OPEN ACCESS

Global Journal of Research in Agriculture & Life Sciences
ISSN: 2583-4576 (Online)
Volume 06 | Issue 02 | March-April | 2026
Journal homepage: https://gjrpublication.com/gjrals/

Research Article

Quality Assessment of Hydromorphic Soils in Koko-Besse Local Government Area of Kebbi State, Nigeria

*Ogbobe M. O [1], Augie M. A [1], Y. B. Attahiru [2] and Ibrahim M [2]

[1] Department of Soil Science Faculty of Agriculture. Abdullahi Fodiyo University of Science and Technology, Aliero.
[2] Department of Civil Engineering Faculty of Engineering. Abdullahi Fodiyo University of Science and Technology, Aliero.

DOI: 10.5281/zenodo.19875165 **Submission Date: 20 March 2026 | Published Date: 29 April 2026**

***Corresponding author: Ogbobe M. O**
Department of Soil Science Faculty of Agriculture. Abdullahi Fodiyo University of Science and Technology, Aliero.

Abstract

This study aimed at assessing the quality status of hydromorphic soils in Koko-Besse Local Government Area of Kebbi State, Nigeria. Soil samples were collected from three villages namely Koko, Dada, and Asarara within the study area. The samples were air-dried, processed, and analyzed in the laboratory for selected physical and chemical properties. The samples were analyzed for various parameters such as soil texture, organic carbon, total nitrogen, available phosphorus, soil pH, electrical conductivity (EC), cation exchange capacity (CEC), exchangeable bases (Ca, Mg, K, and Na), and exchangeable sodium percentage (ESP) following standard procedure given by Sparks et al,(1996).The data obtained were subjected to analysis of variance (ANOVA) and significant differences among means were separated using the Least Significant Difference (LSD) at 5% probability level, results of the particle size distribution revealed that the soils were predominantly sandy loam in texture with overall mean values of 85.52% sand, 8.79% silt and 5.69% clay. The organic carbon content of the soils was low with a mean value of 3.21 g kg^{-1}, suggesting poor organic matter status, the total nitrogen content was relatively high with a mean value of 0.26 g kg^{-1}, which could be attributed to continuous application of nitrogen-based fertilizers by farmers in the study area. The available phosphorus content was very low with a mean value of 1.33 mg kg^{-1}. The mean values for Ca, Mg, K, and Na were 0.50, 0.31, 0.15 and 0.34 cmol(+) kg^{-1} respectively, while the cation exchange capacity was low with an overall mean value of 1.34 cmol(+) kg^{-1}, indicating low nutrient retention capacity. Soil pH ranged from 5.09 to 5.36 with an overall mean value of 5.20, indicating that the soils were slightly acidic in reaction. Electrical conductivity values were very low (0.02 dS m^{-1}), indicating that the soils were non-saline. However, the exchangeable sodium percentage (ESP) was relatively high with an overall mean value of 24.97%, therefore, appropriate soil management practices such as application of organic amendments, phosphorus fertilization, liming of acidic soils, and proper drainage management could be recommended to improve soil fertility and ensure sustainable agricultural production in the area.

Keywords: *Hydromorphic soil, laboratory, physical and chemical, fertilizer, soil samples.*

1.0 INTRODUCTION

Soil is a fundamental component of the ecosystem and serves as the primary medium for plant growth. Hydromorphic soils develop under conditions of excess water, typically in floodplains and lowland environments. These soils play a crucial role in agriculture, especially in regions where irrigation and moisture availability support year-round crop production (Ahmadu and Ibrahim 2022).

In Nigeria, particularly in Kebbi State, hydromorphic (fadama) soils are widely used for farming. Despite their importance, their productivity is influenced by several factors such as nutrient availability, soil structure, salinity, and

drainage conditions. Increasing population pressure has intensified agricultural activities, often leading to soil degradation and declining productivity.

Recent studies emphasize the need for integrated soil quality assessment using both fertility and environmental indicators. Understanding the physical and chemical properties of soils is essential for developing sustainable management strategies (FAO, 2006).

