

ANALYSIS OF THE INFLUENCE OF LAND USE ON SOME SOIL PHYSICOCHEMICAL PROPERTIES IN GIREI, ADAMAWA STATE, NIGERIA

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ABSTRACT

Improper land use and poor soil management practices have become a challenge to an attempt to attain increase in crop production to meet the growing demand for food. Some selected physicochemical properties of soil samples collected from three farm plots in Girei area, was studied. The soil characterization was carried out for properties like the textural class, bulk density, pH, organic matter, water holding capacity, and the cation exchange capacity. The research was conducted on 27 samples obtained from three village locations namely; Bagalchi, Sabongari and Vonoklang designated as plots I, II and III, respectively. The values obtained were subjected to statistical analysis by using Analysis of Variance (ANOVA). The texture of the soils is sandy-loam with mean soil bulk density value of 1.62g/cm³, the mean soil pH values ranged between 5.82 to 6.21 which indicated that the soils are slightly acidic. Soil organic matter was low at values between 1.82% to 1.95% with low cation exchange capacities in the range of 2.55 to 2.70 cmol/kg and water holding capacity between 37.59 to 39.63%. Statistically, it was observed that physicochemical properties of the soils showed no significant difference between the treatments and replications in the study area. This could be as a result of the agricultural land use and management practices carried out in the area. Therefore, there is the need to improve soil organic matter content in the area to improve moisture holding capacity, and cation exchange capacity of the soil in order to retain nutrients for crop growth and increase the crop yields in the study area.

Keywords: Land use, Soil, physicochemical, properties, Girei

1 INTRODUCTION

Land is defined based on the number of natural characteristics, which includes climate, soil topography, hydrology and geology. Land may also be define as any portion of the earth's surface which is capable of ownership as property, including anything natural or human made which is annexed to it. Land is immobile, finite and essential to human exercise [1]. Land use and management practices influences both chemical and physical properties of soils, however, agricultural land conversion is of considerable concern worldwide as it leads to soil degradation and alteration of soil nutrient cycles [2]. Agriculture has enormous consequences on soils, thus the agriculture legacy could be detectable even long after cessation [3, 4]. Soil and water are main elements of agriculture and natural resources and also mentioned as basic economic factors of every country. So, effort to save these sources not only protect the environment but also, ensure economic, cultural, social and political independence that are considered as sustainable development. The increasing rate of population and human being need for food leads farmers among different countries to utilize poor and marginal lands such as pastures and woods located in high potential of erosion and low production [5]. Land use-induced changes in nutrient availability may influence secondary succession and biomass production and reduce Soil Organic Carbon (SOC) which plays a crucial role in sustaining soil quality, crop production and environmental quality [6]. Such changes directly affect soil physical and chemical properties, such as soil water retention and availability, nutrient cycling, gas flux, plant root growth and soil conservation [7] Soil is a dynamic natural body developed as a result of pedogenic processes through weathering of rocks, consisting of mineral

and organic constituents, possessing definite chemical, physical, mineralogical and biological properties, having a variable depth over the surface of the earth, and providing a medium for plant growth. All soils contain mineral particles, organic matter, water and air which determine the soil properties. Soil properties are very important land characteristics particularly when they are put into agronomic uses. The physical properties of soil are important since they determine the manner in which it can be used either for agricultural or non-agricultural purposes. The chemical properties of soils largely depend on the soil collides. It is, therefore, important to know about the soil colloids and their nature to have an insight into their influence on agricultural land use [8]. Many agricultural practices increase the soil's vulnerability to degradation processes, such as erosion, acidification, salinization and soil structural decline. There has been increasing awareness of the impact of various agricultural practices on soil quality, and this has led to growing interest in the measurement of effects of such practices to help assist management of constraints and ensure sustainability of the practices. Soil degradation is a severe issue, and predominant degradative processes accelerate soil erosion, depletion of soil organic matter and plant nutrients, decline of soil structure, and salinization. Most of these degradative processes are more severe in marginal rather than prime agricultural lands, and in resource-based and subsistence agriculture rather than science-based or commercial farming. There is need of judicious and scientific management of soil resources. Degraded soils and ecosystems must be ameliorated, and the depleted organic carbon pool restored and can meet the current and future food demand [9]. The influence of land use on soil properties, which is the physical and chemical properties of soil increase the soils vulnerability to degradation processes such as erosion, soil structure decline, salinization and acidification in the area. Thus, there is the need to evaluate the extent to which these problems affect the agricultural soils to ascertain their effects on the soil properties in the study area. Thus the aim of this study is to analyze the influence of land use on the physical and chemical properties of soil from farms around Girei area and compare the mean values of the results to ascertain the level of impact land use causes.

