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Agroforestry Model Serve as Tools for Improvement in Soil Quality

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ABSTRACT: Tree in agroecosystems present in various combinations and they may support variety of biological diversity in the ecosystem. More the diversity results various set of competition creating varieties of products developed due to the interaction dynamics and resulting the current quality of soil physico-chemical status. Present paper deals with soil analysis of agroforestry and non-agroforestry cropland soil sample were collected from 21 villages randomly from Karera block of Shivpuri district by doing comparative study. Hypothesis of the study (H_O = Two given independent population means are same Vs H_1 = Two population means are not same (Alternate hypothesis postulated that in the presence of any factor there may be the impact of population gives differences in that population which is not affected by any factors). In view of statistical Data analysis at α=0.05 level of significance the calculated value of student's t- test were found 6.4489, 27.347 & 13.72505 for N content, OC % and C:N ration respectively which are at par from t-test table value (α=0.05 and 20 d.f.) was 2.086 which concluded that the significance changes has been observed in soil quality due to the agroforestry model at karera block of Shivpuri district.

Keywords: Karera, C:N ratio, Agroforestry cropland, soil data analysis, student's t-test.

INTRODUCTION

The concept of agroforestry is based on the expected role of on farm and off farm tree production in supporting sustainable land use and natural resource management. While the aboveground and belowground diversity provides more stability and resilience for the system at the site level, the system provides connectivity with forests and other landscape features at the landscape and watershed levels (Nair *et al.,* 2008; Gold and Garrett, 2009). These ecological foundations of agroforestry systems manifest themselves in providing environmental services such as soil conservation, carbon storage, biodiversity conservation, and enhancement of water quality.

In the tropics where small family farms, subsistence food crops, and declining soil productivity are common features, the emphasis on the role of trees in improving soil quality of agricultural lands and providing food and nutritional security are characteristic of the numerous and diverse agroforestry systems. The expectations of environmental benefits of agroforestry systems (AFS) had slightly different connotations in the two contexts. In present study soil in the centre with respect to their physical and chemical properties were the major fields of agroforestry research. During the past decades, with increasing realization of the global impact of human activities on the environment, environmental issues of a global scale such as carbon sequestration/climate change and biodiversity conservation have become increasingly important. Today, the environmental quality and ecosystem service functions that are commonly associated with agroforestry are C sequestration/climate change, biodiversity conservation, water quality enhancement, and soil improvement (Montagnini, 2005; Jose, 2009), and these benefits transcend from local to global levels according to the "act locally, think globally" dictum.

Tree in agroecosystems present in various combinations and they may support variety of biological diversity in the ecosystem. More the diversity results various set of competition creating varieties of products developed due to the interaction dynamics and resulting the current quality of soil physico-chemical status.

The tree biomass (above and below ground) is increased up to 28.71 $MgDMha^{-1}$ from baseline over a simulated period of 30 years. Similarly in case of total biomass (trees + crops) is increased up to 28.78 $MgDMha^{-1}$ from baseline. The net carbon sequestered over a simulated period of 30 years is estimated to be 19.43 Mg C ha^{-1} and carbon sequestration potential is 0.64 Mg C $ha^{-1}yr^{-1}$. The soil organic carbon (SOC) at beginning of the project was 8.10 Mg C ha^{-1} and it is expected to increased up to 13.43 Mg C ha^{-1} in 0-90 cm soil layer over a simulated period of 30 years. It indicated that under agroforestry system build up soil organic carbon is about 0.02 Mg C ha^{-1} Yr^{-1}. Many researchers have provide that agroforestry system are promising land use systems to increase aboveground and soil carbon stock to mitigate green house gas emission (Verchot *et al.,* 2006; Yadava, 2010; Ram Newaj *et al.,* 2020).

