International Scholars Journals

International Journal of Plant and Animal Sciences ISSN: 2756-388X Vol. 10 (1) pp.001-010, May 2022. Available online at www.internationalscholarsjournals.com © International Scholars Journals

Review Article

Comparative analysis of carbon stocks in different agro-forestry systems of district Mardan

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Received: 01-Mar-2022, Manuscript No. IJPS-22-50916; Editor assigned: 03-Mar-2022, Pre QC No. IJPS-22-50916; (PQ); Reviewed: 17-Mar-2022, QC No. IJPS-22-50916; Revised: 29-Apr-2022, Manuscript No. IJPS-22-50916 (R); Published: 9-May-2022.

ABSTRACT

Agroforestry is a system of land utilization that describes trees with different crops fused in a single area for farmers' net income. One or more agroforestry practices in one particular area usually have biological, environmental and economic interaction whilst the main aim of the AFS is not only economic benefits but also modern studies show that AFS could be used as a prime source carbon pool. Up to 12-228 ton ha^{-1}, with an average of 95 ton ha^{-1}, can be stored *via* the AFS. Agroforestry systems with different trees can deal with climate change more efficiently and sequester more carbon. Trees with crops can raise the carbon stocks to several folds compared to monocrop systems. For example, In an agrisilvicultural system, 34.61 ton ha^{-1} compared to 18.74 ton ha^{-1} can be reserved in a monocrop system in order to meet the CO_2 targets anticipated at Kyoto while simultaneously maintaining sustainable farm production and preventing further deforestation, integration of agricultural practices and systems in C Sequestration and C trade projects can be highly useful. Pakistan is a low middle income with an average annual rate of growth of 216.6 million people. Agroforestry has a very important role and is a key part of Pakistan's daily life, particularly rural people Agroforestry is an important timber and fuelwood source, with 70 percent of the urban and 97 percent of the rural domestic fuel wood being the main energy source in Kyber Pakhtunkhwa for centuries. In Khyber Pakhtunkhwa agroforestry is practiced in various models and shapes from the protection of naturally growing trees to the artificial cultivation of trees on agricultural lands. The Soil Organic Matter (SOM) is estimated to store 1500 Pg (1 Pg=1015 g) C to a depth of 1 m. To calculate soil organic carbon it is assumed that total organic matter contains 58% organic carbon contents or a relation i.e. organic carbon=SOM% multiply by 0.58 statistical Analysis were conducted using The jamovi project (2021). jamovi. (Version 1.6). The mean value of SOC for agri silviculture system is 2.65 while that of Silvo pastoral system is 2.23. The means of two systems are different from eachother. The mean value of SOM for agri silviculture system was found to be 4.56 and for Silvo pastoral system it is 3.84. Our results show that soil Organic carbon had an inverse relationship with soil pH. High density of carbon in agricultural Lands including agroforestry is related to the high tree diversity that increases plant production hence increased biomass. Litter fall also contributes to C stock accumulation in Soil. It is the most important known pathway connecting vegetation and soil, and is a good Indicator of aboveground productivity.

Keywords: Carbon stock, Carbon sequestration, Agroforestry, Khyber pakhtunkhwa

INTRODUCTION

New interests have been emerged to recognize the importance of various land use system to stabilize the atmospheric CO_2 accumulation and abating the CO_2 emissions along with enhancing carbon pools of forestry and agroforestry system. Now a days forests have been identified as one of the source in reduction of CO_2 emissions along with increasing carbon pools [1]. (Murthy et al., 2013) Agroforestry is basically a land use system which is used for describing and raising trees with different agricultural crops that are united together in same unit of area in order to gain some economic values to farmers. Under the guidelines of the Kyoto Protocol the AFS has been used as one of the tool in order to control the greenhouse gases and along with this approach it can also be used as one of the afforestation method. Many scientists have realized that raising trees with different vegetation results in more carbon absorption as compare to monocrop systems keeping in view the environmental and socioeconomic of that particular area. Unfortunately the importance of agroforestry

