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ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng MORPHOLOGY, CLASSIFICATION AND SUITABILITY EVALUATION OF SOILS FOR

GROUNDNUT CULTIVATION IN OWERRI SOUTH EAST, NIGERIA

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ABSTRACT

The study was conducted to characterise, classify and evaluate the suitability of soils in Ndegwu, Owerri area, Imo State, Nigeria for groundnut cultivation. Transects and soil angering were used to identify seven soil units. Seven (7) profile pits were dug each representing the soil units. The soils' morphological, physical and chemical properties reveal that percentage sand in all pedons was high with clay particles (54-90%) increasing with soil depth. The soil reaction was strongly acid to moderately acid (pH 4.70-5.80) and organic carbon (0.012.10%). Total nitrogen (0.01-1.20%); CEC (4.00-33.00 cmolkg-1) and exchangeable K (0.041.00 cmolkg-1) were rated very low to high. Percentage base saturation was low to high (30.30-60.90%); Available P was low to moderate (4.50-16.50mgkg-1); Exchangeable Mg was very low to high (0.01-2.00 cmolkg-1). Exchangeable Na was low to moderate (0.020.0.04 cmolkg-1); Available Mn ranged from 1.70-5.50mgkg-1 in all the pedons analysed. Available Fe ranged from 2.33-6.80 mgkg-1; Available Cu ranged from 0.4-2.15mgkg-1, Available Zn ranged from 1.50-6.75mgkg-1 which were all above their critical limits [1.0 mgkg-1(Mn), 2.0mgkg-1 (Fe), 0.4mgkg-1(Cu) and 2.0mgkg-1 (Zn)]. Soil units ON-01, 02, 03 and 07 were classified as Typic Hapludult at the sub-group level or Haplic Acrisol (WRB). Soil units ON-04 were classified as Oxic Dystrudent at the subgroup level or Haplic Arenosol (WRB) while soil units ON-05 and 06 were classified as Typic Paleudult at the subgroup level (USDA) and Haplic Acrisol (WRB). Results of the Land suitability evaluation (LSE) classified the soils as currently unsuitable (N1f) with fertility (Organic carbon, Total N and Base saturation) as a limitation. Agronomic and soil management practices such as liming, organic manuring, avoidance of bush burning and crop rotation could also make these soils highly suitable for groundnut cultivation. Keywords: Classification, Evaluation, Groundnut, Morphology and Suitability

INTRODUCTION

Soil is the most precious basic natural resource, on which depends the security of food, nutrition, income, biodiversity, livelihood, environment and whose proper use depends on the life-supporting systems of a country and the socioeconomic development of its people (Surwase *et al.*, 2023). To ensure the most appropriate and sustainable use of soil, it is necessary to understand the nature, behaviour and distribution of soils and the parent materials that make up the soils through characterization and classification of the soils (Osujieke, 2017). It is also important that the land for agricultural production be used according to its capacity for optimization and sustainability of soil productivity (Adeboye, 1994).

Characterization of soils aids in determining the nature of the soil materials in terms of genesis, morphological, physical, chemical, nutrient and mineralogical properties (Akpan-Idiok *et al.*, 2013). Akamigbo (2012), reported that soil characterization is a major criterion for understanding and classifying the soil to acquire the best knowledge about the environment. Esu (2004) also reported that one of the strategies for achieving food security as well as sustainable environment is by studying the soil resources in details through the processes of soil characterization and land evaluation for various land utilization types. Information



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ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng obtained from soil characterization and detailed survey has been proved to be key for land use planning and sustainable soil management (Igomu and Idoga, 2017).

Land evaluation is the process of estimating the potentials of a piece of land for alternative uses (Ande, 2011). Land suitability is a land evaluation approach that involves the appraisal and grouping of specific areas of land in terms of their suitability for defined uses (Ezeaku, 2009). It helps to tell the farmer the suitability or the most limiting land qualities and provides a good basis for advising farmers for optimum production (FAO, 1976). This is often achieved by matching land qualities/characteristics with the requirements of the envisaged land use (Udoh and Ogunkunle, 2012). The result of land evaluation reflects not only on possible yield, but more importantly, the ease or difficulty of ensuring the sustained use of the parcel of land for a particular purpose.