MATERIALS AND METHODS

The study area having gird zone (VI) of agroclimatic region of Madhya Pradesh. Majority of soil here are black and red soil (Alluvium) is major wheat jowar cultivation area kwon as wheat jowar crop zone it is fourth zone out of five crop zones of Madhya Pradesh. Total minimum rainfall is between 800-100 mm here at Shivpuri. Shivpuri district is situated in the northern part of the Madhya Pradesh and covers an area of about 10278 sq. km. It lies between N Latitude 26^o 05′ and 24^o 40′ and E longitude 77^o 01′ and 78^o 29′ and falling in Survey of India toposheet nos. 54H, K & L. It is bounded in the North by district Gwalior, in the south by the district Guna, in the east by the district Datia and in the west by the Rajasthan state. Shivpuri district is divided into 7 tehsils and 8 blocks. Karera is a Nagar Panchayat city in district of Shivpuri, Madhya Pradesh. The Karera city is divided into 15 wards for which elections are held every 5 years. The Karera Nagar Panchayat has population of 28,705 of which 15,595 are males while 13,110 are females as per report released by Census India 2011. It is the area under Sind – Mahur Sub Basin. The River Mahur crosses the hilly area at an elevation of 296.91 m above MSL after flowing from south to north in Pichor block enters into Karera block at village Bardi. The general slope of the sub basin is towards North.

A field survey was done during 2019-20 in Karera block of Shivpuri (Madhya Pradesh). To know the agroforesytry practices adopted by farmers and what changes occurs in soil properties. First of all number of villages was identified randomly to conduct the field survey. Since, each village is having large acreage and it was not possible to cover each and every village. Samples of 20 percent villages were selected, so that it could represent the whole block. The survey was conducted on the basis of transect walk in the selected village. The village head, local farmers and village youth were associated in the transect walk to have a clear picture of the village. The sampling involves enumeration on agroforestry and non agroforestry lands. The methodologies described by (Ram Newaj *et al.,* 2017) were followed in the present study.

RESULT AND DISCUSSION

It is not a Nobel think that the paper stated but this phenomenon has been tested here at Karera block of Shivpuri district by doing comparative study of soil analysis from cropland area under agroforestry model and between pure crop lands. Hypothesis of the study (H_O = Two given independent population means are same Vs H_1 = Two population means are not same (Alternate hypothesis postulated that in the presence of any factor there may be the impact of population gives differences in that population which is not affected by any factors). Random Soil samples collected from different farmer's cropland from 21 villages of Karera block and soil analysis has been done from Shivpuri soil testing laboratory by using recommended methods of soil analysis. The results of soil analysis are presented in Table 1.

The result of N content in kg/ha are mentioned here for agroforestry and non-agroforestry crop land fields which shows that the range of N at cropland under agroforestry model lies between 266-351and their mean value is 307 whereas, the range of N kg/ha is between 221.80–331.90 and their mean value is 258.02 at non-agroforestry cropland fields (Table 2).

The result of P content in kg/ha are mentioned here for agroforestry and non-agroforestry crop land fields which shows that the range of P at cropland under agroforestry model lies between 19-31.03 and their mean value is 25.57 whereas, the range of P kg/ha is between 14-28 and their mean value is 20.71 at non-agroforestry cropland fields (Table 2).

The result of K content in kg/ha are mentioned here for agroforestry and non-agroforestry crop land fields which shows that the range of P at cropland under agroforestry model lies between 298.60-440.81 and their mean value is 349.99 whereas, the range of K kg/ha is between 210.7-396.00 and their mean value is 276.92 at non-agroforestry cropland fields (Table 2).

The result of OC content in percentile are mentioned here for agroforestry and non-agroforestry crop land fields which shows that the range of OC (%) at cropland under agroforestry model lies between 0.82-0.98 and their mean value is 0.90 whereas, the range of OC (%) is between 0.44-0.59 and their mean value is 0.50 at non-agroforestry cropland fields (Table 2).

Carbon and nitrogen in soils are the main component of organic content which known as soil fertility. Both C and N status associated with C:N ratio may play a key role in regulating soil organic matter mineralization. The ratio indicates the rate of decomposition of organic matter and this results in the release or immobilization of soil nitrogen pointed out that the greatest SOM mineralization would occur at substrate C:N ratio of 25. If the ratio is less than 20, mineral N is released in the early of decomposition process (Deng *et al.,* 2013). The dividing line between immobilization and release of N is about 20:1. The change of soil C:N could lead to significant decline in carbon storage (Aitkenhead & McDowell, 2000). Many factors, including are land use, climate, topography and biotic interaction dynamics influence the biogeochemical cycle in the soil which further the change of C:N storage (Garcia & Alcantara, 2013).