2 LITERATURE REVIEW

2.1 Land Use

Land use is a means of broadly classifying different types of activities relating to how land is used. Land is a valuable natural resource utilized for cultivation of crops, settlements of population, creation of Dams and reservoirs, development of industries and maintaining forests, and Wildlife. Any kind of permanent (or) cyclic intervention of land is called land use. Land use changes are regarded as important components and a primary cause of global environmental changes. These changes are driven by the interaction in space and time between biophysical and human dimensions. The rate of degradation depends on land use systems, soil types, topography, and climatic conditions. Several works showed that inappropriate land use aggravates the degradation of soil physico-chemical and biological properties. Changes in land use and management practices often modify most soil morphological, physical, chemical and biological properties to the extent reflected in agricultural productivity [10]. Land-use activities such as agriculture, mining, and settlement generate economic benefits for the sustenance of man. However, changes in land use, reflecting in changes in land cover have inevitably a detrimental effect on the productivity of the soil. The extent to which this occurs depends on the land-use type and management practices, soil characteristics, and the intensity of the land-use activity. In many parts of the world, particularly in the tropics, soil productivity (quality) is threatened by environmental degradation associated with increasing land-use and land-cover change [11]. The conversion of native forest and native range land into cultivated land is known to deteriorate soil properties. Increment in bulk density, organic matter deterioration and reduction in cation exchange capacity (CEC), which in turn reduce the fertility status of the given soils, are main impacts of land use. In addition, change in land use, long term cultivation, deforestation, overgrazing and mineral fertilization can cause significant variations in soil production of output [10]. Land use systems significantly affected the clay, silt and the sand fractions. Sand and silt decreased with the soil depth, whereas clay increased with it. Soil pH, total N, organic carbon, available P, exchangeable Ca, exchangeable Al, sum of bases, effective cation exchange capacity (ECEC) and Al saturation significantly differed with the land use systems. Al saturation increased with soil depth, and the top soils presented acidity problems while the sub soils exhibited Al toxicity [12].

2.2 *Soil*

Soil is one of the important and valuable resources of the nature. It is composed of particles of broken rock that have been altered by chemical and mechanical processes that include weathering and erosion. All living things are directly and indirectly dependent on soil for day to day needs and 95 % of the human food is derived from the earth. Soil has complex function which is beneficial to human and other living organism. It acts as a filter, buffer storage, transformation system and thus protects the global ecosystem against the adverse effects of environmental pollutants [13]. Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment. Soil is characterized by physical and chemical properties which include soil structure, bulk density, water holding capacity, and permeability while the chemical properties includes; soil pH, soil organic matter, sodicity, and cation exchange capacity[14].

2.3 *Soil Physical Properties.*

2.3.1 *Bulk density*

The bulk density of a soil sample of known volume is the mass (or weight) of that sample divided by the bulk volume. The "ideal" soil would hold sufficient air and water to meet the needs of plants with enough pore space for easy root penetration, while the mineral soil particles would provide physical support and plant essential nutrients. Bulk density is influenced by the amount of organic matter in soils, their texture, constituent minerals and porosity. Knowledge of soil bulk density is essential for soil management, and information about it is important in soil compaction as well as in the planning of modern farming techniques. The bulk density of the soil is the weight of a given volume of oven dried soil divided by the volume, and reflects the amount of pore space in the soil. It is an indicator of soil health [15].

