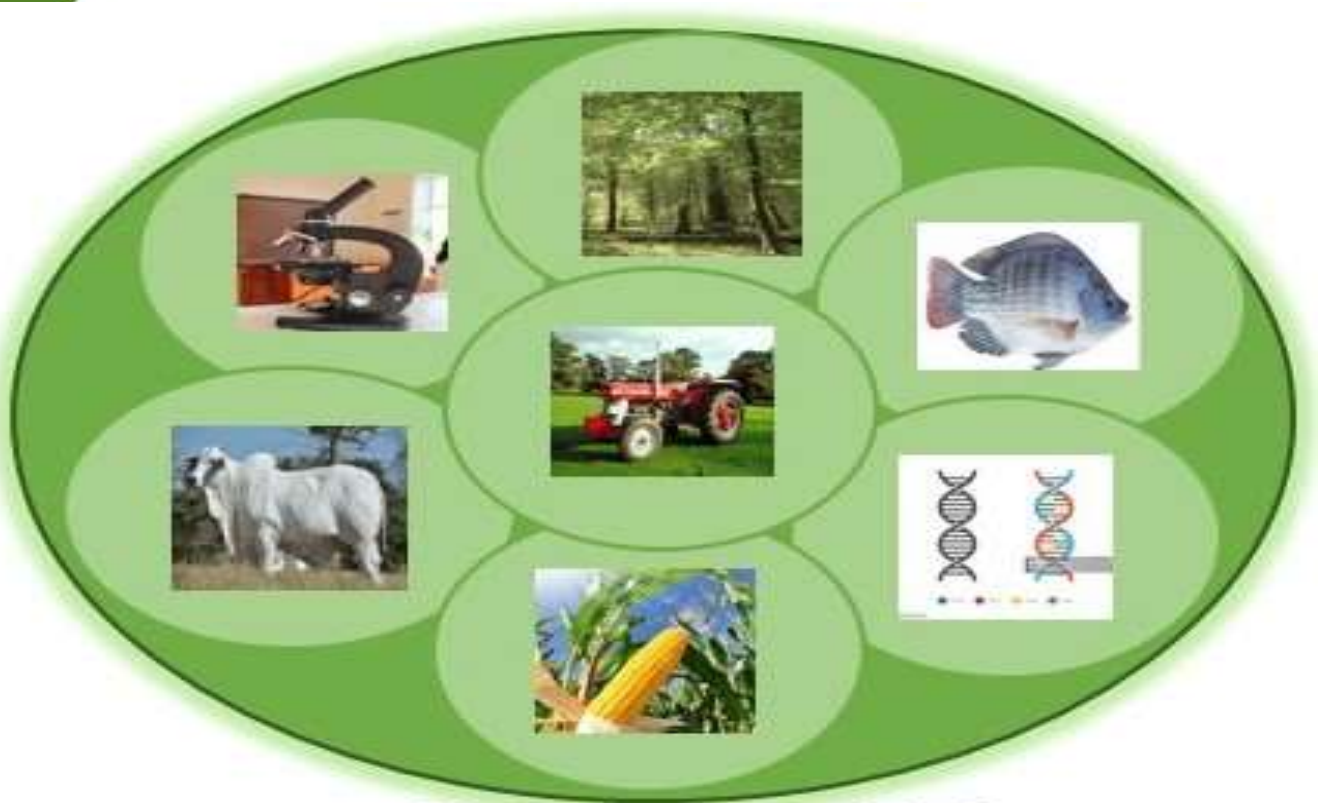




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ALIERO

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This official scientific publication of the Faculty of Agriculture, Abdullahi Fodio University of Science and Technology Aliero, is a non-profit, open access, double-blind peer-reviewed Journal publishing four issues (January, April, July and October) per annum. The Journal is a platform open to collaborations with researchers, authors, institutions, research agencies and private companies related to Agriculture. The Mission of the Journal is to disseminate scientific knowledge through the publication of original research articles, research notes, book reviews, letters to the editor and reviews of Literature, representing a contribution to scientific and technological knowledge in respective areas covered by the Journal. The Kebbi Journal of Agriculture and Natural Sciences seeks to validate and disseminate new knowledge, making it public in order to strengthen the human capacity, constitute a link in the scientific community to the society and encouraging the expansion of University and academic researches.

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The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

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SOIL ASSESSMENT AND SUITABILITY CRITERIA FOR THE CULTIVATION OF CEREAL CROPS IN THE ALIERO AREA OF KEBBI STATE, NIGERIA

