



Research Article

Characterization of Soil Physical and Chemical Properties of Profile Pits in Yamaltu Deba Local Government Area, Gombe State, Nigeria

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ABSTRACT

This study was conducted during the 2024 dry season to characterize the physical and chemical properties of soils from profile pits in Yamaltu Deba Local Government Area (LGA), Gombe State, Nigeria. Ten representative soil profile pits were excavated to depths of 150–215 cm at Kwadon, Dadinkowa, Kanawa, Wajari, Zambuk, Baure, Kwali, Boltongo, Deba, and Jangerigeri. Soil profiles were described following FAO/ISSS guidelines, and horizon-based samples were analyzed using standard laboratory procedures. The result revealed that loamy sand texture dominated the surface horizons and clay accumulation (up to 57.76%) at subsurface horizons. Bulk density ranged from 1.38 g cm⁻³ in the Ap horizon to 1.79 g cm⁻³ in subsurface horizons, while total porosity decreased from 47.92% to 32.45%. Soil pH varied from moderately acidic (pH 5.53) to strongly alkaline (pH 8.87). Higher surface organic carbon and total nitrogen contents were observed in Baure, Boltongo, and Zambuk, whereas Kwali and Kwadon recorded the lowest values. Available phosphorus was highest in Boltongo and Baure but low in Kwadon and deeper horizons across all locations. Exchangeable calcium and magnesium dominated the exchange complex, particularly in Baure, Wajari, and Deba, while cation exchange capacity ranged from 4.13 cmol kg⁻¹ in Kwadon to 13.12 cmol kg⁻¹ in Zambuk. It is therefore recommended that soil exhibit moderate fertility constraints an integrated soil fertility management practices for sustainable agricultural productivity should be adopted in the study area.

Keywords: Savanna Soils; Soil chemical properties; Soil fertility; Soil physical properties; Soil profile pits

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INTRODUCTION

Soil is a fundamental natural resource that affects agricultural productivity, environmental sustainability, and land use planning. Comprehensive characterization of soil physical and chemical properties provides essential information for understanding soil fertility status, pedogenesis, and soil suitability for crop production and other land uses (Nwite, 2016). In Nigeria, differences in geological parent materials, topography, climate, and land use

strongly influence soil properties across various agroecological zones. There is limited published information on the soil profile distribution of physical and chemical properties in the study area. Such information is critical for formulating strategies to improve soil fertility and sustainable land management in the region. Soil profile pits, which allow for in situ examination of pedogenetic horizons, are widely used in pedological studies to investigate soil properties across depth and landscape position.

The evaluation of soil physical properties such as texture, bulk density, and structure, together with chemical properties including pH, organic carbon, nutrient content (e.g., N, P, K), and cation exchange capacity (CEC), offers a complete understanding of soil quality and potential constraints for agricultural production (Ejikeme & Nweke, 2016). However, such comprehensive studies remain sparse for the Yamaltu Deba area.

This study, therefore, was designed to characterize the physical and chemical properties of soils across different pedogenic horizons using profile pits in Yamaltu Deba LGA, with the aim of providing baseline soil information for land use planning, fertility management, and sustainable agricultural development. The specific objectives of this research were to characterize the spatial variability of soil physical properties including particle size distribution, bulk density, particle density, and total porosity across pedogenic horizons of representative soil profiles in Yamaltu Deba Local Government Area. The study also aimed to assess the distribution of some major soil chemical properties, including soil reaction (pH), organic carbon, total nitrogen, available phosphorus, exchangeable bases, exchangeable acidity, and cation exchange capacity (CEC), and to relate these properties to soil horizon development and fertility status. However, the findings are intended to identify dominant soil fertility constraints associated with texture, organic matter depletion, and nutrient retention capacity, and to provide site-specific information to support sustainable soil management and land-use planning in northeastern Nigeria

