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Original Research Article

Evaluation of land use impact on soil quality in Samaru College of Agriculture, Northern Guinea Savanna, Nigeria

Mustapha **Yahqub**[1], Abdulwahab Ibrahim **Jimoh**[2], Ayodele **Owonubi**[3]

[1] *Samaru College of Agriculture, Ahmadu Bello University, PMB 1058, Samaru, Zaria, Nigeria*
[2] *Department of Geography, Gombe State University, P.M.B 127, Gombe, Nigeria*
[3] *Department of Horticulture and Landscape Technology, Federal College of Forestry, Jos, Nigeria*

Correspondence to:
Yahqub M., Samaru College of Agriculture, Ahmadu Bello University, PMB 1058, Samaru, Zaria, Nigeria.
E-mail: myahqub@abu.edu.ng; mustaphayahqub@gmail.com, Tel: +234 (0)8034293478

Abstract

Land use changes influence soil quality, which is of fundamental importance in sustainable crop production and environmental management. This study evaluated land use impact on soil quality at Samaru College of Agriculture farm, Ahmadu Bello University, Zaria, Nigeria. The land use types were Tomato/Pepper, Grapevine/Fluted pumpkin, Mango/Orange, and Guava/Mango. A profile pit was dug in each land unit. Soil samples were collected from genetic horizons, prepared, and analysed in the laboratory using standard methods. Sand, silt, and clay differed significantly ($p < 0.05$) among the land uses. The soil texture varied from clay loam to clay. Bulk density (BD) was significantly ($p < 0.05$) higher under Mango/Orange and Guava/Mango than other land use types. The soil reaction (pH) ranged from 5.0 to 5.8 and was strongly to moderately acidic. Soil organic carbon was low (< 10 g/kg), total nitrogen values of 0.19 – 0.24 g/kg were low, and available phosphorus values of 1.8 – 27.4 mg/kg were rated low to high across the land use types. Soils under the Grapevine/Fluted pumpkin land use type were significantly higher in organic carbon, exchangeable potassium, sodium, and effective cation exchange capacity than the other land use types. Soil quality under Grapevine/Fluted pumpkin was rated best (80%), whereas soil quality under Tomato/Pepper land use type was the worst (40%). The soils were low-to-high in quality and had a higher potential to support crop production if management practices that encourage the build-up of nutrients in the soil system were adopted. The application of manure, liming materials, and phosphorus-based fertilisers is advocated.

Keywords: Land use; soil quality; crop production; land degradation

INTRODUCTION

Soil quality is the ability of a specific kind of soil to function within natural or managed ecosystem boundaries, sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Abera et al., 2021). Changes in land use are a major factor that affects soil quality, leading to soil degradation (FAO, 2020). Soil degradation related to soil quality implies a loss of the vital functions of soil: (i) providing physical support, water, and essential nutrients required for the growth of terrestrial plants, (ii) regulating the flow of water in the environment and (iii) eliminating the harmful effects of contaminants using physical, chemical and biological processes, i.e., environmental buffers or filters (Bastida et al. 2006; Brevik et al., 2020). The quality of soil determines agricultural sustainability and environmental quality, which jointly determine plant, animal, and human health (Brevik et al., 2018; USDA, NRCS, 2019). Tree plantation has been reported to ameliorate soil properties through the following five processes: nitrogen fixation, soil nutrient enrichment through litterfall and root turnover, addition of soil organic matter through litter and root inputs, changes in the above and below ground microclimate, and an increase in organism activities within the rhizosphere, which all lead to soil quality improvement (Fisher, 1995; Shukla, 2009; Akinde et al., 2020). Nutrients accumulated in leaves and over time are returned to the ecosystem through litter fall, and this is the most important component of the forest ecosystem; it is a major pathway of nutrient and energy transfer (Shukla, 2009).