Globally, groundnut (Arachis hypogea) is a crop of economic importance. It is a major internationally traded cash crop and supports the economy of the producing countries, besides providing gainful employment for many people. In order to achieve success in largescale production of groundnut by governments and individuals, more lands must be cultivated. Ahukaemere et al. (2015) reported soil moisture retention capacity, nutrient availability and retention as critical factors to the management of groundnut in Haplustalfs of Owerri, southeastern Nigeria. However, there is paucity of information on the extent to which the land qualities of soils derived from coastal plain sands in Owerri can satisfy the agronomic requirements of groundnuts. Soils of Ndegwu community in Owerri have been generally under intensive cropping by inhabitants of the communities in the area, but the soils are selected by farmers for different crops based on different criteria. Thus, Nwaoba and Adesemuyi (2020) noted that farmers in Ndegwu community use sight and touch to determine the physical properties of the soils suitable for cropping; other criteria focus on the top soil, colour and presence of organic matter in classifying the suitability of their soils and that due to lack of guidance, they cultivate crops on soils that may not be suitable for their cultivation. Therefore, this study aims at characterizing and classifying the soils using the USDA and World Reference Base soil classification systems (Soil Survey Staff, 2014) and to evaluate the suitability of these soils for groundnut cultivation.

MATERIALS AND METHODS

The study Area

The study was conducted in Ndegwu, Owerri West local government area of Imo state, Nigeria. It lies between latitude $4^{0}45^{I}N$ and 7^{0} 15^IN and longitude $6^{0}50^{I}E$ and $7^{0}25^{1}E$, with elevation ranging between 80 – 100m above sea level (Fig. 1). The mean annual rainfall ranges between 1900mm and 2200mm with the southern areas receiving a little more than the northern areas. Generally, the entire state is under an udic moisture regime. The mean annual temperature range is between 26°C and 28°C (NRCRI, 2011). On annual basis, the relative humidity varies with the seasons which itself is a function of the prevailing major air mass. High ranges of 80% to 90% at 10am Nigerian time occur during the rainy season when the south Westerly is prevalent. The dry season range under the dry North easterly wind is between 60% and 80% at the same 10am Nigerian Time. Daily variations of relative humidity depend and fluctuate over a wide range (FDALR, 1995). Average monthly evapotranspiration also remains low during the rainy season with an average of 2.5 to 3.5mm/day during the dry season (FDALR, 1995). The parent material is coastal plain sand. It is of the Pleistocene-Oligocene era and consists of unconsolidated yellow and white sand materials which are sometimes cross bedded with clays, sand clays and sometimes pebbles (NRCRI, 2011). The vegetation is tropical rainforest. The original vegetation however had been destroyed to a considerable extent through human activities. The prevailing plants available in the area are oil palm (Elaeis

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ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng guinensis), African oil beans (Pentaclatra spp.) and a large herbaceous plants and grasses such as Chromolaena odorata, Pennisetum spp, Imperata cylindrical, etc. The general land use is shifting cultivation or bush fallow system. Presently due to population pressure and increased demand on the land, shorter fallow periods are most common (NRCRI, 2011). Land productivity in terms of crop yield has also continued to decline under this system due to declining soil fertility (NRCRI, 2011). Major crops under this traditional farming method include yams (Discorea spp), cassava (Manihot esculenta), maize (Zea mays), cocoyam (Colocasia esculenta) and a variety of vegetable crops -Fluted pumpkin (Telferia occidentalis), Okro (Abelmoschus esculenta) (NRCRI, 2011).



Figure 1: Map of Imo State

Field work

A reconnaissance visit of the area was conducted. Soil augering was done to a depth of 120cm where possible or to impervious layer. All the samples collected from the auger holes were described morphologically on the field in terms of soil texture by feel and consistency, soil colour, presence or absence of mottles, mottle colour, stoniness, presence or absence of concretions, root content etc. Soils from the auger points were grouped into mapping units based on the similarities of the above mentioned following morphological properties. Three mapping units were identified and ten profile pits measuring 2m x 1.5m x 2m were dug. Soils of the pedogenic horizon were described according to (FAO, 2014). Soil samples were collected from the bottom to the top for laboratory analysis. Laboratory Analysis The soil samples collected were air dried, crushed and pass through a 2mm sieve. The resulting soil samples were analyzed for physical and chemical properties as follows: Particle size distribution was determined by hydrometer method (Gee and Bauder, 1986). Total N was determined by the micro kjedahl wet oxidation method (Bremner, 1996). Organic carbon was determined according to Nelson and Sommers (1982). Exchangeable bases were extracted with neutral IN ammonium acetate (NH4OAc) solution; Ca and Mg were determined by EDTA titration while K and Na were determined using Flame photometry. Exchangeable acidity was determined by KCl extraction, following the procedure of Mclean (1965) cation exchange



