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Assessment of Farming Potentials of Soils along the Floodplain Areas of Benue River in Girei Local Government Area of Adamawa State, Nigeria

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Abstract

Floodplains are highly productive agro-ecosystems due to periodic flooding and the deposition of nutrient-rich sediments, yet their soils often exhibit strong spatial variability. This study evaluated the morphological, physical, and chemical properties of soils across nine pedons in the Girei floodplain, Adamawa State, Nigeria, to determine fertility status and key limitations. Standard field descriptions and laboratory analyses were carried out to assess particle-size distribution, pH, electrical conductivity (EC), organic carbon (OC), total nitrogen (TN), available phosphorus (AVP), exchangeable bases, exchangeable acidity, effective cation exchange capacity (ECEC), and base saturation (BS). Results show that sand is the dominant fraction, with surface values ranging from 29–85%, while silt and clay ranged from 4–32% and 8–38%, respectively. Clay generally increased with depth, reflecting alluvial deposition and translocation. Bulk density (1.28–1.63 g/cm³) and porosity (38–52%) indicate favourable physical conditions. Soil pH ranged from 5.60–7.70, classifying the soils as moderately acidic to slightly alkaline, while EC remained low (0.05–0.18 dS/m), indicating nonsaline conditions. Chemical fertility was generally low. Organic carbon ranged from 5.39–16.06 g/kg, and total nitrogen from 0.43–1.25 g/kg, reflecting rapid organic matter mineralization. Available phosphorus was critically low (2.1–7.9 mg/kg), identifying P deficiency as the major constraint. Exchangeable Ca (0.80–2.71 cmol/kg) and Mg (0.42–1.93 cmol/kg) were low, while K was moderate (0.19–0.62 cmol/kg). ECEC ranged from 4.10–9.85 cmol/kg, and BS from 34–68%, indicating low to moderate fertility. The study concludes that, despite favourable physical conditions, the soils are chemically impoverished. Improved management especially organic matter addition and balanced nutrient application is essential to sustain long-term productivity.

Keywords: Agro-ecosystem, floodplain, impoverished, saturation, morphology, sediment

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Introduction

Floodplains constitute highly productive agricultural environments owing to their continually evolving geomorphology and the recurrent deposition of nutrient-rich sediments. Periodic inundation replenishes the soil with alluvial materials, improves moisture availability, and supports diverse cultivation systems (Sandi et al., 2023). In many tropical and subtropical regions including Nigeria floodplain farming plays a crucial role in rural economies by providing major sources of food, dry-season farming opportunities, and income for smallholder households.

Agricultural performance within these landscapes is strongly shaped by the heterogeneity of floodplain soils. Differences in the frequency and duration of flooding, sediment provenance, drainage patterns, and depositional processes result in marked spatial variability. These factors influence soil texture, structural development, organic matter content, nutrient reserves, and water retention capacity, thereby determining the suitability of land for crop production (Khallah et al., 2025a; Khallah et al., 2025b). Although some floodplain soils are inherently fertile, others experience limitations such as seasonal waterlogging, salinity, nutrient imbalances, or poor structural stability (Kefas et al., 2016; Gani, Bako & Christopher, 2020). Moreover, population growth, agricultural expansion, and climate variability continue to heighten the risk of soil degradation and declining yields (Dickson et al., 2021). Limited access to detailed soil information further contributes to suboptimal land-use decisions and underutilization of high-potential areas.

Systematic assessment of floodplain soils is therefore essential for guiding sustainable land management and enhancing agricultural productivity. Such assessment entails characterizing soil morphological, physical, and chemical attributes; determining fertility levels; and evaluating crop-specific suitability. The insights generated can support farmers, extension agents, and policymakers in making evidence-based decisions that optimize land use while safeguarding long-term soil health (Wuese & Usman, 2024).

This study, therefore, investigates the agricultural potential of soils within the floodplain environment; characterize the morphological, physical, and chemical properties of the soils; evaluate soil fertility status and identify key nutrient constraint; recommend management strategies that promote sustainable soil and land use.

Methodology

Location of the Study Area

The study was conducted on a 96-ha site in Girei LGA, Adamawa State, Nigeria, located along the Benue River between latitudes 9°22′–9°31′N and longitudes 12°32′–12°58′E at about 150 m elevation. Girei covers 1,848 km² with a 2016 population density of 93.89 km⁻². The area is inhabited mainly by Fulani and Bwatiye communities, whose livelihoods are dominated by farming and livestock rearing.

