Research Journal of Agriculture and Forestry Sciences ______________________________ ISSN 2320-6063
Vol. **1(3),** 11-14, April **(2013)** *Res. J. Agriculture and Forestry Sci.*

Sequestration of Atmospheric Carbon through Forage Crops Cultivated in Ramayanpatti, Tirunelveli District, Tamilnadu, India

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Available online at: www.isca.in
Received 11th March 2013, revised 18th March 2013, accepted 30th March 2013

Abstract

The present study was conducted to evaluate the potential of altering farming soil use and storage management of organic carbon in soil. Four types of forage crops; fodder maize and fodder cowpea of annual, hedge lucerne and hybrid Napier of perennial were cultivated in Ramayanpatti (Tirunelveli district, Tamilnadu, India). The experiments were conducted in triplicates, the data showed a significance of $P<0.05$ for carbon sequestered by hedge lucerne. The rate of carbon sequestered by hedge lucerne was lower when compared with hybrid Napier, followed by fodder maize and cowpea, in addition with farm yard manure and fertilizers. Agricultural soils and land studied in the present research has the impending nature to restore carbon and hedge lucerne and Hybrid napier crops could be effectively used to enhance and store carbon in the study area. From the present study hedge lucerne promises to be a potential fodder for carbon sequestration in agricultural ecosystems.

Keywords: Forage crops, soil organic carbon, black soil, carbon sequestration, agriculture soil.

Introduction

Carbon dioxide (CO_2) concentration in atmosphere has increased as a result of anthropogenic emissions into the atmosphere. Climate change may lead to other comprehensive concerns including biodiversity loss, land use alterations and degradation of essential soils. It may also lead to limiting the capacity to sequester carbon (C)[1]. Since 1950s agricultural productivity has witnessed a brisk growth owing to novel crop varieties, fertilizer use and development in irrigated agriculture. Cultivation paves a major path in profitable expansion and reducing scarcity of food[2]. Cultivation also plays a significant role in mitigating carbon dioxide (CO_2) and other green house gases. Adoptions of enhanced scientific farming practices and applications has the important and vast prospective in increasing the percentage of carbon stored in soils by enhancing the amount of SOC and to reduce increased carbon dioxide discharge pertaining to change in climate[3].

Land and soil transformation can trigger alterations in soil carbon accumulation. This dynamic process involves plant growth above the soil surface and accumulation of organic carbon below the soil surface. Ultimately, the system reaches a fresh soil carbon stock equilibrium and no fresh carbon is absorbed or lost. Carbon accumulation process can continue for longer periods and eventually gets stabilized, but changes in land management practices can bring SOC stocks to a new equilibrium, with more or less carbon sequestered. To preserve SOC, scientific approaches like minimum tillage and nil tillage has been gaining reputation in agricultural practices[4]. Steps taken to store atmospheric carbon in soils and biomass will normally augment SOM, creating a productive impact on agricultural and environmental aspects. The global carbon balance depends primarily on soil C, which are exaggerated by land-alterations and degradation of top soil. Organizational approaches and practices should primarily spotlight on escalating the inputs and mitigating the release of organic carbon from farming soils. Soils are the principal earthly sink for carbon storage on the planet. The capability of cultivation lands to accumulate atmospheric carbon relay on quite a few factors, with environment, type of soil and crop and scientific organizational farming practices and approaches towards sustainable agriculture[5].

Cultivation of forage crops has a remarkable competence to accumulate carbon from atmosphere and global, farmers have the opening to counterbalance their possess emissions. Thus, augmentation of certifiable carbon pool in soil ecosystems can have mutually cost-effective and ecological remuneration. Contribution towards environmental sustainability depends upon the different methods focused in the storing of soil carbon in soil sinks. Improved soil's agronomic capabilities increase the organic matter content of soil, which in return produces recovered top soil and enhanced fodder crops, developing water table preservation and reducing top soil erosion. Hence, in the present study cultivation of forage crops viz. fodder cowpea, fodder maize, hybrid Napier and hedge lucerne was assessed for soil carbon sequestration in black soil of Ramayanpatti (Tirunelveli district, Tamilnadu, India).