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systems to enhance carbon pools and giving prime importance in global C trading system has not been yet gained a due importance [2]. The Agroforestry system possess a greater tendency to sequester the above ground carbon as well as below ground carbon. (Kotto-Same et al., 1997; Nair et al., 2009). It has been estimated that up to 12-228 Mg ha^{-1} carbon can be stored through AFS, with an average of 95 Mg ha^{-1} (Schroeder, 1994; de Jong et al., 1995; Nair et al., 2009). Now a days, AFS are absorbing around about 0.29 to 15.21 Mg C/ha/year above ground and from 30 to 300 Mg C/ha upto 1 m soil depth by the year 2050 the AFS have the capacity of stocking 6.3 GT of carbon and would be able to absorb the atmospheric carbon usually at the higher pace of about 600 Mt C yr^{-1}. It shows that, AFS possess higher capacity of carbon absorption than any such other type of land use categories.(Gul, 2017). It is considered that agroforestry systems possess higher capacity to absorb carbon as compare to pastures or other field crops [3]. Data shows that Agricultural fields absorb 0.85-0.9 Pg C per year; biomass croplands absorb 0.5-0.80 Pg C per year and the forests can absorbs 1-3 Pg C per year (Albrecht and Kandji, 2003).According to IPCC the agroforestry would prove very useful to combat climate change due to its potential and capacity of carbon absorption. Recent studies shows that tropical agroforestry system has the capacity of carbon abosorption is in between 12 and 228 t C ha with -1 an average of 95 t C ha (Pandey, 2007). It is despicable to say that, Pakistan's terrestrial carbon pool is at its lowest ebb among South Asian countries only due to insufficient forest resources. In order to address this precarious situation the only possible solution lies in agroforestry system due to its capacity of carbon absorption. (Yasin et al., 2019). Enhancing SOC reservoirs is considered as a successful strategy (Lal, 2004a; Janzen, 2006) because it permits the transference of CO_2 from the environment to the soil that adds to the quality as well as fertility of the soil (Lal, 2004b) [5,6]. After oceanic and geological reservoirs (coal, natural gas and oil) soils are considered to be the third prime reservoir of carbon storage in terrestrial ecosystem. The calculatin showed that around 1500 Pg (1 P g=1015 g) of C is sequesered in the Soil Organic Matter (SOM) at a depth of 1 m. This calculation shows that, more than the sum of the atmospheric (828 Pg of C) and biomass stocks (560 Pg of C). Agroforestry has the potential to influence the routine life of the people of Pakistan particularly the population that lives in rural areas. The practices of agroforestry that is done in Khyber pakhtunkhwah is usually done with various patterns most primitive agroforestry system is used is the complicated agrosilvopastoral system that is the combination of local trees, shrubs, grasses, animals and agricultural crop on the This system is workable still at persistence level (FFSP, 2008).

