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Assessment of Impact of Agricultural Land-Use Types on Some Soil Physical and Chemical Properties in Abeokuta, Southwestern Nigeria

[1]Alabi, A. A., [1]Oladimeji, S. B., [2]Olaoye, A. M., [2]Ogungbe, A. S. and *[3]Coker J. O.

[1]Department of Physics, Federal University of Agriculture, Abeokuta, Nigeria
[2]Department of Physics, Lagos State University, Ojo Lagos, Nigeria
[3]Department of Physics, Olabisi Onabanjo University, Ago Iwoye, Ogun State, Nigeria

*Corresponding author's email: coker.joseph@oouagoiwoye.edu.ng

ABSTRACT
Agricultural land-use practices play a pivotal role in shaping the physical and chemical properties of soil, which in turn influence crop productivity, environmental sustainability, and overall ecosystem health. Understanding the impact of different agricultural land-use types on soil properties is crucial for sustainable land management and effective agricultural practices. This study utilized electrical resistivity technique (ERT) and geochemical methods to assess the impact of different land-uses (mineral farms, organic farms, thick plantations, and cattle stations) on soil physicochemical properties. The research aimed to explore the correlation between soil resistivity and fertility, as well as evaluate the influence of specific land-use types on soil characteristics. Four resistivity traverses were conducted, each corresponding to a different land-use type, and soil samples were collected from various depths. Laboratory analysis revealed high clay content in the cattle station, while all land-use types showed high sand content. Available phosphorus was significantly affected by both land-use and soil depth, negatively correlating with electrical conductivity. Exchangeable bases were generally low across all land-use types. The study recommends promoting site-specific, sustainable land management practices within different agricultural land-use systems.

Keywords:
Agricultural land-use,
Electrical resistivity,
Soil properties,
Correlation.

INTRODUCTION

Soil provides media for the growth of the plant (farming), acts as a storage for carbon, serves as means of maintaining atmospheric gases, a habitat for worms and other organisms, a filtration system for surface water, and most importantly, as a host for humans shelter (building construction). Soil is crucial for life because the food consumed by human beings largely depends on soil conditions. Land-use was described (Ajami *et al.*, 2006) as total preparations, activities, and effort contributed by individual people to produce, modify or sustain it. Disparities in soil quality could be traced to the kinds of the parent materials (Ibanga, 2006), topography, erosion, and land-use types. In Nigeria, unmaintainable of land quality has eroded land fertility and causes land degradation (Udoh *et al*., 2002). There is noticeable evidence of land degradation in most parts of Nigeria (Aruleba, 2004).

Alabi *et al.* (2019) investigated how the properties of soil have been affected by different land-use types. The study involved comparing the effect of abattoir wastewater, farming, and activity in automobile workshops on soil properties. The results show that bulk density, Organic matter as well as soil chemicals vary with land-use type. Tellen and Yerima (2018) assessed soils under the effect of six different land-use and submitted that some land-use affect some selected soil physicochemical properties of the soil more than others. The investigation submitted that clearing of forested land for the purpose of farming would affect soil properties adversely.

Kiflu and Beyene (2013) investigated how different land-use types have affected soil properties at two different depths in Sodo Zuria Woreda of Wolaita Zone Southern Ethiopia. The results submitted that land-use has tenacious, multiple-decade effects on the soil properties. It is therefore necessary to conduct research on land-use and landscape to regulate ecology and ensure land administration.

Soil attribute has been investigated extensively by several authors (Mambo and Archer, 2007; Senjobi, 2007; Senjobi and Ogunkunle, 2011; Ahukaemere *et al*.,

2012; Jingzhe *et al*., 2023) to monitor land degradation because of its importance to the land quality generally and also assist in examining land fertility development.
Owing to the increase in population, intensified use of land has affected soil quality negatively. However, the degree of soil degrades depends on comparative sensitivity of the soil to degradation (Anthony *et al.*, 2014). Therefore, study of the consequence of land-use types on soil physical, chemical, and biological parameters is necessary. The result of such a finding will enhance improvement and formulation of new strategies. The study will, therefore, serve as a means to enlighten agriculturists on how the various activities engaged will contribute to soil degradation and how some might even enrich the soil. This research is aimed to assess the influence of diverse agriculture practices on the chemical and physical parameters of soil. The specific objectives include; determining the correlation between the resistivity and fertility potential of the soil, and investigating how agricultural practices affect soil properties.

MATERIALS AND METHODS

Description of the study areas

The study was conducted in four sites of different land-use types, three of which are within the Federal University of Agriculture, Abeokuta (FUNAAB) campus; Organic Farm (OAPTIN), plantation Teak plantation (School Gate Area) and Mineral Farm (DUFARMS) (Fig.1); while the last site, Cattle Station, is located in Karra, Rounda, Lafenwa, Abeokuta, Ogun state (Fig.2).
Abeokuta is situated between latitudes 7°00′ N to 7°30′ N and longitudes 3°00′ E to 3°30′ E and is recognized for an average minimum and maximum annual temperature of 21°C and 30°C respectively, with high precipitation and low-pressure climatic conditions (Orimoloye *et al.*, 2019).