Climate, Vegetation and Geology of the Study Area

The climate is semi-arid with a rainy season (May–October) and dry season (November–April), about 1000 mm annual rainfall, peak temperatures in April (40°C), and lowest in December–January (10°C). Harmattan occurs from November to March, and most soils are well drained. Vegetation belongs to the Northern Guinea Savannah, characterized by scattered shrubs and trees such as Khaya senegalensis, Vitellaria paradoxa, and Prosopis africana, along with common crops (rice, sorghum, maize) and savannah grasses. The

landscape consists of gently undulating relief underlain by Upper Cretaceous marine sediments (shale, limestone, mudstone, sandstone). The geomorphology forms part of the Benue Valley, featuring levees, meander plains, and isolated sandstone hills.

Sampling and Sample Collection

A pre-field survey identified floodplain areas for detailed soil investigation. The field survey used a rigid grid system with four transects spaced 200 m apart, and auger borings at 100 m intervals to 120 cm depth. Soils with similar morphology were grouped into three pedons, and nine profile pits were excavated and described. Infiltration tests were conducted using the double-ring infiltrometer.

Sample Preparation and Laboratory Analyses

Collected samples were air-dried, sieved, and analyzed. Physical analyses included particle size (hydrometer), bulk and particle density, water-holding capacity, and infiltration rate. Chemical analyses determined pH, EC, organic carbon, total nitrogen, available phosphorus, exchangeable cations, effective CEC, and base saturation using standard laboratory procedures.

Physical Properties of the Study Area

Particle-size distribution of the soil is presented in Table 1, showing the sand, silt, and clay content of soils in the study area. Sand was the dominant particle-size fraction in both the surface and sub-surface horizons of all pedons. Surface sand content ranged from 37–75% in P1–P3, 37–85% in P4–P6, and 29–91% in P7–P9, while sub-surface values ranged from 25–77%, 49–95%, and 29–61%, respectively (Table 1). The highest sand content (95%) occurred in pedon P4, likely reflecting the influence of parent material and climatic conditions that promote particle sorting (Adeyemo, Oladele, & Yusuf, 2019; Adewole & Ojeniyi, 2021). Similar trends were reported in southwestern Nigeria (Osujieke, Ibe, & Nnamdi, 2016). The prevalence of sand may also result from downslope deposition of eroded sediments, as lower-slope soils tend to be sandier and prone to nutrient leaching under high rainfall (Adewole & Ojeniyi, 2021).

Silt content in surface horizons ranged from 17–37% in P1–P3, 2–33% in P4–P6, and 5–51% in P7–P9, while sub-surface values ranged from 11–33%, 4–29%, and 11–47%, respectively (Table 1). In some profiles, silt increased slightly with depth. Silt enrichment at the surface is associated with wind-borne dust deposition and soil development processes (Adeyemi, Fawole, & Olabisi, 2020).

Clay content ranged from 4–30% (P1–P3), 2–34% (P4–P6), and 2–30% (P7–P9) in surface horizons, and 8–38%, 0.4–34%, and 6–42% in sub-surface horizons, respectively (Table 1). Clay generally increased with depth, indicating eluviation–illuviation processes. Higher sub-surface clay is consistent with pedoturbation and illuviation, while lower surface clay reflects soils formed over basement complex rocks (Adeleye, Balogun, & Okeke, 2022). Pedons P2, P6, and P7 recorded the highest clay levels.

Surface bulk density ranged from 1.34–1.35 g/cm³ in P1–P3, 1.35–1.78 g/cm³ in P4–P6, and 1.34–1.76 g/cm³ in P7–P9, while sub-surface values ranged from 1.28–1.57, 1.35–2.09, and 1.28–1.76 g/cm³, respectively (Table 1). These values fall within acceptable limits for root growth (Olanrewaju, Oladele, & Agboola, 2019). Higher surface density may be linked to grazing pressure and limited crop rotation. The results are consistent with findings from Musa

and Gisilambe (2017) and Tekwa, Bassey, and Udoh (2011). Pedon P4 had the highest bulk density (1.70 g/cm^3).