The result of C:N Ratio are calculated here by dividing the OC from N content and mentioned here for agroforestry and non-agroforestry crop land fields which shows that the range of C:N Ratio at cropland field under agroforestry model lies between 0.0025156- 0.003478 and their mean value is 0.00296 whereas, the range of C:N Ratio is between 0.00147635-0.002344454 and their mean value is 0.001948146 at non-agroforestry cropland fields (Table 2).

Table 1: Status of N, P, K, OC (%) and C/N Ratio obtained from soil sample collected from agroforestry cropland and Non agroforestry cropland from different village at Karera block of Shivpuri district.

S. No.	Name of village	N available(kg/ha)		P available(kg/ha)		K available(kg/ha)		OC(%)		c/n ratio	
		Agroforestry land	Non Agroforestry land	Agroforestry land	Non Agroforestry land	Agroforestry land	Non Agroforestry land	Agroforestry land	Non Agroforestry land	Agroforestry land	Non Agroforestry land
1.	Ambari	290	232.10	21.70	16.00	317.30	231.90	0.97	0.48	0.003341371	0.002068074
2.	Amolpatha	335	261.30	19.00	14.00	398.00	323.00	0.85	0.47	0.002535951	0.001798699
3.	Bagedhari Abbal	308	254.00	28.28	21.20	298.60	210.70	0.95	0.46	0.003083214	0.001811024
4.	Bahera	351	270.00	30.00	28.00	318.16	226.00	0.92	0.47	0.002620187	0.001740741
5.	Bangwan	266	222.40	23.00	19.70	394.60	321.00	0.87	0.47	0.003269325	0.002113309
6.	Chausija	296	247.20	26.00	19.50	319.50	243.20	0.91	0.45	0.003073078	0.001820388
7.	Chhah	280	221.80	22.00	15.00	319.80	253.80	0.89	0.52	0.003174037	0.002344454
8.	Chhitipur	285	245.40	27.00	24.00	309.20	221.70	0.83	0.44	0.002910238	0.001792991
9.	Chinnod	336	289.70	19.52	17.00	335.80	290.00	0.88	0.52	0.00261749	0.00179496
10.	Damron kala	287	252.00	23.00	16.00	307.17	231.30	0.87	0.47	0.003031359	0.001865079
11.	Dangipura	328	251.00	24.94	18.00	440.81	396.00	0.98	0.55	0.002986166	0.002191235
12.	Jujhaikarera	312	268.30	23.30	18.00	325.40	290.00	0.93	0.48	0.002976953	0.001789042
13.	Karotha	283	265.50	23.42	21.00	346.18	248.70	0.82	0.59	0.002897527	0.002222222
14.	Koond	306	234.90	30.20	26.10	438.12	350.00	0.93	0.51	0.003037925	0.002171137
15.	Kuchlon	330	252.60	31.00	24.80	319.13	234.50	0.93	0.46	0.002817157	0.001821061
16.	Mungawali	321	260.40	31.03	25.40	340.12	310.00	0.90	0.57	0.002802342	0.00218894
17.	Patha	302	250.00	26.00	21.40	410.90	355.00	0.86	0.45	0.002845892	0.0018
18.	Ramnagar	330	296.10	27.00	19.00	363.14	272.80	0.83	0.58	0.002515152	0.001958798
19.	Shankargarh	282	255.00	27.18	24.60	310.00	255.00	0.98	0.54	0.003477644	0.002117647
20.	Teela	282	256.80	23.00	18.00	318.70	220.80	0.92	0.52	0.003262411	0.002024922
21.	Toda pichhor	336	331.90	30.42	28.30	419.13	330.00	0.97	0.49	0.002886905	0.001476348

Table 2: Summary of soil analysis data.

