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Short Communication

Soil Organic Carbon Sequestered by Existing Trees on Farmer's Field: A Case Study of Mihona Block of District Bhind Madhya Pradesh

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Soil organic carbon (SOC) comes from plants, microbes, leaves and wood mostly found in first meter of the soil depth. There are many conditions and processes that determine changes into soil organic carbon like temperature, rainfall, vegetation, agronomic practices and land use change. increase in soil organic carbon through various methods can improve soil health and eventually crop yield and reduce the need for chemical fertilizers. Many studies revealed that increase of SOC can improve crop yield. From various studies it is found that total earth contains roughly 2,350 Giga tones of Soil Organic Carbon. 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. 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]. Agroforestry has been practiced in a wide range of landscape and systems. It has got the unique technique of capturing the atmospheric CO_2 and retains it in standing biomass, harvested products and in soil organic matter. 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.

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Bhind district is situated in the northern part of the Madhya Pradesh and covers an area of about 4459 km^2. It lies between N Latitude 25 55' and 26°45' and E longitude 78°12' and 79°05'. It is bounded in the North and East by Uttar Pradesh, in the South by the Gwalior and in the west by the district Datia. Bhind district is divided into seven tehsils and six blocks. Mihona block is one of the six blocks of Bhind district, Madhya Pradesh India. It is located in the East-Southern area of the district. Climate of the area falls in semi-arid zone with average annual rainfall as 754.40 mm. Average normal maximum temperature in the month of May is 42°C, sometimes it reaches as high as 48°C.

Field observation and sample collection

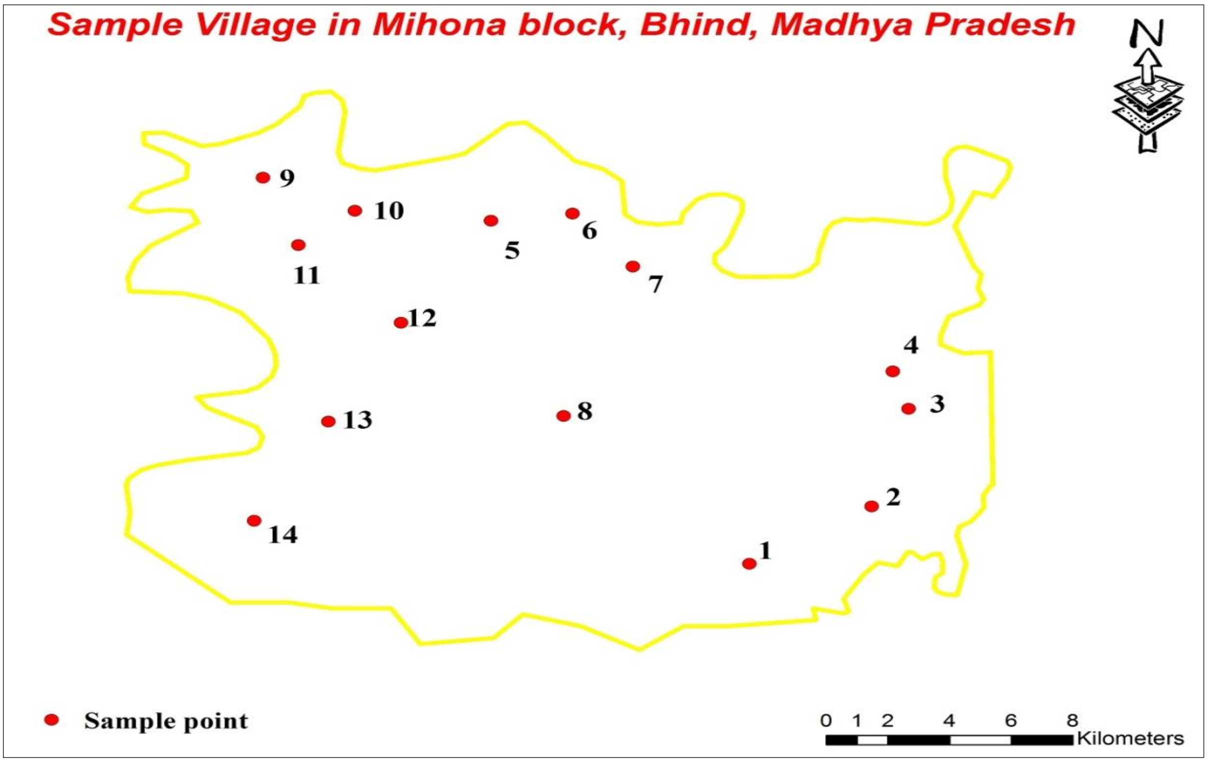
Field observation was done firstly for the analysis of land use change. It was started from second week of May 2019. After completion of field verification, soil samples were collected performed from study area according to sampling design from different land uses through random sampling during first 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.