Total porosity in surface horizons ranged from 32–46% in P1–P3, 33–49% in P4–P6, and 34–46% in P7–P9, with sub-surface values between 21–52% (Table 1). These values indicate adequate pore space for water and nutrient movement in sandy soils (Akinola, Olorunfemi, & Omotosho, 2020). Slightly lower porosity in P4 and P5 is attributed to higher clay content.
Water-holding capacity ranged from 36–49% (P1–P3), 32–49% (P4–P6), and 32–49% (P7–P9) in surface horizons, with corresponding sub-surface values of 40–51%, 21–49%, and 40–51%. High moisture content reflects frequent flooding and a shallow water table (140 cm). In pedons P2, P3, P4, and P9, surface moisture exceeded sub-surface levels, likely due to combined retention effects of surface organic matter and clay (Chukwu, Eze, & Nwachukwu, 2021).

Table 1: Summary of some Physical Properties of Soils of the Study Areas

Pedon No.	Pedon depth (cm)	Horizon designation	Sand (%)	Silt (%)	Clay (%)	Textural class	WHC (%)	BD (g/cm^3)	PD (g/cm^3)	Porosity (%)
Mapping Unit 1										
Pedon 1										
Lat: 9.299307	0 - 30	Ap	75.60	19.60	4.80	Loamy sand	36.40	1.69	2.50	32.40
Long: 12.468453	30 - 60	AB	75.60	17.60	6.80	Sandy loam	38.30	1.63	2.67	38.88
Elev: 154m	60 - 100	B_{t1}	45.60	25.60	28.80	Sandy clay loam	48.50	1.36	2.50	45.60
	100 – 167	B_{t2}	25.60	35.60	38.80	Clay loam	51.60	1.28	2.67	52.00
Pedon 2										
Lat:0.299240	0 - 30	Ap	43.60	37.60	18.80	Loam	46.30	1.42	2.67	46.75
Long: 12.468193	30 - 60	AB	37.60	37.60	24.80	Loam	48.20	1.37	2.50	45.20
Elev: 152m	60 - 80	Bhs	77.60	11.60	10.80	Sandy loam	40.80	1.57	2.67	41.13
	80 - 140	Bs	39.60	33.60	26.80	Loam	48.60	1.36	2.50	45.60
Pedon 3										
Lat: 9.297830	0 - 40	Ap	37.60	31.60	30.80	Clay loam	49.50	1.34	2.50	46.40
Long: 12.467547	40 - 80	AB	37.60	37.60	24.80	Loam	48.30	1.37	2.50	45.20
Elev: 155m	80 - 120	B_{t1}	63.60	27.60	8.80	Sandy loam	40.60	1.57	2.67	41.13
	120 – 170	B_{t2}	63.60	17.60	18.80	Sandy loam	44.80	1.46	2.58	43.43
Mapping Unit 2										
Pedon 4										
Lat: 9.297020	0 - 40	Ap	45.60	29.60	24.80	Loam	47.70	1.39	2.50	44.40
Long: 12.468928	40 - 80	AB	37.60	33.60	28.80	Clay loam	49.10	1.35	2.67	49.38
Elev: 154m	80 - 130	B_t	85.60	13.60	0.80	Sand	25.80	1.97	2.50	21.20
	130 – 190	B_w	95.60	4.00	0.40	Sand	21.20	2.09	2.67	21.63

Table 1 (cont'd): Summary of some Physical Properties of Soils of the Study Areas.