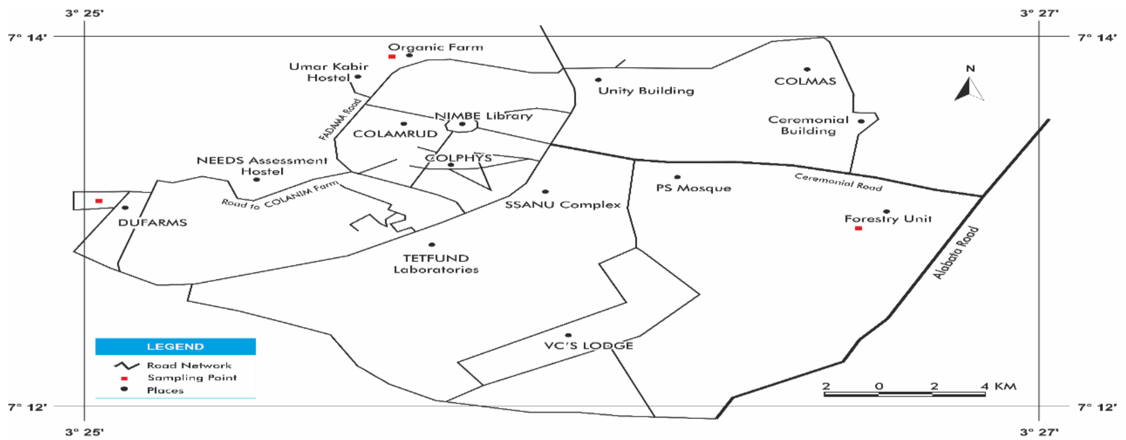

Figure 1: Sampling points in Federal University of Agriculture, Abeokuta [Organic Farm | OAPTIN], [Teak plantation | School Gate], Mineral Farm | DUFARMS*]*

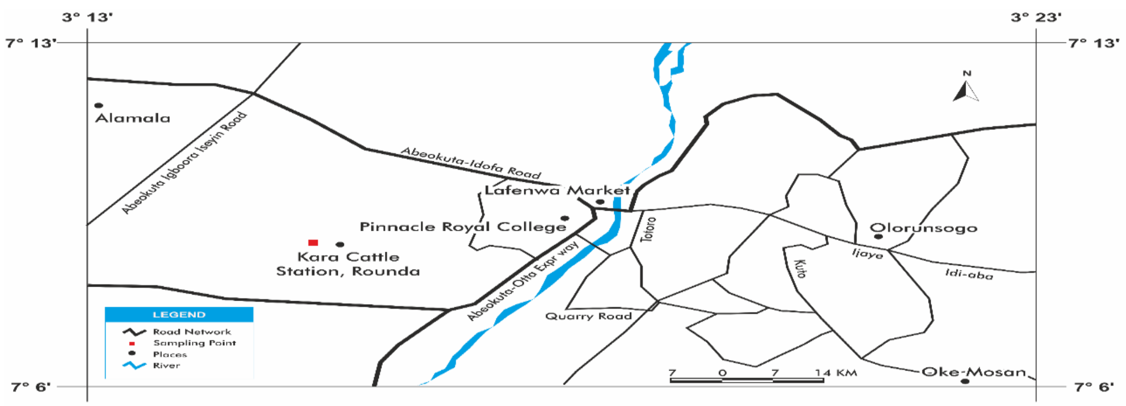

Figure 2: Sampling points in Karra, Rounda, Lafenwa, Abeokuta [Grazing land]

Fieldwork

Geophysical surveys were carried out at four stations with different land-use using MC Miller 400D resistivity meter, which provides a direct read-out of resistance with just the push of a button. Resistance measurement range from 0.01 Ohm o 10 mega-Ohms (auto-ranging). It employs narrow band-pass filters cantered at 82.2 Hz (Miller, 2018). Wenner configuration was adopted. The values of a used in the traverse sections include: $a_o = a_1 = 0.15$, $a_2 = 0.30$, $a_3 = 0.45$, $a_4 = 0.60$, $a_5 = 0.75$, $a_6 = 0.90$.

Direct current was passed into the ground via two current electrodes while two additional (potential) electrodes, usually in-between the current electrodes, were used to measure the corresponding variations in potential at each time current is passed (Fig. 3).

Applying Ohm's law, resistance values were calculated, from which the resistivity values were obtained. Getting this seemingly arduous work has been made easy by sophisticated equipment such as the MC Miller 400D with the aid of which resistivity values are revealed from the setup with just the push of a button (Dehghanpour and Yilmaz, 2020).

For the first reading 1, $|AM| = |MN| = |NB| = a = a_1$

where a_1 *= the least value of a; a is in metres*

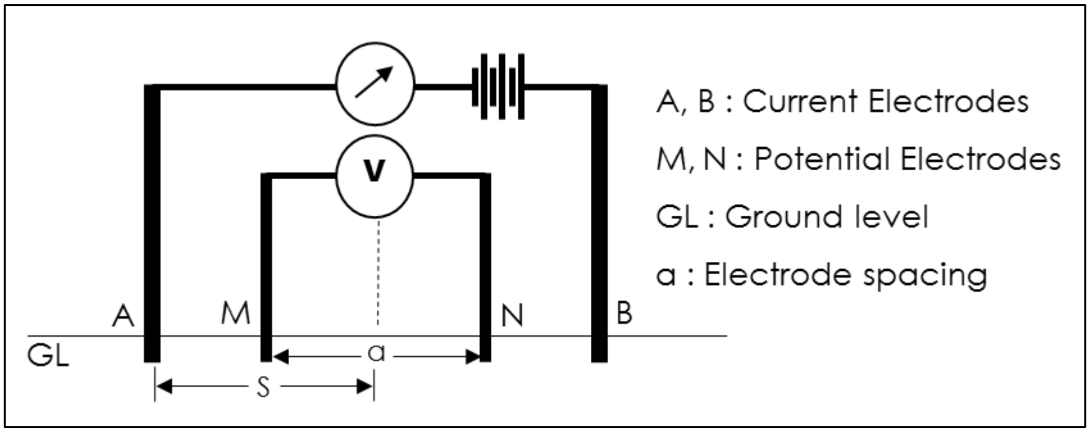

Figure 3: Electrical Resistivity Technique (Wenner array configuration)

Sampling

Sampling was done at the midpoint of the traverse, which was 300/2 cm at each site. A total of twelve soil samples were collected from four different selected land-use sites (Organic Farm, Teak plantation, Mineral Farm, and Cattle Station) at three different depths: (0 – 15), (15 – 30), (30 – 45) cm using a soil-auger. The obtained samples were labelled accordingly and prevented evaporation. The dried samples were crushed, homogenized, and air-dried for 72 hours before being filtered through a 2 mm sieve mesh.