Farmers in Koko-Besse LGA face challenges including poor soil fertility, waterlogging, and possible salinity/sodicity issues. These constraints reduce crop yields and limit sustainable agricultural production. The lack of detailed soil data further hinders effective land management decisions (Adeboye *et al*., 2009).

This study provides essential data on soil quality, which can guide farmers, researchers, and policymakers in improving agricultural productivity. It also contributes to sustainable soil management practices in the region.

The main aim is to assess the quality of hydromorphic soils in Koko-Besse LGA, determine physical properties of the soils, evaluate chemical properties, Assess salinity and sodicity status.

The study focused on selected fadama areas (Koko, Dada, and Asarara). Parameters analyzed included soil texture, pH, EC, ESP, CEC, and exchangeable bases.

2.0 Materials and Methods

The study area lies in the Sudan Savanna zone of Nigeria, characterized by moderate rainfall and seasonal flooding. Agriculture is the main occupation.

2.1 Soil Sampling

Samples were collected from Koko, Dada, and Asarara villages at 0–20 cm depth using a random sampling technique.

2.2 Laboratory Analysis

Standard procedures were used: Particle size: Hydrometer method, Organic carbon: Walkley-Black method, Nitrogen: Kjeldahl method, Phosphorus: Bray I method, pH and EC: Meter readings, Exchangeable bases: Ammonium acetate extraction (Bray and Kurz, 1945).

2.3 Data Analysis

Data obtained were analyzed using ANOVA and LSD at 5% significance level.

3.0 RESULTS AND DISCUSSION

Table 3.1: Particle Size Distributions and Textural classes (Physical Properties) of the Soil of the Study Area

Location	Sand (gkg^{-1})	Silt (gkg^{-1})	Clay (gkg^{-1})	Texture
Asarara	85.00^{b}	8.52^{b}	6.48^{a}	Loamy Sand
Dada	82.96^{c}	10.68^{a}	6.36^{a}	Loamy Sand
Koko	88.59^{a}	7.17^{b}	4.20^{b}	Sandy Soil
Overall Mean	85.52	8.79	5.69	Sandy Loam
LSD	2.231	2.041	2.201	

Means having different letter(s) along the same column differed significantly at $P<0.05$

3.2 Soil Texture

The soils were predominantly sandy loam with mean values, Sand: 85.52%, Silt: 8.79%, Clay: 5.69%. This indicates low water and nutrient retention capacity.

3.3 Chemical Properties of The Soil of the Study Area (Organic carbon Total Nitrogen and Available phosphorus)

Organic carbon is essential for improving both the physical and chemical properties of soil, and soils with high organic carbon are generally considered fertile. The study revealed an organic carbon content of 3.21 g/kg, which is classified as low based on the rating scale. This finding agrees with previous studies in the West African savanna, where hydromorphic soils are typically low in organic carbon. Similarly low values have been reported by various researchers, indicating that low organic carbon is a common characteristic of these soils Singh *et al.* (1996), and Singh (1999b).

The mean total nitrogen content of the soil was 0.26 g/kg, which is rated as high. This contrasts with earlier reports that savanna and hydromorphic soils in northwestern Nigeria are usually low in nitrogen. The relatively high nitrogen content

observed may be attributed to continuous application of fertilizers such as urea and NPK by farmers, as well as the sandy loam texture of the soil. This nitrogen level suggests that the soils can support good crop production under proper management practices Singh (2001).

Available phosphorus in the study area was 1.33 mg/kg, which is considered low. The highest value was recorded in Dada (2.37 mg/kg), while the lowest was observed in Koko (0.29 mg/kg). The low phosphorus availability may be due to the slightly acidic to neutral soil pH, which reduces phosphorus availability through fixation by iron and aluminum compounds. Overall, the soils are characterized by low organic carbon and phosphorus but relatively high nitrogen, indicating the need for improved soil fertility management (Isirimah *et al.,* 2010).

