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Suitability evaluation of land for some commonly grown crops in Abeokuta, Ogun State: Challenges and limitations

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Abstract

A detailed soil survey was carried out at the Teaching and Research Farms of Federal University of Agriculture, Abeokuta to establish an information for land planers and farmers on the suitability of the land for some commonly grown crops in Abeokuta.. Following observed soil variation, modal profile pit was dug, described and sampled following standard guidelines. These samples were subjected to physical and chemical analyses. The result showed that the organic carbon, available phosphorus and the exchangeable bases were low across all the profiles while the total nitrogen was only moderate at the surface but low as the soil depth increased. The soils were suitable for maize and cashew using parametric and non-parametric approaches but permanently not suitable for oil palm using non-parametric approach as climatic condition being the limiting factor and marginally suitable using parametric approach.

Keywords: Land Use, Suitability Evaluation, Parametric Approach

Introduction

Characterizing and evaluation of the soil for suitability purpose for desired crops cannot be over emphasized. Considering the rapid growth of the world population which is in its turn a limiting factor to the arable land around the world, the desperate need for effective and efficient application of the croplands have been felt more than ever (Behzad *et al.,* 2009). Sustainable agriculture would be achieved if lands be categorized and utilized based upon their different uses according to FAO (2016). Based on land utilization, suitability evaluation is one of the strategies for achieving food security as well as sustainable environment (Esu, 2004). The suitability of a given piece of land is its natural ability to support a specified land use; such as rain-fed agriculture, livestock production, forestry, etc. Therefore, suitability is regarded as a state of the wellness of a given type of soil for a defined agricultural use (FAO, 2016). The term "Land suitability assessment" refers to assessment of land performance to derive maximum benefits when used for a specific purpose. This assessment embraces many biophysical factors that directly or indirectly control the ability of this part of land to host the land use under investigation (Rabia and Terribile, 2013). Chandrakala *et al.*(2019) stated that the increased necessity for food production and the limited resources stimulate a need for sophisticated methods of land evaluation. Many methods developed for the assessment of land suitability have taken into consideration its limitations and as well have been divided into hierarchic and parametric approaches (Dengiz and Sarıoğlu, 2013; Karimi *et al.*, 2018). Simple limitation, regarding number and intensity of limitations, Storie, and square root (Khiddir, 1986) methods are the most widely used (Sys *et al.*, 1991; Dengiz, 2002; Rabia and Terribile, 2013). For accurate interpretation and prediction, especially for modern agriculture and non-agricultural uses of soils, quantitative data on composition of the soils are deployed and for sustainable land use, what is required is a synergy between different attributes of land such as; soil properties, land cover, topography, and climate, which themselves are dynamically variable. Land suitability assessment is therefore conventionally evaluated by matching requirements of biophysical/ ecological, socioeconomic and political factors for the particular application with characteristics and qualities of land components (Osinuga *et al.*, 2020). The objectives of this study are to characterize the soil and evaluate the suitability of different land use types on some common crops.

Materials and Methods

Description of study area

The study was conducted at the Teaching and Research Farms of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta (FUNAAB).The area is located between latitude 7^{0} 15' N and 7^{0} 23', Longitude 3° 20' E and 3^{0} 24' and on Elevation 108 m. The vegetation is basically derived savanna, which has been modified by various agricultural practices over time.The climate of Abeokuta falls between the humid and sub -humid tropics with mean annual rainfall of about 1113 mm, two peaks distribution pattern and five dry months in the year. Mean temperature ranges between $25^{\circ}C$-$28^{\circ}C$. The soil temperature which is relatively higher than the air temperature is highest at the 5cm depth ($34^{0}C$ to $35^{0}C$) and decrease with the depth from 10cm to 50cm from the surface, though still remaining above $30^{0}C$. The relative humidity is highest between July and September ranging from 86 % to 88 % and lowest between January and February at 66 % to 68 % in most years (Basil *et al.*, 2023).

Field survey

The total area of land used for this research was 20 hectares. The research was carried out between January and April 2021. Following soil variation on the field, a representative profile pit (2 x 1 x 2 m) was dug at each slope segment and soil types/mapping units encountered. A total number of 10 profile pits were dug across the land according to the variation on the field. The general site description such as climate, vegetation, land use, gradient of slope, drainage type and soil texture by feel was determined. The profile pits were described morphologically after FAO (2006) guidelines. They were sampled and placed in labeled bags and then processed in the laboratory after air-drying.