Pedon No.	Pedon depth (cm)	Horizon designation	Sand (%)	Silt (%)	Clay (%)	Textural class	WHC (%)	BD (g/cm^3)	PD (g/cm^3)	Porosity (%)
Pedon 5										
Lat: 19.296000	0 - 40	Ap	47.60	29.60	22.80	Loam	47.10	1.40	2.50	44.00
Long: 12.470065	40 - 70	B_{w1}	85.60	11.60	2.80	Loamy sand	32.70	1.78	2.67	33.25
Elev: 152m	70 - 100	B_{w2}	57.60	25.60	16.80	Sandy loam	44.70	1.47	2.50	41.20
	100 – 170	C	67.60	36.60	11.30	Loamy sand	39.40	1.61	2.59	38.02
Pedon 6										
Lat: 9.296848	0 - 20	Ap	53.60	19.60	26.80	Sandy clay loam	47.50	1.39	2.50	44.40
Long: 12.470850	20 - 40	AB	43.60	21.60	34.80	Clay loam	49.70	1.33	2.50	46.80
Elev: 153m	40 - 100	B_t	49.60	29.60	20.80	Loam	46.40	1.42	2.50	43.20
	100 – 130	B_s	53.60	11.60	34.80	Sandy clay loam	49.00	1.35	2.50	46.00
Mapping Unit 3										
Pedon 7										
Lat: 9.297493	0 - 20	Ap	63.60	31.60	4.80	Sandy loam	37.30	1.66	2.67	37.75
Long: 12.471623	20 - 30	AB	81.60	13.60	4.80	Loamy sand	36.00	1.70	2.67	36.25
Elev: 150m	30 - 70	B_h	47.60	11.60	40.80	Sandy clay	50.30	1.32	2.50	47.20
	70 - 100	B_s	29.60	27.60	42.80	Clay	51.90	1.28	2.67	52.00
Pedon 8										
Lat: 9.298635	0 - 10	Ap	43.60	51.60	4.80	Silt loam	38.70	1.62	2.67	39.25
Long: 12.470430	10 – 20	B_w	91.60	5.60	2.80	Sand	32.30	1.76	2.67	34.00
Elev: 154m	20 - 40	B_h	61.60	11.60	26.80	Sandy clay loam	46.90	1.41	2.67	47.13

Table 1 (cont'd): Summary of some Physical Properties of Soils of the Study Areas.

Pedon No.	Pedon depth (cm)	Horizon designation	Sand (%)	Silt (%)	Clay (%)	Textural class	WHC (%)	BD (g/cm^3)	PD (g/cm^3)	Porosity (%)
Pedon 9										
Lat: 9.298122	0 - 30	Ap	41.60	27.60	30.80	Clay loam	49.20	1.35	2.50	46.00
Long: 12.469553	30 - 70	AB	29.60	43.60	26.80	Loam	49.30	1.34	2.50	46.40
Elev: 156m	70 - 120	B_{t1}	37.60	47.60	14.80	Loam	45.40	1.46	2.50	41.60
	120 – 160	B_h	47.60	45.60	6.80	Sandy loam	40.40	1.58	2.67	40.75

KEY: WHC = Water Holding Capacity, BD = Bulk Density, PD = Particle Density

Chemical Properties of the Study Area

The chemical properties assessed included pH, electrical conductivity (EC), organic carbon (OC), total nitrogen (TN), available phosphorus (AVP), exchangeable bases (Ca, Mg, Na, K), exchangeable acidity (H^+ and Al^{3+}), effective cation exchange capacity (ECEC), and percentage base saturation (PBS), as shown in Table 2. Soil pH across pedons 1–9 ranged between moderately acidic and slightly alkaline (5.60–7.70) in both surface and sub-surface horizons (Table 2). pH values varied irregularly with depth but generally decreased downward. These results align with recent observations that Fadama soils are slightly to moderately acidic with declining pH at depth (Adewumi, 2015; Maniyunda & Gwari, 2014). The recorded pH range remains suitable for nutrient uptake in most arable crops (Fasina et al., 2015).

EC values were low across all pedons, ranging from 0.08–0.58 dS/m in both surface and sub-surface horizons (Table 2). Based on Malgwi's classification cited in Musa (2015), the soils are non-saline, consistent with observations from the northern Guinea Savanna (Maniyunda & Gwari, 2014; Musa, 2015). EC generally declined with depth, reflecting leaching and landscape position. Low EC further indicates that salinization is not a significant pedogenic process.

Organic carbon contents in pedons 1–3, 4–6, and 7–9 ranged from 7.68–16.06 g/kg, 7.88–11.27 g/kg, and 5.39–15.76 g/kg in the surface horizons, and 5.99–9.58 g/kg, 7.28–15.66 g/kg, and 8.38–15.56 g/kg in the subsoils (Table 2). Across all soils, organic carbon was rated low to medium (Adewumi, 2015). These results agree with Fasina et al. (2015), reflecting rapid organic matter mineralization driven by high temperatures and continuous cultivation. Organic carbon decreased sharply with depth, consistent with recent findings on land use–organic matter interactions (Adewumi, 2015). Generally low organic matter suggests the need for residue management, legume integration, and N–P fertilization. Similar low values have been reported for Northern Guinea Savanna soils (Maniyunda & Gwari, 2014; Musa, 2015).