Deforestation and continuous cultivation are major agricultural activities that were reported as the second largest human-induced source of greenhouse gases in the atmosphere (Lal, 2016) and contribute to climate change impacts on the ecosystem. Sustainable management practices are required to maintain soil quality, environmental health, and crop production for sustainability and economic growth (Ashenafi et al., 2010; Muche et al., 2015). The continuous conversion of natural forests to farmland has led to land degradation, resulting in increased hunger, poverty, and conflicts in developing countries such as Nigeria (FAO, 2020). The United Nations Sustainable Development Goals (SDGs) 15 focus on ensuring the conservation, restoration, and sustainable use of land resources, and understanding the changes in soil properties as a result of land use changes is of great significance in the ecosystem (Tellen and Yerima, 2018). This will help to guide land uses and policymakers in reducing the high rate of land degradation, especially in developing nations where the economy is largely dependent on agriculture (IFPRI, 2010).

Soil organic carbon and its relation to land use characteristics are important in evaluating current regional and global soil fertility status and projecting future changes (Wang et al., 2008). Soil organic matter is a storehouse and source of important plant nutrients, which results in the build-up of nutrients in the topsoil as a result of the accumulation of organic matter (Young, 2000). The relationship between organic matter and land use helps in assessing the effects of land use on soil carbon storage, mitigating climate change, and improving overall soil quality. Studies on the impact of land use on properties and quality are limited on a local scale in Zaria, and there is a need for this current study. This research hypothesises that there are no significant differences in soil quality within the land uses. This study aims to evaluate land use impact on soil quality in Samaru College of Agriculture, Horticulture Section, Division of Agricultural Colleges (DAC), Ahmadu Bello University, Samaru, Zaria, Nigeria.

MATERIALS AND METHODS

Description of the study area

This study was conducted at the Horticulture Section, Samaru College of Agriculture, Zaria, Kaduna State. The study area lies within latitude 11°09'52" – 11°10'22" N and longitude 07°38'05" – 07°38'22" E at 684 – 697 m above sea level (Figure 1). The area is situated in the Northern Guinea Savanna ecology with a mono-modal rainfall pattern and a long-term mean annual rainfall of approximately 1,011±161 mm concentrated entirely in five months (May/June – September/October) and a mean daily temperature of 24 °C (Oluwasemire and Alabi, 2004). The geology of the area is characterised by the Basement Complex with an intricate pattern of rocks comprising metamorphic and igneous origins, which are essentially granites, gneisses, migmatites, schists, and quartzites (Aliyu et al., 2016). Agriculture is the most prevalent land use and farming systems include mixed livestock and crop production. The site is established with Citrus, Mango and Guava planted 14 years ago, while Watermelon/Tomato/Fluted pumpkin/Pepper were planted 12 years ago on an annual basis. Valette and Ibanga (1984) classified the soil of the study area as Typic Haplustalf in the USDA Soil Taxonomy system and Acrisol in the FAO-UNESCO legend.

Field study and laboratory analyses

Four land uses were identified for this study, namely Tomato/Pepper, Grapevine/Fluted pumpkin, Mango/Orange, and Guava/Mango (Figure 1). A profile pit was dug for each of the land use types, and soils were collected from genetic horizons identified and characterised following the guidelines outlined in the Soil Survey Staff. The sampled soils were air-dried, ground, and sieved through a 2 mm sieve. The less than 2 mm fractions were used for laboratory analysis following procedures outlined in Agbenin (1995). The particle size distribution was determined by the hydrometer method. Bulk density was determined using a core sampler. Soil pH was measured in water using a glass electrode pH meter. Also, soil electrical conductivity was determined in a 1:2 soil/solution ratio. Soil organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1996). Base saturation was calculated as the sum of total exchangeable bases divided by cation exchange capacity (NH_4OAc). Available P was determined by Bray-1 extraction