Laboratory analysis

The air-dried soil samples were, ground and sieved with a 2 mm mesh sieve and sub-samples were further sieved with 0.5 mm sieve for the organic carbon and nitrogen determination. The organic carbon was determined using Walkley and Black (1934) method. Soil pH in both water and 0.01M potassium chloride solution (1:1) were determined with the use of a glass electrode pH meter (Mclean,1965). Exchangeable cations were extracted with 1M NH_4OAc (pH7.0), sodium and potassium were determined using flame photometer and exchangeable Mg and calcium by Atomic Absorption Spectrometer (Spark, 1996).Available P was extracted using Bray-1 extractant followed by Molybdenum blue colorimetric. Exchangeable acidity was determined by the KCl extraction method (Mclean, 1965). Percentage base saturation was calculated by dividing the sum of all exchangeable cations by the effective cation capacity (ECEC). Total nitrogen was determined by the Macro-kjeldahl digestion method of Jackson (1962). The bulk density was determined by core method. Soil porosity was estimated from the bulk density data at an assumed particle density of 2.65 gcm^{-3}.Particle size distribution analysis was determined by the Bouyoucos hydrometer (1962) method using calgon as dispersing agent.

Land suitability evaluation

1. Conventional approach (1976).

Pedons were placed in suitability classes by matching their characteristics (Table 1) with the requirements of various crops (Tables 2 - 4). The suitability class of pedon is that indicated by its most limiting characteristic.

2. Parametric approach

For the parametric method, each limiting characteristic was rated as in Tables (2- 4). The index of productivity (actual and potential) was calculated using the following equation; (Sys, 1985).

Where;

$$IP = A \times \sqrt{\underset{(c)}{\frac{B}{100}} \times \underset{(t)}{\frac{C}{100}} \times \underset{(w)}{\frac{D}{100}} \times \underset{(s)}{\frac{E}{100}} \times \underset{(f)}{\frac{F}{100}}}$$

IP = Index of productivity; A= Overall fertility limiting and B, C....F are the lowest characteristic ratings for each land quality group. Five land quality groups climate (c), topography (t), soil physical properties (s), wetness (w) and fertility (f) were used in this method of evaluation. Only one member in each group was used for calculation purpose because there are usually strong correlations among members of the same group (e.g. texture and structure).

For actual productivity index, all the lowest characteristics ratings for each land quality group were substituted into the index of productivity equation above. However, in the case of potential productivity index, it was assumed that the corrective fertility measure will no longer have fertility constraints. Suitability classes S1, S2, S3 and N are equivalent to IP values of 100 – 75, 74 - 50, 49 – 25 and 24 – 0, respectively.

Results and discussion

Physical and chemical properties of the soil profile

The physico-chemical properties of the profile soils are shown in Table 5. The particle size distribution varied across the profiles. The sand content ranged from 850 g/kg at the surface to 473.3g/kg at the sub-surface in all the profiles and decreased as the soil depth increased. The clay content ranged from 123g/kg at the surface to 432g/kg at the sub-surface across all the profiles. This however increased as the soil depth increased. The silt content varied from 8.00g/kg at the surface to 147g/kg at the sub-surface across all the profiles without following a specific pattern. The bulk density varied from 1.00g/cm^3 at the surface to 1.60g/cm^3 at the sub-surface across the profiles.

The soil reaction varied also across the profiles with the highest pH value (7.33) recorded at the surface in the third profile. The pH ranged from 5.6 t0 7.33 across all the profiles. The organic carbon with the range value of 0.50-1.01% across the profile was low. The total nitrogen recorded the highest value of 0.22% at the surface indicating that the total nitrogen was moderate at the surface but as the soil depth increased, it appeared to be low. Available phosphorus <10mg/kg across all the profiles was very low. Exchangeable bases (Ca, Mg, Na, K) varied across the profile. Calcium was moderate, magnesium was low while potassium was very low. Sodium was however also low together with the ECEC and the exchangeable acidity.

Land suitability evaluation (LSE)

According to FAO system, modified by Sys (1985) for tropical soils, the land requirement (land qualities/characteristics) for grouping lands into suitability classes for arable and tree crops production for the three crops evaluated are given in the Table 1. The matching of the land qualities/characteristics of the pedon (Table 1) with the land requirements of the crop (Tables 2-4) produced the various suitability classes for the various crops given in Tables 6-8.