LITERATURE REVIEW

Vikrant et al., (2021) Carried out an analysis in tehri district and uttarkhand among three Subtropical/Lower (286-1200 m), Subtemperate Middle (1200-2000 m) and temperate upper (2000-2800 m) altitudes and three Agrihortisilviculture, Agrihorticulture and Agrisilviculture systems. It showed that altitude is the main factor in influencing the soil organic carbon and biomass. It showed that altitude is the main factor in influencing the soil organic carbon and biomass. In lower altitudes (286-1200 m) of agrihortisilviculture system the accumulation of biomass carbon pool was higher in comparaion with middle and upper altitudes.. And as far soil organic carbon was concerned it was greater in upper altitude (2000-2800 m) in relation with middle and upper altitudes. The results also showed that soil organic carbon was higher in agrihorticulture system as compare to other systems. Pokhrel et al., (2020) the prime objective of this study was to make the comparison of carbon pool in agroforestry system having two contrast ecological regions of Nepal (rom Terai and Mid-hills) 30 and 50 various samples were collected respectively [4]. The appropriate analysis and statistical tests were employed. It was concluded that the mean biomass was greatly higher ($p<0.05$) in terai (21.314 t ha^{-1}) as compare to mid hills (11.203 t ha^{-1}). In terai the carbon content of soil was 61.17 t ha^{-1} in comparison with mid hills that was about 67,608 t ha^{-1}. Besides this the bulk density in terai was 1.38 g cm^{-3} as compare to mid hills that was about 1.076 g cm^{-3}. Although no substantive difference ($p>0.05$) was identified in total carbon pool of two different ecological areas which lucidly implied that almost same content of carbon was conserved between different ecological areas. Yasin et al., (2019) proposed to know the carbon pool along with its future capacity of agroforestry systems in Pakistan by equations that are allometric in nature carried in 3 district'sand 14 Tehsil's. Of Punjab and randomised sampling of 1750 plots of 0.405 ha with the help of Walkley-Black method at 0-30 cm depth a soil carbon pool was also comprehended in a proportion of plots. The result assessed that the sample units comprised of 18 to 51 trees/ha, that could be enhanced to about 42 to 83 trees/ha if farmers utilize maximum stocking along their crops. It was found that the assessed tree carbon pool varied from 0.0003-8.79 $Mgha^{-1}$ as the average value for tehsil Faisalabad was 0.39 $Mgha^{-1}$ that was smallest and for tehsil Chinot it was 1.41 Mgha^{-1} that served to be largest average s compare to Faisalabd. A total of 950,70 Mg carbon pool of woody vegetation and 22,743,008 Mg of soil carbon pool was estimated [7]. In the sampling area decide the status and capability of agroforestry and its part in carbon sequestration under semi-dry conditions [8]. Information was gathered through a multi-unbiased and pre-tried survey from 250 town ranchers in tehsil Sumandri, Pakistan. Stature and bigness of trees were estimated from 250 arbitrarily chose 0.405 ha ranch plots. Soil tests from each cropping design were gathered and investigated. The entire review region has 2069.19 Mt of over the ground carbon stocks and has sequestered an aggregate of 7579.46 Mt of carbon dioxide at the pace of 186201.85 t CO_2 yr^{-1}. Moreover, the review region has the capability of loading 3607.61 Mt and sequestering 13214.67 Mt of CO_2 at the pace of 327232.46 t CO_2 each year [9]. utilized a meta-examination of 427 soil C stock information sets assembled in four fundamental AF frameworks: alley cropping, windbreaks, silvopasture, and homegardens and assessed changes in AF and neighboring control cropland or field. Mean soil C stocks in AF (1 m profundity) were 126 Mg C ha^{-1}, what is 19% more contrasted with cropland or field. The most elevated C stocks in soil were in subtropical homegardens, AF with more youthful trees, and dirt (0-20 cm). Expanded soil C stocks in AF were lower than over-the-ground C stocks in most AF frameworks, with the exception of rear entryway editing. Yadav et al. (2017). In this review we have assessed biomass and carbon portion in various creation frameworks in the mid slopes of Indian Himalaya, at test ranch Hawalbagh of Vivekananda Foundation of Slope Horticulture, Almora, India. The greatest biomass (56.5 t ha^{-1}) and carbon stocks (25.3 t ha^{-1})were recorded in wheat+ walnut nut framework followed by (53.2 and 23.9 t ha^{-1}) in lentil+walnut nut framework while the base worth of biomass and biomass C was recorded 2.75 and 1.17 t ha^{-1} in unadulterated lentil creation framework. The Enduring carbon stockpiling of walnut nut agroforestry estate was 9.21 t C ha^{-1} the commitment of walnut nut in carbon stock and carbon sequestration rate were recorded 22.8 t C ha^{-1} and 1.67 t C ha^{-1} year^{-1}, separately. Soil natural carbon upgrade: In a review directed on intercropping of trees with crops, Singh et al. Announced an improvement in SOC by 33.3 to 83.3% for *Populus deltoides* and *Eucalyptus* half breed with *Cymbopogon sp*. Chauhan et al., (2011) has been made to evaluate the efficiency just as the carbon sequestration capability of this blend The advancement of soil through litter and roots improved the natural carbon in the surface layer of soil (0-15 cm) poplar obstructs when contrasted with open fields with wheat crop as it were [10-16]. The carbon stockpiling potential in agroforestry framework was recorded extremely high in contrast with sole yield. The carbon stockpiling in agroforestr Mardan is located at latitude 34.1979°N and longitude 72.0496°E. At the elevation 314 m above sea level. Mardan district may broadly be divided into two parts, north eastern hilly area and south western plain. The entire northern side of the district is bounded by the hills. The south western half of the district is mostly composed of fertile plain with low hills strewn across it (Figure 1).