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ABSTRACT

The study was carried out to assess soils and the suitability criteria for the cultivation of cereals crops in Abdullahi Fodiyo University of Science and Technology Teaching and Research Farm, Aliero, Sudan Savannah Agroecology. The objectives were to classify the soils and determine its suitability for cereal cultivation in the study area; map the soils of study area. An intensive grid survey was carried out on a 50ha land at a scale of 1:25,000. The land was gridded at 100 x 100m² intervals apart. A baseline was established, followed by augering along intersects for surface sampling of soils to determine boundaries based on differences in soil properties. In each soil mapping unit identified, a soil profile pit was dug, described and soils sampled from each identified genetic horizon from bottom up to minimize contamination by falling debris, for laboratory analysis. Each profile pit was dug to standard size: 150cm length, 100cm width and 200cm depth or until an encounter with impenetrable layer or water table. The description was in accordance with international guidelines. Data sets of measured parameters were subjected to descriptive statistics using means, ranges and percentages. Three mapping units were identified and denoted as TRA1, TRA2 and TRA3. The soils were deep, well-drained, to poorly drained. Textural classes ranged from sand to sandy clay loam. while MC value was low. The fertility was low as indicated by low values of TN, OM, OC, AP, and CEC, as 0.09gkg⁻¹, 1.26%, 0.73% 6.70mgkg⁻¹ and 1.46cmolk⁻¹ respectively. The soils were slightly sodic and non-saline based on ESP and EC ratings. Classification based on USDA Taxonomy system, placed the mapping units as: TRA1 (*Haplustults*), TRA2 (*Haplusterts*) and TRA3 (*Haplustalfs*), which correlated with *Acrisols*, *Vertisols* and *Luvissols* respectively in the WRB system. Land evaluation and suitability showed moderately suitable(S2) for TRA3, marginally suitable(S3) for TRA1, TRA2 and currently not suitable (N) due to acidity, for guinea corn production base on limitation highlighted above remedial majors such as liming organic amendment, gypsum application drainage channel cover cropping and crop rotation are necessary for improved productivity and environmental sustainability.

Keywords: Agroecology, Cereals, Toposequence, Grid, Augerig, Intersects

Introduction

Agricultural production in its view suggests the use of fertile and suitable land for increased yield. The mechanics of food supply correlates number of farmers, variety of crops and soil

fertility gauge. Life sustainability without food simply suggests death. Therefore, no group of people, tribes, languages, and society can exist without farming. In Africa, every family is involved in farming activities, either crop or



animal farming, in large or small scale production. Nigeria in particular, is considerably an Agrarian society with a large agricultural land mass but faced with increased poverty, low food supply and human insecurity, hunger and starvation, and low human capital development (FAO 2006; Usman 2016). While concerted effort is needed to tackle the red-devil menace of human insecurity by Boko Haram, Banditry, farmers-herders clashes and cattle rustling cum kidnappings, there is also need to take a cursory look at the soils of Kebbi State and Aliero in particular as a study area in this research, to generate soil information. This information will be useful in understanding the true nature and properties of the soils to evolve a good systematic approach and management practices that will benefit the immediate farming community of Aliero, knowledge seekers and the entire people of Kebbi State. The Sudan Savanna region is coming under increasing pressure from expanding human population. It has been noted that, the expected population size depends critically on the availability of essential resources and to a large extent, on the availability of suitable habitat (Kumar et al 2006). Resource conservation entails sustainable utilization of resources with the aim of satisfying the societal needs without undue damage to the resource base (Kumar et al 2006). The need for accurate and necessary information on the prevalence and composition of soil types, extent, and the integration of ideas to obtain specific adequate information becomes imminent. Thus, the study; soil assessment and suitability criteria for the production of cereals crops in Abdullahi Fodiyo University of Science and Technology Teaching and Research Farm, Aliero Sudan Savannah Agroecology fits in the right place for use in many future aspects of Agricultural and Sustainable economic development as this aligns with the views of Hartemink (2006).

The Sudan Savannah Agroecology, characterized by its distinctive climatic and ecological features, significantly influences the composition and characteristics of its soils. The interplay of climate, vegetation, and topography in this region gives rise to specific soil properties, emphasizing the importance of further detail study of the soils. Critical insights into the soil ecosystem are gained through soil classification and suitability criteria, which are vital for fostering the adoption of sustainable agricultural practices (Hou et al 2020). A detailed examination of the suitability of the soil forms the basis for soil assessment, providing a comprehensive understanding of its composition and behavior. This knowledge is indispensable for farmers, researchers, and land managers, guiding decisions related to land use, crop selection, and appropriate agricultural interventions. Classification systems, such as those offered by the World Reference Base for Soil Resources (WRB) or the United States Department of Agriculture (USDA) Soil Taxonomy, play a crucial role in systematically categorizing the diverse soils within the Sudan Savannah Agroecology. The study could therefore add to existing literature and provide a basis for specific soil inventory in Aliero, for informed decisions and prediction for future land use, management and conservation practices; as well as foster food sufficiency, economic well-being and agricultural sustainability of the area. The aim of the research was to assess soils and its suitability criteria for the production of cereal crops in Abdullahi Fodiyo University of Science and Technology Teaching and Research Farm, Aliero. The specific objectives were to classify the soils and determine its suitability for cereal cultivation and map the soils of the study area.

