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COMPILATION OF EXISTING SOIL SERIES IN NORTH-EASTERN NIGERIA: PROBLEM AND PROSPECT

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ABSTRACT
Classification of soil to the series level is very important in specific agricultural production, from one location to another, due to the variations that exist in different soil series. In the North Eastern region of Nigeria, numerous soil surveys have been carried out in the past at various scales. The objective of the study was to compile systematically from these reports all the soil series found in these report into one reference report for easy access. A total of one hundred and thirty seven soil series were compiled from reports of surveys mainly from 1960s to 1970s. The series were grouped on the basis of parent material, drainage and geology. Overall about 69 percent of the soil series were well to moderately drained while about 25 percent of them were poorly drained. The Precambrian basement complexes are mostly underlying geology of the soils. Non-uniform data on soil chemical properties and the methods used in their determination were the major setback in the compilation.

Key words**:** soil series, North- Eastern Nigeria.

INTRODUCTION
Soil survey generates a host of information on soils and other environmental factors. In the past, this soil information were primarily used to develop land use plan to support increase crop production. However, the use of soil information for non-agricultural purposes is on the increase. There is increase awareness of the use of soil information as an essential input in the evaluation and prediction of effects of all land use on environment degradation and sustainability. In Nigeria, like most developing countries, one primary constraint to sustainable and successful agricultural programme, is the lack of knowledge about the soil resources and how to manage them. Malgwi and Raji (2005) reported that although about 50% of Nigeria is covered by soil survey of 1;100,000 scale only 0.58% or 567.421 ha are covered by detailed soil survey. Even then, the soil survey intensity is not uniform across Nigeria. In southwest Nigeria, soil survey to the series level has been well documented (Smith and Mortgomery 1962). This is not true for other zones of the country where no such documentation has taken place. In the many reconnaissance and semi-detailed soil surveys carried out in most part of the country has been characterized by un-uniformity of scale and largely un-cordinated and probably duplicated. The objective of this study was therefore, to compile and document the soil series of northeastern Nigeria, from the many soil survey reports, into one literature for ease of access and use by researchers and other land users.

MATERIALS AND METHODS

Study Area

The study area lies in the northeast geopolitical zone of Nigeria. It lies between latitude 10^0 and 20^0N and longitude 12^0 and $13^0$30`E and covers Borno, Gombe, Bauchi, Yobe, Adamawa and Taraba states.

Soil Survey Reports

The soil survey reports use in this study were those available at the Agricultural Library of the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Information on soil series were found only in the old reconnaissance soil survey reports while the more recent soil survey reports and the many student theses have classification to the family level only. The seven (7) reconnaissance soil survey reports used were all carried out between 1960 and early 1970s (Pullan 1960; 1962; 1966; 1969; Hildebrand 1966; Carroll 1974; Carroll and Hope 1974).

Method of compilation

All the soil series found in the seven reconnaissance reports were used in this study. The only minor change made were the conversion of units for the soil depth, distances and for soil properties, to SI units. In the compilation, the definition of soil series was a deciding factor. Soil series were differentiated mainly on the basis of significant variation in the morphological feature which includes the kind, thickness and arrangement of horizons and their structure, colour texture, reactions, consistence, content of carbonates and other salts, content of humus and mineralogical compositions (Soil survey Staff, 1993).

In this study, it was difficult to use the morphological properties listed above as most of the reports were not as comprehensive as detailed above. A significant difference in any one of the above morphological properties could be a basis for recognizing a different series. However, because some of these properties are related, several of them do change together. In the compilation therefore, the soil series were grouped on the basis of soil drainage, geology (parent rock), soil parent material and soil surface texture.

RESULTS AND DISCUSSIONS

A total of 141 soil series were compiled from the seven reconnaissance soil survey reports. As a result of duplication and lack of detail documentation only 137 of these soil series are listed in the Table 1 and discuss below. The main problems had to do with lack of geo-referencing of location of each soil series and the duplication of series names. Duplication of names could have been prevented if there was the statutory National coordinating office responsible for naming or establishing new series. Information at the soil series is very important in the sustainable exploitation of the soil resources and for the transfer of information on proven technology between farming regions.