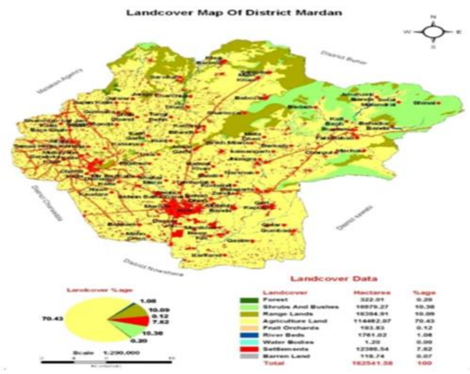


Figure 1. Landover map of District Mardan

MATERIALS AND METHODS

Description of study area

Mardan is located at latitude 34.1979°N and longitude 72.0496°E. At the elevation 314 m above sea level. Mardan district may broadly be divided into two parts, north eastern hilly area and south western plain. The entire northern side of the district is bounded by the hills. The south western half of the district is mostly composed of fertile plain with low hills strewn across it. In Mardan, the summers are long, sweltering, humid, and clear and the winters are short, cold, and partly cloudy. Over the course of the year, the temperature typically varies from 39°F to 105°F and is rarely below 34°F or above 112°F.

Mardan experiences significant seasonal variation in monthly rainfall.

Soil sampling

Random collection method was used for sample collection as indicated in Figure below. A total of 20 samples were collected from two different agroforestry systems in which 10 samples were collected from each. Sampling was carried out in the month of November, dated 10-10-2021. The samples were collected in polythene sample bags. Soil auger was used at the depth of 20 cm for soil collection (Figure 2).

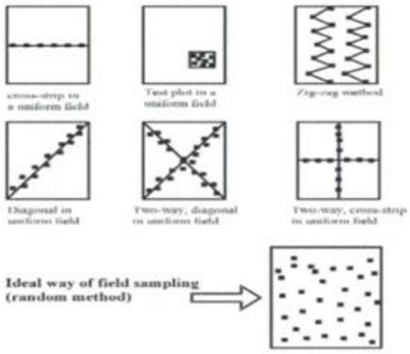


Figure 2. Some suggested method for soil sampling; each dot repreants a sample point, with formation of a sample pattern within the fielded. % $Clay$=corrected 8 hr reading oven dried soil weight × 100, % Silt=100 – (% sand+% clay).

Moisture content

The moisture content of soil also referred to as water content, is an indicator of the amount of water present in soil. Moisture content is the ratio of the mass of water contained in the pore spaces of soil to the solid mass of particles in that material, expressed as a percentage. The method is taken from ASTM D2216: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. A standard temperature of 110 ± 5°C is used to determine the mass of the sample [17].

Moisture content of the given soil sample=Mw/Ms × 100%

pH of soil

Soil pH, which is defined as the negative log of hydrogen ion activity, is an important soil indicator. The pH range found in soils typically ranges from 3 to 9. pH was analyzed by Mettler toledo pH meter using 1:5 ratios of soil and water 50 ml of distilled water is used in 100 ml of glass beaker and 5 gm of finely crushed soil is used glass beaker.

Electrical conductivity

The concentration of soluble inorganic salts in the soil is referred to as soil salinity. The determination of Electrical Donductivity (EC) is made with a Mettler Toledo conductivity cell by measuring the electrical resistance of a 1:5 soil: water suspension. 50 ml of distilled water is used in 100 ml of glass beaker and 5 gm of finely crushed soil is used glass beaker. (Piper, CS 1942, Soil and Plant Analyses. University of Adelaide)

Determination of particle size distribution

The formula used to calculate sand, silt and clay is as below.

% $Sand$=(oven dried soil weight–corrected 40 seconds reading oven dried soil weight × 100)

% $Clay$=corrected 8 hr reading oven dried soil weight × 100

% Silt=100–(%sand+% clay).

Bulk density

Bulk density was obtained by SPAW hydrology software of 6.02.75 version using the data of silt and clay as input. Silt and clay was found by volumetric method in laboratory [18].

Soil organic Carbon%

Soil Organic Carbon (SOC), Soil Inorganic Carbon (SIC) and Soil Organic Matter (SOM) was Determined by loss on ignition method as described. Around 10 g of soil sample was taken in a known Weight of china crucible. The sample was oven dried at 105°C overnight, to remove moisture from the soil sample. After drying, the oven dried sample weight was recorded. For soil organic carbon Content determination, the soil samples were further combusted at 550°C for 4 hours in a muffle Furnace. At 550°C the organic matter present in the soil was combusted and SOC was calculated using the formula as bellow:

LOI=(weight at 105°C)–(weight at 360° C) x 100 /Wt. At 105°C. [19,20]

Statistical analysis

Analysis was conducted using the jamovi project (2021). Jamovi. (Version 1.6), R Core Team (2020) R (version4.0) fox,j.,& weisberg,S. 2020 CAR. Companion to applied regression [R package]. The assumption of normality were tested by Shapiro wilk test and homogeneity of variances were tested by levene's test. Independent sample t test with 5% significance Level (Figure 3).