Laboratory analysis

The use of soil quality indicators comprising two standard groupings; physical (particle size, bulk density, moisture content, and electrical conductivity) and chemical (pH, total nitrogen, available phosphorus, Carbon-Nitrogen ratio, Exchangeable acidity, Organic carbon, Organic matter, exchangeable bases, cation exchange capacity) parameters (Yerima and Van Ranst, 2005), the soil samples were analyzed at the soil science laboratory, College of Plant Science and Crop Production, FUNAAB, following standard procedures and methods.

The soil textural fractions were analyzed using the Bouyoucous Hydrometer method, bulk density was computed using the method described by Bouyoucous (1951), and the gravimetric method was employed to determine moisture content. The pH values were measured with a pH meter. The Kjeldahl distillation method (Pauwels et al. 1992) and Bray I method (Bray and Kurtz, 1945) were employed to determine soil total nitrogen (TN)) and available phosphorous.

Exchangeable bases (Ca2+, Mg2+, K+, and Na) were determined using the flame photometer. Magnesium (Mg2+) and calcium (Ca2+) were determined by complexometric titration. The ratio of carbon to nitrogen (C/N) was calculated using Equation 1.

$$\mathrm{C/N} = \frac{\mathrm{SOC}\ (\%)}{\mathrm{TN}\ (\%)} \qquad (1)$$

where SOC is the concentration ratio to the quantity of carbon present.

Standard procedure (Pauwels *et al*., 1992) was used to determine Electrical Conductivity.

Percentage organic matter (OM) was obtained using the Walkley Black method (Walkley, 1934) and was calculated by multiplying the values of organic carbon by a factor of 1.724 (Van Bemmelen factor) as organic carbon (OC) is considered to be 58% of organic matter (Equation 2).

$$\mathrm{OM}\ (\%) = \mathrm{OC} \times 1.724 \qquad (2)$$

Data analysis

The multivariate analysis of variance (ANOVA) was employed to assess the significant variances in the soil parameters. Separation of mean was done by REGWQ. The analysis process was repeated for every land-use types in twelve combined treatments. Pearson's correlation analysis was applied to investigate the relationships between the land-use type and many physical and chemical properties of the soil.

RESULTS AND DISCUSSION

Interpretation of ERT Results: 2D Inverse Model Resistivity Sections

The 2D inversion imaging results obtained with the aid of the windows software *RES2DINV* are illustrated in Figures 4 and 5. The lateral sections (0.0 m – 3.0 m) were plotted against depth (0.0 m – 0.518 m) in each traverse representation.

Fig 4 was the inversion model resistivity section obtained for the cattle station. The traverse displayed overall resistivity values ranging from 12.5 Ωm – 44.9 Ωm. The majority of the layers in this traverse had resistivity that was less than 30 Ωm; which revealed the contents of clay.

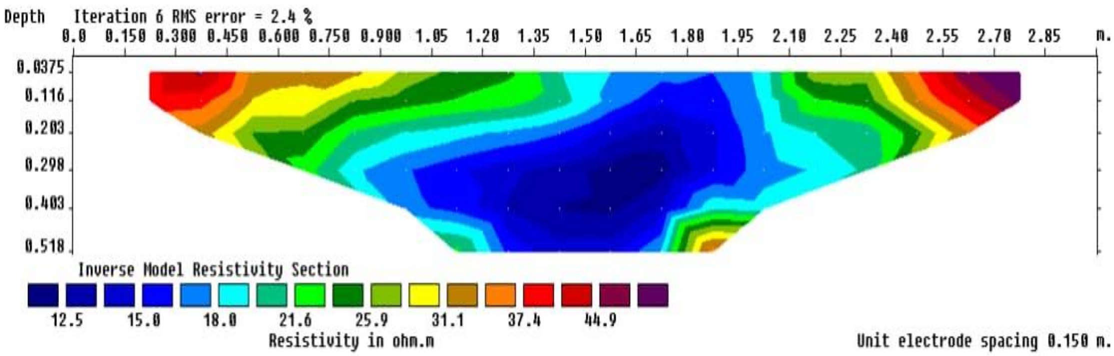

Figure 4: 2D inverse resistivity sections for Cattle Station, Karra, Rounda, Lafenwa, Abeokuta

The traverse sections for sites within the premises of the Federal University of Agriculture, Abeokuta are presented in figures 5 and 7. Traverse for the Teak plantation shown in figure 5 depicts that high resistivity values that falls within 673 Ωm – 1162 Ωm) across the traverse while it covered resistivity values between 172 Ωm and 1162 Ωm in general.