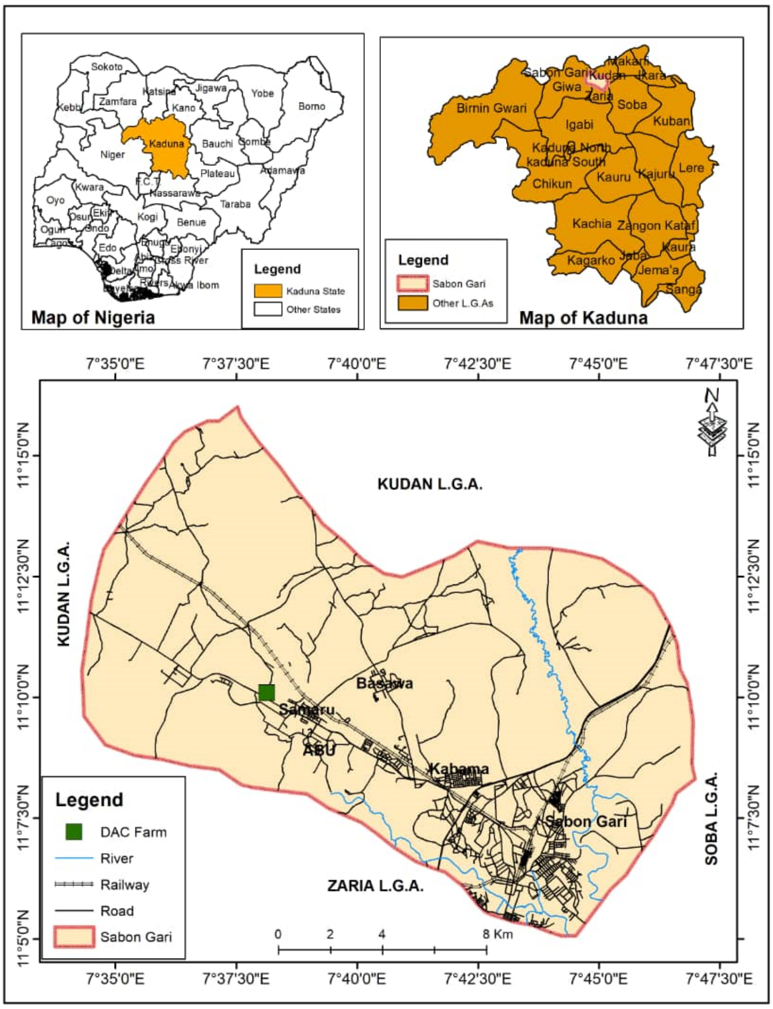

Figure 1. Map of the Study Area Showing the Farm-Source: Authors Analysis (2023)

followed by molybdenum blue colorimetry (Frank et al., 1998). Total N was determined by the micro-Kjeldahl digestion method (Bremner, 1996). Exchangeable bases (calcium, magnesium, potassium, and sodium) in the soil were determined using the ammonium acetate extract. Sodium and K were determined using a flame photometer, while Ca and Mg were determined using an atomic absorption spectrometer.

Soil quality evaluation

Soil quality was evaluated using the tropical soil quality index (TSQI) as described by Arifin et al. (2012), which was used to determine the soil quality index under land uses. The method uses a scoring of 0–2, where soil properties with sufficient amounts receive a higher score (2 or 1), those with medium scores receive (1), and those with low amounts receive zero (0). Mineral soil property threshold levels, interpretations, and associated soil index values are listed in Table 1.

The soil parameters were summed to give a total SQI given as follows:

$$\text{Total SQI} = \Sigma \text{ individual soil properties index values} \quad \text{(eq 1)}$$

$$\text{TSQI (\%)} = \frac{\text{(Total soil quality index)}}{\text{(Maximum posible total SQI for properties measured)}} \times 100 \quad \text{(eq 2)}$$

Statistical Analysis

Analysis of variance (ANOVA) was used to assess the variation in soil properties across land uses using the General Linear Model (GLM) procedure. Mean comparison was done using Fisher's least significant difference test at $p < 0.05$ significance level in statistical packages for social science (SPSS) software version 23 (IBM Corp, 2015).