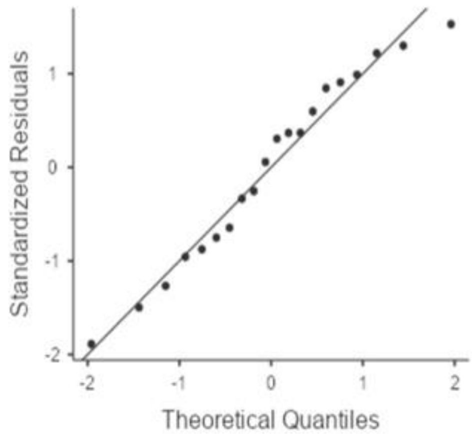


Figure 3. Independent sample t test with 5% significance Level.

RESULTS

After collection and processing of the samples their results were recorded. Table 1 indicates the comparative results of both agri-silvi and silvo pastoral Systems as summarized. The percentage moisture content of the silvi pastoral was found to be 4.02 ± 0.94, which is lesser than the agri-silvi (9.21 ± 0.69) while pHof silvo pastoral was 8.02 ± 0.162 as compare to agri-silvi which was 7.85 ± 0.108 that is slightly less than silvi pastoral system. The EC of Agri-silvi is 1541.50 ± 2.87 as compare to silvo-pastoral that was 1541.90 ± 3.69 that is slightly higher than agri-silvil system. The SOC of Agri-silvi was 2.56 ± 0.253 as compare to silvo-pastoral that was 1.63 ± 0.4420 that is also slightly higher than silvo pastoral system. At final the SOM of Agri-silvi was 4.41 ± 0.439 and that of silvo-pastoral are 2.60 ± 0.459 as compared the SOM of Agri-silvi are higher than silvi-pastoral system (Tables 1 and 2).

Table 1. Normality test (shapiro-Wilk).

	W	P
SOC	0.942	0
SOM	0.949	0
pH	0.928	0
EC	0.958	1
Moisture	0.963	1

Table 2. Group descriptives.

	Group	N	Mean	Median	SD	SE
SOC	Agri silvi Silvo pastoral	10 10	2.56 1.63	2.58 1.67	0.253 0.442	0.0801 0.1399
SOM	Agri silvi Silvo pastoral	10 10	4.41 2.60	4.43 2.60	4.439 0.459	0.1388 0.1451
pH	Agri silvi Silvo pastoral	10 10	7.85 8.02	7.85 8.05	0.108 0.162	0.0342 0.0512
EC	Agri silvi Silvo pastoral	10 10	1541.50 1541.90	1541.00 1541.50	2.877 3.695	0.9098 1.1686
Moisture	Agri silvi Silvo pastoral	10 10	9.21 4.02	9.35 4.13	0.693 0.942	0.2190 0.2979

Normality test

Using the independent-samples t test, to test the assumption of normality, where the Null Hypothesis is that there is no significant departure from normality [21].

Null hypothesis: H0: σ21=σ 22

The Alternative Hypothesis is that there is a significant departure from normality, as such; rejecting the null assumptions [22].

Hypothesis in favor of the alternative indicates that the assumption of normality has not been met for the given sample.

Alternative Hypothesis: Ha: σ 21 ≠ σ 22 The results of moisture, soil pH, electrical conductivity, soil organic matter and soil organic carbon as shown in descriptive table were subjected to normality test using Shapiro wilk test. Fig shows that all the resultant p value for SOM, SOC, moisture content, soil pH, Electrical conductivity is greater than 0.05 (significance level or α) (p>0.05) thus we accept the null hypothesis. Following are the Q.Q plots (Figure 4).