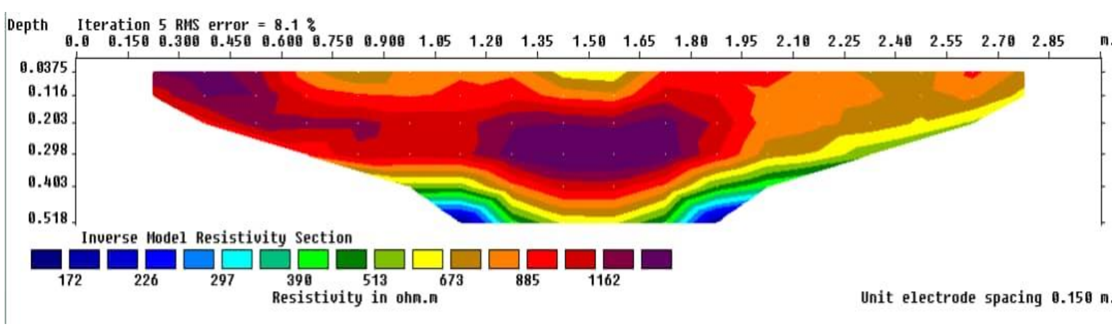

Figure 5: 2D inverse resistivity sections for teak plantation

The topmost soil of the mineral farm whose profile was illustrated in figure 6 composed of sand with resistivity value range of about 286 Ωm – 406 Ωm along the depth 0.0375 m – 0.116 m. Between the depths 0.116 m – 0.403 m, 0.203 m downwards and horizontal distances along 0.75 m – 1.60 m, 1.80 m – 2.55 m were high resistivity values ranging from 802 Ωm – 3124 Ωm

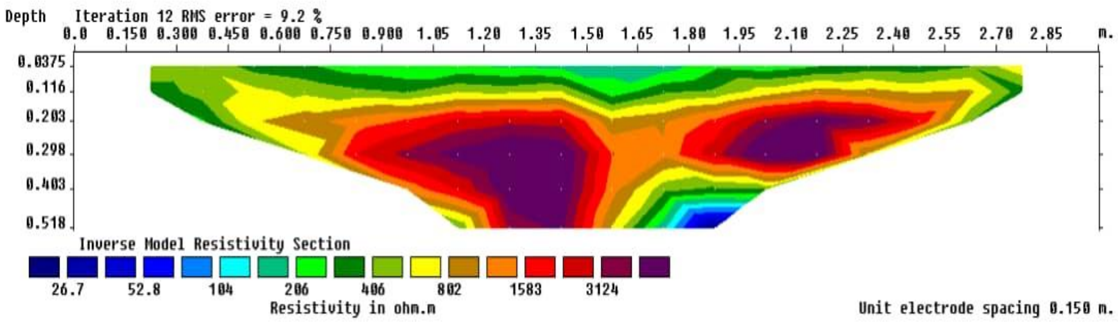

Figure 6: 2D inverse resistivity sections for mineral farm

Fig. 7 presents the inverse section curve for the organic farm where the mid region across the depth approximately 0.116 m – 0.403 m had high values resistivity (654 Ωm - 1574 Ωm). The top layer of this traverse is mostly composed of sand with observed resistivity values of 272 Ωm – 422 Ωm. Resistivity range of 72.9 Ωm - 422 Ωm was observed below the depth 0.483 m.

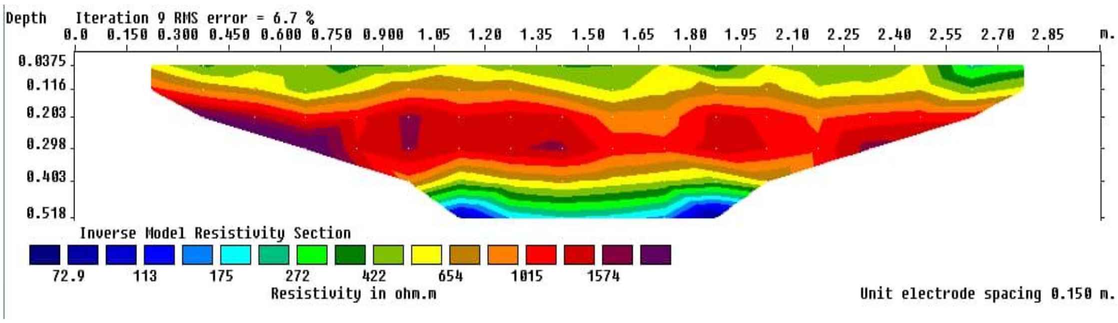

Figure 7: 2D inverse resistivity sections for Organic farm

Physical Properties of Soil Samples at Different Depths and Land-Use Types

The results of the analysis of the physical properties at different depths across the four land-use types located within the same geological settings are shown in Table 1.

Table 1: Physical properties of soils across the four land-use types

Land-Use Type	Depth (cm)	Sand (%)	Clay (%)	Silt (%)	BD (g/ml)	MC (%)	EC (mS/m)
	0 - 15	71.6	1.4	27.0	1.26	3.08	12.8
Mineral Farm	15 - 30	74.51	1.2	24.3	1.37	4.06	11.2
	30 - 45	72.6	1.2	26.2	1.31	4.50	12.4
	0 - 15	68.4	1.8	29.8	1.58	3.78	14.8
Organic Farm	15 - 30	69.1	3.6	27.3	1.51	4.68	14.9
	30 - 45	69.5	1.2	29.3	1.46	4.42	14.2
	0 - 15	69.6	1.8	28.6	1.18	5.47	15.8
Teak Plantation	15 - 30	68.4	1.2	30.4	1.26	5.11	16.6
	30 - 45	70.2	1.4	28.4	1.21	3.81	16.1
	0 - 15	73.4	25.7	0.9	1.60	8.77	22.5
Cattle Station	15 - 30	74.6	24.2	1.2	1.68	8.13	20.8
	30 - 45	72.1	26.8	1.1	1.64	10.34	21.7

Note: *BD = Bulk density; MC = Moisture Content; EC = Electrical Conductivity*

The particle size distribution was characterized with high sand contents was and there were no particular sequence in sand, clay and silt across all depths in all the four sites; they were distributed in irregular patterns. Although, the percentages of clay content in the Cattle Station, compared to other sites, is obviously high. The bulk density values decreased with depth in Organic Farm but did not follow a definite sequence across the other land-use sites. The moisture content decreased with depth in the teak plantation, while it had no definite classification in the distribution down the profile at the mineral farm, organic farm and cattle station. Although the moisture content of the Teak plantation was relatively higher than other land-use types because of the presence of coverage (leaves) that protected it from evaporation. This also explained why mineral farm has the least moisture content as it has no coverage. Electrical conductivity was distributed in irregular sequences across all depths in all the four land-use types but has higher values in the Cattle Station. Bulk density values of the Cattle station were the highest due to constant presence of cattle herds in the area to keep the soil particles compact.