Total Nitrogen (TN) ranged from 0.08–0.16%, 0.05–0.16%, and 0.07–0.16% in the surface horizons of pedons 1–3, 4–6, and 7–9; subsoil values were 0.08–0.11%, 0.06–0.10%, and 0.08–0.16% (Table 2). TN was rated very low, likely due to losses through volatilization, denitrification, fixation, and leaching (Awanish et al., 2014). Similar low N levels were reported by Sharu et al. (2013) and Maniyunda & Gwari (2014). TN varied irregularly with depth, reflecting continuous cultivation and residue removal. Its distribution paralleled organic carbon, confirming organic matter as the main N source (Fasina et al., 2015). Comparable observations have been reported for intensively cultivated floodplain soils (Hossain et al., 2011).

Available phosphorus ranged from 3–9 mg/kg, 6–10 mg/kg, and 4–9 mg/kg in surface soils and 5–9 mg/kg, 4–11 mg/kg, and 8–14 mg/kg in subsoils. P levels were uniformly low and remained below the critical 10–16 mg/kg requirement. Values were lower than those reported for similar Nigerian floodplains (Tekwa et al., 2011). Subsoils generally had higher P, attributed to low organic matter and management practices such as bush burning (Adewumi, 2015). Exchangeable Ca ranged from 0.08–0.24, 0.21–0.38, and 0.06–0.40 cmol/kg in surface soils, with similarly low subsoil values. Ca was rated low, likely due to plant uptake and leaching. Exchangeable Mg values were 0.09–0.35, 0.33–0.45, and 0.14–0.41 cmol/kg in surface horizons and increased slightly with depth. Exchangeable Na values were 0.26, 0.13–2.13, and 0.17–1.43 cmol/kg in surface soils and were higher in subsoils; Na was rated high,

consistent with findings in irrigated and alluvial soils (Musa, 2015; Babalola et al., 2011). Exchangeable K ranged from 0.17–0.59, 0.15–0.79, and up to 0.59 cmol/kg and remained medium to high, reflecting both leaching and continuous cropping (Maniyunda & Gwari, 2014).

Exchangeable acidity (H^+/Al^{3+}) was low, with surface values of 2.60, 1.77, and 2.20 cmol/kg, and subsoil values of 2.10, 3.00, and 2.48 cmol/kg, indicating minimal acidity problems. Total Exchangeable Bases (TEB) in surface soils ranged from 0.63–1.35, 1.14–3.51, and 0.77–2.26 cmol/kg, and were generally low, reflecting poor basic nutrient status (Atofarati et al., 2012). Effective Cation Exchange Capacity (ECEC) ranged from 2.82–5.81, 1.60–7.31, and up to 7.42 cmol/kg, showing low and inconsistent depth variations (Fasina et al., 2015). Base saturation in surface soils ranged from 17.32–42.94%, 41.59–75.06%, and 25.89–59.75%, with most soils rated low to medium. This indicates overall low fertility status, consistent with recent studies in savanna and floodplain agroecosystems (Atofarati et al., 2012; Adewumi, 2015).

Table 2: Summary of some Chemical Properties of Soils of the Study Areas.