2.3.2 *Water holding capacity*

Soil water holding capacity is the amount of water that a given soil can hold against the force of gravity. Soil texture and organic matter are the key components that determine soil water holding capacity. Soils with smaller particle sizes, such as silt and clay have larger surface area can hold more water compared to sand which has large particle sizes which results in smaller surface area. A 1% increase in soil humus will result in a 4% increase in stored soil water and 1 part humus holds 4 parts of water. Therefore, the more humus that can be added to the soil, the greater the water holding capacity of the soil. As the level of organic matter increases in a soil, the water holding capacity also increases due to the affinity of organic matter for water. The water holding capacity of the soil is determined by the amount of water held in the soil sample vs. the dry weight of the sample [16].

2.4 *Chemical Properties of Soil*

2.4.1 *Soil pH*

The soil solution can be neutral, acid, or alkaline. This is called the soil pH. The pH measures the concentration of positively charged hydrogen ions (H^+) in the soil solution on a logarithmic scale ranging from 0 to 14. When a soil solution contains more H^+ ions, it is acidic. When there are fewer H^+ ions [i.e., more hydroxyl (OH^-) ions], the soil solution is alkaline. The level of acidity or alkalinity in a soil affects the availability of soil nutrients and the activity of soil micro-organisms and can affect the level of exchangeable aluminum [17]. Soil pH is an important indicator of soil health. It affects crop yields, crop suitability, plant nutrient availability, and soil micro-organism activity, influencing key soil processes. Soil pH can be managed by practices such as applying the proper amount of nitrogen fertilizer, liming, and using cropping systems that increase soil organic matter content and improve overall soil health. Inherent factors that affect soil pH include climate, mineral content, and soil texture. Natural soil pH reflects the combined effects of the soil-forming factors (parent material, time, relief or topography, climate, and organisms). The pH of newly formed soils is determined by the minerals in the parent material. Temperature and rainfall affect the intensity of

leaching and the weathering of soil minerals. In warm, humid environments, soil pH decreases over time through acidification due to leaching from high amounts of rainfall. In dry environments where weathering and leaching are less intense, soil pH may be neutral or alkaline. Soils that have a high content of clay and organic matter are more resistant to changes in pH (higher buffering capacity) than are sandy soils. Although clay content cannot be altered, organic matter content can be altered by management practices. Sandy soils commonly have a low content of organic matter, resulting in a low buffering capacity and a high rate of water percolation and infiltration. Thus, they are susceptible to acidification [18].

2.4.2 Soil organic matter

Soil organic matter is any material produced originally by living organisms (plant or animal) that is returned to the soil and goes through decomposition process. At any given time, it consists of a range of materials from the intact original tissues of plants and animals to the substantially decomposed mixture of materials known as humus. Most soil organic matter originates from plant tissue. Plant residues contain 60–90 percent moisture. The remaining dry matter consists of carbon (C), oxygen, hydrogen (H) and small amounts of Sulphur (S), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Although present in small amounts, these nutrients are very important [19].

2.4.3 Cations exchange capacity

A cation is a positively charged ion. Most nutrients are cations; Ca^{2+} , Mg^{2+} , K^+ , NH_4^+ , Zn^{2+} , Cu^{2+} and Mn^{2+} . These cations are in the soil solution and are in dynamic equilibrium with the cations adsorbed on the surface of clay and organic matter. CEC is a measure of the quality of cations that can be adsorbed and held by a soil. CEC is dependent upon the amount of organic matter and clay in soils and on the types of clay. In general, the higher organic matter (OM) and clay content, the higher the CEC. There are numerous methods available for measuring the CEC of soil. As with many other physical and chemical parameters, the CEC values is the result of a particular state of equilibrium between the test sample and a given environment, consisting of the reagent and the experiment of the condition chosen [20]. According to [21], one of the method used is wavelength of 304.4nm where the extracts was diluted in water with a ratio of 1/10 for a signal integration time of 12s, in a repeatability condition.