Maize

All the pedons are highly suitable (S1) for both non-parametric and parametric approaches in all the land use types for maize production (Table 6).

Oil palm

The suitability of the soils is presented in Table 7. The result showed that the soils are permanently not suitable (N2) for oil palm, using the non-parametric approach in all the land uses. The limiting factors are the climatic condition basically the annual rainfall; drainage and the fertility. On the other hand, using parametric approach, the soils are marginally suitable (S3) for oil palm production. Tables 6-8 show the individual ratings of the land characteristics as well as the aggregate ratings for the pedons at all land use sites. The aggregate suitability ratings are for both potential and actual (or current) suitability. The Tables also show the classification by conventional and parametric methods.

Cashew

The suitability of the soils is presented in Table 8. The actual and potential results using non-parametric approach showed that the soils are moderately suitable (S2) for cashew. However, using parametric approach, the soils are highly suitable (S1) for cashew.

The sand content which was > 800 g/kg at the surface indicated that the particle size was dominated by sand. This indicated that the infiltration rate and the rate of leaching would be high. This was evident in the exchangeable bases. This result was similar to the reported result of Senjobi *et al* (2019). Basil *et al* (2023) also reported a similar result that the high percentage sand is a good indication of high infiltration rate. The implication of this is the capacity of the soil to be eroded away as reported by Senjobi *et al.* (2010). The effect of the high percentage of sand was evidently seen in the clay movement down the profiles. The increase in clay content as the depth increased might be as a result of clay migration through a process known as clay lessivage. This trend was similar to the result reported by Osinuga *et al.* (2020). Calabrese *et al.* (2018) also reported that clay movement down the profile is as a result of leaching of clay materials caused by the downward movement of water and depositing them in the next profile horizons. Bulk density >1.5g/cm^{3}may impede root elongation according to Aminu *et al.* (2013). Soil organic carbon is one of the principal components and correlate strongly with soil structural stability and water holding capacity. The low organic carbon observed in all the profiles could be as a result of micro-organism activity which aid decomposition of organic materials which are favoured by high temperature of the tropics. This is similar to the result reported by Basil *et al.* (2019). Available phosphorus was low across the profiles. The parent materials of the soils could be poor in phosphorus minerals according to Aiboni, (2001). The land suitability evaluation by parametric approach showed that all the pedons were highly suitable (S1) currently for maize. 95% of the pedons were suitable for cashew and 5% moderately suitable (S2) for cashew. The pedons were marginally suitable (S3) for oil palm. However using non-parametric approach, 95% of the pedons were highly suitable (S1) for maize, 5% moderately suitable (S2) for cashew but were temporarily not suitable (N2) for oil palm. The limitations to suitability of the land for oil palm are the climate (rainfall) and fertility. Sys (1985) reported that oil palm thrives at rainfall ≥2000mm. This was more than the result for the rainfall data reported.

Conclusions

It is concluded that the soil characteristics as regards the physical and chemical varied across the pedons as the organic carbon was found to be low, available phosphorus was also low while total nitrogen was moderate at the surface The exchangeable bases have been used up or leached away and this on the other hand, left the soil to be slightly acidic. The pH of the soil confirmed this claim. Even though the soil nutrients were low in most cases, the soils were suitable for maize and cashew using parametric and non-parametric methods but however permanently not suitable for oil palm using non-parametric method and marginally suitable using parametric approach.

Recommendations

Based on the study, it is recommended that for a land to be judiciously put to proper use, suitability evaluation test must be carried out to ascertain the use at which the land needs to be subjected to.This especially under agriculture will prevent mismanagement and misappropriation of land.

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Table 1: Land qualities/ Characteristics of the Selected Site for Suitability Classification