Pedon No.	Pedon depth	Horizon designation	pH	EC	OC	TN	AVP	Ca	Mg	K	Na	TEB	TEA	ECEC	PBS
	(cm)			(dS/m)	(g/kg)	%	(mg/kg)	→			(cmol(+)/kg)	←			%
Mapping Unit 1															
Pedon 1															
Lat: 9.299307	0 - 30	Ap	7.60	0.12	16.06	0.16	8.00	0.08	0.19	0.64	0.30	1.21	4.60	5.81	20.87
Long:	30 - 60	AB	7.40	0.11	11.37	0.11	3.00	0.15	0.19	0.26	0.26	0.86	2.00	2.86	30.10
12.468453	60 - 100	B_{t1}	6.20	0.10	11.27	0.11	6.00	0.24	0.38	0.59	0.35	1.57	3.20	4.77	32.85
Elev: 154m	100 – 167	B_{t2}	6.50	0.11	10.77	0.11	5.00	0.24	0.24	0.44	0.57	1.49	1.00	2.49	59.83
Pedon 2															
Lat:0.299240	0 - 30	Ap	7.50	0.11	7.68	0.08	3.00	0.24	0.24	0.15	0.30	0.93	2.40	3.33	27.93
Long:	30 - 60	AB	7.70	0.10	8.68	0.09	8.00	0.24	0.35	0.15	0.61	1.35	1.80	3.15	42.94
12.468193	60 - 80	B_{hs}	6.50	0.08	7.88	0.08	6.00	0.32	0.40	0.18	0.26	1.16	2.00	3.16	36.64
Elev: 152m	80 - 140	B_s	6.30	0.14	8.18	0.08	9.00	0.26	0.34	0.18	0.26	1.03	2.40	3.43	30.08
Pedon 3															
Lat: 9.297830	0 - 40	Ap	6.20	0.13	10.97	0.11	9.00	0.09	0.13	0.23	0.57	1.02	1.80	2.82	36.17
Long:	40 - 80	AB	6.20	0.11	9.28	0.09	4.00	0.10	0.09	0.18	0.26	0.63	3.00	3.63	17.32
12.467547	80 - 120	B_{t1}	7.60	0.12	9.38	0.09	9.00	0.06	0.14	0.08	0.48	0.75	1.40	2.15	34.80
Elev: 155m	120 – 170	B_{t2}	6.50	0.10	8.58	0.09	5.00	0.24	0.31	0.10	0.43	1.09	2.80	3.89	28.01
Mapping Unit 2															
Pedon 4															
Lat: 9.297020	0 - 40	Ap	5.60	0.08	13.47	0.13	7.00	0.33	0.45	0.23	0.43	1.45	2.00	3.45	41.95
Long:	40 - 80	AB	7.30	0.12	10.97	0.11	8.00	0.29	0.43	0.18	0.30	1.20	0.40	1.60	75.06
12.468928	80 - 130	B_t	6.30	0.10	8.98	0.09	11.00	0.28	0.27	2.56	0.57	3.68	3.60	7.28	50.53
Elev: 154m	130 – 190	B_w	5.70	0.09	7.88	0.08	8.00	0.26	0.28	0.49	0.35	1.37	3.00	4.37	31.37

Table 2 (Cont'd.): Summary of some Chemical Properties of Soils of the Study Areas.

Pedon No.	Pedon depth	Horizon designation	pH	EC	OC	TN	AVP	Ca	Mg	K	Na	TEB	TEA	ECEC	PBS
	(cm)			(dS/m)	(g/kg)	%	(mg/kg)	→			(cmol(+)/kg)	←			%
Pedon 5															
Lat: 19.296000	0 - 40	Ap	6.80	0.12	12.07	0.12	7.00	0.22	0.33	0.15	0.87	1.58	1.80	3.38	46.67
Long:	40 - 70	B_{w1}	6.50	0.09	5.39	0.05	6.00	0.34	0.43	0.15	0.22	1.14	1.60	2.74	41.59
12.470065	70 - 100	B_{w2}	6.10	0.10	8.98	0.09	8.00	0.36	0.42	0.08	0.17	1.03	2.40	3.43	30.05
Elev: 152m	100 – 170	C	6.30	0.09	9.58	0.10	6.00	0.31	0.37	0.10	0.74	1.52	2.40	3.92	38.80
Pedon 6															
Lat: 9.296848	0 - 20	Ap	6.30	0.11	15.76	0.16	9.00	0.21	0.40	0.79	0.13	1.53	1.00	2.53	60.46
Long:	20 - 40	AB	6.60	0.14	11.37	0.11	10.00	0.38	0.43	0.56	2.13	3.51	3.80	7.31	48.02
12.470850	40 - 100	B_t	6.90	0.22	7.98	0.08	6.00	0.22	0.22	0.23	0.74	1.41	3.40	4.81	29.37
Elev: 153m	100 – 130	B_s	6.30	0.11	5.99	0.06	4.00	0.18	0.26	0.18	0.30	0.93	3.20	4.13	22.48
Mapping Unit 3															
Pedon 7															
Lat: 9.297493	0 - 20	Ap	6.70	0.11	15.66	0.16	4.00	0.40	0.41	1.23	0.22	2.26	3.20	5.46	41.35
Long:	20 - 30	AB	7.30	0.11	7.28	0.07	6.00	0.14	0.20	0.26	0.43	1.03	2.20	3.23	31.91
12.471623	30 - 70	B_h	5.90	0.12	15.56	0.16	8.00	0.23	0.37	1.74	0.26	2.61	2.00	4.61	56.60
Elev: 150m	70 - 100	B_s	6.00	0.11	10.27	0.10	10.00	0.31	0.44	1.46	1.22	3.42	4.00	7.42	46.11
Pedon 8															
Lat: 9.298635	0 - 10	Ap	6.80	0.10	14.86	0.15	8.00	0.27	0.31	1.10	0.39	2.08	1.40	3.48	59.75
Long:	10 – 20	B_w	5.90	0.10	8.98	0.09	4.00	0.17	0.20	0.23	0.17	0.77	2.20	2.97	25.89
12.470430	20 - 40	B_h	7.60	0.58	10.47	0.10	8.00	0.08	0.08	0.23	0.30	0.70	2.20	2.90	24.01
Elev: 154m															