Materials and Method

The Study Area

Abdullahi Fodiyo University of Science and Technology Teaching and Research Farm, Aliero is located on Latitude 12° 16' 25.20''N and Longitude 4° 27' 3.59''E - serves as an agricultural research and training facility for the people of Kebbi State and Nigeria at large. It has a land area of over 8.2 hectares (82,000m²). And is bordered in the East by Tambuwal Local Government Area of Sokoto State; in the Northwest by Birnin Kebbi Local Government Area; in the Southwest by Jega Local Government Area (Ambursa et al 2020). Kebbi State has 21 Local Government Areas and covers a total land area of 36,229 km² of which 12,600km² is under cultivation (KARDA 2008). The population is estimated about 3,630,931 people (NPCN-KB 2007).

The natural vegetation of Kebbi state consists of a mix pattern: Northern guinea Savannah in the South and Southeast, Sudan Savannah in the Western part, Sahel Savanna in the extreme Northwest and Northeast (Ambursa et al 2020). The vegetation is characterized by dense population of grasses with scanty shrubs and few trees (coexistence of trees and grasses); high rainfall variability and high temperature (Ambursa et al 2020). Natural vegetation in Aliero is characterized by open woodland with scattered trees such as *Pakia biglobosa*, *Vitellaria paradoxa*, *Combretum* species and *Dum palms* etc (Ambusa et al 2020).

Aliero enjoys a tropical type climate generally characterized by wet and dry season. The rainfall begins April with the heaviest rainfall recorded in July and August. The cold

harmattan periods that come with dust laden wind prevails in the month of November to February, while the months of March to May are extremely hot. The mean annual temperature varies considerably but usually stands at 42°C. The mean annual rainfall is 500mm (Amburs et al 2020). Relative humidity range is 21-47% and 57-59% during the dry and rainy seasons respectively.

The soils of Kebbi State are mostly Entisols (Usman 2007) and Aridisols (Soil Survey Staff 2010). They are highly weathered and fragile with low activity clays, thus making their fertility decline under continuous arable cropping (IUSS 2022). As Aridisols, they are characterized as slowly permeable with most of the water lost by run-off (Moss 1975). Some soils in Kebbi State have also been attributed to ferruginous tropic soil and characterized as having sandy texture, covering a large area of land with very low water holding capacity and low organic matter, Nitrogen, Phosphorus content, neutral or moderately acidic in pH and also having low cation exchange capacity (CEC).

An intensive grid soil survey was conducted in the Abdullahi Fodiyo University of Science and Technology Teaching and Research Farm, Aliero. A scale of 1:25,000 covering a 500,000m² (50 ha) land was adopted. This was done first by establishing a baseline, thereafter soil augering carried out along grid intersects at 100m x 100m interval to identify soil types, surface texture and boundaries based on landforms within the study area (Fig.2). In addition, Visual Soil Assessment (VSA) as well as environmental assessment was conducted.

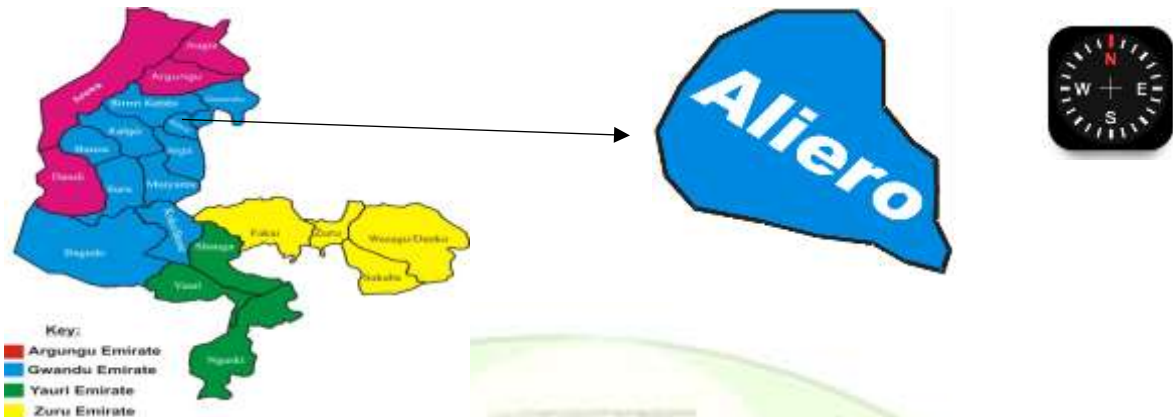


Figure 1: Maps of Kebbi State (Left) and Aliero (Right) Extracted from Map of Kebbi State) Source; Kebbi State Geographic Information System (KSGIS) 2025.

Soil Profile Description

Each soil mapping unit identified in the study area, had a profile pit dug and described. Soil samples from each horizon were collected from bottom up the profile to minimize contamination by falling debris, for laboratory analysis. Each profile pit was dug to standard at 150cm length, 100cm wide and 200cm depth or until an impenetrable layer or water was encountered. Description of each profile pit

was done according to (FAO 2006; Soil Survey Staff 2015) guidelines. Soil depth, horizon thickness, colour of matrix and mottles, inclusive materials, roots and horizon boundary was determined and described for each horizon of the pedons. Also, records of vegetation and land use for each profile were obtained (Fig.3).