S. No.	N available(kg/ha)		P available(kg/ha)		K available(kg/ha)		OC(%)		C:N Ratio	
	AGF	NAGF	AGF	NAGF	AGF	NAGF	AGF	NAGF	AGF	NAGF
Min	266	221.8	19	14	298.6	210.7	0.82	0.44	0.0025156	0.00147635
Max	351	331.9	31.03	28	440.81	396	0.98	0.59	0.003478	0.002344454
mean	307	258.02	25.57	20.71	349.99	276.92	0.90	0.50	0.00296	0.001948146

(Note- AGF= Agroforestry, NAGF= non agroforestry)

A. Statistical analysis

Statistical analysis for checking its significance we are using student t-test for N, OC and CN Ratio by online analysis using T-Test Calculator for 2 Independent Means (socscistatistics.com) website. Analysis tables (Table 2 to Table 5) has been given below.

Table 3: Student t-test analysis for two independent mean on N Content soil data.

Treatment 1 (X)	Diff(X - M)	Sq. Diff(X - M)^2	Treatment 2 (X)	Diff(X - M)	Sq. Diff(X - M)^2
290	-16.95	287.38	232.10	-25.92	671.80
335	28.05	786.67	261.30	3.28	10.76
308	1.05	1.10	254.00	-4.02	16.15
351	44.05	1940.19	270.00	11.98	143.54
266	-40.95	1677.10	222.40	-35.62	1268.72
296	-10.95	119.95	247.20	-10.82	117.05
280	-26.95	726.43	221.80	-36.22	1311.82
285	-21.95	481.91	245.40	-12.62	159.24
336	29.05	843.76	289.70	31.68	1003.68
287	-19.95	398.10	252.00	-6.02	36.23
328	21.05	443.00	251.00	-7.02	49.27
312	5.05	25.48	268.30	10.28	105.70
283	-23.95	573.72	265.50	7.48	55.96
306	-0.95	0.91	234.90	-23.12	534.49
330	23.05	531.19	252.60	-5.42	29.37
321	14.05	197.34	260.40	2.38	5.67
302	-4.95	24.53	250.00	-8.02	64.31
330	23.05	531.19	296.10	38.08	1450.16
282	-24.95	622.62	255.00	-3.02	9.11
282	-24.95	622.62	256.80	-1.22	1.49
336	29.05	843.76	331.90	73.88	5458.40
	M: 306.95	SS: 11678.95		M: 258.02	SS: 12502.91

Analysis:

Significance Level:

○ .01
◉ .05
○ .10

One-tailed or two-tailed hypothesis?:

○ One-tailed
◉ Two-tailed

<u>Difference Scores Calculations</u>

Treatment 1

N_1: 21
$df_1 = N - 1 = 21 - 1 = 20$
M_1: 306.95
SS_1: 11678.95
$s^2_1 = SS_1/(N - 1) = 11678.95/(21-1) = 583.95$

Treatment 2

N_2: 21
$df_2 = N - 1 = 21 - 1 = 20$
M_2: 258.02
SS_2: 12502.91
$s^2_2 = SS_2/(N - 1) = 12502.91/(21-1) = 625.15$

<u>T-value Calculation</u>

$s^2_p = ((df_1/(df_1 + df_2)) * s^2_1) + ((df_2/(df_2 + df_2)) * s^2_2) = ((20/40) * 583.95) + ((20/40) * 625.15) = 604.55$

$s^2_{M_1} = s^2_p/N_1 = 604.55/21 = 28.79$
$s^2_{M_2} = s^2_p/N_2 = 604.55/21 = 28.79$

$t = (M_1 - M_2)/\sqrt{(s^2_{M_1} + s^2_{M_2})} = 48.93/\sqrt{57.58} = 6.45$

The *t*-value is 6.44888. The *p*-value is < .00001. The result is significant at *p* < .05.

Note: If you wish to calculate the effect size, this calculator will do the job.

Table 4: Student t-test analysis for two independent population on OC (%) of soil data.