Table 2 (Cont'd.): Summary of some Chemical Properties of Soils of the Study Areas.

Pedon No.	Pedon depth	Horizon designation	pH	EC	OC	TN	AVP	Ca	Mg	K	Na	TEB	TEA	ECEC	PBS
	(cm)			(dS/m)	(g/kg)	%	(mg/kg)	→			(cmol(+)/kg)	←			%
Pedon 9															
Lat: 9.298122	0 - 30	Ap	6.40	0.14	13.17	0.13	5.00	0.09	0.14	0.33	1.43	1.99	2.20	4.19	47.52
Long:	30 - 70	AB	7.40	0.11	9.08	0.09	9.00	0.06	0.14	0.08	0.57	0.84	2.00	2.84	29.63
12.469553	70 - 120	B_{t1}	6.40	0.11	8.38	0.08	13.00	0.06	0.30	0.13	0.43	0.93	2.00	2.93	31.67
Elev: 156m	120 – 160	B_h	6.40	0.12	9.68	0.10	14.00	0.20	0.27	0.05	0.57	1.08	2.20	3.28	33.02

KEY: EC = Electrical Conductivity, OC = Organic Carbon, OM = Organic Matter, TN = Total Nitrogen, AVP = Available Phosphorus, Ca = Calcium, Mg = Magnesium, K = Potassium, Na = Sodium, TEB = Total Exchangeable Bases, TEA = Total Exchangeable Acidity, ECEC = Effective Cation Exchange Capacity, PBS = Percentage Base Saturation

Summary and Conclusion

The study investigates the agricultural potential of soils within the Girei floodplain of Adamawa State, Nigeria, focusing on their morphological, physical, and chemical characteristics. Floodplain environments in the region are recognized for their high agricultural productivity due to periodic sediment deposition and improved moisture conditions. However, spatial heterogeneity arising from variations in flooding intensity, sediment origin, drainage patterns, and geomorphology creates substantial differences in soil fertility. This study addressed the lack of detailed soil information by conducting systematic field surveys, soil profiling, and laboratory analyses across nine pedons distributed along three mapping units. Results show that sand dominates the particle-size distribution of most pedons, with clay generally increasing with depth due to eluviation–illuviation processes. Bulk density and porosity values fell within ranges favorable for root penetration and water movement, although a few pedons showed compaction associated with grazing or low organic matter. Water-holding capacity was moderate to high, reflecting the influence of frequent flooding and shallow groundwater.

Chemically, soil pH ranged from moderately acidic to slightly alkaline, suitable for most arable crops. Electrical conductivity values were low, confirming non-saline conditions. Organic carbon and total nitrogen levels were generally low to medium, indicating rapid mineralization and continuous cultivation pressure. Available phosphorus remained below critical thresholds, making P a major limiting nutrient. Exchangeable Ca and Mg were low, while Na and K were relatively higher in some pedons. Effective CEC and base saturation were low to medium, reflecting the overall low fertility status of the soils.

The study concludes that while the Girei floodplain soils possess favorable physical properties such as good porosity, moderate water-holding capacity, and suitable pH their chemical fertility is generally low. Key nutrient constraints include low organic carbon, very low total nitrogen, and suboptimal available phosphorus, alongside low exchangeable Ca and Mg. These limitations are linked to continuous cultivation, rapid organic matter decomposition, and leaching.

Despite these challenges, the soils remain productive when properly managed. Sustainable soil management strategies such as organic matter incorporation, balanced N–P fertilization, reduced residue burning, controlled grazing, and soil conservation practices are recommended. Improved soil information from this study will support farmers, extension workers, and policymakers in optimizing land use, enhancing productivity, and maintaining long-term soil health within the floodplain environment.

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