MATERIALS AND METHODS

Location and Extent of the Study Area

Yamaltu Deba Local Government Area (LGA) is one of the eleven LGAs that constitute Gombe State, situated in the North-Eastern geopolitical zone of Nigeria. Geographically, the LGA lies between latitude $10^{\circ}10'N$ and $10^{\circ}35'N$ and longitudes $11^{\circ}10'E$ and $11^{\circ}45'E$, covering an estimated land area of approximately 1,981 km². It shares boundaries with Akko and Kwami LGAs to the west, Dukku LGA to the north, and Adamawa State to the south and east. The study area is characterized by gently undulating plains interspersed with low hills, dissected plateaus, and isolated inselbergs, with elevations ranging from

approximately 400 to 700 m above sea level. The landscape slopes gradually southwards toward the Gongola River basin, which, together with its tributaries, forms the principal drainage system and provides seasonal and perennial water resources for domestic, agricultural, and industrial activities. Climatically, Yamaltu Deba Local Government Area lies within the West African tropical continental climate zone, exhibiting a distinct wet season from April to October and a dry season from November to March. Mean annual rainfall shows a clear north-south gradient, ranging from about 750–850 mm in the northern parts to 1,400–1,600 mm in the southern sector, with peak rainfall occurring in July and September. The dry season, particularly between March and May, is characterized by high temperatures that may reach up to 43°C. Mean annual temperatures generally range between 18°C and 28°C, while relative humidity is higher during the wet season and declines markedly during the dry season under the influence of the Harmattan winds (Upper Benue River Basin Development Authority, 2025).

Soil Profile Pit Excavation and Description

A total of 10 representative soil profile pits were excavated at Kwadon, Dadinkowa, Kanawa, Wajari, Zambuk, Baure, Kwali, Boltongo, Deba, and Jangerigeri to reflect differences in landscape, land use, and soil morphology. Each profile pit was excavated to a depth of at least 150 cm or until refusal, whichever occurred first. Soil profiles were described in situ according to FAO/ISSS soil description standards, including horizon designation, colour (using Munsell colour charts), texture, structure, consistence, root presence, and boundary characteristics.

Soil Sampling

Soil samples were collected from each identified horizon in every profile pit. Undisturbed samples were taken for bulk density determination using core rings, while disturbed samples were collected into labeled polythene bags for laboratory analyses. All samples were taken to the laboratory for air-drying, crushing, and sieving (2 mm mesh) prior to analysis.

Physical Properties Analyses

Particle Size Distribution: Soil particle size (sand, silt, and clay fractions) was determined using the hydrometer method as described by (International Institute of Tropical Agriculture, 2007). The textural

class was assigned based on the United States Department of Agriculture (USDA) textural triangle. Bulk Density and Porosity these were determined using the core method, calculated as the dry mass of soil per unit volume of the core sample while Total porosity was calculated using bulk density and particle density (assumed to be 2.65 g cm^{-3}) based on standard formulas.

Chemical Properties Analyses

Soil pH and Electrical Conductivity: Soil pH was measured in a 1:2.5 soil-water suspension using a glass electrode pH meter. Electrical conductivity (EC) was determined in the same extract to assess the salinity status as described by (International Institute of Tropical Agriculture, 2007)

Organic Carbon and Total Nitrogen: Soil organic carbon were determined using the Walkley-Black wet oxidation method while Total nitrogen measured using the Kjeldahl digestion and distillation technique (IITA, 2007). Available Phosphorus and Exchangeable Bases: Available phosphorus was extracted using the Bray-P1 or Olsen method (depending on soil pH range) and determined colorimetrically. Exchangeable bases (Ca^{2+} , Mg^{2+} , K^{+} , Na^{+}) were extracted with ammonium acetate and quantified using atomic absorption spectrophotometry or flame photometry (IITA, 2007). Cation Exchange Capacity (CEC): CEC was determined by ammonium acetate saturation followed by displacement with sodium, according to standard soil analysis procedures.