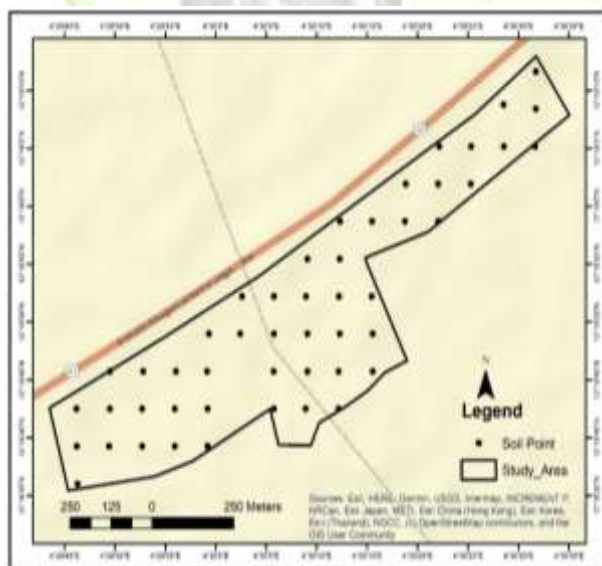


Figure 2. Surface Sampling Points of the Study Area Source: field survey and mapping 2025.

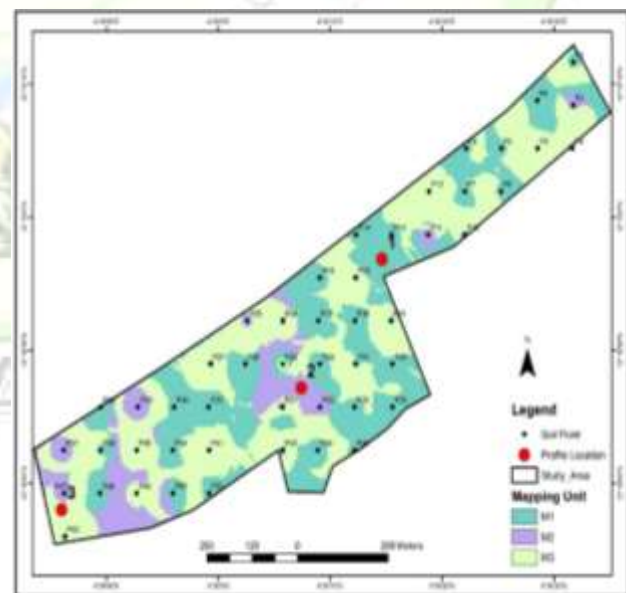


Figure 3. Soil Mapping Unit Source: field survey and mapping 2025.

Laboratory Analyses

Soil samples collected from each genetic horizon and those from surface soils were air-dried in the laboratory, crushed with porcelain pestle and mortar, sieved to remove materials greater than 2mm (gravel). Thereafter, the following soil analyses of the processed sample (less than 2mm soil particles) were carried out.

Determination of Soil Chemical Properties

i. *Organic Carbon (OC)*

Soil organic carbon was determined using the Wet Oxidation Method as suggested by Nelson and Summar (1986). The method involved digesting the soil sample with a mixture of conc acid-dicromate ($K_2Cr_2O_7$ and H_2SO_4 and H_2PO_4) and adding phenyl amine indicator. The excess $K_2Cr_2O_7$ was then titrated with $FeSO_4 \cdot 7H_2O$ solution (1N).

ii. *Total Nitrogen*

Total Nitrogen was determined by Micro Kjeldahl digestion and distillation method as described by Jackson (1962). The method involved digesting 2g of soil sample in concentrated H_2SO_4 and heating in a block digester at very high temperature (4000C), broth turn clear. The clear mixture was diluted with water and 40% NaOH was added to the mixture and the mixture distilled in Micro-Kjeldahl apparatus and received in boric acid. This was then titrated with 0.1m HCl (Jackson et al 1975).

iii. *Available Phosphorus*

Available Phosphorus was extracted using Bray-1 method (0.025M HCl + 0.03M NH_4F) as described by Bray and Kutz (1945). Available Phosphorus in the extract was determined colorimetrically using blue

ammonium molybdate ascorbic acid method.

iv. *pH*

Soil pH was determined using glass electrode digital pH meter in a 1:2 soil water mixture.

v. *Exchangeable Basic Cations*

Exchangeable Basic Cations (Ca, Mg, K and Na) in the soil were extracted with 1.0M ammonium acetate (NH_4OAc) extracting solution buffered at pH7. Exchangeable Ca and Mg were determined by EDTA titration method. Flame photometry method (Uriyo and Singh 1974) was used to determine Exchangeable K and Na concentration in solution.

vi. *Cation Exchange Capacity (CEC)*

Soil CEC was determined by ammonium saturation method as described by Chapman (1965). The soil will be saturated with excess neutral NH_4OAc solution and washing with excess alcohol.

vii. *Electrical Conductivity (EC)*

Electrical Conductivity meter was used to determine the electrical conductivity in a 1:2 soil water ratio at 250C. The result was multiplied by a conversion factor of 2.063 as suggested by Alberta Provincial Laboratory in 1988 to obtain the saturation extract.