Table 3.2: Organic carbon Total Nitrogen and Available phosphorus

Location	O.C gkg^{-1}	TN gkg^{-1}	AP (mgkg^{-1})
Asarara	2.87^{b}	0.31^{a}	1.32
Dada	5.09^{a}	0.31^{a}	2.37
Koko	1.67^{b}	0.17^{b}	0.29
Overall Mean	3.21	0.26	1.33
LSD	2.150	0.160	1.110

Means having different letter(s) along the same column differed significantly at P<0.05

3.4 Exchangeable Cations

The exchangeable cations of the soils in the study area—Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}—play significant roles in soil fertility and plant growth. The mean exchangeable calcium (Ca^{2+}) was 0.50 cmol (+) kg^{-1}, with the highest value recorded in Dada. This value is relatively low compared to findings from other regions in Nigeria, suggesting moderate soil fertility and less dominance of calcium in the exchange complex Mustafa *et al.* (2001), Singh (1997b), and Yusufu *et al.* (2004).

Magnesium (Mg^{2+}) had a mean value of 0.31 cmol (+) kg^{-1} and was rated high, making it the second most abundant cation after calcium. While this reflects the typical dominance of Mg^{2+} in West African soils, excessive levels may predispose the soils to salinity problems if not properly managed (Jones and Wild, 1975). Similar studies include Abdullahi and Dauda (2002), Singh *et al*. (2002), Mustafa *et al.* (2001), and Yusufu *et al*. (2004).

Potassium (K^{+}) recorded a mean value of 0.15 cmol (+) kg^{-1}, which falls within the low to medium range. This indicates that the soils can respond positively to potassium fertilizer application for improved crop yield. Sodium (Na^{+}), with a mean value of 0.34 cmol (+) kg^{-1}, was rated high. Elevated sodium levels may negatively affect soil structure, permeability, and aeration, possibly due to irrigation practices and prevailing arid conditions Singh *et al.* (1996), and Singh *et al.* (2002).

The Cation Exchange Capacity (CEC) of the soils averaged 1.34 cmol (+) kg^{-1}, with the highest value in Dada and the lowest in Asarara. These values are generally low compared to other studies, indicating limited nutrient retention capacity. Overall, while Mg^{2+} and Na^{+} are relatively high, the low Ca^{2+}, K^{+}, and CEC suggest the need for improved soil fertility and management practices (Mustafa *et al.,* 2001).

Table 3.3: Mean Value of Ca^{2+} Mg^{2+} Na^{+} K^{+} and CEC of the Soil of the Study Area

S. Location	Calcium^{2+}	Mg^{2+}	Na^{+}	K^{+}	CEC (Cmol (+) kg^{-1}
Asarara	0.45	0.32	0.26	0.13	1.27
Dada	0.66	0.33	0.51	0.18	1.39
Koko	0.39	0.28	0.24	0.15	1.35
Overall Mean	0.50	0.31	0.34	0.15	1.34
LSD	0.356	0.350	0.311	0.232	1.200

Means having different letter(s) along the same column differed significantly at P<0.05

3.5 Soil pH, Electrical Conductivity, and ESP

Soil pH is a key factor controlling nutrient availability and overall soil fertility. The study area recorded a mean pH of 5.2, indicating that the soils are acidic. Among the sampling locations, Koko had the highest pH (5.36), while Dada recorded the lowest (5.09). Acidic conditions can increase the availability of toxic elements such as iron, manganese, and aluminum, while also reducing phosphorus availability through fixation. The observed pH is lower than values reported for semi-arid Nigerian soils, suggesting the need for soil amendment practices such as liming to improve soil conditions for optimal plant growth and microbial activity (Jones and Wild, 1975).

Electrical conductivity (EC), which measures soluble salt content, was uniformly low across all sampling locations, with a mean value of 0.02 dS/m**.** This indicates that the soils are non-saline and free from salinity-related constraints to crop production. The values are consistent with previous findings for similar soils in the Sokoto-Rima Basin (Mariya *et al,* 1982).