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ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng capacity (CEC) was measured using ammonium acetate leaching at pH 7.0 (Roades, 1982) The base saturation was calculated by multiplying the quotient obtained after dividing TEB and CEC by 100. Soil pH in H20 and KCL were determined using pH meter at 1:1 and 1:2.5 soil ratios according to Thomas, (1996). Available phosphorus was determined by Bray P-ll method (Nelson and Sommers, 1982) modified. Electrical conductivity was determined in a 1:2.5 soil/water ratio using the conductivity meter (Fox, 1982). Bulk density was measured by core method (Grossman and Reinsch, 2002) and saturated hydraulic conductivity (ksat) was determined using the constant head parameter method and obtained using the equation of the form (Klute and Dirksen, 1986). The soils were classified according to the USDA soil classification (Soil Survey Staff, 2010) with side-by-side correlation with World Reference Base (WRB) soil map of the world legend.

RESULTS AND DISCUSSION Morphological and physical properties

The topography of all the soils is nearly level plains with slope range of 0 - 2%. The soils are deep and well drained; depth to water table is below 180cm. Results of the particle size analysis show that sand particles are the dominant size particles at the surface horizon (53 -90%) followed by clay with values (7 - 45%) and silt fraction with values (1-7%). There was decrease in sand with all the soil depths while the clay particles increased with the soil depth. There existed an irregular pattern of silt distribution in the soils which may be as a result of lithology or the parent material or other anthropogenic influences and the high sand particles at the uppermost horizon could be attributed to deposition by flowing water (Nsor and Okonkwo, 2004). Soil textures of mapping units ON-01, 02, 03 and 07 ranged from loamy sand at the surface and sandy loam at the sub surface horizons. The bulk density and the saturated hydraulic conductivities of ON-01, 02, 03 and 07 ranged from loamy sand to sand clay at the surface and sandy clay loam to sandy clay to the sub surface horizons while soil unit ON-04 ranges from loamy sand to sandy loam to the sub surface horizons. The bulk density and the saturated hydraulic conductivities of mapping unitsN-01, 02, 03 and 07 ranged from 1.051.47 g/cm3 and 0.09-9.28 cm/hr respectively. Soil unit 04 ranged from 1.06-1.25 g/cm³ and 34.20 -40.64 cm/hr while soil units 05 and 06 ranged from 1.24-1.38g/cm³ and 0.09-50.33 cm/hr for bulk density and saturated hydraulic conductivity respectively. The bulk density increased with the soil depth while the saturated hydraulic conductivity decreased with the soil depth.

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Table 1: Summary of the morphological properties of soil units