Soil Classification and Evaluation

Soil classification was based on the USDA Soil Taxonomy guideline (Soil Survey Staff, 2015; USDA 2014) and correlated with the World Reference Base (WRB) System (FAO 2006). The mapping units that were identified in the study area were denoted and classified according to USDA Taxonomy and correlated with the WRB System.

The criteria for suitability assessment were centered on climate and soil such as rainfall, drainage, soil texture, soil depth, slope, pH, erosion hazard, risk of flooding, solar radiation, temperature and evaporation (Mueller et al 2010; FAO/ISS 2006;

Ogunkunle 2005). Analysis on climate and soil suitability at the research site (Location) revealed highly suitable (S1), moderately suitable (S2), marginally suitable (S3), or currently not suitable (N), using Sys et al. 1993 method.

Table 1. Suitability Criteria Adopted for Guinea Corn (Sys et al 1993)

Land characteristics	S1	S2	S3	N
Climate				
Rainfall (mm)	600-1000mm	500-600mm	500mm	<400mm or >1000mm (poor/excessive)
Temperature (T)	20-30°C	Above 30°C	40°C	Above 40°C
Soil texture	SL – L	CL	Heavy Clay	Stony soil/Rock Outcrop
Soil PH	6.0 – 7.0	5.5 – 6.0	<5.5	<3.0 or >7.5
Soil fertility	Moderate to high	Moderate	Low fertility	Very Low
Soil depth	Deep	Moderately deep	Shallow	Very shallow
Moisture content	20-25% (FC)	10-20% (Moderate)	20-30% (High)	<10% or >30% (Low/Very high)
Slope	Level to Gentle	Gentle to moderate	Moderate to Steep	Very Steep
Drainage	Well drained	Moderately drained	Imperfectly drained	Poor or excessive drainage
Risk of flooding	None	Low	Moderate	High
Erosional hazard	None	Slight	Moderate	Severe
Salinity	None saline	Slightly saline	Moderately saline	Strongly to very strongly saline
Sodicity	None sodic	Slightly sodic	Sodic	Highly sodic
Distance to road	0 – 4km	4 – 8km	8 – 16km	>16km

S1 = Highly suitable, S2 = Moderately suitable, S3 = Marginally suitable, N = Currently not suitable, SL = Sanday Loam, CL= Clay Loam.

Results and Discussion

Soil Classification and Correlation with World Reference Base (WRB) System

The soils of Abdullahi Fodiyo University of Science And Technology Aliero, were classified based on USDA soil taxonomy (soil survey staff 2015) and were correlated with the world reference base WRB system (FAO 2006). Three mapping units were identified and denoted as TRA1, TRA2 and TRA3.

TRA1 soils are classified as Ultisols at the order level, because they are highly weathered, low base saturation (<35%) in the subsoil, argillic horizon (clay- enriched) subsoil, moderately drained with low fertility due to leaching and weathering and low pH range of acidic to moderately acidic (4.5 - 5.5).

At the suborder level, they are classified as Ustults because they experience a mix of moist and dry period due to variable rainfall. They have Ustic moisture regime (soil moist for a

significant part of the growing season, with dry period), have moderate to deep rooting depth (an adaptation to drought), varying levels of organic matter and clay accumulation.

At the subgroup levels, they are classified as: Typic Haplustults, because they have characteristic reddish colour indicating iron (ferruginous soils), mottling or gleying. Simply therefore, TRA1 soils are classified in the following manner:

Order – Ultisols, Suborder- Ustults, Greatgroup – Haplustults, Subgroup - Typic Haplustults

Ultisols (Typic Haplustults) correlate with Acrisols in the WRB system.

TRA2 soils at the order level are classified as Vertisols, having high clay content, shrink and swell properties (creating cracks, self-mulching and gilgai micro-relief), high organic matter content (dark colour or dark brown), very hard when dry and sticky when wet. At the suborder level, they are classified as Usterts, because they experience a mix of moist and dry periods, with variable rainfall. They have an Ustic moisture regime. They are characterized by high clay content, shrink-swell properties and often exhibit cracks during dry periods, deep rooting zone for drought adaptation.

At the subgroup level we have Typic Haplusterts. This is because the subgroup experiences minimal cracking, shrink and swelling properties, reduced condition, characterized by mottling, gleying. Therefore, TRA2 soils are presented as follows:

Order – Vertisols, Suborder -Usterts, Greatgroup – Haplusterts, Subgroup - Typic Haplusterts

Vertisols (Typic Haplusterts) correlate with Vertisols in the WRB system.

TRA3 at the order level are classified as Alfisols. They have moderate weathering, retaining some nutrient and minerals, argillic horizon (clay accumulation at depth) with high CEC, pH range of moderately acidic to neutral, moderate to high fertility (making them productive for agriculture), and a moderate to high base saturation (>35%) in the subsoil. They are formed in a variety of temperate, forest and grassland environments. The suborder level classifications are Ustalfs. They have a mix of moist and dry period with variable rainfall, characterized by Ustic moisture regime and deep rooting zone, enhancing adaptation to drought, and varying level of base saturation, fertility and clay accumulation.