2.5 Influence of Land Use

2.5.1 Influence of land use on soil degradation

Improper land use is being observed as a result of the challenges to increase food production to meet the food demand of increased population potentially resulting in land degradation. Land degradation in turn has severe negative impact on agronomic productivity of crops, environmental quality and on food security and overall livelihood of human beings. Traditional farming practices such as slash and burn, removal/burning of crop residues, overgrazing, and continuous cultivation without fallowing and excessive plowing tremendously aggravated soil degradation resulting in decline in soil fertility and organic matter and soil acidification. National crop yield averages in tropical Africa rarely show an upward trend despite availability of improved cultivars and agrochemical inputs mainly because of such severe soil-related constraints. Increased human population exerted high pressure on existing cropland as well as grazing land resources further demanding encroachment of forest areas for food production. The expansions of agricultural land in the tropical for instance have been responsible for at least 50% of deforestation since 1970s. From 1970 to 1999, lands under arable and permanent crops increased by 1.9 million hectares (Mha) while the areas under forests decreased by 3.1 (Mha) over the same time [22]. The major reason behind opting for horizontal expansion as a means to increase food production has been the inability of farmers to adopt improved farming practices for intensification of agricultural production. As a result, soil degradation remained a serious problem in most developing countries due to the mining of soil fertility and a serious problem of soil erosion following the periodic change in land use. Degradation is a collective term that describes the loss of productivity which results from soil erosion, increases in soil salinity, loss of soil structure, and so on [23].

2.5.2 *Influence of and use on acidification*

Soil acidity is one form of chemical degradation of soils. The problems of acid soils is high acidity and low amount of exchangeable cations especially calcium and it is considered to be one of the most important factors that affect the soil chemical fertility. Soil acidity affects productivity of the soil through its effect on nutrient availability and toxicity by some elements like aluminum and manganese. The four major causes for soils to become acid are rainfall and leaching, acidic parent material, organic matter decay and harvest of high yielding crops and crop residues [24].

2.5.3 *Influence of land use on salinization*

Salinity is one of the most widespread soil degradation processes in both agricultural and native soils. Saline soils are environments characterized by high concentrations of salts and by an uneven temporal and spatial water distribution. These excess salts change the availability of water and nutrients for both plants and microorganisms. A basic distinction must be made between primary and secondary salinization processes. Primary salinization involves salt accumulation through natural processes due to a high salt content of the parent material or in groundwater. Secondary salinization is caused by human interventions such as inappropriate irrigation practices, e.g. with salt-rich irrigation water and/or insufficient drainage [25].

3 MATERIALS AND METHODS

3.1 *Study Area*

The study area is Girei local government area of Adamawa State. Girei is located between latitude $9^{\circ} 11''$ and $9^{\circ} 33''$ N and longitude $12^{\circ} 12''$ and $12^{\circ} 49''$ E. The climate is broadly divided into dry and rainy season. Rainy season commence in May and reaching its peak in August and stop in November. The area has an average rainfall of 972mm. Temperature in the area varies with season, which ranges from 27 to 40°C . The coldest month being December and January with mean average temperature of 15°C , while the hottest period in the area are April and May with an average temperature of 34°C . The relative humidity of the area ranges from 15% in February to 68% in August with an average annual relative humidity of 40.9% [26]. Figure 1 shows map of the study area.

3.2 *Experimental Design*

Three villages, Bagalchi, Sabongari and Vonoklang were identified for the study. In each village, a groundnut farm size of 93m by 96m was identified. The farm was divided into three plots of 31m x 32m designated as Plot I, II and III, respectively. Three soil samples A, B and C, designated as treatments were taken at incremental depths of 100 mm to a depth of 300 mm from each plot. This was replicated three times in a complete randomized design. A total of twenty seven (27) soil samples were collected from the three villages and used for the study.