RESULTS

Soil physical properties

Soil physical properties across the land use types are presented in Table 2. Sand, silt, and clay content were significantly ($p < 0.05$) different among the land use types. Sand content was significantly ($p < 0.01$) higher

Table 1. Selected Soil properties for Tropical Soil Quality Index (TSQI)

S/N	Parameters	Level	Interpretations	Index
1	**Bulk density (Mg/m)**	>1.5	Possible adverse effects	0
		≤1.5	Adverse effects unlikely	1
		3.01 to 4.0	Strongly acid – only the most acid-tolerant plants can grow.	0
		4.01 to 5.5	Moderate acid – growth of acid-intolerant plants is affected	1
2	**Soil acidity**	5.51 to 7.2	Slightly acid to Near neutral – optimum for many plant species	2
		7.21 to 8.5	Slightly to moderately alkaline – optimum except those preferring acid soils	1
		>8.5	Strongly alkaline – preferred by plants adapted to this pH,	0
		>5	High excellent buildup of organic C with all associated benefits	2
3	**Total carbon (g/kg)**	1 to 5	Moderate adequate levels	1
		<1	Low – could indicate a possible loss of organic Carbon.	0
		>0.5	High – an excellent reserve of nitrogen	2
4	**Total nitrogen (g/kg)**	0.1 to 0.5	Moderate – adequate levels	1
		<0.1	Low – could indicate loss of organic N	0
		>30	High – excellent reserve of Available P	2
5	**Available P (mg/kg)**	15 to 30	Moderate – adequate levels for plant growth	1
		<15	Low – P deficiencies likely	0
6	**Exchangeable K (cmol/kg)**	>1.28	High – excellent reserve of exchangeable K	2
		0.26 to 1.28	Moderate – adequate levels for most plants	1
		<0.26	Low – possible deficiencies	0
		>4.17	High – excellent reserve exchangeable Mg	2
7	**Exchangeable Mg (cmol/kg)**	0.42 to 4.17	Moderate – adequate levels for most plants	1
		<0.42	Low – possible deficiencies	0
		>5.00	High – excellent reserve, probably calcareous soil	2
8	**Exchangeable Ca (cmol/kg)**	0.51 to 5.00	Moderate – adequate levels for most plants	1
			Very low – severe Ca depletion, adverse effects likely	0

Source: Arifin et al. (2012)

Table 2. Ranking of mean physical soil properties with respect to land use

Land Use/Parameters	Sand	Silt	Clay	Si/Cl	Bulk Density
		g/kg			Mg/m^3
Tomato/Pepper	293a	247bc	460b	0.54	1.30b
Grapevine/Pumpkin	127b	347a	527ab	0.66	1.37b
Mango/Orange	360a	220c	420b	0.55	1.56a
Guava/Mango	57b	307ab	607a	0.51	1.46ab
SE+/–	40.92	17.05	26.38	0.03	0.04
Depth					
Surface	243	270	465	0.59	1.48
Subsoils	193	285	523	0.55	1.40
SE+/–	40.92	17.05	26.38	0.03	0.04

Source: Authors Analysis (2023)

in Mango/Orange and Tomato/Pepper land use than other land uses. The silt content in Grapevine/Fluted pumpkin was similar to that of Guava/Mango but significantly ($p < 0.01$) higher than the others. Guava/Mango and Grapevine/Fluted pumpkin had similar clay content compared to other land uses and were significantly ($p < 0.05$) higher in clay content than other land uses. The silt-clay ratio was higher in the Grapevine/Fluted pumpkin land use type though the difference was not significant.

Bulk density (BD) was significantly ($p < 0.05$) different among the land use types. Mango/Orange and Guava/Mango land use types had similar BD compared to others and were significantly ($p < 0.05$) higher in bulk density than other land uses. Soil physical properties across the depths were not significantly different. Sand, silt clay ratio and bulk density decreased with