TRA3 subgroup level classification, are Typic Haplustalfs. because they do not show signs of mottling or gleying or any additional distinguishing feature other than their normal or typical features (central concept). Classification therefore goes as follows:

Order – Alfisols, Suborder – Ustalfs, Greatgroup – Haplustalfs, Subgroup - Typic Haplustalfs

Alfisols (Typic Haplustalfs) correlate with Luvisols in the WRB system.

Key factors for land aggregate suitability criteria are shown in Figures 1-4, suitability classification for Cereal Crops in Figure 5 and suitability criteria for Cereal Crops in Fig. 6-7.

Table 2: Land Suitability Classification using Sys et al. (1993) Method

Criterion	S1	S2	S3	N
Soil Texture	Sandy loam to loam	Clay loam	Heavy clay	Others (e.g., sand, silty clay)
Soil pH	6.0–7.0	5.5–6.0 or 7.0–7.5	5.0–5.5 or 7.5–8.0	<5.0 or >8.0
Soil Fertility	Moderate–High	Moderate	Low	Very low
Rainfall (mm)	600–1000	500–600 or 1000–1100	400–500 or 1100–1200	<400 or >1200
Temperature (°C)	20–30	18–20 or 30–32	15–18 or 32–34	<15 or >34
Slope (%)	0–5	5–10	10–15	>15

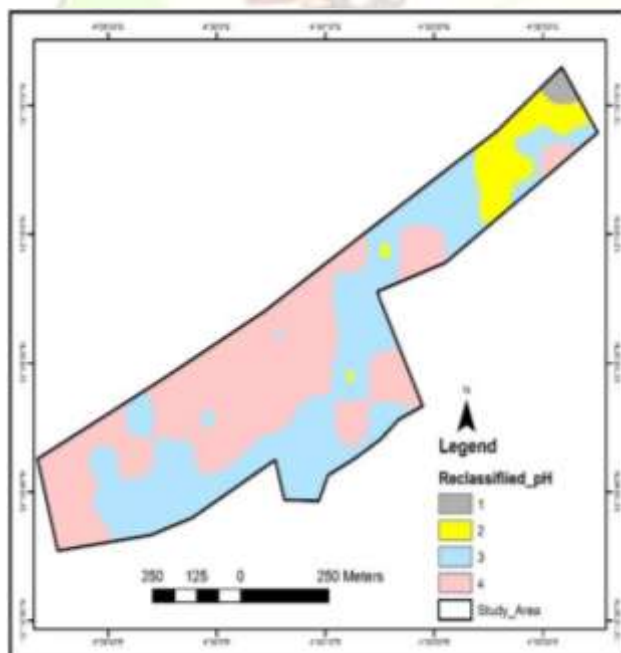


Figure 4: Key factors map for land aggregate suitability criteria
 Source: Author’s Field work 2025

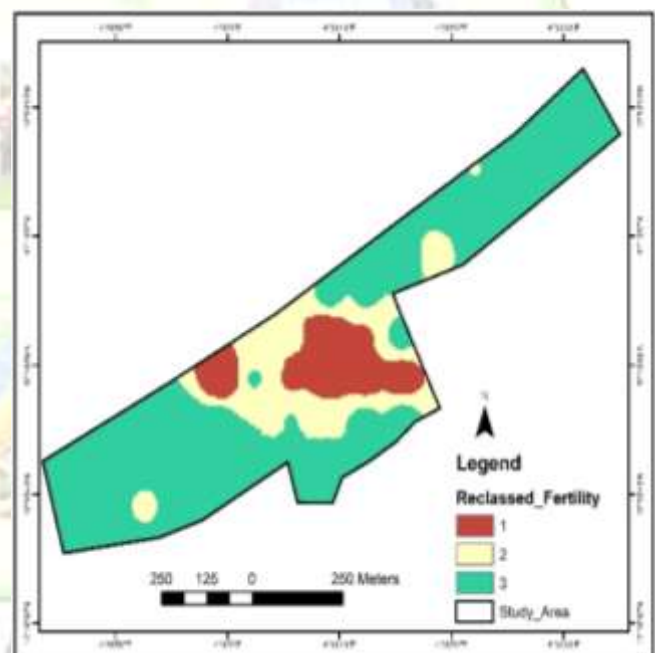


Figure 5: Soil Map on Fertility Aggregate Suitability Criteria
 Source: Author’s Field work 2025

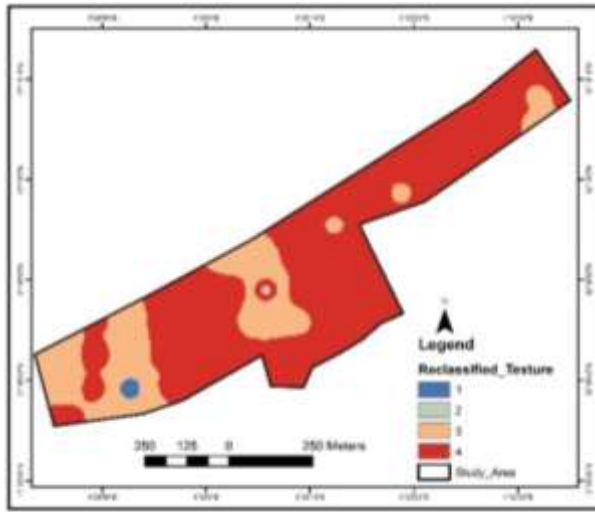


Figure 6: Soil Map on Texture Aggregate Suitability Criteria
 Source: Author's Field work 2025

