International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 497-499

Received: 19-05-2019
Accepted: 21-06-2019

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Influence of different cropping system on carbon sequestration and soil organic carbon stock after eight years in loamy sand

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Abstract
Most of agricultural soils contain lower soil organic carbon pools than their counterparts under natural ecosystems. The rate of decomposition of soil organic matter is generally higher in tropical than in temperate climate. However, crop species also play an important role in maintaining soil organic carbon pools, through the quality and quantity of the residues that are returned to the soil in different cropping system. The CO_2 sequestration was estimated from carbon content in different cropping system of AICRP – IFS, Sardarkrushinagar. The CO_2 sequestration of different cropping system did not exhibit momentous difference among the different cropping system but, the higher value of CO_2 sequestration and SOC stock was noted under Greengram – Mustard – Pearlmillet cropping system (1.89 and 9.21 Mg/ha, respectively) while, horticulture system recorded lowest CO_2 sequestration and SOC stock (1.37 and 8.70 Mg/ha, respectively) over other cropping system of experiment.

Keywords: Carbon sequestration, soil organic carbon stock (SOC stock) and cropping system

Introduction

Since last decades world is facing bad effect of climate change in our part also farmers and scientists are facing and observing good and bad effect of climate change. In some part of West North Gujarat like Kutch region, total rainfall has received within short time while in some part of semi-arid region rainfall. Farmers are seeking alternative crops having higher price and resistance to changing environment. Marginal & small farmers are interested in integrated farming systems with resources conservation and efficient utility of farm waste & organic manure. Presently some cropping systems are newly emerging, so it is necessary to taste their economic viability & sustainability against present situation therefore the present experiment with different cropping systems diversification suite in integrated farming system model.

The increase in CO_2 emission by anthropological activity is attributed to fossil fuel combustion, biomass burning, deforestation, and intensive soil tilling and drainage problems of wet and marshy lands. Anthropogenic disquiets of the global C cycle are the serious alarm about the threats of global warming. Thus, identifying viable sinks for atmospheric CO_2 is a top priority with the objective of sequestering it into other C pools with long dwelling time.

Now-a-days carbon sequestration by agricultural land has international arena because of its potential benefits for both agriculture and climate change adaptation and mitigation. Carbon sequestration from plant biomass is a key sequestration pathway in agriculture; offering a mitigation strategy for agriculture's greenhouse gas emissions. Each 1% increase in average soil organic carbon levels could in principle reduce atmospheric CO_2 by up to 2% (Azeez, 2009) [4]. However, soil carbon stocks of agricultural land have decreased historically and decline progressively. Thus, improved agronomic techniques which lead to C sequestration are highly desired, this includes improved crop varieties, retention of crop residues, zero-till farming and incorporation of cover crops in a diversified rotations, integrated input management (MM) techniques, application of FYM/compost or waste products from livestock husbandry in the form of slurry or stacked manure and other bio-solids, erosion control, water conservation, contour hedges with perennial shrubs, controlled grazing, etc. Although these practices are not common in chemical based modern agriculture, relied on excessive ploughing, irrigation, iertilizers and pesticides use. Residue removal and biomass burning, and exhaustive cropping practices resulted in progressively depletion of SOC pool. However, crop production in organic agriculture relies on closed nutrient cycles by returning plant residues and manures from livestock back to the land and/or by integrating perennial plants into the production system. It is therefore, assumed that the adoption of organic farming will lead to a reduction in soil carbon losses and enhancing net carbon sequestration over time (Niggli *et al.,* 2009) [5].

Materials and Method

Details of the experimental site

The Sardarkrushinagar Dantiwada Agricultural University is situated in arid and semi-arid tropical climate. The mean annual rainfall of this region is 2083 mm with 37 mean rainy days. Area received more than 100 % rainfall mainly through the influence of S-W monsoon. The lowest rainfall 68 mm was received in 1987 while the highest 2083 mm was recorded in 2017-18 during last 31 year. The maximum rainfall 1198.4 mm observed received on fourth week of July, 2017-18. The distribution of rainfall during the monsoon season was uneven. The minimum temperature during November, December, January and February was below normal. This is helpful for increasing production of *Rabi* season crops. The maximum temperature during April, May and June was recorded higher than normal which resulted poor performance of summer crops during the year.