Table 3. Ranking of soil chemical properties under different land use

Land Use/ Parameters	pH	OC	AP	TN	C/N	EC	Ca	Mg	K	Na	ECEC	H+Al	BS
		g/kg	mg/kg	g/kg		dSm^{-1}			cmol/kg				%
Tomato/Pepper	5.23	2.82b	1.76	0.21	14.50	2.70	3.72	1.28b	0.16b	0.76b	7.15b	1.20	91.3
Grapevine/Pumpkin	5.38	5.95a	27.40	0.24	63.07	3.37	7.59	2.74a	3.70a	2.32a	15.24ab	1.20	87.5
Mango/Orange	5.32	2.24b	11.56	0.19	13.94	3.01	7.60	3.40a	1.78b	1.73b	15.71a	1.20	88.7
Guava/Mango	5.51	2.88b	26.27	0.20	14.66	0.09	7.47	1.25b	0.62b	1.64b	11.91b	0.93	87.9
SE+/–	0.06	0.57	5.44	0.56	9.36	1.11	0.84	0.31	0.59	0.25	1.50	0.09	1.18
Depth													
Surface	5.29	3.17	12.26	0.15	21.60	4.55	6.60	2.34	1.18	1.40	12.61	1.10	89.5
Subsoils	5.40	3.62	19.00	1.06	29.02	1.17	6.60	2.09	1.76	1.73	12.45	1.15	88.5
SE+/–	0.06	0.57	5.44	0.56	9.36	1.11	0.84	0.31	0.59	0.25	1.50	0.09	1.18

Source: Authors Analysis (2023)

an increase in soil depth while silt and clay content increased with an increase in soil depth.

Soil chemical properties

Soil chemical properties for the various land use types are presented in Table 3. Soils under all the land use types were strongly acidic (5.1–5.5). Soil organic carbon was generally rated low (<10 g/kg) under all land use types. Soil organic carbon differed significantly ($p < 0.05$) among the land use types under investigation. However, the Grapevine/Fluted pumpkin land use type had a significantly ($p < 0.05$) higher organic carbon content than other land uses. Available phosphorus was rated low (<10 g/kg) under Tomato/Pepper, medium (10–20 g/kg) under Mango/Orange, and higher (>20 g/kg) under Grapevine/Fluted pumpkin and Guava/Mango land use types. Soil total nitrogen (TN) was rated low (<1.5 g/kg) over all the land use types. Soils under the Grapevine/Fluted pumpkin land use type had higher C/N ratios but it was lowest for Mango/Orange land use type.

The electrical conductivity (EC) value was rated low (<4 dS/m) over all the land use types. Soils under the Grapevine/Fluted pumpkin land use type were significantly ($p < 0.05$) higher in exchangeable potassium and sodium than the other land use types. Generally, all the land use types were rated high in exchangeable bases except soils under Tomato/Pepper, which was rated medium in exchangeable calcium, potassium, and effective cation exchange capacity. The exchangeable acidity of the soils was rated high (>1.0 mg/kg). The effective cation exchange capacity (ECEC) was rated low (<10 cmol/kg) under Tomato/Pepper and medium to high (10–20 cmol/kg) under the other land use types. Soils under Grapevine/Fluted pumpkin and Mango/Orange land use types were significantly ($p < 0.05$) higher in ECEC than the other land use types. Soil chemical properties across the depths were also not significantly different.

Table 4. Tropical Soil Quality Index (TSQI) score limit

S/N	Parameters	Tomato/ Pepper	Grapevine /Fluted pumpkin	Mango/ Orange	Guava/ Mango	Prime Quality Land	Tomato/ Pepper	Grapevine/ Fluted pumpkin	Mango/ Orange	Guava/ Mango
1	Bulk density (Mg/m^3)	1.3	1.37	1.56	1.46	1	1	1	0	0
2	Soil acidity	5.23	5.38	5.32	5.51	2	1	1	1	2
3	Total carbon (g/kg)	2.82	5.95	2.24	2.88	2	1	2	1	1
4	Total nitrogen g/kg)	0.21	2.43	0.19	0.20	2	1	2	1	1
5	Available P mg/kg)	1.76	27.40	11.56	26.27	2	0	1	0	1
6	Exch. K (cmol/kg)	0.16	3.70	1.78	0.62	2	0	2	2	1
7	Exch. Mg cmol/kg)	1.28	2.74	3.40	1.25	2	1	1	1	1
8	Exch. Ca (cmol/kg)	3.72	7.59	7.60	7.47	2	1	2	2	2
	Total Score					15	6	12	8	9
	Percentage (%)					100	40	80	67	60