The results of two-way ANOVA and the mean values are shown in Tables 2 and 3, respectively.

The contents of sand were not significantly ($p > 0.05$) affected by land-use but were affected significantly ($p < 0.05$) by soil depth; while the contents of clay and silt were not significantly ($p > 0.05$) affected by depth but were affected significantly ($p < 0.05$) by land-use (Table 2).

Bulk density was not significantly ($p > 0.05$) affected by soil depth but land-use had significant ($p < 0.05$) effect on it (Table 2), which is caused by the differences in the organic matter content of the sites (Olsen *et al.* (1954). The highest mean bulk density (1.640 g/ml) was observed at the Cattle Station, which may be enhanced by pressures being exacted during movement of cattle and people in their regular daily routine, which have direct impact on the soil compaction; the lowest value (1.217 g/ml) of bulk density was at the Teak plantation (Table 3). Moisture content and Electrical Conductivity were significantly ($p \leq 0.05$) affected by land-use but not by soil depth (Table 2).

Table 2: Two-way ANOVA result for the physical properties of soils in the selected land-use types

		MS	F	p-value	Sig
Sand	**Depth**	0.828	0.610	0.007	Yes
	Land-use	15.672	11.548	0.574	No
Clay	**Depth**	0.051	0.060	0.942	No
	Land-use	420.172	495.129	0.000	Yes
Silt	**Depth**	0.606	0.422	0.674	No
	Land-use	547.516	381.618	0.000	Yes
Bulk Density	**Depth**	0.03	1.523	0.292	No
	Land-use	0.110	50.462	0.000	Yes
Moisture Content	**Depth**	0.243	0.286	0.761	No
	Land-use	17.391	20.419	0.002	Yes
Electrical Conductivity	**Depth**	0.368	0.813	0.487	No
	Land-use	48.868	108.128	0.000	Yes

Note: *ANOVA = Analysis of variance; MS = Mean-square; F = F-Calculated value; p = Probability; sig = Significance.*

The sand has highest mean value (73.367%) and lowest mean value (69.00%) respectively at Cattle Station and at the Organic Farm. Silt fractions were highest (29.133%) and lowest (1.067%) respectively at the Teak plantation and Cattle Station. Meanwhile, the highest clay content (25.3%) was observed at the Cattle Station, whereas its lowest content (1.267%) was observed at the Mineral Farm (Table 3).

Table 3: Mean values of the physical properties of soils in the selected land-use types

Land-Use	Sand (%)	Clay (%)	Silt (%)	BD (g/ml)	MC (%)	EC (mS/m)
Mineral Farm	72.903	1.267	25.833	1.313	3.880	12.133
Organic Farm	69.000	2.200	28.800	1.517	4.293	14.633
Teak plantation	69.400	1.467	29.133	1.217	4.797	16.167
Cattle Station	73.367	25.300	1.067	1.640	9.080	21.667
SEM (±)	0.656	3.097	3.538	0.516	0.662	1.066

Note: *BD = Bulk density; MC = Moisture content; EC = Electrical conductivity; SEM = Standard error of the mean.*

Chemical Properties of Soil at Different Land-Use Types and Depths

The results of chemical analysis of soils across the four land-use types at some specified depths are shown in Tables 4.

The pH of Organic farm and Teak plantation remained constant across the profile; while pH of the Cattle station and Mineral farm varied in similar irregular pattern with depth. The organic carbon and organic matter contents reduced with depth in the Mineral and Organic farms; while they did not have a definite order down the profile in the Teak plantation and the Cattle station. The level of available phosphorus increased with depth across the four land-use types. Exchangeable acidity of Organic farm and Teak plantation remained constant at all considered depths; it reduced with depth in the Cattle station; while, in the Mineral farm, it followed an irregular pattern. The proportions of nitrogen, phosphorus and potassium were highest in the Mineral farm, followed the Organic farm because of the application of fertilizers and manure respectively on these sites (Table 4).

Table 4: Chemical properties of soils across the four land-use types

Land-Use Type	Depth (cm)	pH	TN (%)	AvP (mg/kg)	ExA (mEq/100g)	OC (%)	OM (%)	C/N
Mineral Farm	0 – 15	6.8	0.171	18.64	0.4	0.586	0.924	3.13
	15 – 30	6.6	0.177	18.96	0.2	0.554	0.955	3.13
	30 – 45	6.8	0.157	20.11	0.4	0.489	0.843	3.11
	Mean	6.73	0.17	19.24	0.33	0.54	0.91	
Organic Farm	0 – 15	6.6	0.179	16.53	0.2	0.548	0.945	3.06
	15 – 30	6.6	0.165	16.72	0.2	0.518	0.893	3.14
	30 – 45	6.6	0.157	18.16	0.2	0.492	0.848	3.13
	Mean	6.60	0.17	17.14	0.20	0.52	0.89	
Teak Plantation	0 – 15	6.8	0.16	18.15	0.4	0.492	0.848	3.08
	15 – 30	6.8	0.165	18.73	0.4	0.513	0.884	3.11
	30 – 45	6.8	0.151	20.08	0.4	0.475	0.819	3.15
	Mean	6.80	0.16	18.99	0.41	0.49	0.85	
Cattle Station	0 – 15	6.8	0.157	16.45	0.4	0.483	0.833	3.08
	15 – 30	6.6	0.168	16.93	0.2	0.521	0.898	3.1
	30 – 45	6.8	0.151	17.22	0.2	0.463	0.798	3.07
	Mean	6.73	0.16	16.87	0.27	0.49	0.84	

Note: *TN = Total nitrogen; AvP = Available phosphorus; ExA = Exchangeable acidity; OC = Organic carbon; OM = Organic matter; C/N = Carbon-Nitrogen ratio.*

The soil pH of the four land-use types are generally acidic (less than 7). The mean values informed that pH was lowest (6.6) at the Organic farm and was highest (6.8) in the Teak plantation (Table 4).