Treatment details

Sr. No.	Area (ha)	Cropping Systems
1	0.32	Castor + Greengram
2	0.08	Groundnut – Wheat – Multicut Fodder Rajkabajra
3	0.24	Greengram – Mustard – Pearlmillet
4	0.06	Hybrid Napier + Cowpea (F) – Lucerne + Fodder Chicory
5	0.25	• Mango (*Mangifera indica*): [8m x 8m (40 plants)] • Lemon (*Citrus limonum*): [In between two rows of mango at 4 m distance (80 plants)] • Custard apple (*Annona reticulata*): [In between two plants of mango (36 plants)] • Seasonal vegetables in between fruit trees

SOC stock and carbon sequestration determinations

Calculation of soil carbon stocks of experimental site requires determination of soil OC concentrations, bulk densities (BD) and soil depth, which all vary in space and have different measurement errors associated.

About 1 kg of bulk samples composed of three sub-samples are to be taken from each treatment at 0-15 cm. Half of the bulk sample is air-dried, crushed and sieved through a 2 mm diameter sieve.

Carbon stock (Mg/ha) = SOC concentration (g/kg) × Bulk density (Mg/m3) × depth (m) × 10

Total C sequestered (Mg C/ha soil) = Current carbon stock - Initial carbon Stock

Results and Discussion

The study was conducted to assess diversification of different cropping systems including pulse, oilseed, forage grass and commercial crops so as to bring in the concept of sustainability. A set of key variables were used to quantify soil organic carbon and carbon sequestration to compare the different cropping systems over a period of eight years.

A perusal of data graphically depicted in Fig. 1 revealed that significantly the highest SOC stock at 0-15 cm soil depth (9.21 Mg/ha) was recorded under CS_3 (Greengram – Mustard – Pearlmillet). Among the all treatments the lowest SOC stock (8.70 Mg/ha) at 0-15 cm soil depth was recorded under Horticulture system. The increasing trend of SOC stock under different cropping system was as $CS_3 > CS_2 > CS_1 > CS_4 >$ Horticulture system. Cropping system 3 (Greengram – Mustard – Pearlmillet) stored 125.82 per cent higher SOC stock in soils over initial status.

The CO_2 sequestration of different cropping system did not exhibit major difference under different cropping system (Figure 1). However the maximum value (1.88 Mg/ha) was noted under CS_3 (Greengram – Mustard – Pearlmillet) and minimum (1.37 Mg/ha) was recorded under Horticulture system. Different agricultural crops to be the most efficient capturing CO_2 from the atmosphere because crops where the stores carbon dioxide in the growing biomass through the process of photosynthesis and also increasing the soil organic carbon content.

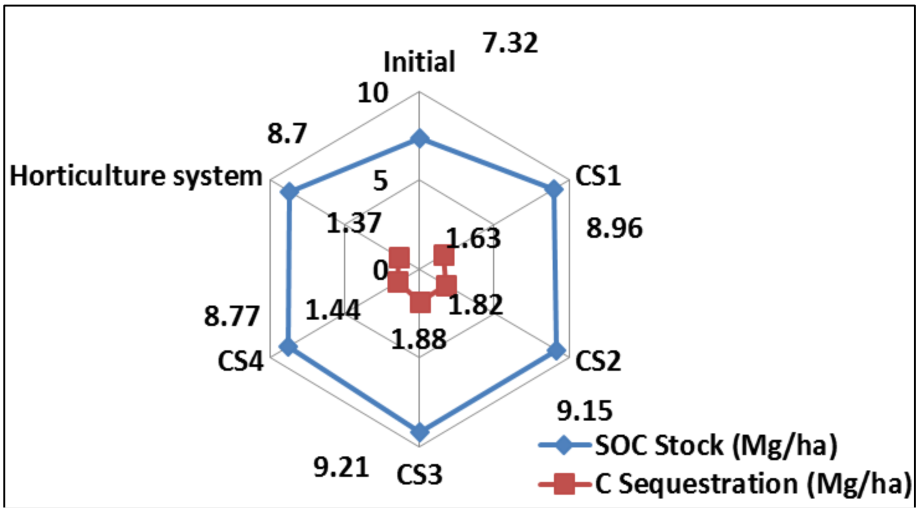

Fig 1: SOC stock and carbon sequestration of different cropping system after eight years

Conclusions

This five cropping system is most common in North Gujarat, especially in Banaskantha district, under different cropping system Greengram – Mustard – Pearlmillet is not only provide to economic benefits but, also had many other co-benefits, such as adaptation to climate change, biodiversity, soil conservation and the improvement of rural livelihood at the same time.

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