3.3 *Soil Sample Collection*

Soil samples were taken at incremental depth of 100 mm down to 300 mm below the soil surface. Three replications were taken during each sampling. Soil sampling Auger was used to collect the samples at different locations in each plot. Sampling was randomized using Complete Randomized Design. Polythene bags were used to collect the soil sample from the field to the laboratory for analysis. The total number of samples collected from each farm in each village was nine, making a total number of twenty seven soil samples for the study.

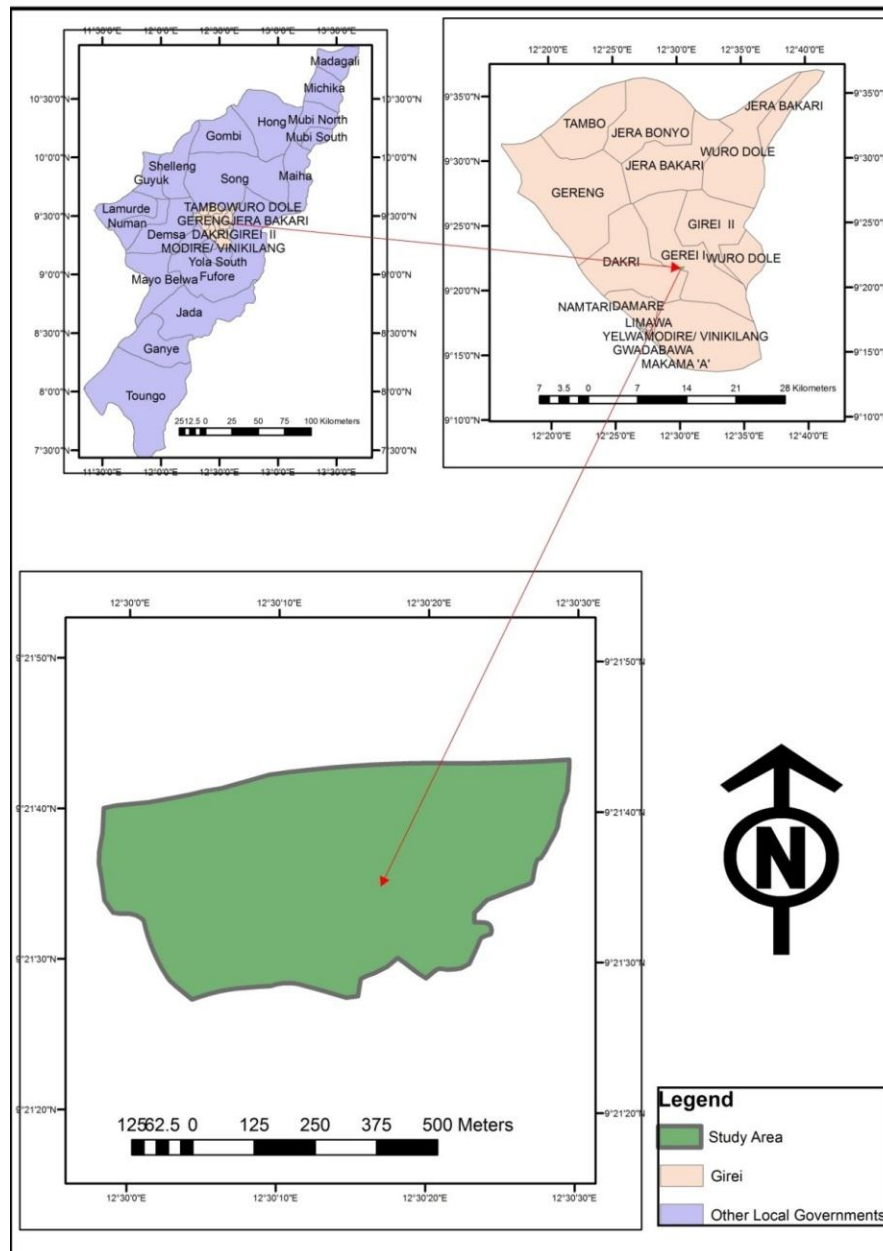


Figure 1. Map of the study Area

3.4 Determination of Soil Bulk Density

The soil was sieved through 2.00mm sieve, according to (Soil and Water Conservation Society, 2000) in order to have average soil size particles. Mould of 100mm diameter, 127.3mm height and 21.90g weight was used. 200g of soil was be measured out of the different depth of different location and was compacted using 25 blows to evaluate the bulk density using 2.5kg standard proctor and soil profile. The bulk density of each of the content was determined using the following relationship [27].

$$BD = M/V \quad (1)$$

Where; BD = Bulk density, (g/cm^3) M = Mass of soil, (g),

$$M = M_2 - M_1 \quad (2)$$

where; M_1 = Mass of air dried soil and empty weight, (g), M_2 = Mass of compacted soil and mould weight, (g), V = Volume of the container, (cm^3).

$$V = \pi r^2 h \quad (3)$$

where; h = height of the mould, (cm), r = radius of the mould, (cm).

3.5 Determination of Water Holding Capacity

The bottom of a milk can was covered with filter paper and weighed on the balance (W_1), then fill dry soil gently into the milk can and weigh it again (W_2). Then place the filled can on a petri dish and add water to the side of the milk can until water depth is 6mm and was left to stand overnight and carefully remove the can and leave it to stand overnight and carefully remove the can wipe dry out on the sun and weigh again (W_3). Place the can in an oven at the temperature of 105°c for 24hours and remove to cool down and weigh again (W_4). The water holding capacity was determined as;