The exchangeable acidity was not affected by neither land-use nor soil depth significantly. The mean values of exchangeable acidity gave the highest value as 0.407, which was observed in the teak plantation (Table 4). The lowest mean value of organic carbon (0.489) was recorded at the Cattle station while the highest (0.543) was at the Mineral farm (Table 4). Organic carbon was characterized with low value in all the four sites, which may be caused by high humidity and temperature that boost mineralisation. Similarly, organic matter had highest value in the Mineral farm and lowest value at the Cattle station (Table 4).

Available phosphorus had values that ranged from 16.867 mg/Kg to 19.237 mg/Kg at the Cattle station and Mineral farm respectively (Table 4). It was significantly ($p < 0.05$) affected by both land-use and soil depth. Total nitrogen was not substantially affected by land-use and soil depth (Table 5).

Table 5: Two-way ANOVA result for some chemical properties of soils

		MS	F	p-value	Sig
Soil pH	**Depth**	0.130	3.000	0.125	No
	Land-use	0.210	4.750	0.050	Yes
Total Nitrogen	**Depth**	0.000	7.846	0.210	No
	Land-use	0.000082	2.509	0.156	No
Available Phosphorus	**Depth**	2.250	24.632	0.001	Yes
	Land-use	4.520	49.482	0.000	Yes
Exchangeable Acidity	**Depth**	0.010	1.800	0.242	No
	Land-use	0.022	4.000	0.070	No

Organic Carbon	**Depth**	0.003	5.935	0.038	Yes
	Land-use	0.002	3.786	0.078	No
Organic Matter	**Depth**	0.007	9.130	0.15	No
	Land-use	0.003	4.011	0.070	No

Table 6: Two-way ANOVA result for the exchangeable bases of soils

Include other metals		**MS**	**F**	**p-value**	**Sig**
Sodium	**Depth**	0.000013	0.194	0.828	No
	Land-use	0.001	17.794	0.002	Yes
Potassium	**Depth**	0.000	2.612	0.153	No
	Land-use	0.002	34.644	0.000	Yes
Calcium	**Depth**	0.000022	0.276	0.768	No
	Land-use	0.000	5.733	0.034	Yes
Magnesium	**Depth**	0.000014	0.616	0.571	No
	Land-use	0.001	57.118	0.000	Yes

Calcium was significantly ($p < 0.05$) affected by land-use but was not significantly ($p > 0.05$) affected by soil depth (Table 6). The highest mean calcium content (0.286) was observed at the Cattle station; while the lowest (0.256) was found at the Mineral farm (Table 7).
The exchangeable bases (Na, K, Ca and Mg) were low in all land-use types. Calcium and Sodium followed no specific pattern across the profile in all the four land-use types. Potassium and Magnesium did not follow a particular pattern across the profile in all the four land-use types, except in Organic farm and Cattle station respectively, where they reduced with depth (Table 7).
Magnesium was significantly ($p \leq 0.05$) affected by soil depth but was significantly ($p > 0.05$) affected by land-use. The mean values of magnesium ranged from 0.318% to 0.3667% recorded in Mineral farm and Cattle station respectively (Table 7).

Table 7: Chemical Analysis of soils

Land Use Type	**Depth (cm)**	**Na (cmol/kg)**	**K (cmol/kg)**	**Ca (cmol/kg)**	**Mg (cmol/kg)**	**Zn (mg/kg)**	**Cu (mg/kg)**	**Mn (mg/kg)**	**Fe (mg/kg)**
Mineral Farm	0 - 15	0.296	0.596	0.248	0.312	11.986	1.345	4.388	1.102
	15 - 30	0.311	0.58	0.256	0.324	12.081	1.164	3.981	1.098
	30 - 45	0.304	0.584	0.264	0.318	12.162	1.187	4.106	1.006
	Mean	0.3037	0.5867	0.256	0.318				
Organic Farm	0 - 15	0.335	0.621	0.263	0.338	11.236	1.382	4.732	0.991
	15 - 30	0.324	0.618	0.271	0.334	10.849	1.551	4.916	0.986
	30 - 45	0.328	0.602	0.278	0.338	10.914	1.416	4.791	0.981
	Mean	0.329	0.6137	0.2707	0.3367				
Teak Plantatio	0 - 15	0.321	0.563	0.284	0.348	10.016	1.034	3.845	1.121
	15 - 30	0.341	0.571	0.276	0.357	10.112	1.009	3.901	1.116
	30 - 45	0.331	0.556	0.268	0.351	9.867	1.018	3.926	1.11
	Mean	0.331	0.5633	0.276	0.352				
Cattle Station	0 - 15	0.358	0.618	0.294	0.371	9.891	1.289	4.922	0.941
	15 - 30	0.348	0.605	0.276	0.367	9.622	1.031	4.881	0.973
	30 - 45	0.351	0.611	0.288	0.362	9.456	1.211	4.839	0.962
	Mean	0.3523	0.6113	0.286	0.3667				

Sodium was affected significantly ($p < 0.05$) by land-use but not significantly vary with depths (Table 6). Sodium content have highest value (0.3523) at the Cattle station (Table 7).
Potassium was significantly ($p < 0.05$) affected by land-use but was not significantly varied with depth.
The overall exchangeable obtained in all the four land-use types were relatively low compared with the levels of exchangeable bases (Landon *et al.*, 1991; Ermias *et al.*, 2017). The enfeeblement of exchangeable bases could due to diminishing of nutrients that may leads to low fertility potential.