Exchangeable Sodium Percentage (ESP), which indicates the degree of sodium saturation in the soil, had a mean value of 24.97%, which is relatively high. Dada recorded the highest ESP (36.69%), while Koko had the lowest (17.79%). High ESP levels can lead to soil alkalinity, poor structure, reduced permeability, and restricted plant growth. Overall, while salinity is not a major issue, the high ESP and acidic pH highlight the need for proper soil management practices to improve soil quality and productivity (Isirimah *et al.,* 2010; Singh *et al.,* 2002; Graham and Singh, 1997).

Table 3.4: Concentration of Temp, pH, Temp, EC and ESP of The Soil of the study Area

Location	Temp	pH	E.C (dsm^{-1})	ESP (%)
Asarara	27.00	5.17	0.02	20.47
Dada	27.00	5.09	0.02	36.69
Koko	27.00	5.36	0.02	17.77
Overall Mean	27.00	5.20	0.02	24.97
LSD	1.52	1.01	0.100	

Means having different letter(s) along the same column differed significantly at P<0.05

3.6 Salinity and Sodicity status: Assessment of soil salinity and sodicity is important because of their effect on crop performances and soil physical conditions. While high salt content in saline soils inhibits the uptake of plant nutrients and water, high sodium content in sodic soils destroys soil structure consequently, reducing the rate of permeability and aeration.

Table 3.4 indicated that the temperature, pH, EC (dS m^{-1}) and ESP (%) were valued at 27.00°C, 5.02, 0.02 dS m^{-1} and 24.97%, respectively. According to the criteria in (Table 3.4) set by Richards (1954), soils with EC > 4 dS m^{-1}, ESP < 15% and pH < 8.5 are saline; those with EC > 4 dS m^{-1}, ESP > 15% and pH < 8.5 are saline-sodic; while those with EC < 4 dS m^{-1}, ESP > 15% and pH > 8.5 are sodic. The soil is free from salinity but measures should be taken to prevent further accumulation of Na ions to avoid sodicity hazard on the soil of the study area.

Soil	**EC (dsm^{-1})**	**ESP (%)**	**pH**	**Description**
Saline	>4	<15	<8.5	Non-sodic soils containing sufficient soluble soils to interfere with growth of most crops
Saline Sodic	>4	>15	<8.5	Soils with sufficient exchangeable sodium to interfere with growth of Sodic most plants, and containing appreciable quantities of soluble salts
Sodic	>4	>15	>8.5	Soils with sufficient exchangeable. sodium to interfere with growth of most plants, but without appreciable quantities of soluble salts

Source: Richard (1954)

Conclusion

The hydromorphic soils of the study area have moderate potential for agricultural production but are limited by low organic matter, low phosphorus, low potassium, and low nutrient retention capacity. Although nitrogen levels are adequate, the overall fertility status remains low to moderate. The slightly acidic nature of the soils is favorable, but the high sodium content poses a future risk to soil structure and productivity if not properly managed.

Recommendations

Organic amendments: Apply manure, compost, and crop residues to improve soil fertility and structure. Phosphorus fertilization: Use fertilizers such as SSP or TSP to correct phosphorus deficiency. Potassium supplementation: Apply potassium fertilizers (e.g., NPK) to balance nutrients. Liming: Periodically lime the soil to correct acidity and enhance nutrient availability. Sodium management: Monitor sodium levels and adopt proper drainage and leaching practices to prevent sodicity.