Treatment 1 (X)	$Diff(X - M)$	$Sq. Diff(X - M)^2$	Treatment 2 (X)	$Diff(X - M)$	$Sq. Diff(X - M)^2$
0.97	0.07	0.00	0.48	-0.02	0.00
0.85	-0.05	0.00	0.47	-0.03	0.00
0.95	0.05	0.00	0.46	-0.04	0.00
0.92	0.02	0.00	0.47	-0.03	0.00
0.87	-0.03	0.00	0.47	-0.03	0.00
0.91	0.01	0.00	0.45	-0.05	0.00
0.89	-0.01	0.00	0.52	0.02	0.00
0.83	-0.07	0.01	0.44	-0.06	0.00
0.88	-0.02	0.00	0.52	0.02	0.00
0.87	-0.03	0.00	0.47	-0.03	0.00
0.98	0.08	0.01	0.55	0.05	0.00
0.93	0.03	0.00	0.48	-0.02	0.00
0.82	-0.08	0.01	0.59	0.09	0.01
0.93	0.03	0.00	0.51	0.01	0.00
0.93	0.03	0.00	0.46	-0.04	0.00
0.90	0.00	0.00	0.57	0.07	0.00
0.86	-0.04	0.00	0.45	-0.05	0.00
0.83	-0.07	0.01	0.58	0.08	0.01
0.98	0.08	0.01	0.54	0.04	0.00
0.92	0.02	0.00	0.52	0.02	0.00
0.97	0.07	0.00	0.49	-0.01	0.00
	M: 0.90	SS: 0.05		M: 0.50	SS: 0.04

Analysis:

Significance Level:

- ○ .01
- ◉ .05
- ○ .10

One-tailed or two-tailed hypothesis?:

- ○ One-tailed
- ◉ Two-tailed

Difference Scores Calculations

Treatment 1

N_1: 21
$df_1 = N - 1 = 21 - 1 = 20$
M_1: 0.9
SS_1: 0.05
$s^2_1 = SS_1/(N - 1) = 0.05/(21-1) = 0$

Treatment 2

N_2: 21
$df_2 = N - 1 = 21 - 1 = 20$
M_2: 0.5
SS_2: 0.04
$s^2_2 = SS_2/(N - 1) = 0.04/(21-1) = 0$

T-value Calculation

$s^2_p = ((df_1/(df_1 + df_2)) * s^2_1) + ((df_2/(df_2 + df_2)) * s^2_2) = ((20/40) * 0) + ((20/40) * 0) = 0$

$s^2_{M_1} = s^2_p/N_1 = 0/21 = 0$
$s^2_{M_2} = s^2_p/N_2 = 0/21 = 0$

$t = (M_1 - M_2)/\sqrt{(s^2_{M_1} + s^2_{M_2})} = 0.4/\sqrt{0} = 27.35$

The t-value is 27.34689. The p-value is < .00001. The result is significant at $p < .05$.

Note: If you wish to calculate the effect size, this calculator will do the job.

Table 5: Student t-test analysis for two independent mean on C:N Ratio of soil data.

Treatment 1 (X)	Diff (X - M)	Sq. Diff (X - M)^2	Treatment 2 (X)	Diff (X - M)	Sq. Diff (X - M)^2
0.003341371	0.00	0.00	0.002068074	0.00	0.00
0.002535951	0.00	0.00	0.001798699	0.00	0.00
0.003083214	0.00	0.00	0.001811024	0.00	0.00
0.002620187	0.00	0.00	0.001740741	0.00	0.00
0.003269325	0.00	0.00	0.002113309	0.00	0.00
0.003073078	0.00	0.00	0.001820388	0.00	0.00
0.003174037	0.00	0.00	0.002344454	0.00	0.00
0.002910238	0.00	0.00	0.001792991	0.00	0.00
0.00261749	0.00	0.00	0.00179496	0.00	0.00
0.003031359	0.00	0.00	0.001865079	0.00	0.00
0.002986166	0.00	0.00	0.002191235	0.00	0.00
0.002976953	0.00	0.00	0.001789042	0.00	0.00
0.002897527	0.00	0.00	0.002222222	0.00	0.00
0.003037925	0.00	0.00	0.002171137	0.00	0.00
0.002817157	0.00	0.00	0.001821061	0.00	0.00
0.002802342	0.00	0.00	0.00218894	0.00	0.00
0.002845892	0.00	0.00	0.0018	0.00	0.00
0.002515152	0.00	0.00	0.001958798	0.00	0.00
0.003477644	0.00	0.00	0.002117647	0.00	0.00
0.003262411	0.00	0.00	0.002024922	0.00	0.00
0.002886905	0.00	0.00	0.001476348	0.00	0.00
	M: 0.00	SS: 0.00		M: 0.00	SS: 0.00