RESULTS AND DISCUSSIONS

Soil Physical Properties Across Profile Pits

Soil texture and textural classes

The soils across the ten profile pits exhibited varying textures ranging from loamy sand (LS) to clay (CL) and sandy clay loam (SCL), indicative of diverse parent materials and pedogenic processes (Table 1) Locations such as Kwadon, Kanawa, and Dadinkowa had dominant loamy sand textures in surface horizons (e.g., Kwadon-Ap horizon designation 85.44% sand), reflecting weak weathering and possibly aeolian deposition or coarse alluvium. In contrast, subsoils in Dadinkowa (Bt and C horizon designation) and Baure showed significantly higher clay content (up to 57.76%), indicating illuviation of clay and argillic horizon development (Brady & Weil, 2017; Soil Survey Staff, 2006). Zambuk and Wajari exhibited more sandy clay loam (SCL) in subsoils,

suggestive of moderate clay accumulation, while Jangerigeri showed sandy clay (SC) in the surface horizon, hinting at potential surface clay enrichment due to surface runoff or anthropogenic influences. This variability in texture influences water retention, permeability, and root penetration potential (Brady & Weil, 2017).

Bulk density (BD) and particle density (PD)

Bulk density values across the soil profiles ranged from 1.38 to 1.79 g cm^{-3} , reflecting pronounced variation within the profiles. Surface horizons generally recorded lower BD values, particularly in Zambuk (Ap: 1.38 g cm^{-3}) and Kanawa (Ap: 1.41 g cm^{-3}), which can be attributed to higher organic matter content, better aggregation, and reduced overburden pressure. These conditions favor improved soil structure and pore space development in the surface layers. In contrast, subsurface horizons exhibited progressively higher bulk density, with maximum values observed in the C horizons of Kwadon and Kanawa (up to 1.79 g cm^{-3}). The increase in BD with depth could be attributed to reduced organic matter input, increased clay content, soil compaction due to overlying layers, and possible lithologic discontinuities. Such high BD values may restrict root penetration, water movement, and gaseous exchange, particularly in clay-enriched or weakly structured subsoils (Guo *et al.*, 2018). Particle density remained relatively constant at approximately 2.65 g cm^{-3} across all horizons and locations, indicating dominance of mineral constituents, mainly quartz and other silicate minerals. The uniformity of PD suggests that observed variations in bulk density are largely controlled by changes in soil structure, organic matter content, and porosity rather than mineralogical differences. Overall, the vertical increase in bulk density coupled with stable particle density highlights the influence of pedogenic processes and land-use effects on soil physical quality in the study area (Guo *et al.*, 2018).

Total porosity

Total porosity values calculated from BD and PD ranged from 32.45% to 47.92%, with surface horizons typically having higher porosity (Zambuk-Ap: 47.92%; Jangerigeri-Ap: 47.17%), indicative of better aggregation and less compaction. Lower porosities were observed in deeper horizons (e.g., Kanawa-C: 34.34%; Baure-Cg: 33.58%), often related to finer

textures and increased overburden pressure (Lal, 2020). This decline in porosity with depth could negatively affect water infiltration, aeration, and root penetration, especially in locations with clay-rich subsoils such as Baure, Dadinkowa, and Deba (Table 1a and b)

Soil Chemical Properties Across the Locations

Soil reaction (pH)

The pH values across profiles range from 5.53 (Zambuk) to 8.87 (Kwali), indicating that the soils span from moderately acidic to strongly alkaline. Surface horizons (Ap) generally tend to be near-neutral to slightly acidic, while subsoils display greater variability. (Table 2) Kwali and Baure show high alkalinity (pH > 8), possibly due to accumulated basic cations or presence of carbonates, particularly in deeper horizons. Profiles such as Zambuk and Kanawa showed a decline in pH with depth, suggesting leaching of bases and the progression of acidification down the profile. Slight acidity to near-neutral pH in Ap horizons (Dadinkowa, Wajari, Kwadon) indicates favorable conditions for nutrient availability (Brady & Weil, 2017).

Electrical conductivity (EC)

EC values across all profiles are low (0.01–0.08 dS/m), confirming non-saline soils throughout the study area. Even in deeper horizons (e.g., Kwali 0.08 dS/m), EC remains within safe thresholds. This suggests minimal salt accumulation, likely due to good drainage and low evaporation rates, and supports high crop suitability without osmotic stress (Rengasamy and Olsson 2006) (Table 2).