		·	-		Particl	Particle size Analysis							
Soil Units	Hori	Depth (cm)	Texture	Munsell color (moist)	Sand	Silt	Clay	Structure	Consistence Wet	Moist	Mottles	Horizon	
01	AP	0-13	LS	DGB (10YR3/2)	90	3	7	fine crumb	None	VFr	None	Abrupt Wavy	
	AB	13-28	SL	DB (7.5YR3.4)	81	3	16	fine sbk	None	Fr	None	Gradual smooth	
	Btl	28-80	SCL	RB (7.5YR3/4)	70	4	26	fine sbk	None	Fr	None	Clear smooth	
	Bt2	80-126	SCL	YR (5 YRS5/4)	64	4	32	strong sbk	None	Fr	None	Clear smooth	
	BC	126-180	SC	R(2.5YR.8)	58	3	39	strong sbk	None	Fr	None		
02	AP	0-13	LS	DB(10YR3/3)	86	7	7	weak fine granular	None	Fr	None	Gradual smooth	
	AB	13-32	SL	DYB (10YR4/4)	78	4	18	v. fine sbk	None	Fr	None	Gradual smooth	
	Btl	32-70	SCL	SB (7.5YR)	73	3	24	m.fine sbk	None	Fr	None	Clear smooth	
	Bt2	70-127	SC	RB (5YRS5/4)	64	2	34	msbk	None	Fr	None	Clear smooth	
	BC	127-180	SC	YR (5YRS5/8)	54	2	44	coarse sbk	None	Fr	None		
03	AP	0-13	LS	DB(10YR3/2)	86	5	9	fine crumb	None	Fr	None	Abrupt wavy	
	AB	13-29	SL	DYB (10YR4/4)	81	J	16	weak fine sbk	None	Fr	None	Gradual smooth	
	Btl	29-63	SCL	RB (5YRS5/4)	67	2	31	msbk	None	Fr	None	Clear smooth	
	Bt2	63-128	SCL	YR (5YR5/8)	64	1	35	msbk	None	Fr	None	Clear smooth	
	BC	128-180	SC	RY (5YR6/6)	53	2	45	coarse sbk	None	Fr	None		
	AP	0-14	LS	DB (10YR3/3)	88	3	9	weak crumb	None	Fr	None	Gradual smooth	
	AB	14-33	LS	DB (7.5YR3/4)	84	5	11	weak s bk	None	Fr	None	Clear smooth	
	BA	33-78	SL	SB (7.5 YR4/6)	80	3	17	msbk	None	Fr	None	Gradual smooth	
	В	78-126	SL	YR (7YR4/6)	82	2	16	msbk	None	Fr	None	Clear and smooth	
	BC	126-180	SL	Weak crumb	78	3	19	msbk	None	Fr	None		
05	AP	0-12	LS	DB (10YR3/3)	86	3	10	fine crumb	None	Fr	None	Abrupt smooth	
	AB	12-30	SL	DB (7.5YR3/4)	81	4	16	weak fine sbk	None	Fr	None	Clear smooth	
	Btl	30-72	SCL	RB (5YR5/8)	73	4	23	msbk	None	Fr	None	Clear smooth	
	Bt2	72-217	SCL	YR (5YR5/8)	60	3	27	mssbk	None	Fr	None	Gradual smooth	
	BC	127-180	SC	YR (5YR4/8)	58	2	40	mssbk	None	Fr	None		
06	AP	0-13	LS	DG (10YR3/2)	87	3	10	fine granular	None	Fr	None	Abrupt smooth	
	AB	13-31	SL	DB (7.5YR4/4)	80	4	16	fine msbk	None	Fr	None	Gradual smooth	
	Bt1	31-69	SCL	RB (5YR5/4)	73	4	23	msbk	None	Fr	None	Clear smooth	
	Bt2	69-124	SSC	BY (5YR45/8)	60	3	27	msbk	None	Fr	None	Gradual smooth	
	BC	124-180	SC	RY (5YR4/8)	58	2	40	coarse msbk	None	Fr	None		
07	AP	0-13	LS	DB (10YR3/2)	90	2	8	fine crumb	None	Fr	None	Abrupt smooth	
	AB	13-32	SL	DB (7.5YR4/6)	80	4	16	msbk	None	Fr	None	Clear smooth	
	Bt1	32-78	SL	SB (7.5YR4/6)	74	3	23	msbk	None	Fr	None	Gradual smooth	
	Bt2	78-129	SCL	YR (54YR4/6)	62	6	32	msbk	None	Fr	None	Clear smooth	
	BC	129-180	SCL	YR (5YR5/8)	60	4	36	coarse abk	None	Fr	None		

DGB-Dark greyish brown, DB- Dark brown, RB-Reddish brown, YR-Yellowish red, R-red, DYB- Dark yellow brown, RY- Reddish yellow, SB- Strong black, DG- Dark Grey, Fr-Friable, VFr- Very friable, LS –Loamy sand, SL- Sandy loam, SCL-Sandy Clay loam, abk-Angular blocky, sbk-sub angular blocky, msbk-medium sub angular blocky, m.fine sbk- medium fine sbk.