Profile No	Annual rainfall (mm)	Length of dry season (month)	Mean Temp. (°C)	RH (%)	Slope (%)	Soil depth (cm)	Texture	Exch.K	Mg	Na (cmol/kg)	Ca	ECEC	B.sat(%)	pH (H_2O	Org. Carbon (%)
P1	1113	4-5	26	75	6	>155	SL-SCL	2.45-3.50	1.76-2.22	3.28-5.44	25.95-27.95	36.23-38.01	96.39-98.24	6.50-7.00	0.58-1.23
P2	"	"	"	"	12	>180	SL-SCL	3.15-6.19	1.81-2.49	4.33-5.94	29.17-32.31	41.81-46.06	98.19-98.70	6.50-7.00	0.58-1.23
P3	"	"	"	"	7	>160	SL-SCL	4.01-5.22	1.40-2.24	2.90-8.44	20.62-32.01	30.57-47.23	97.21-98.88	6.77-7.33	0.50-0.94
P4	"	"	"	"	2	>145	SCL-SL	0.01-0.03	0.08-0.12	0.02-0.04	27.16-34.24	28.37-35.62	96.12-96.63	6.20-6.50	0.28-0.68
P5	"	"	"	"	2	>160	SCL-SL	0.01-0.03	0.08-0.11	0.04-0.05	28.91-32.95	29.58-34.23	96.79-98.47	5.60-6.40	0.36-1.04
P6	"	"	"	"	7	>162	LS-SCL	0.01-0.02	0.11-0.12	0.01-0.05	32.15-37.76	33.22-38.73	97.29-98.31	6.10-6.30	0.44-1.04
P7	"	"	"	"	4	>152	LS-SCL	0.02-0.07	0.09-0.11	0.03-0.04	30.24-36.30	30.90-37.50	97.33-98.39	5.70-6.10	0.20-0.88
P8	"	"	"	"	6	>105	LS-SCL	0.01-0.02	0.11-0.12	0.04-0.11	22.74-38.58	23.65-39.31	97.04-98.73	6.30-6.50	0.76-1.20
P9	"	"	"	"	5	>160	SL-SCL	0.13-0.31	1.59-2.25	0.49-1.05	16.07-33.22	19.07-36.84	92.51-98.28	6.07-6.47	0.81-1.07
P10	"	"	"	"	3	>110	SL-SCL	0.31-0.41	1.48-2.18	0.44-0.77	28.84-30.61	32.30-35.11	96.49-97.93	6.50-7.00	0.58-1.23

Table 2: Land and Soil Requirements for Maize (Modified from Sys, 1985)

Land Qualities	100	95	85	60	40	25
	SI1	SI2	S2	S3	N1	N2
Climatic (c)						
Annual rainfall(mm	850-1250	850-750 1250-1600	750-600 1600-1800	600-500 >1800	550-500	>500
Length of growing season (days)	150-220	220-270	270-325	325-335	335-245	>345
		130-150	110-130	90-110	90-100	<90
Mean Annual temp(°C)	22-26	22-18 26-32	18-16 32+	16-14	14	<14
Relative humidity Developmental stage (%)	50-80	50-42	42-36	36-32	32-30	<30
Topography (t) Slope (%)	0-2	2-4 4-8	4-8 8-16	8-16 16-30	30-50	>16 >50
Wetness (w)		Moderate	Somewhat poorly drained	Poor	Poor	Poor and very poor
Drainage	Good somewhat poorly drained	Moderate	good	Aeric	Drainage	Poor not drainable
Soil physical properties (s): Texture						
	Cs, SiCs Co,CL	Cs, SC,L,SCL	SL Lfs,LS	LCS,fs	Cm, CL	Cm,CS
Soil Depth (cm)	<100	75-100	50-75	30-50	20-30	<20
Fertility (f):						
CEC (cmol/kg clay)	>24	16-24	<16(-)	<16	<10	<10
Base saturation (%)	>50	35-50	20-35	15-20	<15	<15
Organic matter (%C)	>2	1.2-2	1.0-1.2	0.8-1.0	0.6-0.8	<0.6
(0-15cm)	>1.5	0.8-1.2	0.6-0.8	0.5-0.6	<0.5	<0.5
	>0.8	0.6-0.8	0.5-0.6	0.4-0.5	<0.4	<0.4

Symbols used for soil texture and structures are defined as follows:
Cs:strudture clay; Cm:massive clay; SiCs:siltyclay,blocky clay; SiCL:silty clay loam;CL:clay loam; Si:silt;SiL:silty loam; SC; sandy clay; L; loam; SCL:sandy clay loam: SL: sandy loam; Lfs: loamy fine sand; LS: loamy sand; lcs: loam coarse sand: Fs: fine sand: S:sand:

Table 3: Land and Soil Requirements for Cashew (Widiatmaka*et al.*, 2014)