Organic carbon (Org. C) and organic matter (OM)

Organic carbon content ranges from 0.10% (Kwali) to 0.96% (Baure), with corresponding organic matter between 0.17% and 1.66%. Generally, Ap horizons have higher OM, consistent with litter input and biological activity. The sharp decline in OM with depth is typical of mineral soils and indicates limited root penetration and microbial activity in subsurface layers (FAO, 2006). Sites like Zambuk, Boltongo, Baure show relatively high surface OM, suggesting better land use or native vegetation influence. Overall, OM levels are low to moderate, implying that soil fertility may be constrained and organic amendments will be beneficial.

Total nitrogen (TN)

TN varies from 0.03% to 0.08%, with most Ap horizons falling below 0.06%, which is considered low for

agricultural soils (Hazelton & Murphy, 2016). The C:N ratios (Org. C/TN) suggest a generally narrow range (10:1 to 12:1), indicative of active mineralization and low organic matter stabilization, common in tropical soils. Sites with higher OM (e.g., Kanawa and Baure) also show higher TN, reflecting the strong correlation between OM and N content.

Available phosphorus (Av-P)

Available phosphorus across the study area ranged from 3.36 mg kg⁻¹ in Kwadon to 12.22 mg kg⁻¹ in Boltongo, indicating low to moderate P availability. Relatively higher available P values were observed in the surface (Ap) horizons of Zambuk, Wajari, Baure, and Boltongo, where concentrations exceeded the critical level of 10 mg kg⁻¹ required for most crops (Olsen *et al.*, 1954). This pattern could largely be attributed to surface accumulation of organic residues, fertilizer inputs, and limited downward mobility of phosphorus, which tends to be strongly fixed in soils. In contrast, subsurface horizons generally recorded lower available P values (<6 mg kg⁻¹), reflecting reduced organic matter content and increased P fixation by clay minerals and sesquioxides (Fe and Al oxides) commonly found in tropical soils. Additionally, the weak mobility of phosphorus limits its translocation to deeper horizons, thereby restricting P availability for deep-rooting crops. The low P levels observed in Kwadon and deeper horizons across all locations indicate a potential phosphorus deficiency that may constrain crop productivity without external P inputs.

Exchangeable bases (K, Na, Ca, Mg)

Exchangeable potassium ranged from 0.10 to 0.31 cmol kg⁻¹, indicating low to moderate reserves across the profiles. The moderate K levels may be linked to weathering of K-bearing minerals and recycling from crop residues in surface horizons. Exchangeable sodium values were consistently low (0.06–0.15 cmol kg⁻¹), suggesting an absence of sodicity hazards and favorable soil structural conditions across the study area. Calcium and magnesium were the dominant exchangeable cations, particularly in deeper horizons of Deba, Baure, and Zambuk. Their dominance reflects the influence of base-rich parent materials and limited leaching under the prevailing semi-arid to sub-humid climatic conditions. The observed increase in Ca and Mg with depth in locations such as Kwadon and Zambuk may be attributed to downward translocation and accumulation of base cations, a

process commonly associated with pedogenic horizon development and partial eluviation–illuviation dynamics (Landon, 1991). This accumulation contributes to relatively higher base saturation in subsurface layers.

Exchangeable acidity (EA) and cation exchange capacity (CEC)

Exchangeable acidity values were generally low ($\leq 1.32 \text{ cmol kg}^{-1}$), reflecting the dominance of basic cations in most profiles. However, relatively higher exchangeable acidity in the subsoils of Kwadon and Zambuk suggests localized accumulation of exchangeable H^+ and Al^{3+} ions, which is characteristic of more weathered horizons where leaching and clay

accumulation have occurred. Cation exchange capacity ranged from $4.13 \text{ cmol kg}^{-1}$ in Kwadon to $13.12 \text{ cmol kg}^{-1}$ in Zambuk, indicating low to moderate nutrient-holding capacity. Lower CEC values in surface horizons, particularly in Kwadon and Kwali, are associated with sandy textures and low organic matter content, which limit the availability of exchange sites. Conversely, higher CEC values in the subsoils of Wajari, Zambuk, and Jangerigeri correspond with increased clay content and possible dominance of sesquioxide-rich clays, reflecting advanced pedogenic development (Singh *et al.*, 2018).