Volume 7, Number 4, December, 2024 <u>ISSN (Print): 2651-6144; ISSN (Online): 2651-6365</u> <u>Website: http://www.jasd.daee.atbu.edu.ng</u> Table 2: Physical Properties of the Soil Units

Chemical Properties

The chemical properties of the soils are presented in Table 3. The overall result indicates that the soils are very strongly acid (pH 4.70-5-5.80). The results confirm earlier study by Chukwu (2007) that soils of south eastern Nigeria derived from Shale are acidic. Organic carbon content of the soils is generally low in all the soil units and ranged from (0.09-0.9%). The decrease in organic carbon with depth of all the soils indicates continuous decomposition of organic materials and sediments which may have slowed decomposition. Also, based on soil fertility ratings of south eastern Nigeria (Enwezor et al., 1990), the area suffers nutrient deficiencies particularly N and K. Total N is low (<0.15%). Similarly, exchangeable K is also low (<0.2 cmolkg-1). In all the soils, exchangeable cations are low for calcium (0.22-6.3 cmolkg-1), very low for magnesium (0.06-2.00) low for sodium (0.06-0.2). The low availability of the exchangeable cations could be as a result of low pH. Available phosphorus is low (4.25-15.00 mgkg-1). Cation Exchange capacity is low to- moderate (4.0015.00 mg/kg) and percentage base saturation is low to moderate (06.30- 50.00%). According to Chukwu and Okonkwo (2015), the low overall soil fertility could be associated with repeated cycles of erosion history of landscape in the humid and arid climates of Africa in the tertiary geological period. Consequently, most of their basic nutrients might have been leached before decomposition. Available micronutrients indicated medium to high for Fe (1.65-6.80mgkg-1), Zn (1.507.5mgkg-1), Cu (0.13-2.15mgkg-1) and Mn (0.20-5.55mgkg-1) Table 3. The medium to high levels of micronutrients in these soils might be as a result of low pH status of the soils. Consequently, these soils will require liming to avert micronutrient toxicities.



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 Table 3: Chemical properties of soil units