Land Qualities	100 S1	85 S2	60 S3	40 N
Climatic (c)				
Annual rainfall(mm)	987-2247	827-987 2247-3197	601-827 3197-4926	<601
Length of growing season (months)				
Mean Annual temp(^{o}C)	>25	20-25	18-20	16-18
Relative humidity (%)	>75	65-70	62-65	60-62
Topography (t)				
Slope (%)	<12	12-23	23-77	>77
Wetness (w):				
Flooding				
Drainage	Good somewhat poorly drained	Mod.well	Mod.Well	Poor aeric
Soil physical properties (s):				
Texture	CL, SCL L	CL SCL,L	SLC	SCL-Lfs
Structure	Blocky	Blocky		
Soil Depth (cm)	>40	21-40	7-21	<7
Fertility (f):				
CEC (cmol/kg clay)	>12.4	8.5-12.4	2.6-8.5	<2.6
Base saturation (%)	>66	<66		
Organic matter (%C) (0-15cm)	>0.8	0.5-0.8	0.1-0.5	<0.1

Symbols used for soil texture, structures and flooding are defined as follows:Cs:strudture clay; Cm:massive clay; SiCs:siltyclay,blocky clay; SiCL:silty clay loam;CL:clay loam; Si:silt; SiL:silty loam; SC; sandy clay; L; loam; SCL:sandy clay loam: SL: sandy loam; Lfs: loamy fine sand; LS: loamy sand; lcs: loam coarse sand: Fs: fine sand: S:sand: CS: coarse sand.

Table 4: Land and Soil Requirements for Oil palm (Modified from Sys, 1985)

Land Qualities	100 S11	95 S12	85 S2	60 S3	40 N1	25 N2
Climatic (c)						
Annual rainfall(mm)	>2000	1700-2000	1450-1700	1300-1400	1300-1250	<1250
Length of growing season (months)	<1	1-2	2-3	3-4	3-4	<4
Mean Annual temp(^{o}C)	>25	22-25	20-22	18-20	16-18	<16
Relative humidity (%)	>75	70-75	65-70	62-65	60-62	<60
Topography (t)						
Slope (%)	0-4	4-8	8-18	16-30	>30	>30
Wetness (w):						
Flooding	Fo	Fo	F1	F2	F2	F3
Drainage	Good somewhat poorly drained	Mod.well	Mod.Well	Poor aeric	Poor,drainable	Poor , very poor,not Drainable
Soil physical properties (s):						
Texture	CL, SCL L	CL SCL,L	SLC	SCL-Lfs	Any	C,Cs, any
Structure	Blocky	Blocky				
Soil Depth (cm)	>125	>100	>75	>50	>55	<50
Fertility (f):						
CEC (cmol/kg clay)	>16	Any	<10	<10	<5	<5
Base saturation (%)	>35	35-20	20-15	15-10	<10	<10
Organic matter (%C) (0-15cm)	>1.5	0.8-1.5	<0.8	<0.5	<0.3	<0.2

Symbols used for soil texture, structures and flooding are defined as follows:
Cs:strudture clay; Cm:massive clay; SiCs:siltyclay,blocky clay; SiCL:silty clay loam;CL:clay loam; Si:silt;SiL:silty loam; SC; sandy clay; L; loam; SCL:sandy clay loam: SL: sandy loam; Lfs: loamy fine sand; LS: loamy sand; lcs: loam coarse sand: Fs: fine sand: S:sand: CS: coarse sand. Fo=No Flooding, F1=1-2 flooding months in >10 years, F2=not more than 2-3 months in 5 years out of 10 years, F3=2 months almost every year, F4=2-3 months every year