Source: Authors Analysis (2023)

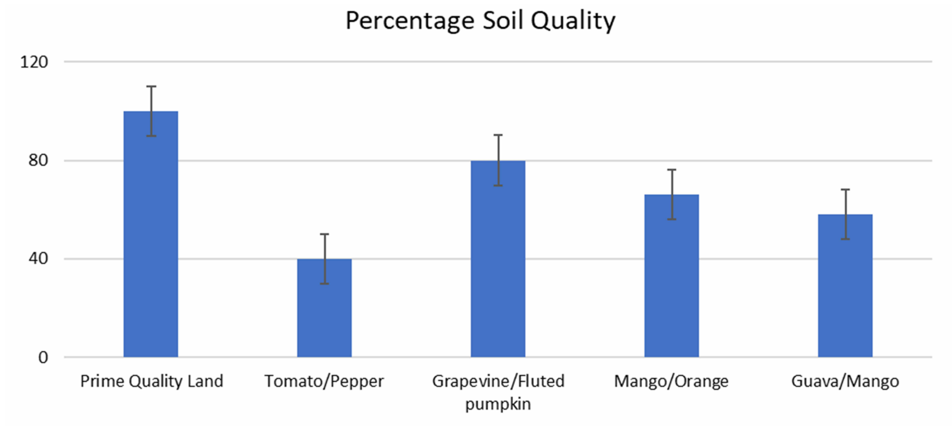

Figure 2. Soil quality variation over the land uses in the study area
Source: Author Analysis (2023)

Soil pH, OC, TN, C/N, Available P, exchangeable sodium, and acidity increased with an increase in soil depth while EC, exchangeable magnesium, potassium, sodium, ECEC, and base saturation content increased with an increase in soil depth.

Soil quality based on the tropical soil quality index under land use

The results of the soil quality analysis are presented in Table 4 and Figure 2. Soils under Grapevine/Fluted pumpkin were best in quality (Q1) with 80% scores, soils under Mango/Orange and Guava/Mango were moderate in quality (Q2) with 60–67% scores, while soils under Tomato/Pepper were poor in quality (Q3) with 40% scores.

DISCUSSION

Soil physical properties

Soil texture varied from clay loam in the surface soil to clay in the subsurface soils signifying a higher content of clay with an increase in depth across land use types. Also, Sharu et al. (2013), Owonubi (2017), and Jimoh et al. (2020) reported an increase in silt and clay content with soil depth in soils of the Savannah region and attributed it to eluviation and illuviation processes. The silt-clay ratio was higher for Grapevine/Fluted pumpkin, and implies a higher rate of weathering in Grapevine/Fluted pumpkin than in the other land use types. Bulk density (BD) is a measure of the rate of soil compaction, porosity, root penetration, and soil aeration. BD was significantly ($p < 0.05$) different among the land use types. The BD values across land use types were less than 1.63 Mgm^{-3}, hence, indicating that root penetration, water and air movement, and seed emergence will not be impaired. Akinde et al. (2020) also reported a significantly higher BD under continuous cultivation than under other land use types in the soils of Ile-Ife. A similar high bulk density was reported in cultivated land of the Afaka forest, which was attributed to high silt content and continuous cultivation (Odunze et al., 2019). The increase in BD with soil depth could be attributed to a decrease in organic matter, soil fauna activities, and pore space distribution as depth increases and compression of soil trapped between plant roots occurs (Singh et al., 2015).

Soil chemical properties

The acidic nature of the soils could be attributed to the leaching of plant nutrients by excessive rainfall, uptake by plants, or the acidic nature of the parent rock. The observed acidic nature of the soils corroborates the results of Shobayo et al. (2013) in soils of gneiss in the savannah region. Muche et al. (2015) and Akinde et al. (2020) also reported slightly to strongly acidic soils under various land uses and attributed it to the frequent application of acidic/ammonium-based fertiliser, intensive cultivation, and accelerated erosion. The low pH of soils under the Tomato/Pepper and Guava/Mango land use type system might limit the availability of some plant nutrients (Cresswell and Hamilton, 2002). Thus, this will require liming for nutrient availability and sustainable crop production. Exchangeable acidity values in soils across land-use types indicate that acidity is a threat to the functionality of the soil and will require ameliorations, except for soils under Guava/Mango land use type with slightly lower values. The content of exchangeable acidity recorded under the land use types was higher than that in previous studies (Shobayo et al., 2013; Aliyu et al., 2016; Jimoh et al., 2020) in the savannah region.