			pH					Exchangeable Acidity cmo/kg		Exchangeable Cations			CEC	BS	Mg/kg	Mn	Fe				
												Cmo/l	ĸg								
Soil units	Horizon	Depth (cm)	TT O	KC	EC ma/am	Organic	Total	TEA	H+	AL3+	Avail P Ma/ka	Ca	Mg	К	TN	Cmo/kg	%	Zn	Mn	Fe	Cu
ON-01	AP	0-13	5.4	46	0.10	0.98	0.08	2 10	1.90	0.20	13.00	0.22	0.06	0.13	0.08	5.00	9.80	2 50	3 50	4 40	1 75
011-01	AB	13-28	53	4.0	0.10	0.90	0.00	1.80	1.50	0.20	10.20	1.09	0.00	0.15	0.00	9.00	17 30	1.50	4 20	5 20	2.15
	Btl	28-30	5.2	4.1	0.0	0.62	0.04	1.60	1.30	0.20	8 70	0.28	0.02	0.00	0.10	5.00	11.30	1.50	$\frac{4.20}{2.50}$	3.20 4 70	1.60
	Bt2	80-126	5.1	3.8	0.7	0.51	0.02	50	1.50	0.50	0.70 7.60	0.20	0.02	0.13	0.13	8.00	5.80	2 20	3 40	3.80	0.90
	BC	126-80	5.0	37	0.32	0.31	0.02	1 20	0.30	0.00	6.75	0.22	0.00	0.13	0.15	4.00	15.00	2.20	1 70	5.00	0.20
ON-02	AP	0-13	53	4 1	0.32	0.20	1.06	0.70	0.50	0.00	14 00	210	0.01	0.15	0.15	7.50	40.40	2.00	2.20	4 60	0.00
011 02	AB	13-32	5.2	4.0	0.12	0.20	0.05	0.09	0.01	0.09	12.00	1 70	1.01	0.46	0.00	9.30	20.00	4 70	2.20	240	0.20
	Rt1	32-70	50	39	0.12	0.75	0.05	0.85	0.72	0.00	10.50	2 50	1.50	0.40	0.02	10.40	50.20	4.70	1 30	2.40	0.13
	Bt?	70-127	49	3.8	0.10	0.09	0.01	0.05	0.90	0.10	7 30	2.50	1.20	0.72	0.10	12 50	30.30	3.80	2.15	3 40	0.13
	BC	127-180	4.7	3.6	0.10	0.09	0.01	0.90	0.90	0.05	675	2.05	2.00	1.00	0.20	15.00	36.30	3.80	3 14	5.14	0.00
ON-03	AP	0-13	5.8	49	1.63	0.98	0.05	0.74	0.60	0.05	8.15	2.15	2.00	0.17	0.20	15.00	29.40	3.80	2.20	4 80	0.90
011 05	AB	13-29	5.6	47	0.08	0.96	0.07	0.84	0.58	0.07	7 20	1.20	0.80	0.12	0.15	11 20	20.00	3.90	1 70	5 40	0.70
	Bt1	29-63	53	4 5	0.00	0.54	0.06	0.68	0.32	0.17	6.10	0.08	0.00	0.12	0.20	9.60	16.20	3.10	1.70	3 65	1 10
	Bt2	63-128	5.0	3.0	0.06	0.27	0.04	0.70	0.25	0.05	5.20	2.40	2.00	0.09	0.14	7.70	66.30	3.85	2.40	2.33	0.88
	BC	128-180	4.9	3.7	0.32	0.26	0.02	0.55	0.03	0.01	4.25	2.60	1.20	0.11	0.17	5.50	68.90	4.50	2.34	3.32	0.95
0N-04	AP	0-14	5.5	4.6	0.08	0.98	0.08	0.74	0.61	0.14	15.70	1.00	0.34	0.20	0.12	4.30	39.80	3.70	1.10	2.10	0.66
011 01	AB	24-33	5.4	4.4	0.11	0.86	0.06	0.65	0.72	0.10	12.30	0.20	0.34	0.20	0.13	2.60	29.00	3.10	0.80	3.15	0.75
	Bt1	33-78	5.2	4.3	0.06	0.62	0.02	0.49	0.75	0.10	11.00	1.40	0.10	0.08	0.04	8.80	09.00	3.80	1.60	2.15	1.84
	Bt2	73-126	5.1	3.9	0.07	0.54	0.01	0.40	0.90	0.08	7.80	0.40	0.18	0.06	0.03	6.50	10.00	4.00	1.80	1.65	0.95
	BC	126-180	5.0	3.8	0.05	0.45	0.01	0.30	0.85	0.13	5.15	0.90	0.12	0.17	0.12	8.60	13.00	4.30	1.40	2.54	0.66
ON-05	AP	0-13	5.4	4.9	0.08	0.20	0.11	1.42	1.34	0.08	15.50	1.90	0.60	0.10	0.10	6.00	45.00	3.80	1.15	4.90	0.75
	AB	13-28	5.2	4.8	0.07	0.95	0.05	1.15	1.00	0.15	7.40	0.95	0.35	0.05	0.13	6.00	25.00	4.15	1.60	5.80	1.84
	Bt1	28-65	5.1	4.3	0.06	0.70	0.03	0.96	0.89	0.05	11.75	0.60	0.50	0.04	0.08	6.00	20.00	3.89	1.80	6.70	0.95
	Bt2	65-125	5.0	3.9	0.05	0.43	0.02	0.80	0.70	0.10	9.58	1.45	0.15	0.17	0.07	7.50	25.00	4.50	2.10		0.88
	BC	125-180	4.9	3.8	0.04	0.24	0.02	0.70	0.05	0.36	6.89	0.50	0.30	0.14	0.08	3.00	34.00	5.10	1.35	4.50	0.50
0N-06	AP	0-13	5.3	4.7	0.120.	1.00	0.08	1.85	1.75	0.10	13.10	1.20	0.80	0.23	0.06	8.00	27.00	4.90	2.50	4.90	0.77
	AB	13-31	5.2	4.6	0.10	0.95	0.06	1.20	1.60	0.60	9.60	1.10	0.40	0.18	0.04	5.70	30.00	2.80	5.90	5.60	0.60
	Bt1	31-69	5.1	4.3	0.10	0.84	0.04	1.15	1.00	0.15	10.20	1.10	0.40	0.19	0.11	5.40	32.00	3.90	4.20	6.55	0.90
	Bt2	69-124	5.0	3.0	0.08	0.54	0.03	0.98	0.85	0.13	6.60	0.20	0.13	0.04	0.70	3.10	21.00	4.67	5.00	4.80	1.00
	BC	124-180	4.9	3.9	0.07	0.43	0.03	0.80	0.76	0.04	7.85	0.50	0.70	0.13	0.40	2.60	53.00	4.40	3.70	4.80	0.70
0N-07	AP	0-13	5.3	5.0	1.02	2.10	0.09	1.80	1.20	0.60	16.50	1.40	0.80	0.26	0.13	7.00	37.00	4.50	2.50	6.50	1.00
	AB	13-32	5.4	4.8	0.90	1.50	0.07	1.00	0.90	0.10	12.60	1.32	1.88	0.42	0.07	8.20	40.00	5.60	3.47	5.40	0.75
	Bt1	32-78	5.2	4.3	0.80	0.95	0.06	0.95	0.85	0.10	10.70	1.75	1.84	0.42	0.06	10.00	41.00	7.45	4.70	3.50	0.59
	Bt2	78-129	5.1	4.2	0.70	0.80	0.02	0.86	0.76	0.10	8.60	1.63	1.73	0.29	0.07	12.40	30.30	4.54	5.55	5.10	0.60
	BC	120-180	5.4	4.0	0.60	0.01	0.01	0.75	0.69	0.06	7.50	2.50	1.70	0.43	0.05	15.50	30.30	3.12	2.60	4.50	0.58

