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Short Communication

Soil Organic Carbon Sequestration Enhanced by Different Agroforestry Systems on Farmer's Field in Narwar Block of Shivpuri District

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The ecological processes in agroforestry systems due to continuous addition of litter and decomposition activities make the system more efficient in terms of carbon stocking and nutrient cycling. Soil is the largest pool of terrestrial organic carbon in the biosphere, storing more carbon than contained in plants and the atmosphere combined and a relatively stable pool of various organic and inorganic carbon fractions. Soil organic carbon stock has a unique function in mitigating climate change as a key component of the biosphere carbon cycle. Changes in soil organic stock can have a considerable effect on atmospheric carbon dioxide concentration, contributing to global warming. Trees on the farm have a vital role in mitigating the effects of climate change. Both soils and trees on the farmlands are significant media for carbon storage. The ability of soil to sequester carbon is good strategy for farmer community and climate change. Estimating shifts of carbon due to land use change is a key process in determining impacts of disturbances on carbon storage in ecosystems. The carbon is stored in the living biomass of the trees and other vegetation by the process of photosynthesis and it goes into soil through nutrient cycling. Organic matter content in the soil is the most important ecological factor that determines the productivity of terrestrial ecosystem as, it effects physical, chemical and biological properties of soil, thus considered a key attribute of soil fertility. This adjudges land management issues to enable greater sequestration of carbon. As far as food production system is concerned for a greater carbon stocking, agroforestry systems are prescribed.

The carbon builds up in soils and the forest floor when dead and decaying biomass is detached from the parent plant. In general, there is a favorable interplay between carbon stock and various recommended land management practices: tillage, grazing, and agroforestry. Increase long-term sequestration of carbon in soils will benefit the environment and agriculture. Cropping, grazing and agroforestry can be managed for both economic productivity and carbon stock. The importance of agroforestry system for global carbon sequestration is time immemorial but its potential has been recognized recently [1]. In the present investigation, we have tried to capture the potential of indigenous agroforestry system for soil carbon sequestration prevalent on farmer's field in Gird region of Madhya Pradesh.

Shivpuri district is situated in the northern part of the Madhya Pradesh and covers an area of about 1539 km^2. It lies between N Latitude 25° 25' 26.83" and E longitude 77° 39' 28.76. It is bounded in the North by Morena, Gwalior, and Datia district on the East by Jhansi district of Uttar Pradesh, on the South by Gwalior district and on the west by Kota district of Rajasthan. Shivpuri district is divided into eight tehsils and eight blocks. Narwar block is one of the eight blocks of Shivpuri district, Madhya Pradesh India. It is located in the North East area of the district. Climate of the area falls in semi-arid zone with average annual rainfall as 816.30 mm. Average normal maximum temperature in the month of June is 45^{0}C, sometimes it reaches as high as 48°C.

Field observation and sample collection

Field observation was done firstly for the analysis of land use change. It was started from second week of May 2019. After completion of field verification, soil samples were collected performed from study area according to sampling design from different land uses through random sampling during first week of June to second week of July 2019. Geographic Positioning System (GPS) observations of sampling sites and changed land uses were also recorded at same time. A short field observation was carried out during 2018-2020 to obtain basic information of the area. The verification of area, identification of existing tree species and land use / land use cover condition and collection of some secondary information from local peoples was done during this field trip.

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Soil sample collection

The Sampling points were determined by random sampling technique generating random numbers within the strata. Soil samples from each stratum were collected using Core Sampler of 10 cm diameter and 12.73 cm height (volume 999.305 cc) up to 90 cm for each incremental depth at every selected site. The depth increments were 0-15 cm, 15-30 cm, 30-60 cm and 60-90 cm. Fresh soil samples were collected from each depth. A portion of bulk soil of core cutter was cut using knife and transferred to plastic bag for estimation of moisture and same soil was transferred to laboratory for further processing.

Laboratory analysis

Moisture correction for bulk density calculation was determined by taking soil in plastic can, sampled from core cutter [2]. Samples were prepared for SOC measurement passing an oven-dried portion of soil through 2 mm sieve. SOC was determined by titrimetric method [3]. For fragment correction soil samples in plastics bags were dried in room temperature. Air-dried such soil samples were passed through a 2 mm sieve. The weight of fragments retaining in the 2 mm sieve was recorded. Volume correction was done by water displacement method.

There are many agroforestry practices prevailing in the Narwar block of Shivpuri and tree species varied within the block. The following agroforestry practices were identified during research work in Narwar block of Shivpuri Madhya Pradesh (Table 1).

