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SUITABILITY ASSESSMENT OF SOILS OF NIFOR SUB-STATION OHOSU EDO STATE FOR OIL PALM (*Elaeis guineensis Jacq.*) AND COCONUT (*Cocos nucifera*) CULTIVATION

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ABSTRACT

The need for appropriate and maximum utilization of available agricultural lands on sustainable basis cannot be over emphasized. Hence, this study was conducted to investigate the suitability of the soils of NIFOR sub-Station Ohosu in Ovia South West Local Government Area, Edo State, Nigeria for both oil palm and coconut cultivation. Data from five pedons covering 2,100 hectares were used following the limitation and index of productivity approaches. The results showed that by the parametric method, potentially, the entire pedons were moderately suitable (S2) for oil palm cultivation but currently, one pedon was marginally suitable (S3) while four pedons were not suitable (N1). With respect to coconut, two pedons were highly suitable (S1) while three pedons were moderately suitable (S2) potentially but currently, the entire pedons were not suitable (N1). With respect to limitation approach, the entire pedons were marginally suitable (S3) for both oil palm and coconut cultivation potentially. Currently, one of the five pedons was marginally suitable (S3) for both oil palm and coconut cultivation while four of the pedons were not suitable (N1).The major limitations for the sub-optimum level of suitability of the land for oil palm were fertility, climate and soil physical characteristics, while that of coconut was mainly fertility.Therefore, in optimizing and sustaining the soils for oil palm and coconut production, site specific fertilizer protocol should be developed and applied at the recommended rate for both oil palm and coconut. In addition, appropriate drainage should be considered in area with high flooding condition. Also, planting of cover crops and application of organic residue should be considered especially in area with sandy texture for oil palm. Furthermore, the study shows that oil palm and coconut can be adapted to a similar environment in terms of climatic and edaphic factors.

INTRODUCTION

Conservation and precision land management practices requires the appropriate usage of the soils for the purpose they are best suited, in order to optimize and sustain its productivity without degradation (Oko-oboh, 2016). The use of a given piece of land without the determination of its suitability has serious consequences. Furthermore, inadequate soil information on the degree and extent of its suitability constitutes a setback to the achievement of global food security, particularly in developing countries with large population like Nigeria. Thus, Land evaluation is the process of estimating the potential of a land for alternative uses (FAO, 1976). In principle, land evaluation aims at estimating land characteristics and economic conditions for optimum

use of land resources without land degradation (FAO, 1976).

Attempts are made to increase the production of oil palm and coconut palms due to the tremendous advantages of these crops in boosting both industrial and economic development. To achieve this goal, it is necessary to have comprehensive information on the biophysical resource and to identify the major limitations to the cultivation of the crops in order to optimize land use and increase production. Several procedures have been used for physical land evaluation (Sys *et al.,* 1991). The main objective of this study is to evaluate the suitability of the soils of Ohosu NIFOR sub-station for oil palm and coconut cultivation using parametric and non-parametric evaluation approaches to assess the degree of limitation posed by land characteristics and to recommend appropriate soil management for optimal oil palm and coconut cultivation.

MATERIALS AND METHODS

Description of the study Area

The study was conducted at the Nigerian Institute for Oil Palm Research (NIFOR) Ohosu sub-station in Ovia South West Local Government Area of Edo State, Nigeria. The site is 2,100 hectares, it lies within latitudes N06^0 39'.908'' and N06^0 39'.745'' and longitudes E005^0 07'.333'' and E005^0 09'.469''. The annual rainfall for the area ranges from 1595 – 2127.2 mm. The temperatures and relative humidity distribution pattern is shown in figure. The area is a transitional rainforest zone dominated by semi-deciduous forest, but due to human interference, the vegetation has been altered over the decades. The present land use is arable with few tree crops (mango, orange, pear, etc) and fallow land with few timbers. The elevation above the sea level ranged from 35 and 70 m with a