Key: O.C = Organic carbon, O.M= Organic matter, N= Nitrogen, TEA= Total Exchangeable Acidity, EA= Exchangeable Acidity, P= Phosphorus, ECEC= Effective Cation Exchange Capacity, BS= Base Saturation

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Taxonomic Classification of the Soil Units

The taxonomic classification of the soil units is shown in Table 4. Map showing taxonomic classification of the soil units is shown in figure 2. Soil units ON-01, 02, 03 and 07 were classified as Ultisol or Acrisol because of the argillic or kandic B horizon with low base saturation. Udic soil moisture regime that is freely and well drained is classified as Udults. It was further classified as Hapludult at great group level because of the clay distribution in which the clay content increases with increasing depth and Typic Hapludults because they are freely and moderately deep to hard rock and also have an ochric epipedon that is not both thick and sandy. Soil unit ON-04 is classified as Entisols because it shows no evidence of pedogenic horizons. The soil unit has an udic moisture regime hence classified as udent. The soil unit was further classified as Dystrudent at great group level because it does not have free carbonates within the soils and has a base saturation of less than 60 percent in all sub horizons between depths of 25 and 75cm between the soil surface hence was further classified as Oxic Dystrudent. Soil units ON- 05 and 06 were classified as Ultisols because they have thick argillic horizon, low base saturation and low CEC. Ultisols with udic soil moisture regime are classified as Udults. They are also classified as Paleudults because they have a clay distribution in which the percentage clay does not decrease from its maximum amount more than 20 percent within 150cm of the soil surface.

Table 4: Taxonomic Classification of the Soil Units									
Soil Unit	USDA Soil Taxonomy	World Reference Base							
ON 01	Typic Hapludult	Haplic Acrisol							
ON 02	Typic Hapludult	Haplic Acrisol							
ON 03	Typic Hapludult	Haplic Acrisol							
ON 04	Oxic Dystrdent	Haplic Arenosol							
ON 05	Typic Paleudult	Haplic Acrisol							
ON 06	Typic Paleudult	Haplic Acrisol							
ON 07	Typic Hapludult	Haplic Acrisol							



Figure 2: Map showing Taxonomic classification of the soil Units

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Land Suitability Evaluation

Land characteristics of the study area (Table 5) were matched with the agronomic requirements of groundnuts (Tables 6) to obtain suitability class scores of groundnuts in the study area (Table 7).