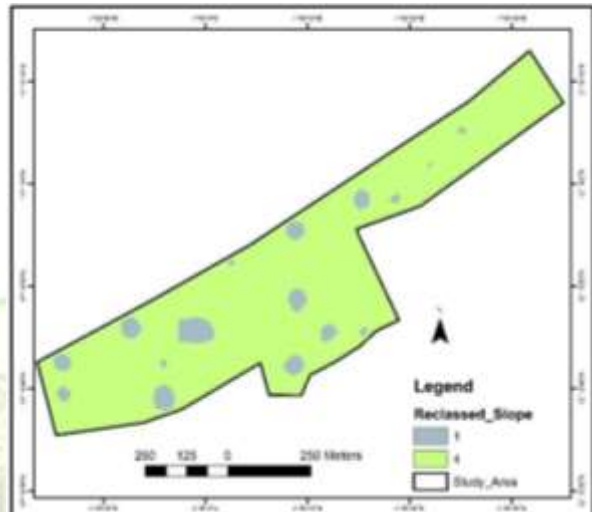


Figure 7: Soil Map on Slope Aggregate Suitability Criteria
 Source: Author's Field work 2025

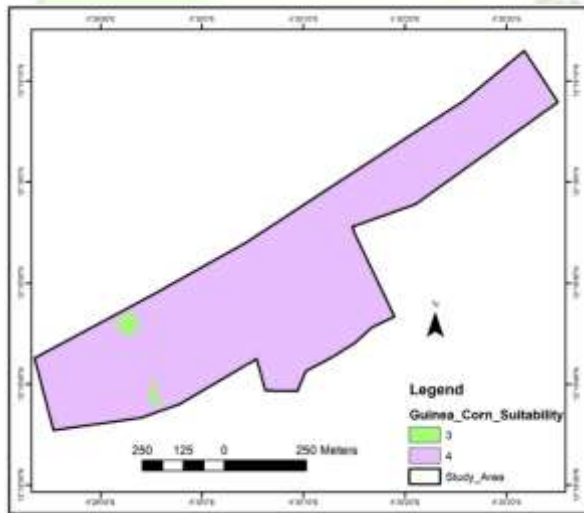


Figure 8: Soil Map on Suitability Classification for Cereal Crops:
 S3 = Marginally Suitable, S4 = Currently not Suitable.
 Source: Author's Field work 2025.

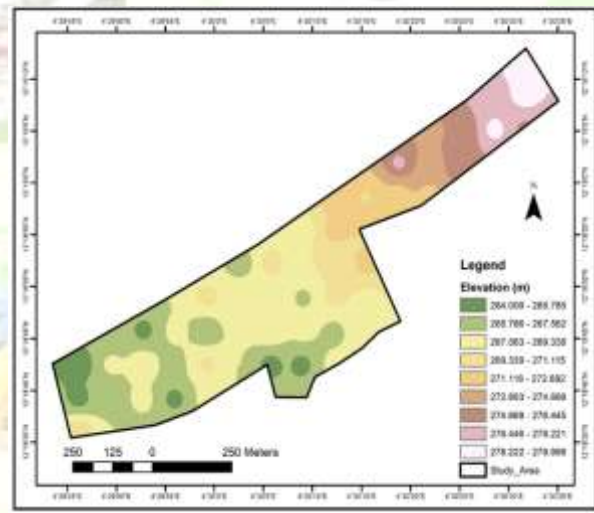


Figure 9: Soil Elevation Suitability map Criteria for Guinea Corn
 Source: Author's Field work 2025

Table 3: Land Suitability Classification of Guinea Corn for the Mapping Units TRA 1

Mapping Unit and Lat/Long	Land characteristics	Suitability Class	Aggregate Suitability
Soil Unit TRA1 12 ^o .31528N 4 ^o .50583E ALT: 246.2M	Climate		59%
	Rainfall (mm)	S3 (500mm)	
	Temperature (T)	S3 (40°C)	
	Soil texture	S1 (SL)	
	Soil Ph	S3 (4.8)	
	Soil fertility	S3 (Low fertility)	
	Soil depth	S2 (Moderately deep)	
	Moisture content	N (<10% Low)	
	Slope	S1 (Level to Gentle)	
	Drainage	S2 (Moderately drained)	
	Risk of flooding	S2 (Low)	
	Erosional hazard	S1 (None)	
	Salinity	S1 (None saline)	
	Sodicity	S3 (Sodic)	
Distance to road	S1 (0 – 4km)		