From the data used in this study, it was discovered that about 80% of the soil series of the Northeastern region were well drained, 2% are imperfectly drained while 16% were poorly drained (Table 1). Shallow soils, which were mostly less than 50cm to impenetrable layer constituted about 32% and were found mostly on basement complex rocks and sand stone parent materials. Most of the soils were therefore, deep and developed from a wide variety of soil parent material such as aeolian, alluvial, Basement complex rocks and sandstone. In general, the soils were sandy especially in the surface horizons where the influence of sand drift was noticeable in the first few centi-meters of the surface.

The well-drained soil which could be found on most parent material but rarely on the alluvial deposits was the most widespread. They were mostly yellowish brown (10YR5/4) to brown (10YR4/3) Ap horizon over reddish yellow (10YR7/8) subsoil. The soil were normally acidic with low base saturation, low cation exchange capacity and how organic matter content. The soils were therefore, inherently of

low productivity. Texturally, the soils were sand to loamy sand in the Ap horizon but got finer with depth resulting in the occurrence of clay loam in subsoil. These soils were extensively cultivated during the raining seasons but were left fallow during the dry season because of the topography and distance from rivers and streams.

The poorly drained soils occupied the narrow strip of depression along the major rivers and streams in the area. In some cases they also occured in the inter dual depressions and other flat areas. Most of the poorly drained soils were deep and medium-fine textured. They were found mostly in the Gubio, Gundubali, Latan, Kakara, Yamtage and Gambaki (Table 2) axes of the study area.

Generally, the poorly drained soils which constituted about 16% of the soil have near soil neutral soil pH, moderate to high base saturation, cation exchange capacity and organic matter content. These properties make these soils of relatively better productivity and therefore, cultivated throughout the year. However, in few places, like in the Dikwa Association (Table 2), where salinization and the water-table were high, the soils had little agricultural value. Although from the available reports, classification was not available, the poorly-drained soils are expected to be mostly Entisols, Inceptisols and some few Vertisols.

The imperfectly drained soils were distributed among four soil Associations (Table 1) and could be found closely associated with the poorly drained soil on alluvial deposits. On the basement complex rocks, these soils were found along the Azare-Borno axes. The soils were usually deep, occurring on the middle-lower slope positions. They were mostly dark brown/brown/grey (10YR3/3) in the surface horizons to yellowish brown (10YR5/4) or yellowish red (7.5YR5/6) at depth. The imperfectly drained soils were usually slightly acidic, low to moderate CEC, base saturation and organic matter content. Some of the series like the clayed series of the Yedseram Associations were occasionally flooded and mottled at depth (Table II). They are therefore, of moderate productivity and extensively cultivated depending on the availability of water source.

Table 1: Distribution of the soil series based on drainage and parent materials.

Drainage	Depth	Parent material	Soil Association	Soilll Series	Percentage
		Aeolian	5	47	
	Deep	Sandstone/Grit	2	8	49.6%
Well		Basement	2	13	
	Shallow	Basement	2	27	
		Sandstone/Grit	3	8	32.1%
		Schists	1	8	
Imperfectly	Deep	Varied	4	4	2.2%
Poorly	Deep	Varied	8	22	16.1%
	Total		**27**	**137**	**100%**