Reference

1. Abdullahi, A. & Dauda, O. (2002). Fertility evaluation of soils of Gwagwalada area, Abuja Nigeria. *Nigerian Journal of Soil Research*, 3, 12-19.
2. Adeboye, M. K. A., Osunde, A. O., Ezenwa, M. I. S., Odofin, A. J., & Bala, A. (2009). Evaluation of fertility status and suitability of some soils for arable cropping in the Southern Guinea Savanna of Nigeria. *Nigerian Journal of Soil Science*, 19(2), 16–118.
3. Ahmadu, M. A., & Ibrahim, M. (2022). Assessment of physical and chemical properties of the hydromorphic soils of Birnin Kebbi Local Government Area, Kebbi State, Nigeria. Science *Journal of Advanced and Cognitive Research*, 3(1), 52–61.
4. Bray and Kurtz L. T. (1945). Determination of total, organic and available forms Phosphorus in soils. Soil Science, 59: 39-45.
5. FAO. (2006). Guidelines for soil description (4th ed.). Rome: Food and Agriculture Organization.
6. Graham, W. R. and B. R. Singh (1997). Soil and water quality under large irrigation in semi-arid ecosystem I. Wurno Irrigation Project area Sokoto State In: B. R. Singh (edn.). Management of Marginal lands in Nigeria. Proceedings of the 23rd Annual Conference of the Soil Science Society of Nigeria, held at Usmanu Danfodiyo University Sokoto 2nd – 5th March, 1997, pp.209-218
7. Isirimah, N. O. Dickson, A. A. & Ikpe, F. N. (2010). Introduction to Soil Chemistry and Biology for Agricultural and Biotechnology. Osia International Publishers Ltd., Nigeria. 175–228 pp. (textbook covering soil chemistry and biology fundamentals).
8. Jones, M. J. & Wild, A. (1975). Soils of the West African Savanna: The maintenance and improvement of their fertility. Technical Communication No. 55, Commonwealth Bureau of Soils, Commonwealth Agricultural Bureaux, Harpenden, England; 246 pp. ISBN 0851983480. (Classic reference for savanna soil properties and management).
9. Mustafa, M. (2001). Properties and classification of soils develop over basement complex and sedimentary rocks in Bauchi State, *Nigerian journal of soil research*, 2(1), 45-52
10. Richards L. A. (1954). Diagnosis and Improvement of Saline and Alkaline soils. USDA Handbook No. 60, US Government Printing Office, Washington D.C
11. Singh, B. R., Ibrahim S. A. and Augie M. A. (2002). Quality of fadama soils irrigated with tube well water in Sokoto State Nigeria. *Journal of Agriculture and Environment* 3: 183-186
12. Singh, B. R., & Tsoho, H. K. (2001). Fertility and salinity/sodicity studies of fadama soils in north-western Nigeria III. In Sokoto State along perennial surface water bodies. *Nigerian Journal of Basic and Applied Sciences*, 10, 12–16
13. Singh, B. R. (1999b). Fertility and salinity/sodicity status of fadama soils of North western Nigeria. In Kebbi State journal of Basic and Applied Sciences. Pp. 1-14
14. Singh, B. R. (1997b). Characteristics of fadama soils in Sokoto Rima Basin in Dundaye District, Sokoto State. In B. R, Singh (edn.). Management of soil resources of Nigeria for sustainable agricultural production in the 21st Century Proceedings of the 25th Annual Conference of the soil science society of Nigeria, held at Benin 21st- 25th Non, 1999, pp 147-152
15. Singh, B. R., Babaji, G. A. and Ibrahim S. A. (1996). Characteristics of soils in Dundaye 1. District 3. The soils and water quality along the Kandoli Shela stream valley. *Nigerian journal of basic and applied Science*, 5: 77-84.
16. Yusufu, A. A, Amadu, A. F Ebenjohnson and V. O. Chude (2004). "Characteristic of fertility status of tin mine soils of the Jos Plateau Nigeria." *Nigerian journal of Soil Resources* 5: 44-52

CITATION

Ogbobe M. O, Augie M. A, Y. B. Attahiru, & Ibrahim M. (2026). Quality Assessment of Hydromorphic Soils in Koko-Besse Local Government Area of Kebbi State, Nigeria. In Global Journal of Research in Agriculture & Life Sciences (Vol. 6, Number 2, pp. 67–71). https://doi.org/10.5281/zenodo.19875165