequestration activities are not permanent and will continue as long as appropriate management practices are sustainably implemented and followed. If a land management or land use is upturned, the carbon sequestered in the soil at a particular depth with top soil will vanish, frequently than it was sequestered for longer duration of time. Additional studies considering the role of carbon payments in the capacity of farmers to cope with risk are needed. Soil analyses and improved farming practices are needed urgently because productivity gains are highest in healthy soils and where pesticide, fertilizer, tools, and machinery are used properly. maximizing plant production through appropriately matched fertilizer application and grazing regimes, sheep producers can have confidence that these grazing systems are not likely to be detrimental to soil carbon sequestration. The maintenance, and eventual improvement, of soil carbon levels will provide direct benefits to farmers in terms of soil structure and fertility, water retention, reduced erosion, and improved sustainability of the farming enterprise.

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Conflicts of Interest: None Declared.

References

[1] IPCC (2001) *Intergovernmental Panel on Climate Change*, Third Assessment Report. Cambridge University Press, Cambridge, UK.

[2] Schimel D.S., House J.I. and Hibbard K.A. (2001) *Nature*, 414, 169-172.

[3] World Bank (2005) *Agricultural Growth for the Poor: an Agenda for Development*. The International Bank for Reconstruction and Development, the World Bank, Washington, DC.

[4] Thirtle C., Irz X., Lin L., McKenzie-Hill V. and Wiggins S. (2001) *Relationship Between Changes in Agricultural Productivity and the Incidence of Poverty in Developing Countries*. Report commissioned by the Department for International Development, London.

[5] Liu X., Herbert S.J., Hashemi A.M., Zhang M. and Ding G. (2006) *Plant Soil and Environment*, 52(12), 531-543.

[6] EPA (2008) *Environmental Protection Agency US, Carbon Sequestration in Agriculture and Forestry*.

[7] CPG (2005) *Crop Production Guide*, Tamilnadu Agricultural University, Dept. of Agriculture, Govt. of Tamilnadu.

[8] Ravindranath N.H., Somashekhar B.S. and Gadgil M. (1997) *Climatic Change*, 35 (3), 297-320.

[9] Lal R. (2004) *Science*, 304, 1623-1627.

[10] Sauerbeck D.R. (2001) *Nutrient Cycling Agroecosystems*, 60, 253-266.

[11] Lal R. (2003) *Critical Reviews in Plant Sciences*, 22, 151-184.

[12] Sa J.C., Cerri C.C., Lal R., Dick W.A., Filho S.P.V. and Piccolo M.C. (2001) *Soil Science Society of American Journal*, 65, 1486 -1499.

[13] Rosenberg N.J., Izaurralde R.C. and Malone E.L. (1999) *Proc. St. Michaels Workshop*. Columbus, USA, Battelle Press; Boca Raton, USA, CRC Press.

[14] Franzluebbers A.J. and Stuedemann J.A. (2002) *Environmental Pollution*, 116, 53-62.

[15] De Koning J.H.J., Vedlkamp E. and Lopez-Ulloa M. (2003) *Global Biogeochemical Cycles Journal*, 17, 1098-1110.

[16] Degryze S., Six J., Paustian S., Mosrross S., Paul E. and Merckx R. (2002) *Global Change Biology Journal*, 10, 1120-1132.

[17] Smith P. (2004) *Soil Use and Management*, 20, 212-218.