Table 2: Soil series description, location, crops grown and management

1. Dune Fields and Sandy Drift plain: (A) Magumeri Association; Magumeri and Meri series. Well drained deep, fairly loose pale brown sand to loamy fine sand; low plant nutrient, slighty acidic. Suitable crops include millet, sorghum, cowpea and groundnut, sole or intercrop. Soil management includes crop residue, mulching and addition of mineral and organic fertilizers.
   (B) Asagar Association; Dodoro, Kesangala, Bulachirabe, Bimbim, Bida and Gama series. Well drained deep, grey brown sand to loamy sand, freely drained and low fertility. Suitable crops include millet, sorghum, cowpea and groundnut, sole or intercrop. Soil management includes crop residue, mulching and addition of mineral and organic fertilizers.
   (C) Chad Association; Keji, Jebra, Peteke and Chad series. Well drained deep, Yellowish-brown sand to loamy sand, freely drained with fainted mottled. Suitable crops include millet, sorghum, cowpea and groundnut, sole or intercrop. Soil management includes crop residue, mulching and addition of mineral and organic fertilizers.
   (D) Biu-mubi Association; Pirgidi, Tsauni, Mbororo, Bani, Pulda, Pella, Gaada, Gombi, Mamourgi, Zale, Arawa, Ashigashiya, Doutarou, Guva, Kinkiya, Kazan, Askira, Maki, Balala, Mubi, Pakko, Lassa, Velgwa, Garha, Magadali, Birnewa, Myidamu, Babashe, Bir, Wamuri, Torteri, Gulumba and Dougouma series. Well drained deep, yellowish brown loamy sand to loam, occurring on middle to upper slope, soils are acidic, low in CEC. Suitable crops include millet, sorghum, cowpea and groundnut, sole or intercrop. Soil management includes crop residue, mulching and addition of mineral and organic fertilizers.
   (E) Kalaguda Association; Tireji and Limanti series. Well drained deep, pale brown to brown sand occurring on upper to middle slope, slighty acidic; Suitable crops include millet, sorghum, cowpea and groundnut, sole or intercrop. Soil management includes crop residue, mulching and addition of mineral and organic fertilizers.

2. Sandstone/Grit. (A) Kadi, Agia, Ligda, Dwaja and Gumsuri series. Well drained deep, dark grey brown loamy sand, acidic, low BS with faint mottling in subsoil. Suitable crops include cereal crops like millet and sorghum grown as sole, leguminous crops like groundnut and cowpea as sole crops or intercropped with millet and sorghum. Use of animal dung, incorporation of residues, mulching and inorganic source of nutrients can improve the soil.
   (B) Konduga Association; Gizie, Kouna and Kirawa series. Well drained deep, brown to pale yellow sand, unmottled, acidic with low BS. Suitable crops include cereal crops like millet and sorghum grown as sole; leguminous crops like groundnut and cowpea as sole crops or intercropped with millet and sorghum. Use of animal dung, incorporation of residues, mulching and inorganic source of nutrients can improve the soil.

3 Sedentary/ Basement complex. (A) Bature Association; Zongo, Bature and Jemuri series. Well drained deep, Very shallow, stony, brown sandy clay loam, with low CEC, BS and acidic reaction. Suitable for groundnut and cowpea, maize sorghum and millet both as sole and intercropped. Mulching, incorporation of crop residue and inorganic fertilizer will improve the soil fertility status.
   (B) Sedentary/ Schists . (B) Magu, Kusuku, Lareski, Buratai,Pawa, Jimbarau, Kuda, Biu, Tilla and Delle series. Moderately deep, light yellow loamy sand, slightly acidic but medium in CEC and BS. Suitable for groundnut and cowpea, maize sorghum and millet

both as sole and intercropped. Mulching, incorporation of crop residue and inorganic fertilizer will improve the soil fertility status.

4 Sedentary/Basement complex. (A) Kukawa Association; Kukawa, Mongomu, Balda, Kessa, Transfir, Stialfir, Ngala, Birabilan, Gambaru, Fedau, Feau, Waza, Pulke, Ngoshie, Pirgidi, Tsauni, Mbororo, Mayo, Bani, Gokwal, Pulda and Pella series. Well drained-shallow Pale brown to brown, shallow soil occurs on lower slope, low CEC and BS. Cereal crops like Sorghum and millet as well as leguminous crops like cowpea, groundnut and soybean all under rainfed..

(B) Tunokalia Association; Wulgo, Tunokalia, Birkeb, Kebbi and Ninbi series. Well drained- Shallow soils occurring on upper slopes. The soils are gravely mottled, pale brown to brown sandy clay loam, covered by sand. Suitable for cereal crops like Sorghum and millet as well as leguminous crops like cowpea, groundnut and soybean all under rainfed.