Pearson's Correlation Matrix for the Various Physical and Chemical Properties of Soil

The clay and sand were significantly ($p \leq 0.05$, $p \leq 0.01$) negatively correlated with silt, having correlation coefficient r = – 0.989, and r = – 0.674 respectively

(Table 8). The bulk density was significantly ($p \leq 0.01$) positively correlated with clay while having $r = 0.75$ and was significantly ($p \leq 0.05$) negatively correlated with silt content with $r = -0.723$. While moisture content was significantly ($p \leq 0.05$) negatively correlated with silt ($r = -0.92$), and significantly ($p \leq 0.01$) positively correlated with clay ($r = -0.946$); sodium and potassium were significantly ($p \leq 0.05$, $p \leq 0.01$) correlated with negatively correlated with phosphorus. Available phosphorus was observed to be significantly ($p \leq 0.01$) negatively correlated with electrical conductivity; the plot of electrical conductivity against Available phosphorus (Fig. 8) more supports that an increase in available phosphorus will aid soil resistivity.

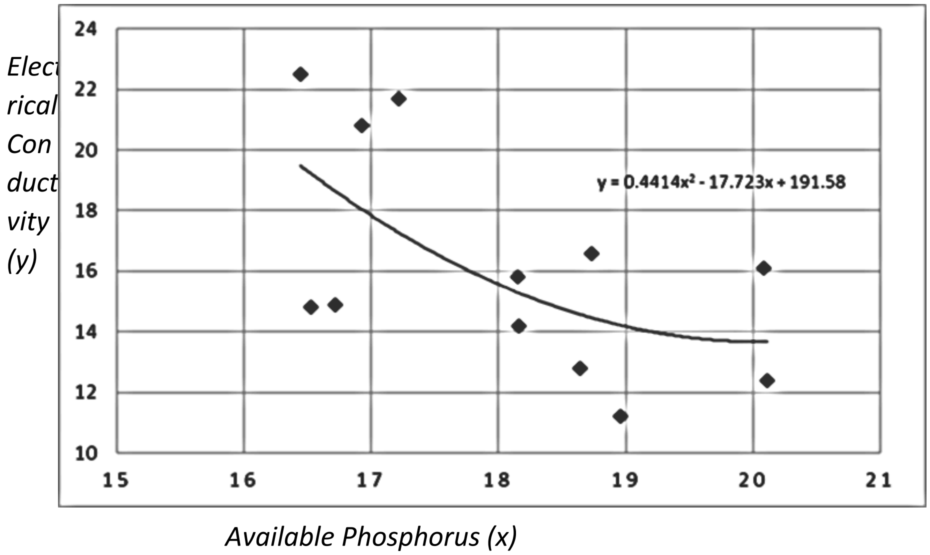

Figure 8: Relationship between Electrical Conductivity and Available Phosphorus

Table 10: Pearson's correlation and p-value matrix for the various physical and chemical properties of soil