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 999.305cc) up to 90 cm for each incremental depth at every selected site. The depth increments were 0-15cm, 15-30, 30-60cm and 60-90cm. 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.



Sample villages in Mihona block, Bhind, Madhya Pradesh

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

Table 1 Different Agroforestry practices used by farmer's field in Mihona block of Bhind district Madhya Pradesh

S. No.	Agroforestry systems	Tree component	Crop component	
			Rabi	Kharif
1.	Bund plantation / Trees on farm boundaries	*Prosopis juliflora, Acacia nilotica, Azadirachta indica, Ziziphus mauritiana, Tectona grandis, Eucalyptus tereticornis, Gmelina arborea, Dalbergia sissoo* etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo*
2.	Scattered trees on farm lands	*Acacia nilotica, Azadirachta indica, ziziphus mauritiana, Dalbergia sissoo, Madhuca indica, Mangifera indica* etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo*
3.	Block plantation	*Tectona grandis, Eucalyptus tereticornis, Dalbergia sissoo, Leucaena leucocephala*		
4.	*Agrihortisil viculture*	*Phyllanthus emblica, Aegle marmelos, Psidium guajava, Syzygium cumini, Ziziphus mauritiana* etc.	*Triticum aestivum, Cicer arietinum, Brassica spp., Pisum sativum*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo*
5.	Home-gardens	*Phyllanthus emblica, Aegle marmelos, Psidium guajava, Syzygium cumini, Ziziphus mauritiana, Citrus spp, Punica granatum, Carissa carandas* etc.	*Lagenaria siceraria, Lablab purureus, Momordica charantia, Luffa acutangula, Abelmoschus esculentus, Capsicum frutescens* etc.	

6.	Silvipasture	*Prosopis juliflora, Acacia nilotica, Azadirachta indica, Ziziphus mauritiana, Ailanthus excelsa, ficus spp., Leucaena leucocephala* etc.	*Trifolium alexandrinum,*	*Pannisetum glaucum, Sorghum bicolour, Pennisetum purpureum* etc.

Table 2 Soil organic carbon stock in different depth of agroforestry land use and croplands in farmer's field Mihona block of Bhind

Land use	No. of sample collected	Depth (cm)	SOC (%)	Bulk density (g cm^{-3})	Soil carbon (Mg C ha^{-1})
Agroforestry	36	0-15	0.41	1.30	7.99
	36	15-30	0.23	1.31	4.51
	36	30-60	0.19	1.33	3.79
	36	60-90	0.18	1.37	3.69
Total	144	90	0.25*	1.32*	19.98
Crop-land	36	0-15	0.21	1.31	4.12
	36	15-30	0.18	1.33	3.59
Total	64	30	0.19*	1.32*	7.71

*Mean value

Soil organic carbon stock in different depth of agroforestry land use and croplands in farmer's field Mihona block of Bhind

Results of this research work obviously shows that agroforestry playing a role in the storage of soil organic carbon (SOC) in block Mihona district Bhind Madhya Pradesh. The average bulk density of soil in agroforestry was 1.32 g cm^{-3} in up to 90cm soil depth. The average SOC in the agroforestry was estimated to be 19.98 Mg C ha^{-1}. A number of similar studies have shown that total SOC on farmer's field in different district of India varied from 4.28 to 24.13 Mg C ha^{-1} [4-5]. In different district of Madhya Pradesh SOC varied from 7.92 to 23.38 Mg C ha^{-1}. *Leucaena leucocephala* alley cropping system build up SOC up to 13.6 Mg C ha^{-1} [6] and it was decreased with increased soil depth (Table 2). Bulk density of the soil was found increasing with increased soil depth. The Agroforestry soil has high SOC stock 7.99 Mg C ha^{-1} in upper layer of soil (0-15cm) than crop land in 0-15cm soil depth (4.12 Mg C ha^{-1}). 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 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.

SUMMARY

A field survey was conducted during 2018-2020 in Mihona Block of Bhind district Madhya Pradesh to Know the agroforestry practices adopted by the farmers trees species is existing on the farmers' field. The vertical distribution of soil organic carbon (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 soil organic carbon sequestration at four soil depth under agroforestry system and cropland. The sample were taken from 0-15, 15-30, 30-60, 6-90cm soil depth. The average soil organic carbon in the agroforestry was estimated to be 19.98 Mg C ha^{-1} in depth upto 90cm. The Agroforestry soil has high soil organic carbon stock 7.99 Mg C ha^{-1} in upper layer of soil (0-15cm) than crop land in 0-15cm soil depth (4.12 Mg C ha^{-1}). In general, estimated soil organic carbon 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 is potential to improve soil organic carbon and it can play a role in mitigation of climate change.

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