Soil organic carbon (SOC) is a dynamic soil property that determines soil physical, chemical and biological properties. Grapevine/Fluted pumpkin land use type had a higher organic carbon content than other land uses. Similarly, Jamala and Oke (2013) reported 15 % and 8 % higher SOC under natural forests than in fallow and cropland. This implies that land use type influences the SOC content in the ecosystem (Alcantara et al., 2016). Consequently, the low content of SOC and TN may be attributed to sparse vegetation due to low rainfall and high temperature in the savannah region where accumulation, decomposition, and incorporation of plant residues is limited (Balthazar et al., 2018). The prevalence of bush burning and plant residue harvesting, which encourage the export of nutrients in harvested crops without adequate replacement, could also result in low organic carbon and nitrogen contents (Demelash and Stahr, 2010; Jimoh et al., 2016; Odunze et al., 2019).

The generally low organic carbon and nitrogen corroborates previous findings in the savannah region (Shobayo et al., 2013; Aliyu et al., 2016; Jimoh et al., 2020). The soil carbon/nitrogen (C/N) ratio is an indicator of soil nitrogen mineralization capacity. A high soil C/N ratio (> 20) can slow the decomposition rate of organic matter and nitrogen by limiting soil microbial activities, whereas a low soil C/N ratio (<20) could accelerate the process of microbial decomposition of organic matter and nitrogen (Wu et al., 2001). Soils under Grapevine/Fluted pumpkin were higher in C/N than other land use types. This implies a low rate of decomposition of organic carbon and nitrogen compared to the low C/N in other land use types. Deficiency in available phosphorus was observed for the Tomato/Pepper land use type. The low available phosphorus under Tomato/Pepper was similar to the report of Akinde et al. (2020), who also reported low available P in soils under all the land use types studied. This also corroborates the findings of Dawit et al. (2002), who submitted that acidic soils were deficient in available P. This soil will require the application of phosphorus-based fertilisers for sustainability.

Generally, soils of all the land use types were rated high in exchangeable bases except soils under Tomato/Pepper, which was rated medium in exchangeable calcium, potassium and effective cation exchange capacity. The medium content of exchangeable bases under the Tomato/Pepper land use type could be attributed to annual disturbance and export of nutrients through crop harvest and plant materials. The low plant cover under Tomato/Pepper will support a high rate of leaching and erosion compared to other perennial land use types, which provide higher plant cover, reduce the rate of erosion to the nearest minimum, and add organic matter to the soil through litter decomposition that is the major source of soil nutrients. In addition, exchangeable bases (Ca, Mg, K, and Na) increase with soil depth for all the land use types; except soils under Grapevine/Fluted pumpkin, where exchangeable bases decrease with soil depth. The increase in bases with soil depth could be attributed to the leaching of basic cations or weathering of parent rock with soil depth (Demessie et al., 2011), in contrast, the decrease in exchangeable bases with soil depth could be attributed to nutrient absorption by plants and a decrease in organic carbon with soil depth. This might be a result of soil organic carbon being reported to be a storehouse and reservoir of plant nutrients (Young, 2000).