$$WHC = \frac{W_3 - W_2}{W_4 - W_2} \times 100 \quad [28] \quad (4)$$

3.6 Determination of Soil pH

The soil pH was determined using pH meter by electrometric method as detailed by [29].

3.7 Determination of Soil Organic Carbon and Organic Matter

The Walkey-Black method for determining organic carbon as detailed by [30] to obtain the organic matter content derived from the organic carbon percentage computed as;

$$\text{Organic matter (\%)} = \text{Organic carbon (\%)} \times 1.724 \quad (5)$$

3.8 Determination of Ca and Mg in the Soil

The calcium and magnesium in the soil was determined by the EDTA titration method as detailed by [31].

4 RESULTS AND DISCUSSION

4.1 Soil Bulk Density of the Experimental Plots

Table 1 present the soil bulk density of the study areas. The table indicates that the bulk density varies in all the depths of samples in all the plots. It was observed that bulk density predominantly decreases with depth of soil sampling in the experimental area. Highest mean bulk density value of 1.66 g/cm³ was obtained from Vonoklang groundnut farm, while the lowest value of bulk density of 1.60 g/cm³ recorded from Bagalchi groundnut farm. Statistically it was observed as shown in Table 2 that there was no significance difference between the bulk densities in all the plots in the experimental farm. This implies that land use had effect on soil bulk density regardless of groundnut farm location in the area. In addition, the non-significant difference among the soil bulk densities be due fact that the area is predominantly sandy with small amounts of loamy and clay soils, which is in line with earlier studies carried out by [32].

Table 1. Soil Bulk Density of the study areas (g/cm³)

Sample	Depth of sample (cm)	Bagalchi	Sabongari	Vonoklang
A	0-10	1.66	1.53	1.62
	10-20	1.52	1.53	1.59
	20.30	1.46	1.46	1.73
B	0-10	1.72	1.76	1.67
	10-20	1.55	1.59	1.62
	20-30	1.51	1.66	1.62
C	0-10	1.73	1.64	1.72
	10-20	1.62	1.53	1.67
	20-30	1.64	1.61	1.65
Mean		1.60	1.59	1.66