Table 1a: Soil Physical Properties Across Profile Pits in the study Area

Location	Horizon designation	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	TCL	BD (g/cm^{-3})	PD (g/cm^{-3})	Total Porosity (%)
Kwadon 753682 1128860 Elv: 357	Ap	0-48	85.44	1.8	12.76	LS	1.52	2.65	42.64
	Ab	48-92	69.44	10.8	19.76	SL	1.60	2.65	39.62
	C	92-215	73.68	8.56	17.76	SL	1.74	2.65	34.34
Dadinko wa 770265 1141309 Elv: 220	Ap	0-51	85.44	2.80	11.76	LS	1.66	2.65	37.36
	Bt	51-95	29.44	28.80	41.76	CL	1.69	2.65	36.23
	Bw	95-140	81.44	3.80	14.76	LS	1.79	2.65	32.45
	C	140-205	19.44	32.80	47.76	CL	1.68	2.65	36.60
Kanawa 753682 1128861 Elv: 384	Ap	0-28	85.68	4.56	9.76	LS	1.41	2.65	46.79
	Bt	28-49	83.68	4.56	11.76	LS	1.57	2.65	40.75
	Bw	49-77	81.68	8.56	9.76	LS	1.63	2.65	38.49
	C	77-180	67.68	8.56	23.76	SCL	1.74	2.65	34.34
Wajari 785542 1169722 Elv: 320	Ap	0-26	58.56	29.12	12.32	SL	1.52	2.65	42.64
	Bw	26-89	54.56	23.12	22.32	SCL	1.58	2.65	40.38
	Cg	89-160	42.56	17.12	40.32	CL	1.66	2.65	37.36
Zambuk 758712 1142151 Elv: 296	Ap	0-26	77.68	10.56	11.76	SL	1.38	2.65	47.92
	Ab	26-64	58.56	19.12	22.32	SCL	1.47	2.65	44.53
	Bt	64-120	52.56	21.12	26.32	SCL	1.62	2.65	38.87
	Cg	120-200	38.56	19.12	42.32	CL	1.71	2.65	35.47

Key: LS: Loamy Sand, C: Clay, SL: Sandy Loam, SCL: Sandy Clay Loam, SL: Sandy Loam, SC: Sandy Clay Elv: Elevation, TCL: Textural Class, BD: Bulk Density, PD: Particle Density, T: Total

Table 1b: Soil Physical Properties of profile pits in the study Area

Location	Horizon designation	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	TCL	BD (g/cm ³)	PD (%)	Total Porosity (%)
Baure	Ap	0-59	39.44	18.80	41.76	CL	1.6	2.65	39.62
777997	Bt	59-110	37.44	14.80	47.76	CL	1.6	2.65	36.23
1126178	Bt2	110-165	19.44	22.80	57.76	CL	1.6	2.65	34.72
Elv: 343	Cg	165-200	37.44	24.80	37.76	CL	1.7	2.65	33.58
Kwali	Ap	0-33	75.68	4.56	19.76	SL	1.49	2.65	43.77
764151	Ab	33-120	75.68	10.56	13.76	SL	1.44	2.65	45.66
1140985	B	120-165	69.68	10.56	19.76	SL	1.70	2.65	35.85
Elv: 266	C	165-201	43.68	24.56	31.76	CL	1.67	2.65	36.98
Boltongo	Ap	0-26	72.96	12.00	15.04	SL	1.46	2.65	44.91
753688	Ab	26-75	82.96	4.00	13.04	SL	1.63	2.65	38.49
1127720	B	75-150	58.96	8.00	33.04	SCL	1.70	2.65	35.85
Elv: 398									
Deba	Ap	0-66	60.56	11.12	28.32	SCL	1.57	2.65	40.75
758817	Ab	66-150	66.96	8.00	25.04	SCL	1.67	2.65	36.98
1132070	B	150-185	82.96	2.00	15.04	SL	1.69	2.65	36.23
Elv: 335	C	185-210	64.96	14.00	21.04	SCL	1.71	2.65	35.47
Jangerigeri	Ap	0-33	52.56	9.12	38.32	SC	1.40	2.65	47.17
757123	Bw	33-89	74.56	13.12	12.32	SL	1.55	2.65	41.51
1133892	C	89-175	58.26	9.42	32.32	SCL	1.65	2.65	37.74
Elv: 381									