The effective cation exchange capacity was rated low under Tomato/Pepper and medium to high under the other land use types. The low value of ECEC under Tomato/Pepper suggests a dominance of sesquioxides and kaolinite clays over 2:1 clay minerals, while the medium to high value of ECEC on the other land uses suggests a dominance of 2:1 clay minerals over sesquioxides and kaolinite clays (Tan, 2000). Continuous cultivation and use of inorganic fertiliser might be responsible for low ECEC under Tomato/Pepper land use type. Soil leaching, low basic cations of parent rock, and the type of clay minerals are factors that might influence the variation in ECEC over land use types (Muche et al., 2015; Akinde et al., 2020). Base saturation (BS) was rated higher under Tomato/Pepper and medium for other land use types. The lower value of exchangeable cations under Tomato/Pepper could be attributed to the high rate of disturbance through annual tillage operation compared to the other land use types. This corroborates Demessie et al. (2011), who reported a low content of exchangeable cations under plantations established on previously cultivated lands compared to that established on primary forestland in Ethiopia.

Soil quality based on the tropical soil quality index under land use

The minimum data set for assessing soil quality (prime quality agricultural land) includes eight soil parameters ranked from 0 to 2 for soil quality assessment. These include bulk density, pH, total carbon, total nitrogen, available phosphorus, exchangeable potassium, magnesium, and calcium. A score of 0 was allocated to parameters with low nutrient rates, while scores of 1 to 2 were allocated to parameters with optimum and high nutrient rates (Table 4). The ideal full scores, i.e., prime quality agricultural land, are defined as soils with the necessary quality to produce high crop yields when properly managed (Odunze et al., 2019), and the real scores under each land use type were compared to deduce how much variation is between the ideal score and the real score to determine the soil quality. Table 4 shows that the total score under prime quality agricultural land was 15, which is 100% quality. Soil quality values of the land use types vary from 40 to 80%. The most severe limitation to soil quality for Tomato/Pepper land use type was available phosphorus and exchangeable potassium, which were very limited, suggesting that the soils will not support crop production on a sustainable basis. Bulk density was also very limiting under Mango/Orange and Guava/Mango land use types, suggesting that the soils were more compacted because of frequent traffic during harvest periods and erosion processes (Lal, 1996; Odunze et al., 2019).

Soil pH, total nitrogen, total carbon and exchangeable Mg were moderately limiting for the various land use types, while exchangeable Ca limitation was only recorded under Tomato/Pepper. The poor soil quality under Tomato/Pepper land use type could be attributed to the high rate of mineralization of organic matter following cultivation activities and the high diurnal temperature of the savanna ecology (Odunze et al., 2017). The moderate quality under the perennial crops was similar to the report of Arifin et al. (2012) and Jimoh et al. (2019), who reported 50–60% as percentage soil quality for Malaysia and Nigeria plantations, respectively. The lowest quality noted for Tomato/Pepper land use types also corroborates Odunze et al. (2019), who reported low quality under cultivated land in Afaka forest, Nigeria.

CONCLUSION AND RECOMMENDATION

The study examined the impact of land use on soil quality in Samaru College of Agriculture, Northern Guinea savanna zone of Nigeria. The results obtained showed that the texture of the soils was generally loamy sand to sandy clay loam. The soil pH was strongly acidic, organic carbon and total nitrogen were low, while the available P content of soils was low to high in the study area. The exchangeable cations depict relatively medium values throughout the land uses. The values of soil ECEC were low to medium, and base saturation was high. The soils under the land uses assessed were low to moderate in quality with 40–80% and have high potential to improve the soil quality for sustainable production and environmental management. Therefore, the adoption of land use strategies that focus on soil organic carbon protection against further depletion and erosion of soil nutrients is advocated especially under Tomato/Pepper land use which was low in quality. The following good agricultural practices are recommended:

a) Incorporation of farmyard manure and crop residues to increase organic carbon and total nitrogen contents of the land uses since all the land uses were low in OC and TN.
b) Improvement in soil pH through liming to allow availability of soil nutrients for plant uptake since all the land uses were strongly acidic.
c) Application of cation and phosphorus-based fertilisers is advocated for soils under Tomato/Pepper due to low available phosphorus and other exchangeable bases.
d) Adequate monitoring of the soil fertility and quality status of orchards should be carried out at regular intervals for sustainability in the study area.

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CONFLICT OF INTEREST

The author declared no conflict of interest to this research, authorship, and publication of this article.

ETHICAL COMPLIANCE

The authors have followed ethical standards in conducting the research and preparing the manuscript.

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