Table 2. ANOVA for Soil Bulk Density in the Farm Plots

SV	D.f	SS	MS	F _c	F _t
Replicate	2	0.02	0.01	0.125 ^{ns}	3.63
Treatment	8	0.08	0.01	0.125 ^{ns}	2.59
Error	16	0.08	0.005		
Total	26				

Note: F_c = F-calculated, F_t=F-table, ns = non significance

4.2 Soil pH, Organic Matter and Water Holding Capacity

Table 3 shows soil pH values of the experimental farm. The pH values varies in all the depth of sampling from the experimental plots. It was observed that highest soil pH value of 6.21 was obtained from Vonoklang farm plot compared to the pH values of 6.19 and 5.82 recorded from Bagalchi and Sabongari farms, respectively. This indicate that the level of the soil in all the study area is likely acidic Statistically, as shown in Table 4 it was observed that there was no significance difference between the soil pH of all the farm plots in the study area. The result indicates that Soil pH is affected by land use. In addition, the soils have low content of organic matter, resulting in a low buffering capacity and a high rate of water percolation and infiltration. Thus, they are susceptible to acidification. The result revealed that the study area is slightly acidic which may affects crop yield and suitability. This is in line with earlier studies by [18].

Table 3. Soil pH of the Farm Plots

Sample	Depth of sample (cm)	Bagalchi	Sabongari	Vonoklang
A	0-10	5.30	5.60	5.50
	10-20	5.70	5.30	6.80
	20-30	6.20	5.10	6.20
B	0-10	5.20	6.30	6.80
	10-20	7.20	6.40	5.80
	20-30	6.50	5.60	5.40
C	0-10	6.40	5.60	5.50
	10-20	6.70	7.40	6.60
	20-30	6.50	5.10	7.30
Mean		6.19	5.82	6.21

Table 4. ANOVA for Soil pH in the Farm Plots

SV	D.f	SS	MS	F _c	F _t
Replicate	2	0.86	0.29	0.62 ^{ns}	3.63
Treatment	8	4.35	0.54	1.15 ^{ns}	2.59
Error	16	7.56	0.47		
Total	26				

Note: F_c = F-calculated, F_t=F-table, ns = non significance

Table 5 shows the soil organic matter for the experimental farm. It was observed that the organic matter of the soil varied for all the soil depth of sampling in the farm in the study area. The result shows that highest organic matter mean value of 1.92% was obtained from Vonoklang farm, while mean organic matter values of 1.87 and 1.82% were recorded from Sanongari and Bagalchi farms, respectively, which revealed that organic matter percentage is low. Statistically, as presented in Table 6, it was also observed that there was no significance difference between the soil organic matters of all the farms in the study area. This implies that the continuous use of land for cultivation causes decrease in the soil organic matter in the study area which is in agreement with findings from the studies of [23].

Table 5. Soil Organic Matter (%) in the Farm Plots

Sample	Depth of sample (cm)	Bagalchi	Sabongari	Vonoklang
A	0-10	2.10	1.99	1.53
	10-20	2.20	1.53	2.49
	20-30	1.69	1.82	1.59
B	0-10	1.62	1.94	1.81
	10-20	1.82	1.82	2.20
	20-30	2.06	1.50	1.81
C	0-10	1.91	2.15	1.29
	10-20	1.65	1.99	2.17
	20-30	1.34	2.13	2.36
Mean		1.82	1.87	1.95

Table 6. ANOVA for Soil Organic Matter in the Farm Plots

SV	D.f	SS	MS	F _c	F _t
Replicate	2	0.04	0.02	0.15 ^{ns}	3.63
Treatment	8	0.32	0.04	0.31 ^{ns}	2.59
Error	16	2.07	0.13		
Total	26				

Note: F_c = F-calculated, F_t=F-table, ns = non significance

Table 7 shows the water holding capacity of the soils in the experimental farm. It was observed that the percentage level at which water is retained in the soils of the farms in the study area was not above 45%. Water holding capacity of the soils in the study area vary even for the same depth of sampling and are generally less at the surface. Soil water holding capacity mean values of 39.63, 39.00 and 37.59% were obtained from Bagalchi, Sabongari and Vonoklang, respectively which indicates that water holding capacity in all the groundnut farms in the study area are similar. In addition, statistically shown in Table 8, it was observed that there was no significance difference between water holding capacity of all the groundnut farms in the study area. The result revealed that the effect of cultivation in the area affects the soils ability to hold moisture and nutrients which affects the water holding capacity as it fluctuates in different parts of the farm, which is in line with studies by [16].