Table 5: Some selected Physical and Chemical Properties of the Pedons

Pit no	Depth (cm)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	B.D (g/cm^3)	pH (H_2O)	O.C (%)	T.N (%)	Av.P mg/kg	K cmol/kg	Na cmol/kg	Ca cmol/kg	Mg cmol.kg	Ex.A cmol/kg	ECEC cmol/kg
1	0-40	840.0	33.0	127.0	1.08	6.67	0.76	0.22	5.79	2.45	5.44	2.60	1.76	0.63	12.88
	40-95	843.3	18.0	138.7	1.12	7.00	1.23	0.19	2.58	2.65	3.28	2.74	2.22	1.33	12.22
	95-155	655.0	45.0	300.0	N.D	6.50	0.58	0.16	2.58	3.50	4.34	2.80	2.14	0.67	13.45
2	0-40	840.0	37.0	123.0	1.00	6.67	0.76	0.22	5.79	3.15	4.33	3.23	1.81	0.77	13.29
	40-120	785.0	25.0	190.0	1.22	1.23	1.23	0.19	2.58	6.19	5.94	3.11	2.08	0.73	18.05
	120-180	630.0	39.0	331.0	N.D	6.58	0.58	0.16	2.58	4.22	5.39	2.92	2..49	0.53	15.55
3	0-50	835.0	42.0	123.0	1.06	7.33	0.94	0.22	2.75	5.22	5.47	3.15	1.40	1.20	16.44
	50-120	810.0	49.0	141.0	1.10	7.17	0.90	0.19	3.31	4.58	2.90	2.06	1.84	0.63	12.01
	120-160	645.0	141.0	214.0	N.D	6.77	0.50	0.16	2.11	4.01	8.88	3.20	2.24	0.53	18.86
4	0-30	820.0	38.0	142.0	1.58	6.50	0.28	0.17	2.40	0.01	0.02	2.72	0.08	1.10	3.93
	30-45	770.0	38.0	192.0	1.60	6.30	0.40	0.14	3.55	0.03	0.03	2.80	0.11	1.00	3.97
	45-130	710.0	38.0	255.0	N.D	6.20	0.68	0.14	4.83	0.02	0.04	3.42	0.12	1.20	4.8
5	0-46	850.0	08.0	142.0	1.55	6.40	0.48	0.15	3.70	0.04	0.04	3.21	0.08	0.50	3.87
	46-95	580.0	18.0	402.0	1.41	6.10	1.04	0.15	1.75	0.04	0.04	3.30	0.11	1.10	4.59
	95-110	610.0	48.0	342.0	1.50	5.60	0.36	0.13	1.39	0.05	0.02	2.89	0.10	0.50	3.56
6	0-27	620.0	84.7	295.3	1.22	6.3	1.04	0.11	1.67	0.01	0.05	3.78	0.11	0.8	4.75
	27-100	620.0	84.7	295.3	N.D	6.1	0.68	0.11	2.31	0.01	0.03	3.47	0.15	0.6	4.26
	100-162	473.3	94.7	432.0	N.D	6.1	0.44	0.13	3.26	0.01	0.04	3.22	0.13	0.9	4.30
7	0-30	766.7	51.3	182.0	1.14	6.1	0.88	0.17	5.85	0.07	0.04	3.63	0.09	1.00	4.83
	30-100	660.0	31.3	308.7	N.D	5.7	0.76	0.10	3.14	0.03	0.05	3.22	0.12	0.8	4.22
	100-152	653.3	51.3	295.3	N.D	6.0	0.20	0.11	2.59	0.02	0.05	3.02	0.10	0.5	3.69
8	0-40	720.0	88.0	189.3	1.42	6.5	0.76	0.17	2.11	0.01	0.04	2.94	0.09	0.7	3.78
	40-90	746.0	48.0	207.0	1.38	6.3	0.76	0.17	2.71	0.01	0.09	2.27	0.13	0.7	3.20
	90-105	596.7	147.3	297.0	N.D	6.4	1.17	0.14	3.34	0.01	0.11	3.86	0.10	0.5	4.58
9	0-30	830.0	36	134.9	1.21	6.47	0.83	0.16	1.98	0.23	0.49	1.61	1.48	1.0	4.81
	30-130	805.0	28	167	1.23	6.07	1.02	0.12	2.00	0.31	1.05	2.86	2.18	0.73	7.13
	130-160	660.0	37	300	ND	6.20	1.07	0.11	4.69	0.13	0.71	3.32	2.15	0.63	6.94
10	0-46	850.0	19	131	1.78	6.67	0.76	0.22	5.79	0.41	0.44	2.88	1.95	0.67	6.35
	46-95	815.0	46	139	1.51	7.00	1.23	0.19	2.58	0.31	0.77	2.93	1.59	0.83	6.43
	95-110	715.0	67	218	ND	6.50	0.58	0.16	2.28	0.40	0.61	3.06	2.25	1.23	7.55

O.C= organic carbon; B.D= bulk density; T.N= total nitrogen; Av.P= Available phosphorus; K= potassium; Na= sodium; Mg= magnesium; Ex.A= exchangeable acidity; ECEC= effective cation exchange capacity

Table 6: Suitability Class Scores and Aggregate Suitability of the Representative Pedons for maize