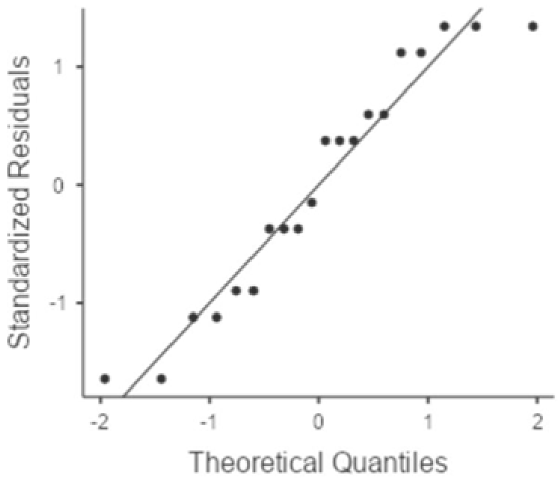
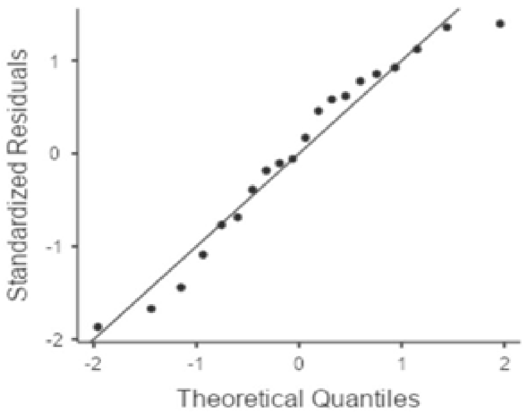


Figure 4. Homogeneity of variance.

Using the independent-samples t-test statistical analysis is to test the assumption of homogeneity of variance, where the null hypothesis assumes no difference between the two group's variances. The homogeneity of variances test was conducted on the data in descriptive table using levene's test. The Levene's test uses the level of significance set a priori for the t test analysis (e.g., α=.05) to test the assumption of homogeneity of variance. figures shows that the data of SOM, SOC, moisture content, soil pH and electrical conductivity has a p value more than the significance level (α=0.05), therefore we retained the null hypothesis and concluded that the variances are equal (Figure 5) [23].



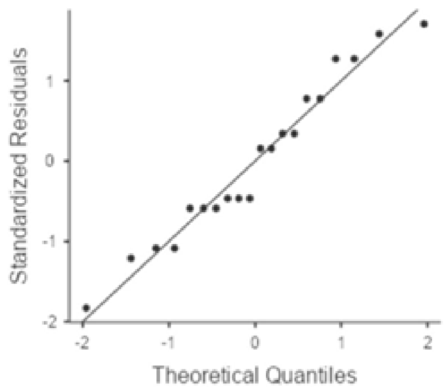


Figure 5. Shows that the data of SOM, SOC, moisture content, soil Ph.

T-test

The independent-samples t-test was conducted with a significance level of 95% to evaluate the difference between the means of independent groups of two agroforestry systems i.e. agri-silviculture system and salvi-pastoral system. As the assumption of normality and homogeneity of variances were found to be significant (Table 3) [24-30].

Table 3. Homogenity of Variances Test (Levens's).

	F	df	df2	p
SOC	1.5	1	18	0.2
SOM	0.156	1	18	0.7
pH	3.516	1	18	0.1
EC	1.19	1	18	0.3
Moisture	2.617	1	18	0.1

Moisture content%

Moisture content has a p value of 0.609 (student's t test) which is greater than the significance level i.e. p>0.05 thus we accept the null hypothesis and assume that there is no significant difference in the mean of moisture content of the two agroforestry system and the data is not statistically significant level mean MC% of silvi-pastoral system is 4.02 and that of agri-silviculture system is 9.21 as shown in above Figure.

Table 4. Group description**.**

							95% Confidence level	
		Statistic	**df**	**p**	**Mean differnce**	**SE differnce**	**Lower**	**Upper**
	Stuednt's t	6	18	<0.001	0.94	0.161	0.597	1.275
SOM	Stuednt's t	9	18	<0.001	1.81	0.201	1.384	2.228
pH	Stuednt's t	-3	18	0	-0.2	0.062	-0.299	-0.04
EC	Stuednt's t	-0	18	0.8	-0.4	1.481	-3.511	2.711
Moisture	Stuednt's t	14	18	<0.001	5.19	0.37	4.408	5.962

PH

Soil pH has a low p value 0.144 which is greater than the significance level ($p<0.05$) therefore we accept the null hypothesis of no difference and assume that the pH of two agroforestry system is statistically significant in their mean as can be seen in the Table. The mean pH of silvi-pastoral system is 8.02 which are slightly higher than agri-silviculture system of 7.85 as shown in Figure 6.