5 Sandstone/Grit. (A). Gashagar Association; Bulawudi series. Well drained- Shallow dark brown sandy loam, occurring on upper slope and have low CEC, BS and slightly acidic. Suitable for cereals and legumes under rainfed. Conservation measures like planting across the slope

(B) (Gadau Association; Inkeb, Buzawa, Loyed and Soyed series. Well drained- Shallow dark coloured heavily mottled, predominantly loamy soils resting on light coloured sand, fairly high base status and non-saline. Suitable for cereals and legumes under rainfed. Conservation measures like planting across the slope

(C) Biu-mubi Association; Liman Kara and Tokumbere series. Well drained- Shallow Pale coloured structureless loamy fine sand, mottled, low CECand BS, slightly alkaline reaction. Suitable for cereals and legumes under rainfed. Conservation measures like planting across the slope.

6 Schists. Kumshe Association; Kumshe, Yabiri, Warajaya, Caldik, Daya, Yagana, Irracob and Logomani series. Well drained- Shallow uniformly pale brown to grey brown, sandy loam, structureless, mottled and slightly alkaline in reaction, with iron concretions, low in BS and CEC. Suitable for cereal crops and legumes under rainfed condition. Incorporation of crop residue, mulching, addition of organic manure and inorganic fertilizer will help to improve the fertility.

7 Varied parent material. (A) Keronawa Association; Keronawa series. Imperfectly drained dark coloured horizons of varying texture from sand to loamy clay, medium BS and humic in surface horizon. Suitable for cereals and legumes as rainfed, and irrigated crops like vegetables, wheat, rice and sugarcane.

(B) Yedseram Association; Clayed series. Imperfectly drained deep, brown to grey soils on middle to upper slopes that are water logged at depth, low BS and CEC. Suitable for cereals and legumes as rainfed, and irrigated crops like vegetables, wheat, rice and sugarcane.

(C) Gadau Association; Birnin series. Imperfectly drained uniformly water affected, fine sand with predominantly grey upper horizon colour becoming white at depth. Suitable for cereals and legumes as rainfed, and irrigated crops like vegetables, wheat, rice and sugarcane.

(D) Kesangala Association; Kesangala series. Imperfectly drained deep, dark brown over yellowsish brown alluvial soils, moderately acidic, low in CEC and BS with fewer

mottles at lower depths. Suitable for cereals and legumes as rainfed, and irrigated crops like vegetables, wheat, rice and sugarcane.

8 Varied parent material. (A) Gudumbali Association; Gudu,Gudum and Zuwa series. Poorly drained deep, brown mottled sand over reddish sandy clay loam with iron concretion at lower depth and alkaline pH. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice. Tillage to break the surface crust for easy infiltration of water.

(B) Gambaki Association; Gambaki, Gamb and Gam series. Poorly drained deep, coarse sand on levee with moderate CEC and BS acidic with iron concretions and sandy clay loam at depth. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice. Tillage to break the surface crust for easy infiltration of water.

(C) Yamtage , Ndagaya and Banki series. Poorly drained deep, soils with cracks and no diagnostic horizon, acidic in reaction with medium CEC and BS in the surface, which decrease with depth. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

(D) Bantei and Bardari series. Poorly drained yellowish loamy sand structureless with cracks when dry. Alkaline pH, with high CEC. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

(E) Latan and Kakara series. Poorly drained deep, moderate to fine texture with gleyed A horizon. Dark brown to very dark brown clayed loam. CEC and BS are high but the soils are usually flooded. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

(F) Gundubali Association; Bali, Dumbal, Peripan and Cladik series. Poorly drained colluvial brown loamy fined sand, with mottled sand over reddish sandy clay loam and iron concretions at depth. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

(G) Gubio Association; Gubio, Clapan and Sanpan series. Poorly drained deep, dark brown to dark grayish brown, coarsed textured soils with water table close to the surface. The pH is alkaline, low CEC and BS with moderate SAR. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

(H) Dikwa Association; Ladik and Kirik series. Poorly drained shallow, moderate to fine texture with gleyed A horizon. Dark brown to very dark brown clayed loam. CEC and BS are low but the soils are usually flooded. Suitable for wheat, rice, cotton and sorghum as well as vegetables and sugarcane can either be under rainfed or irrigation practice.

BS=Base Saturation, CEC=Cation Exchange Capacity, SAR=Sodium Adsorption Ratio.

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