Table 1 Different agroforestry practices used by farmer's field in Narwar block of Shivpuri district Madhya Pradesh

Agroforestry systems	Tree component	Crop component	
		Rabi	Kharif
Bund plantation / Agri-silviculture	*Prosopis juliflora, Acacia nilotica, Azadirachta indica, Ziziphus mauritiana, Tectona grandis, Eucalyptus tereticornis, Gmelina arborea, Dalbergia sissoo, Leucaena leucocephala, Pithecellobium dulce, Melia azedarach, Butea monosperma, Holoptelea integrifolia, Derris indica*, etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo, Glycine max, Arachis hypogaea, Sasamum indicum, Zea mays* etc.
Agri-horti-silviculture	*Acacia nilotica, Azadirachta indica, Ziziphus mauritiana, Dalbergia sissoo, Madhuca indica, Mangifera indica, Pithecellobium dulce, Syzygium cumini* etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo*
Block plantation	*Tectona grandis, Eucalyptus tereticornis, Dalbergia sissoo, Leucaena leucocephala*, etc.	*Curcuma longa, Zingiber officinale*	
Agri-horticulture	*Phyllanthus emblica, Aegle marmelos, Psidium guajava, Syzygium cumini, Ziziphus mauritiana, Tamarindus indica, Artocarpus heterophyllus, Moringa oleifera Annona squamosa* etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo*
Home-gardens	*Phyllanthus emblica, Aegle marmelos, Psidium guajava, Syzygium cumini, Ziziphus mauritiana, Citrus spp, Punica granatum, Carissa carandas, Annona squamosa, Artocarpus heterophyllus*, etc.	*Lagenaria siceraria, Lablab purureus, Momordica charantia, Luffa acutangula, Abelmoschus esculentus, Capsicum frutescens* etc.	
Silvipasture	*Prosopis juliflora, Acacia nilotica, Azadirachta indica, Ziziphus mauritiana, Ailanthus excelsa, Ficus spp., Leucaena leucocephala, Albizia lebbeck, Albizia procera* etc.	*Trifolium alexandrinum, Vigna unguiculata*	*Pannisetum glaucum, Sorghum bicolour, Pennisetum purpureum,* Bajra: *Napier hybridetc.*

Soil Organic Carbon Stock in different depth of agroforestry land use in farmer's field Narwar block of Shivpuri

Soil organic carbon

The data pertaining to soil organic carbon (SOC) content (%) in different soil depth under different agroforestry systems indicated differences (Table 2), Amongst the systems, the top 0-15 cm soil layer in homegarden system registered the highest SOC (0.81%), followed by Block plantation system (0.78%) and lowest value was recorded under agrihorticultural (0.14%) SOC. In sub-surface layer (60-90 cm). Variation in organic matter across the present study sites might be due to differences in plant species composition [4-6]. For instance, the homegarden systems had greater species richness that might have resulted indiverse litter accumulation on the floor leading to higher SOM. Significant increase in SOC was also reported in grazed permanent pasture fields due to high return of leaf litter and animal dung [7].

Bulk density of the soil was found increasing with increased soil depth. It is the found that the agroforestry is potential to improve soil organic carbon and it can play a role in mitigation of climate change. The top soil contained higher amount of SOC, it seems that the agroforestry land use produces and retain more organic matter than pure cropping system. Differences in SOC stock in different land-use/covers support the hypothesis that different land uses have different SOC stock.

Table 2 Effect of different agroforestry system on bulk density and soil organic carbon stock in different depths of farmer's field Narwar block of Shivpuri

Agroforestry Systems	Bulk density				SOC (%)			
	0-15 cm	15-30 cm	30-60 cm	60-90 cm	0-15 cm	15-30 cm	30-60 cm	60-90 cm
Agri-silviculture	1.39	1.48	1.58	1.60	0.65	0.43	0.32	0.21
Agri-horticulture	1.41	1.47	1.60	1.61	0.48	0.42	0.29	0.14
Agri-horti-silviculture	1.32	1.42	1.53	1.57	0.50	0.41	0.25	0.17
Silvi-pasture system	1.30	1.36	1.56	1.56	0.76	0.55	0.38	0.18
Homegarden	1.30	1.38	1.53	1.55	0.81	0.59	0.40	0.20
Block plantation	1.28	1.39	1.45	1.53	0.78	0.60	0.42	0.21

SUMMARY

A field survey was conducted during 2018-2020 in Narwar Block of Shivpuri district Madhya Pradesh to know the agroforestry practices adopted by the farmers trees species exists on the farmer's field. The vertical distribution of SOC, considered to be a key component of carbon cycle, is still poorly understood in semi-arid region. The aim of this research was to determine SOC sequestration at four soil depth under agroforestry system and cropland. The samples were taken from 0-15, 15-30, 30-60, 60-90 cm soil depth. The top 0-15 cm soil layer in homegarden system registered the highest SOC (0.81%), followed by Block plantation system (0.78%) and lowest value was recorded under agrihorticultural (0.14%) SOC. In sub-surface layer (60-90 cm). In general, estimated SOC stock was observed to be higher in the topsoil (0-15 cm) compared to lower depths in various land use types. It is the found that the agroforestry has potential to improve soil organic carbon and it can play a role in mitigation of climate change.

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