Table 7. Soil Water Holding Capacity (%) of the Farm Plots

Sample	Depth of sample (cm)	Bagalchi	Sabongari	Vonoklang
A	0-10	37.40	42.50	38.80
	10-20	42.80	42.30	40.10
	20-30	44.80	44.80	34.70
B	0-10	35.00	33.50	37.10
	10-20	41.40	40.10	38.90
	20-30	43.20	37.30	38.80
C	0-10	34.93	38.10	35.00
	10-20	38.90	42.20	37.00
	20-30	38.10	39.20	37.90
Mean		39.63	39.00	37.59

Table 8. ANOVA of the Soil Water Holding Capacity in the farm plots

SV	D.f	SS	MS	F _c	F _t
Replicate	2	30.20	15.10	2.30 ^{ns}	3.63
Treatment	8	118.74	14.84	2.26 ^{ns}	2.59
Error	16	105.19	6.57		
Total	26				

Note: F_c = F-calculated, F_t=F-table, ns = non significance

4.3 Cation Exchangeable Capacity

Table 9 present the cation exchange capacity values of the study area. It was observed that cation exchange capacity varies in all the depth of soil sampling for the entire study area. Cation exchange capacity was noted to be more in the 100-200 mm depth of soil sampling in all the farms. Cation exchange capacity mean values of 2.56, 2.55 and 2.70 cmol/kg, were obtained from Bakalchi, Sabongari and Vonoklang, respectively, which indicate that cation exchange capacity is low in the study area. Statistically, it was observed that there was no significance difference between the cation exchange capacities in all the farm plots (Table 10). This implies that the three farm plots from the three location in the study area show that due to continuous cultivation of this land, the cation exchange capacity is low, and as CEC measures the ability of soils to hold nutrients these soils cannot do so properly because the soils are acidic and have low organic matter. This is in line with earlier studies by [13, 23].

Table 9. Soil Cation Exchangeable Capacity (cmol/kg) of the Farms

Sample	Depth of sample (cm)	Bagalchi	Sabongari	Vonoklang
A	0-10	2.47	2.85	2.12
	10-20	3.30	2.99	2.86
	20-30	2.03	2.63	1.65
B	0-10	4.14	3.10	1.67
	10-20	1.98	2.43	3.20
	20-30	1.90	1.57	3.37
C	0-10	2.43	2.42	2.03
	10-20	2.13	2.63	3.43
	20-30	2.73	2.35	3.95
Mean		2.56	2.55	2.70

Table 10. ANOVA of the Soil Cation Exchange Capacity in the Farm plots

SV	Df	SS	MS	F _c	F _t
Replicate	2	0.12	0.06	0.11 ^{ns}	3.63
Treatment	8	2.96	0.37	0.67 ^{ns}	2.59
Error	16	8.77	0.55		
Total	26				

Note: F_c = F-calculated, F_t = F-table, ns = non significance

5 CONCLUSIONS

The physicochemical properties of soils used for agricultural cultivation in Girei, Adamawa state were analyzed to determine the effects of land use on the properties that are important for plant growth. Soils in the area are sandy-loam, mean soil bulk density value of 1.62 g/cm³ was obtained for the study area. The soil pH is slightly acidic and the organic matter of the soils was low which resulted in low soil cation exchange capacity of the area. The low organic matter affects the moisture holding capacity of the soil as well as the cation exchange capacity, this in turn affects the soils ability to retain nutrients for crop growth and reduces the crop yields for the study area.

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