Table 5: Land characteristics / quality of the study area										
Soil Unit (ON)	(01,02,03,07)	(04)	(05,06)							
Land Characteristics	Typic Hapludults	Oxic Dystrudents	Typic Paleudults							
Rainfall (mm)	1900-2200	1900-2200	1900.2200							
Temperature (⁰ C)	27-28	27-28	27-28							
Relative humidity (%)	72	72	72							
pH (H ₂₀)	5.18	5.24	5.11							
pH (KCl)	4.14	4.20	4.32							
E.C	0.27	0.08	0.077							
Organic carbon (%)	0.77	0.70	0.73							
Total N (%)	0.19	0.09	0.13							
Avail P	9.05	10.99	9.84							
Exch.Ca ²⁺ (cmol/kg)	1.58	0.78	0.95							
Exch.Mg ²⁺ (cmol/kg)	1.08	0.61	0.41							
Exch.K ²⁺ (cmol/kg)	0.39	0.16	0.13							
Exch.Na ²⁺ (cmol/kg)	1.77	0.10	022							
Total Exch. Acidity	1.10	0.71	1.11							
H+	0.91	0.59	1.42							
A1 ³⁺	0.16	0.11	0.14							
BS	30.71	20.00	29.30							
Avail. Mn ²⁺	2.77	1.34	2.90							
Fe ²⁺	4.54	2.39	5.32							
Zn^+	4.24	3.78	4.21							
CEC	9.33	12.16	5.33							
Ksat	3.36	30.41	10.71							
Texture	SCL	SCL	SCL							
Soil drainage	Well drained	Well drained	Well drained							
Bulk density	0.51	0.92	1.04							
Topography	0.2%	2-3%	2-3%							
Soil Depth	126	125	130							

Table 5: Land characteristics / quality of the study area

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Table 6: Land use requirement for Groundnut production									
	Factor	Suitability	ratings						
Land quality/characteristics	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)					
Climate (C)									
Rainfall (mm)	>700	600-700	500-600	<500					
Temperature (°C)	22-28	18-22	15-18	<15					
Soil physical characteristics (S)									
Soil depth (cm)	> 120	75-120	30-70	<30					
Soil texture	SL, SiL, LS	CL,SCL, SiCL	S, SC, SiC	С					
Topography (t)									
Slope (%)	0-2	2-5	5-8	>8					
Drainage	Well drained	Moderately drained	Imperfectly drained	Poorly drained					
Soil fertility status (s)									
рН	5.8-6.2	5.5-5.7,6.3- 6.5	5.0-5.4, 6.6-7.0	<5, >7					
Total N (g kg ⁻¹)	>0.5	0.2-0.5	0.2	< 0.2					
Available P (mg kg ⁻¹)	>20	10-20	5-10	<0.5					
CEC (Cmolkg ⁻¹)	>12	6-12	4-6	<4					
Base saturation (%)	>80	50-80	40-50	<50					
Organic C (g kg ⁻¹)	>12	8-12	5-8	<5					

Modified from Sys et al., 1985

LS = Loamy Sand, SL = Sandy Loam, CL = Clay loam, SiL = Silt Loam, SiCL = Silt Clay Loam, C-Clay, S = Sand, SC = Sandy Clay.

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	ON							
Soil units	01	02	03	04	05	06	07	
Rainfall (mm)	S1	S 1	S1	S1	S1	S1	S1	
Temp (⁰ C)	S1	S 1	S 1	S 1	S1	S 1	S 1	
Soil Drainage	S 1							
Texture	S2							
Soil depth (cm)	S 1							
Fertility								
CEC	S 3	S2	S2	S2	S2	S3	S3	
B.S (%)	N1							
pH (H ₂₀)	S 3	S3	S3	S3	S3	S3	S3	
Total N	S 3	S3	S3	N1	N1	N1	S3	
Avail. P	S 3	S3	S3	S3	S3	S3	S3	
Organic carbon (%)	N1							
Aggregate suitability score	N1-f							

Table 7: Suitability class score of the soil units for groundnut cultivation

CONCLUSION AND RECOMMENDATIONS

The soils were strongly acidic and can be reduced by liming. This will also increase the effectiveness of fertilizers and growth of arable crops. Fertility (organic carbon, total nitrogen and base saturation) was the major limitation to the soil's suitability for groundnut cultivation. As such, groundnuts can be cultivated at any of the soil units after improving the fertility. Proper land preparation, avoidance of bush burning, practicing crop rotation, cultivation of leguminous crops to ensure increase in total nitrogen and application of organic fertilizer could also make these soils suitable for groundnut cultivation in the study area.

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