Material and Methods

Ramayanpatti is located in Tirunelveli 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 2010-11. The field site was divided into 4 blocks (10 x 10 m) with 3 replicates in each block as a randomized complete block design. Field plots measuring 1200 m^2 were used for the four crops. Standard agronomic practices including farm yard manure and fertilizers were followed in cultivation of these crops[6]. Crops were harvested at random periodically up to 240 days to study biomass accumulation pattern and for carbon analysis. Fodder crops of hedge lucerne and Hybrid Napier were of perennial group and fodder maize and fodder cowpea were annual crops. Finally, the crops 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) along with roots. The farming land sample at the depth of 30 cm of soil was collected for the study. Soil samples were dried in oven (at 80°C) overnight. The oven dried soil samples were passed through 0.2 mm mesh and were grounded in pestle and mortar. Analytikjena multi N/C 2100S carbon analyzer was used for analyzing carbon content in soil, with furnace temperature of 950°C, NDIR detector and oxygen as supportive gas. The total carbon present before cultivation of crops and amount of carbon captured at the time of harvest was estimated. One-way ANOVA (multiple comparison tests) was performed to analyze significant difference in rate of carbon sequestered. Soil Bulk Density (Mg/m^3) was calculated by dividing the dry weight of the soil with the volume of the soil. Tonnes carbon per hectare was calculated by the following formulae:

Tonnes carbon per ha = SOC (%) x Soil Bulk Density (Mg/m^3) x Soil Sampling Depth (cm)

Results and Discussion

The SOC is an imperative resource for nearly all soil living beings, when consumed; the carbon in the soil organic matter is let off as carbon dioxide and reverted into the air. The total organic carbon present in the soil of Ramayanpatti ranged from 0.65 to 0.89 per cent before cultivation was started, i.e. 57.67 tonnes of carbon per ha. The amount of carbon sequestered in the soil varied from 1.34 % by fodder maize, 1.32 % by fodder cowpea, 1.48 % by hedge lucerne and 1.45 % by hybrid Napier after harvest was accomplished (figure 1 and 2). The calculated tonnes of carbon per hectare were higher for hedge lucerne (95.90) followed by hybrid Napier (93.96), fodder maize (86.83) and fodder cowpea (85.54) respectively (figure 3). The soil bulk density varied from 1.44 to 1.56 mg/m^3, the calculated soil bulk density showed positive correlation with the soil organic carbon sequestered by the forage crops in Ramayanpatti (figure 4). It is evidently clear that hedge lucerne has the maximum potential of sequestering carbon in the soil followed by hybrid Napier, fodder maize and fodder cowpea. Carbon accumulation in farming lands is naturally associated to sustainability conclusion to significant implementation or reducing universal rising of temperature. According to Ravindranath et al.[7] for the year 1986, the standing Indian biomass is estimated to be 8,375 million tons, out of which the carbon accumulation was 4,178 million tones. Enhancing the organic carbon in the soil is a superior design in any circumstances to engender or preserve vigorous soils[8], benefiting the agro farm market of farmers who confiscate carbon. The velocity of accumulation carbon in organic form in soil depends with implementation of optional expertise relay on texture, structure of soil, rainfall, temperature, farming system, and soil management. Scientific approaches to augment the soil carbon pool comprise no-till farming, cover crops, nutrient management, manuring, efficient irrigation and budding energy crops on unused lands. An increase of one ton of soil carbon collection of tarnished cropland soils may amplify crop yield by 20 to 40 kg ha^{-1} for wheat, 10 to 20kg ha^{-1} for maize, and 0.5 to 1kg ha^{-1} for cowpeas[8]. Approximation of the entire probable of C restoration in globe soils fluctuate extensively starting a low of 0.4 to 0.6Gt C/ year[9] to a elevated 0.6 to 1.2Gt C/ year[10].

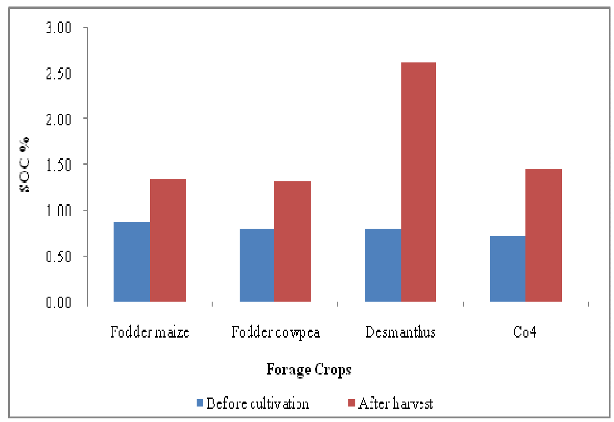

Figure-1
Comparison between the total carbon present before cultivation and after the cultivation of forage crops in the soil