Table 4: Soil unit TRA2

Mapping Unit and Lat/Long	Land characteristics	Suitability Class	Aggregate Suitability
Soil Unit TRA2 12 ^o .31389N 4 ^o .50583E ALT: 264m	Climate		52%
	Rainfall (mm)	S3 (500mm)	
	Temperature (T)	S3 (40°C)	
	Soil texture	S3 (SCL)	
	Soil PH	S3 (4.4)	
	Soil fertility	S3 (Low fertility)	
	Soil depth	S1 (Deep)	
	Moisture content	N <10% (Low)	
	Slope	S2 (Gentle to moderate)	
	Drainage	S3 (Poorly drained)	
	Risk of flooding	S2 (Moderate)	
	Erosional hazard	S3 (Moderate)	
	Salinity	S1 (None saline)	
	Sodicity	S3 (Slightly sodic)	
Distance to road	S1 (0 – 4km)		

Table 5. Soil unit TRA3

Mapping Unit and Lat/Long	Land characteristics	Suitability Class	Aggregate Suitability
Soil Unit TRA3 12°.31056N 4°.49611E ALT: 267m	Climate		
	Rainfall (mm)	S3 (500mm)	63%
	Temperature (T)	S3 (40°C)	
	Soil texture	S1 (LS)	
	Soil pH	S3 (4.7)	
	Soil fertility	S3 (Low fertility)	
	Soil depth	S1 (Deep)	
	Moisture content	N (<10% Low)	
	Slope	S2 (Gentle to moderate)	
	Drainage	S1 (Well drained)	
	Risk of flooding	S2 (Low)	
	Erosional hazard	S1 (None)	
	Salinity	S1 (None saline)	
	Sodicity	S3 Slightly (sodic)	
Distance to road	S1 (0 – 4km)		

SI = Highly Suitable, S2 = Moderately Suitable, S3 = Marginally Suitable, N = Not currently Suitable,

TRA = Teaching and Research Farm, Aliero

Source: Author’s field work 2025

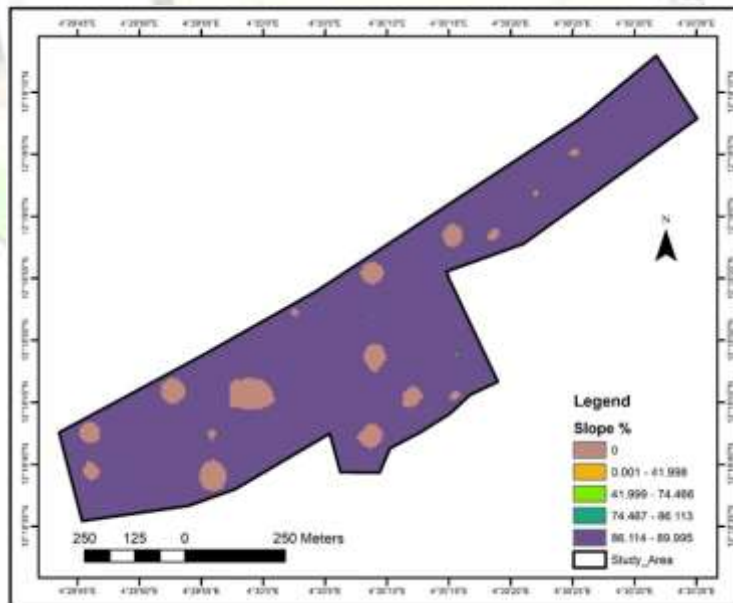


Figure 10: Soil Map Showing Slope Suitability Criteria for Guinea Corn
 Source: Author’s Field work 2025

Soil Suitability Evaluation and Classification

The morphological and chemical of the study area as shown in Tables 3.1, 3.2, 3.3 and 3.5 turned suitability level of the soil to suitable (S1), Moderately Suitable (S2) and Marginally Suitable (S3).

The chemical properties for most of the nutrients were low, making the soil marginally suitable. With fertility amendment measures and conservative management practices put in place, such soils can be improved upon, while some were moderate to high (Na), making the soils currently not Suitable (N), due to sodicity. Measures to reclaim or amend such soils require application of gypsum to reduce the exchangeable Na levels in the soil (FAO 2006). Other environmental considerations relating to topography, erosion hazard, risk of flooding and accessibility to road were rated suitable (S1) and moderately suitable (S2). On Aggregate Suitability, key factors such as texture, soil fertility, pH, moisture content, soil depth, slope, drainage, salinity, sodicity and erosion hazard were considered and weights assigned to each based on importance. Therefore, the three mapping units TRA1, TRA2 TRA3 of the study area were rated 59%, 52% and 63% Aggregate Suitability respectively, indicating their potentials for the growth and performance of guinea corn and other cereal crops.

Conclusion

Agriculture is the predominant economic activity in Nigerian and Aliero in particular. Accordingly, due to expanding population and agricultural sector, there is a corresponding pressure on available soil resources (near farms), leading to rising demand for experimental data that would evolve sustainable management practice to protect the resources base. Therefore, soil classification and mapping serve as a valuable resource for

food security and environmental sustainability. The study have identified the dominant soil types in both surface and subsurface of the study area, mapped, classified and determined its suitability potentials for use. This would assist farmers in making informed decisions and choices for future agricultural ventures and sustainability. Knowledge seekers would also benefit from data information of the study as well.

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