Key: LS: Loamy Sand, C: Clay, SL: Sandy Loam, SCL: Sandy Clay Loam, SL: Sandy Loam, SC; Sandy Clay, TCL: Textural Class, BD: Bulk Density, PD: Particle Density, T: Total

Table 2: Soil Chemical Properties Across the Locations in the study area

Location	Horizon Designation	Depth (cm)	pH (1:1)	EC	Org. C (%)	OM (%)	TN (%)	Av-P (mg/kg)	K (cmol/kg)	Na (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	EA (cmol/kg)	CEC (cmol/kg)
KWADON	AP	0-48	6.14	0.02	0.42	0.72	0.04	5.40	0.16	0.07	1.16	0.53	0.71	4.13
753682	AB	48-92	8.55	0.02	0.74	1.28	0.05	6.66	0.25	0.12	2.89	0.68	1.24	6.14
112886	C	92-215	5.89	0.02	0.70	0.89	0.04	3.36	0.29	0.10	3.11	0.75	1.32	7.4
Elv=375														
DADINKOWA	AP	0-51	7.54	0.01	0.12	0.21	0.04	5.64	0.11	0.06	1.18	0.34	0.34	4.51
770265	Bt	51-95	6.77	0.03	0.82	1.41	0.07	6.23	0.18	0.09	4.38	0.66	0.38	9.43
1141309	Bw	95-140	6.52	0.02	0.36	0.62	0.04	4.21	0.14	0.10	1.04	0.39	0.43	4.86
Elv=220	C	140-205	7.25	0.03	0.22	0.38	0.03	4.66	0.22	0.11	3.12	0.75	0.28	8.45
KANAWA	AP	0-28	6.74	0.06	0.78	1.34	0.06	7.34	0.19	0.08	1.93	0.45	0.50	5.11
753682	AB	28-49	6.62	0.02	0.43	0.74	0.04	8.21	0.19	0.11	1.10	0.20	0.78	6.06
112886	Bw	49-77	6.55	0.03	0.24	0.41	0.03	8.68	0.15	0.09	1.13	0.42	1.18	5.11
Elv=384	C	77-180	6.41	0.03	0.18	0.31	0.03	5.44	0.26	0.12	3.39	0.86	1.57	8.11
WAJARI	AP	0-26	6.83	0.03	0.68	1.17	0.05	9.00	0.28	0.09	3.97	0.90	0.37	9.25
785542	Bw	26-89	6.68	0.01	0.32	0.55	0.04	4.77	0.29	0.12	4.31	1.10	0.48	11.33
1169722	Cg	89-160	6.52	0.02	0.14	0.24	0.03	5.05	0.27	0.15	4.88	0.91	0.68	12.75
Elv=320														
ZAMBUK	AP	0-26	6.09	0.03	0.77	1.33	0.05	10.11	0.20	0.10	2.44	0.55	0.30	7.84
758712	AB	26-64	6.13	0.01	0.66	1.13	0.05	7.55	0.22	0.11	2.53	0.84	0.43	6.66
1142151	Bt	64-120	5.53	0.01	0.22	0.38	0.03	3.97	0.31	0.12	3.03	0.93	0.78	8.07
Elv=296	Cg	120-200	6.71	0.03	0.14	0.24	0.04	4.22	0.31	0.10	3.81	1.06	1.14	13.12
BAURE	AP	0-59	7.09	0.05	0.96	1.66	0.08	11.03	0.26	0.10	3.87	0.93	0.44	8.84
777997	Bt	59-110	7.22	0.06	0.32	0.55	0.04	4.75	0.24	0.09	4.44	0.79	0.52	9.62
1126178	Bt2	110-165	7.81	0.07	0.16	0.28	0.03	6.09	0.21	0.10	3.71	0.76	0.75	8.72
Elv=343	Cg	165-200	6.64	0.53	0.12	0.21	0.04	4.11	0.27	0.11	4.92	0.85	1.46	11.12