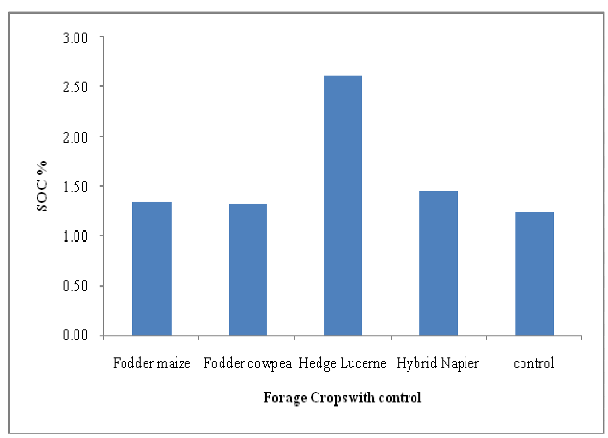

Figure-2
Comparison between the accumulated carbons (SOC %) by forage crops with control

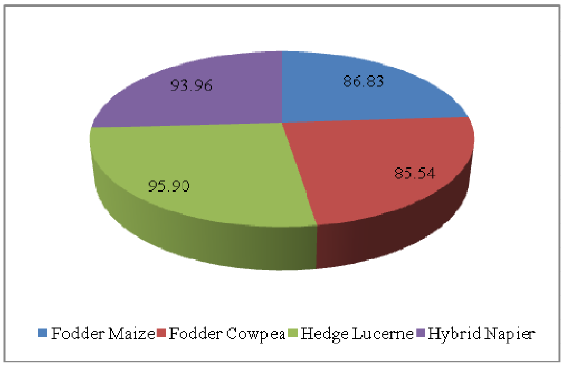

Figure-3
Soil carbon sequestered by the forage crops

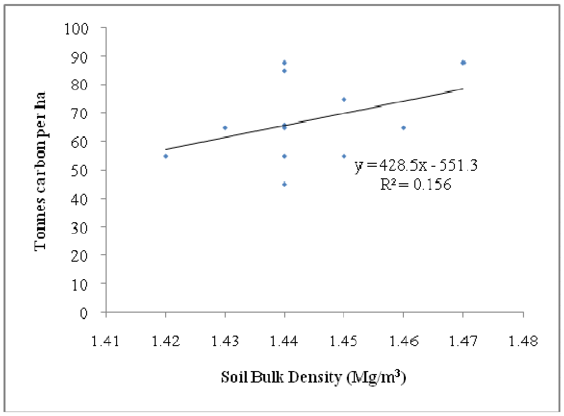

Figure-4
Correlation between the bulk density (Mg/m^3) and Soil organic carbon (%) sequestered by the fodder crops

Evidence on long-standing research disclose that organic carbon in soil are degraded as a consequence of corrosion and erosion, either can be overturned throughout better soil management such as abridged tillage[11]. Consequently, enhanced land-management approaches to augment carbon in soils contain feasible technique to condense atmospheric carbon volume extensively[12]. In modern time, collection of confirmation advocates that definite portion of SOC is achievable to counter further swiftly than entire soil C to ground exercise revolutionization and proper management skills[13]. Considerable dissimilarity in SOC amid land-use dealing designate that soil C can be augmented by converting yearly crops to permanent forages. Studies have recommended that land use can have an extensive variety of special effects on soil C but will be prejudiced by environmental variables[14]. The variations in soil C connecting land use treatments separated by period of land use adaptation can provide as a marker of C accumulation pace[15]. Cultivable lands be able to potentially accumulate carbon from atmosphere and reduce greenhouse gas emissions throughout implementation of reduced and no-tillage, utilization of elevated carbon participation and rotations that contain hay, legumes, pasture, cover crops, irrigation or organic amendments, setting aside lands from cropland manufacture, and through crop strengthening.

The set of approaches recognized in this study presume that the purpose of farmers is to augment both carbon accumulation and returns. Nevertheless, farmers' practices can be supple in array to curtail hazard by presentation of opportunistic retort to the altering ecological circumstances[16]. Soil carbon sinks consequential from accumulation activities are not stable and will persist as extensive as suitable management practices are maintained. Supplementary studies taking into consideration the function of carbon expenses in the aptitude of farmers to survive with threat are desired.

Conclusion

Agriculture has a significant task to play towards an effort to mitigate the climate change due to atmospheric enrichment of CO_2. Scientific agriculture can be a explanation to ecological issues but especially to plummeting the rate of fortification of CO_2 in the atmosphere. Recommended management approaches comprise translation from cultivate till to no-till, amalgamation of wrap crops and forages in the crop rotation, nutrient management including compost/manures and cautious exploitation of fertilizers. The immovability of soil C accumulated depends on the permanence of the recommended scientific approaches adopted. With continuation of recommended management practices, however, the sequestered C stays for a relatively extensive time in the soil pool and decline the rate of enhancement of atmospheric CO_2 absorption. Decline in the enlarged rates of farming invention and productivity is a solemn concern bearing in mind the questions of food security, livelihood, and environment. As such, a decisive assessment of the advance for sustainable agricultural expansion is indispensable.

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