Analysis:

Significance Level:

- .01
- (selected) .05
- .10

One-tailed or two-tailed hypothesis?:

- One-tailed
- (selected) Two-tailed

Difference Scores Calculations

Treatment 1

N_1: 21
$df_1 = N - 1 = 21 - 1 = 20$
M_1: 0
SS_1: 0
$s^2_1 = SS_1/(N - 1) = 0/(21-1) = 0$

Treatment 2

N_2: 21
$df_2 = N - 1 = 21 - 1 = 20$
M_2: 0
SS_2: 0
$s^2_2 = SS_2/(N - 1) = 0/(21-1) = 0$

T-value Calculation

$s^2_p = ((df_1/(df_1 + df_2)) * s^2_1) + ((df_2/(df_2 + df_2)) * s^2_2) = ((20/40) * 0) + ((20/40) * 0) = 0$

$s^2_{M_1} = s^2_p/N_1 = 0/21 = 0$
$s^2_{M_2} = s^2_p/N_2 = 0/21 = 0$

$t = (M_1 - M_2)/\sqrt{(s^2_{M_1} + s^2_{M_2})} = 0/\sqrt{0} = 13.73$

The *t*-value is 13.72505. The *p*-value is < .00001. The result is significant at $p < .05$.

Note: If you wish to calculate the effect size, this calculator will do the job.

The ratio of carbon and nitrogen shows the degradation rate of organic matter which is the main source of carbon in soil. Soil organic carbon reservoir in tropical ecosystem is an important component of global terrestrial ecosystem**.**

CONCLUSION

In view of statistical Data analysis at α = 0.05 level of significance the calculated value of student's t- test were found 6.4489, 27.347 & 13.72505 for N content, OC % and C:N ration respectively which are at par from t-test table value (α = 0.05 and 20 d.f.) was 2.086 which concluded that the significance changes has been observed in soil quality due to the agroforestry model at karera block of Shivpuri district.

Based on data analysis result, it is cleared that agroforestry model having significant positive impact on the soil quality and hence, it is clearly indicating that, agroforestry model used as an improvement tools by applying different tree varieties over bund plantation around the cropland.

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REFERENCE

Aitkenhead, J.A., & McDowell, W.H. (2000). Soil C: N ratio as a predictor of annual riverine DOC flux at local and global scales. *Global Biogeochemical Cycles*, **14**(1): 127-138.

Deng, Y., Gao, L., & Wang, B. (2013). ppiPre: predicting protein-protein interactions by combining heterogeneous features. *BMC Systems Biology*, **7**(2), 1-10.

Gold, M.A., & Garrett, H.E. (2009). Agroforestry nomenclature, concepts, and practices. *North American Agroforestry: an Integrated Science and Practice*, 45-56.

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: An overview. *Agrofor. Syst.* **76**, 1–10.

Montagnini, F. (2005). (ed.) Environmental services of agroforestry. Food Products Press, Binghamton, NY. 2005.

Nair, P.K.R., Gordon, A.M., and Mosquera Losada, M.R. Agroforestry. p. 101–110. In S.E. Jorgensen and and B.D. Faith (ed.) Encyclopedia of ecology. Vol. **1**. Elsevier, Oxford, UK. 2008.

Newaj, R., Chaturvedi, O.P., Kumar, D., Chavan, S.B., Rajawat, B.S., & Yadav, D.K. (2020). Carbon Sequestration Potential of Agroforestry Systems for Rehabilitating Degraded Lands of India. *Agroforestry for Degraded Landscapes*, 319-348.

Newaj, R., Rizvi, R.H., Chaturvedi, O.P., Alam, B., Prasad, R., Kumar, D., & Handa, A.K. (2017). A country level assessment of area under agroforestry and its carbon sequestration potential. *Technical Bulletin*, **2**, 1-48.

Verchot, L.V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., ... & Palm, C. (2007). Climate change: linking adaptation and mitigation through agroforestry. *Mitigation and Adaptation Strategies for Global Change*, **12**(5), 901-918.

Yadava, A.K. (2010). Carbon sequestration: underexploited environmental benefits of Tarai agroforestry systems. *Indian Journal of Soil Conservation*, **38**(2), 125-131.

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