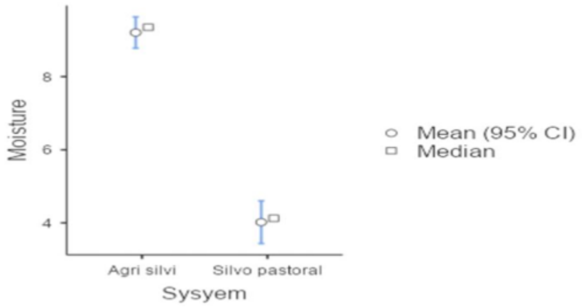


Figure 6. The mean pH of silvi-pastoral system is 8.02 which are slightly higher than agri-silviculture system of 7.85.

Electrical Conductivity (EC)

Electrical conductivity of two agroforestry system is found to be statistically significant i.e. $p<0.05$ in their means [31]. The p value for EC is 0.501 which is greater than the significance level thus we accept the null hypothesis of no difference and conclude that the electrical conductivity of silvi-pastoral system (M=1541.90) is almost same as that of agri-silviculture system (M=1541.50) as shown in Figure 5.

Soil organic carbon

Soil organic carbon has a p value of 0.265 as shown in table, which is greater the significance level of 0.05 i.e. $p>\alpha$. Therefore we accept the null hypothesis of no difference and assume that there is no statistically significant difference between the means of SOC of two agroforestry system [34]. But the mean value as seen in descriptive table for salvo-pastoral (Figure 7).

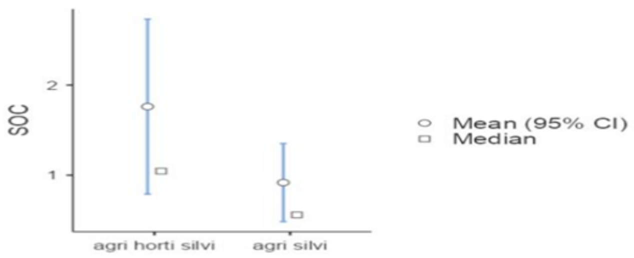


Figure 7. The mean value as seen in descriptive table for salvo-pastoral system is 1.63 while that of agri-silviculture system is 2.56.

System is 1.63 while that of agri-silviculture system is 2.56 as shown in Figure 7. We conclude that the differences between the two Means are likely due to soil texture or management practices.

Soil organic matter

Soil organic matter is found to have a p value of 0.355 as shown in Table, which is higher than our significance level of 0.05 so we accept the null hypothesis of no difference and assume that the data is not statistically significant. Means of two systems are different from each other the mean value for agri-silviculture system was found to be 4.41 and for salvi-pastoral system it is 2.60 as shown in Figure.

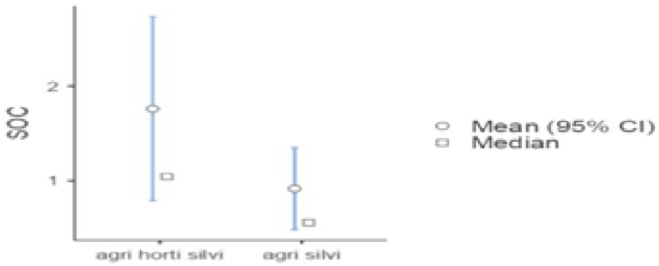


Figure 8. The mean value for agri-silviculture system was found to be 4.41 and for salvi-pastoral system it is 2.60.

DISCUSSION

Moisture

Soil moistureconditions are an important environmental factor that controls survival and activity of microorganisms in soils. The rapid change in SM may cause osmotic shock, inducing cell lysis and release of labile intracellular substrates. Moisture content of silvopastoral system is less than agrisilvi system may be due to the compaction of soil by cattle foot traffic. Generally, a soil with very low moisture content is less vulnerable to compaction than a soil with high moisture content. But when the moisture content is so high that all the soil pores are filled with water, the soil becomes less compressible. Using the bulk density as the soil compaction indicator, showed as to vulnerability of the soil to compaction increases with increasing water contents up to a limit after which it decreases with the increasing water contents. The silvo pastoral system are subjected to high trampling so as a result there is a significant difference in soil physical properties of both silvo pastoral and agri silvi systems.. The soil of Silvo pastoral system was more expose to sun light as compare to agri silvi system that may be the reason for less accumulation of moisture in silvo pastoral system (Figure 9) [32].