		Sand	Clay	Silt	BD	MC	EC	pH	TN	AvP	Ex.A	OC	OM	Na	K	Ca	Mg
Sand	Pearson Correlation	1	0.556	-.674*	0.321	0.429	0.226	-0.021	0.028	0.025	-0.092	0.050	0.033	0.027	0.103	-0.020	0.075
	p-value		0.060	0.016	0.310	0.164	0.480	0.948	0.930	0.937	0.775	0.877	0.918	0.933	0.749	0.951	0.816
Clay	Pearson Correlation	0.556	1	-.989**	.750**	.946**	.907**	0.095	-0.301	-.584*	-0.205	-0.378	-0.381	.744**	0.500	.643*	.729**
	p-value	0.060		0.000	0.005	0.000	0.000	0.768	0.342	0.046	0.522	0.226	0.222	0.006	0.098	0.024	0.007
Silt	Pearson Correlation	-.674*	-.989**	1	-.723**	-.920**	-.845**	-0.084	0.266	0.510	0.202	0.329	0.336	-.663*	-0.461	-0.566	-.658*
	p-value	0.016	0.000		0.008	0.000	0.001	0.794	0.404	0.090	0.528	0.296	0.285	0.019	0.131	0.055	0.020
BD	Pearson Correlation	0.321	0.750**	-.723**	1	.652*	.604*	-0.486	0.092	-.800**	-.692*	-0.100	0.017	.640*	.865**	0.385	0.454
	p-value	0.310	0.005	0.008		0.021	0.038	0.109	0.777	0.002	0.013	0.758	0.957	0.025	0.000	0.216	0.138
MC	Pearson Correlation	0.429	.946**	-.920**	.652*	1	.905**	0.192	-0.431	-0.522	-0.177	-0.553	-0.524	.768**	0.377	.786**	.775**
	p-value	0.164	0.000	0.000	0.021		0.000	0.550	0.162	0.082	0.581	0.062	0.081	0.004	0.227	0.002	0.003
EC	Pearson Correlation	0.226	.907**	-.845**	.604*	.905**	1	0.232	-0.436	-.577*	-0.033	-0.535	-0.525	.899**	0.348	.807**	.918**
	p-value	0.480	0.000	0.001	0.038	0.000		0.468	0.157	0.049	0.919	0.073	0.080	0.000	0.268	0.001	0.000
pH	Pearson Correlation	-0.021	0.095	-0.084	-0.486	0.192	0.232	1	-0.572	0.405	.845**	-0.374	-.592*	-0.009	-0.448	0.223	0.144
	p-value	0.948	0.768	0.794	0.109	0.550	0.468		0.052	0.192	0.001	0.231	0.043	0.977	0.144	0.485	0.656
TN	Pearson Correlation	0.028	-0.301	0.266	0.092	-0.431	-0.436	-0.572	1	-0.239	-0.337	.896**	.985**	-0.304	0.226	-.613*	-0.401
	p-value	0.930	0.342	0.404	0.777	0.162	0.157	0.052		0.454	0.285	0.000	0.000	0.337	0.479	0.034	0.196
AvP	Pearson Correlation	0.025	-.584*	0.510	-.800**	-0.522	-.577*	0.405	-0.239	1	0.511	-0.057	-0.142	-.603*	-.822**	-0.456	-0.469
	p-value	0.937	0.046	0.090	0.002	0.082	0.049	0.192	0.454		0.089	0.860	0.660	0.038	0.001	0.137	0.124
Ex.A	Pearson Correlation	-0.092	-0.205	0.202	-.692*	-0.177	-0.033	.845**	-0.337	0.511	1	-0.139	-0.321	-0.210	-0.575	0.013	-0.027
	p-value	0.775	0.522	0.528	0.013	0.581	0.919	0.001	0.285	0.089		0.667	0.309	0.512	0.050	0.968	0.933
OC	Pearson Correlation	0.050	-0.378	0.329	-0.100	-0.553	-0.535	-0.374	.896**	-0.057	-0.139	1	.926**	-0.533	0.146	-.786**	-.590*
	p-value	0.877	0.226	0.296	0.758	0.062	0.073	0.231	0.000	0.860	0.667		0.000	0.075	0.651	0.002	0.043
OM	Pearson Correlation	0.033	-0.381	0.336	0.017	-0.524	-0.525	-.592*	.985**	-0.142	-0.321	.926**	1	-0.394	0.168	-.697*	-0.483
	p-value	0.918	0.222	0.285	0.957	0.081	0.080	0.043	0.000	0.660	0.309	0.000		0.205	0.602	0.012	0.112
Na	Pearson Correlation	0.027	.744**	-.663*	.640*	.768**	.899**	-0.009	-0.304	-.603*	-0.210	-0.533	-0.394	1	0.348	.801**	.950**
	p-value	0.933	0.006	0.019	0.025	0.004	0.000	0.977	0.337	0.038	0.512	0.075	0.205		0.268	0.002	0.000
K	Pearson Correlation	0.103	0.500	-0.461	.865**	0.377	0.348	-0.448	0.226	-.822**	-0.575	0.146	0.168	0.348	1	0.173	0.113
	p-value	0.749	0.098	0.131	0.000	0.227	0.268	0.144	0.479	0.001	0.050	0.651	0.602	0.268		0.591	0.725
Ca	Pearson Correlation	-0.020	.643*	-0.566	0.385	.786**	.807**	0.223	-.613*	-0.456	0.013	-.786**	-.697*	.801**	0.173	1	.841**
	p-value	0.951	0.024	0.055	0.216	0.002	0.001	0.485	0.034	0.137	0.968	0.002	0.012	0.002	0.591		0.001
Mg	Pearson Correlation	0.075	.729**	-.658*	0.454	.775**	.918**	0.144	-0.401	-0.469	-0.027	-.590*	-0.483	.950**	0.113	.841**	1
	p-value	0.816	0.007	0.020	0.138	0.003	0.000	0.656	0.196	0.124	0.933	0.043	0.112	0.000	0.725	0.001	

Notes; *BD = bulk density; MC = moisture content; CEC = cation exchange capacity; OC = organic carbon; OM = organic matter; AvP = available phosphorus; EA = exchangeable acidity; TN = total nitrogen. **Correlation is significant at the 0.01 level (two tailed); *correlation is significant at the 0.05 level (two tailed). Others are not significant at the 0.01 and 0.05 levels (two tailed).*

CONCLUSION

In conclusion, this study employed combination of electrical resistivity technique (ERT) and geochemical methods to assess the impact of diverse agricultural land-use types on the physicochemical properties of soil. The traverse conducted in the cattle station distinctly revealed elevated clay content compared to other sites, indicating the heterogeneous nature of soil composition under different land-uses. The statistical analysis of geochemical results consistently demonstrated high sand content across all four land-use types. Furthermore, soil nutrient levels exhibited variation according to land-use, influencing crucial factors such as pH, available phosphorus, sodium, calcium, and potassium at different soil depths. Interestingly, total nitrogen remained unaffected by both land-use and soil depth. Notably, the depth-wise analysis indicated an increase in available phosphorus levels across all land-use types. Organic carbon and organic matter, however, exhibited a reduction with increasing depth specifically in mineral and organic farms. This underscores the importance of considering both horizontal and vertical dimensions when evaluating soil characteristics under different land-uses. The observed higher electrical conductivity in the cattle station suggests a potential correlation with the substantial concentration of ions in deposited cattle dung. This finding highlights the need for a nuanced understanding of the intricate interactions between land-use practices and soil properties. In light of these findings, it is evident that land-use exerts a significant influence on soil composition and nutrient dynamics. The outcomes of this study contribute valuable insights for informing sustainable land management practices tailored to specific agricultural contexts. Moving forward, a continued emphasis on site-specific strategies is crucial to optimize soil health and promote the long-term productivity and resilience of agricultural lands.

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