Prf. no	Annual rainfall (mm)	Mean Annual Temp(O°)	Length growth season (month)	%Rel. H	Topography Slope (%)	Net(w) Drainage	Soil physical characteristics Texture/ structure	Soil Depth (cm)	B.sat %	ECEC cmolkg/kg	Non-Parametric		Parametric	
											Actual	Potential	Actual	Potential
P1	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1wts	S1ts	S1(93)	S1(93)
P2	S1(100)	S1(100)	S1(95)	S1(100)	S2(85)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S2wts	S2ts	S1(88)	S1(88)
P3	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(100)	S1(95)	S1(100)	S1(100)	S1(100)	S1ts	S1ts	S1(95)	S1(95)
P4	S1(100)	S1(100)	S1(95)	S1(100)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1ws	S1s	S1(95)	S1(95)
P5	S1(100)	S1(100)	S1(95)	S1(100)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1ws	S1s	S1(95)	S1(95)
P6	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	S1tw	S1t	S1(95)	S1(95)
P7	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	S1tw	S1t	S1(97)	S1(97)
P8	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	N1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1t	S1t	S1(97)	S1(97)
P9	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100)	S1(95)	S1twsf	S1ts	S1(86)	S1(90)
P10	S1(100)	S1(100)	S1(95)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100	S1(100)	S1twts	S1ts	S1(93)	S1(93)

Table 7: Suitability Class Scores and Aggregate Suitability of the Representative Pedons for Oil Palm

Profile no	Annual rainfall (mm)	Mean Annual Temp (Oc)	Length growth season (month)	%Relati Humid	Topo. Slope (%)	Net(w) Drainage	Soil physical characteristics Texture/structure	Soil depth (cm)	B.sat %	ECEC cmolkg/kg	Org.C %	Non-Parametric		Parametric	
												Actual	Potential	Actual	potential
P1	N2(25)	S1(100)	S3(60)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cwf	N2	S3(46)	S3(46)
P2	N2(25)	S1(100)	S3(60)	S1(100)	S2(85)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2ctf	N2t	S3(44)	S3(44)
P3	N2(25)	S1(100)	S3(60)	S1(100)	S1(95)	S1(100)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(48)	S3(48)
P4	N2(25)	S1(100)	S3(60)	S1(100)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(45)	S3(48)
P5	N2(25)	S1(100)	S3(60)	S1(100)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(43)	S3(46)
P6	N2(25)	S1(100)	S3(60)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(46)	S3(46)
P7	N2(25)	S1(100)	S3(60)	S1(100)	S1(100)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(48)	S3(48)
P8	N2(25)	S1(100)	S3(60)	S1(100)	S1(95)	N1(40)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	N2cwf	N2	S3(30)	S3(30)
P9	N2(25)	S1(100)	S3(60)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100)	S1(100)	S1(100)	S1(100)	N2cf	N2	S3(46)	S3(46)
P10	N2(25)	S1(100)	S3(60)	S1(100)	S1(100)	S1(95)	S1(95)	S1(95)	S1(100	S1(100)	S1(100	N2cf	N2	S3(48)	S3(48)

Table 8: Suitability Class Scores and Aggregate Suitability of the Representative Pedons for Cashew

Profile no	Annual rainfall (mm)	%Relati Humid	Topo. Slope (%)	Net(w) Drainage	Soil physical characteristics Texture/structure	Soil depth (cm)	B.sat %	ECEC cmolkg/kg	Org.C %	Non-Parametric		Parametric	
										Actual	Potential	Actual	Potential
1	S1(100)	(100)	S1(100)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2wc	S2c	S1(85)	S1(85)
2	S1(100)	(100)	S1(100)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2wc	S2c	S1(85)	S1(85)
3	S1(100)	(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2c	S2c	S1(92)	S1(92)
4	S1(100)	(100)	S1(100)	S2(85)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S2wtc	S2tc	S1(78)	S1(78)
5	S1(100)	(100)	S1(100)	S2(85)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S2wtc	S2tc	S1(78)	S1(78)
6	S1(100)	(100)	S1(100)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2wt	S2c	S1(85)	S1(85)
7	S1(100)	(100)	S1(100)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2wc	S2c	S1(85)	S1(85)
8	S1(100)	(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2c	S2c	S1(92)	S1(92)
9	S1(100)	(100)	S1(100)	S2(85)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S2wc	S2c	S1(85)	S1(85)
10	S1(100)	(100)	S1(100)	S2(85)	S3(60)	S1(100)	S1(100)	S1(100)	S1(100)	S3twc	S2c	S2(66)	S2(66)