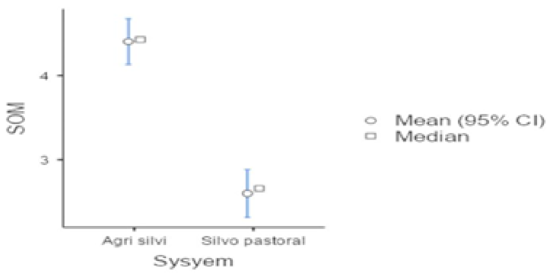


Figure 9. Moisture content of silvopastoral system.

PH

Soil pH is only essential for the chemistry and fertility of soils. However, the recognition of soil functions beyond plant nutrient supply and the role soil as a medium of plant growth required the study of the soil and its properties in light of broader ecosystem. As moisture increased, pH increased, whereas redox potential (Eh) decrease. The results showed that agri silvi has a higher pH as compare to silvo pastoral so it is more likely that it may be due to moisture content in agri silvi system. The plant residues also affect the pH of the soils so agri silvi has higher pH as in comparison with silvo pastoral may be due to the accumulation of plant residues in agri silvi system [35].

Electrical conductivity

Most importantly to fertility, EC is an indication of the availability of nutrients in the soil. The higher the EC, the more negatively charged sites (clay and organic particles) there must be in the soil, and therefore the more cations (which have a positive charge) there are that are being held in the soil. The general rule of thumb for salinity is that very high EC values (>1600 mS/m) are an indication of strong saline soils. Low EC values (0-200 mS/m) on the other hand, are an indication of non-saline soils [36].

Soil organic matter

It becomes highly essential to maintain and improve its level in the soil is a pre-requisite to ensuring soil quality, future productivity, and sustainability (Haynes 2005). Chan et al. 2000 suggest that certain fractions of soil organic matter are more important in maintaining soil quality and are, therefore, more sensitive indicators of the impact of management practices Soil organic matter tends to increase as the clay content increases.(Rice, 2002). The organic matter content in fine textured (clayey) soils is two to four times that of coarse textured (sandy) soils (Prasad and Power, 1997). Soil organic matter accumulated rapidly due to the production of litter and dead roots. It may be the reason for higher soil organic matter in agri silvi system as compare to silvo pastoral system.

Soil organic carbon

Soil biochemistry and physical characteristics significantly affected the accumulation of SOC. In addition, the soil physical property (especially the silt content) was another controlling factor in the early stages (grassland), and urease activity and saccharase activity were important controlling factors in the early-middle and middle-late stages, respectively. The amount of Soil Organic Carbon (SOC) in agroforestry systems differs with regions, Agroforestry systems and soil depths. In General, SOC sequestration rate can be up to 0.5 to 1.5 t ha yr. in cool and humid climates and 0.05 to 0.5 t ha yr. in warm conditions And in arid regions. The rate of decomposition of SOM is generally higher in Tropical than in temperate climates. The Carbon Sequestration rates in some major agroforestry systems around the world are highly variable, ranging from 0.29 – 15.21 Mg ha yr (Nair et al., 2010). The results showe that Agri silvi system posess higher organic carbon as compare to silvo pastoral system. Liu. et al, 2015. Soil organic carbon pool was higher under pure forest followed by horti-silvipastoral, agri-silviculture and the least was under silvi-pastoral system. The total carbon pool for different agroforestry system followed the decreasing order: PF >HSP > AS > NG > HP>SP.

CONCLUSION

The agroforestry system potential to carbon storage depends on the soil texture, site characteristics and management practices. Trees in particular play substantial roles for enhancing carbon stocks in agroforestry. Moreover, soil is the largest pool of terrestrial carbon in the biosphere store more carbon than stored by plants and atmosphere combined. This will also enhance soil fertility, productivity and food security. The amount of carbon sequestration largely depends on agroforestry systems. As our results show that soil organic carbon had an inverse relation with pH. At low pH the decomposition rate is reduced due to that there are high accumulation of soil organic carbon' thus, valuing the carbon storage potential of agroforestry help to promote the ecosystem services of the system, and boost up its acceptance in sustainable natural resource management strategy throughout the tropics. Comparison of Different agroforestry systems for total soil organic carbon Stock revealed the superiority of pure forest system Followed by Agri-silviculture system (Agroforestry).

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