Key; Elv: Elevation, pH: Soil Reaction, EC:Electrical Conductivity, Org.C : Organic Carbon, OM: Organic Matter, TN: Total Nitrogen, AvP: Available Phosphorus, K: Potassium, Na: Sodium, Ca: Calcium, Mg: Magnesium, EA: Exchangeable Acidity, CEC: Cation Exchange Capacity

Table 2 Cont'd

KWALI	AP	0-33	6.71	0.02	0.29	0.45	0.04	5.61	0.13	0.10	1.16	0.53	0.54	4.35
764151	AB	33-120	8.87	0.02	0.16	0.28	0.03	7.11	0.12	0.10	2.89	0.68	0.86	4.13
1140985	B	120-165	5.91	0.03	0.10	0.17	0.03	4.09	0.15	0.11	3.11	0.75	1.18	5.51
Elv=266	C	165-201	6.35	0.08	0.10	0.17	0.03	6.17	0.27	0.13	1.17	0.12	1.29	7.72
BOLTONGO	AP	0-26	6.84	0.03	0.92	1.59	0.08	12.22	0.22	0.12	2.66	0.71	0.44	5.32
753688	AB	26-75	6.83	0.02	0.45	0.78	0.04	4.89	0.17	0.11	1.12	0.42	0.75	4.30
1127720	C	75-150	6.25	0.03	0.22	0.38	0.03	3.55	0.23	0.13	3.55	0.75	1.14	10.95
Elv=398														
DEBA	AP	0-66	7.53	0.05	0.54	0.93	0.04	6.82	0.25	0.10	3.97	0.91	0.35	9.27
758817	AB	66-150	6.64	0.08	0.20	0.34	0.04	4.78	0.10	0.14	2.86	0.74	0.41	7.43
1132070	B	150-185	7.76	0.03	0.15	0.26	0.03	5.07	0.13	0.12	1.24	0.39	0.30	5.24
Elv=335	C	185-210	7.01	0.45	0.12	0.21	0.04	4.44	0.17	0.15	2.22	0.55	0.30	5.48
JANGERIGERI	AP	0-33	7.82	0.02	0.24	0.41	0.04	3.88	0.14	0.09	1.11	0.35	0.62	5.06
757123	Bw	33-89	7.67	0.01	0.18	0.31	0.03	4.38	0.16	0.11	2.02	0.49	1.24	7.01
1133892	C	89-175	7.86	0.02	0.12	0.21	0.04	4.23	0.24	0.12	4.22	0.77	1.39	12.88
Elv=381														

CONCLUSION

The soils of (Yamaltu Deba Local Government Area) exhibit marked spatial and vertical variability in physical and chemical properties. Sandy surface horizons and clay-enriched subsurface layers reflect ongoing pedogenic processes, while increasing bulk density and decreasing porosity with depth may restrict root growth and water movement in some profiles. Soil reaction ranges from moderately acidic to strongly alkaline, with no evidence of salinity or sodicity constraints. Despite generally favorable physical conditions at the surface, the soils are characterized by low organic carbon, total nitrogen, and moderate to low available phosphorus, indicating inherent fertility limitations. Low to moderate cation exchange capacity further suggests limited nutrient retention, particularly in sandy horizons. To improve soil productivity and sustainability, the adoption of integrated soil fertility management practices such as the use of organic amendments, balanced fertilizer application, and conservation-based land management is recommended. The findings provide a useful baseline for soil management, land use planning, and future research in northeastern Nigeria.

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