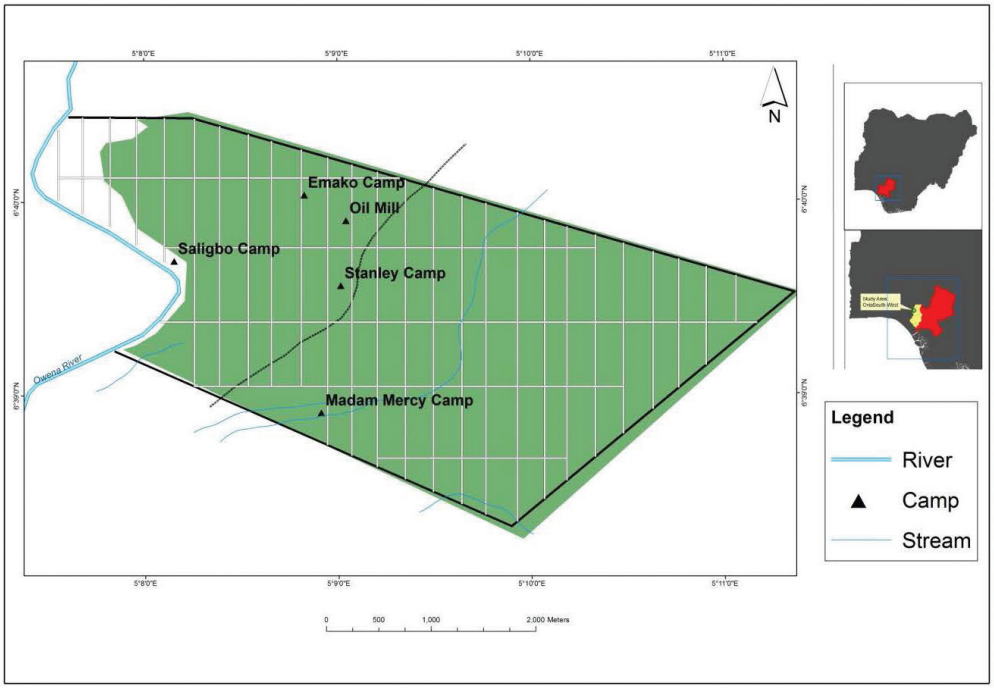


Figure 1: Perimeter Map of NIFOR-Ohosu Substation

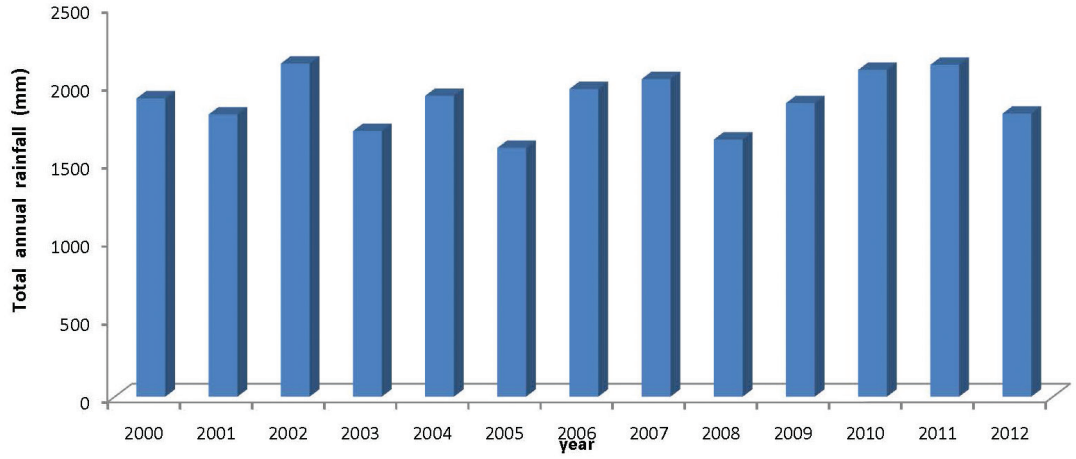


Figure 2: Total Annual Rainfall of Study Area and Environs **(Source:** NIFOR Meteorological Station)

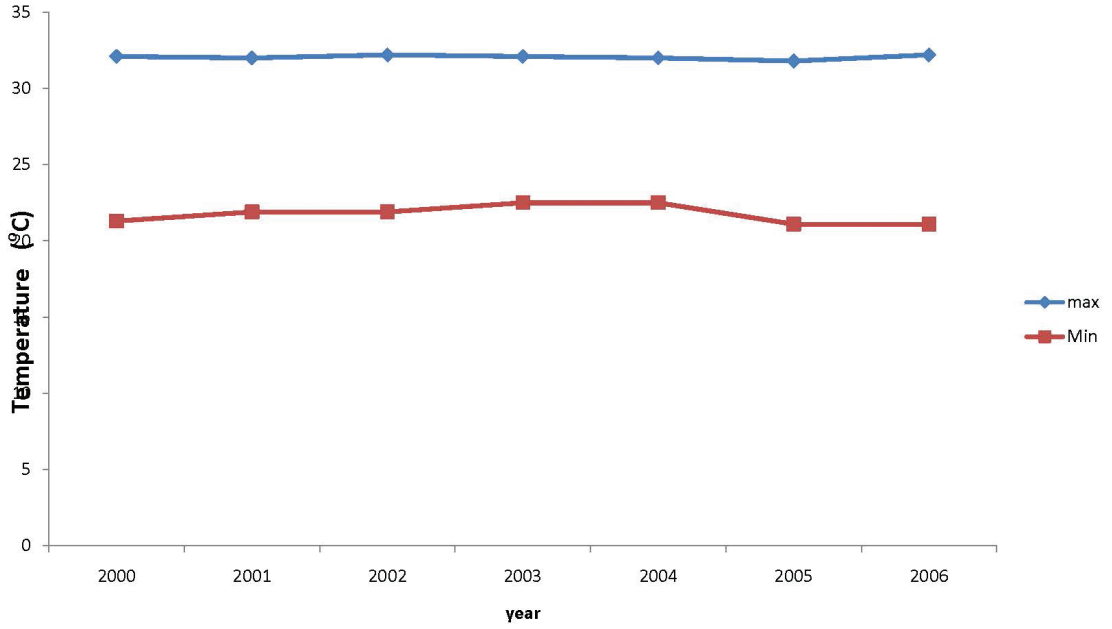


Figure 3: Air Temperature of the Study Area

(Source: NIFOR Meteorological station)

slope of <4 %. Five soil types were identified in the study area according to Oko-oboh (2016) as Rhodic Kanhanpludalf (Lixisol), Plinthic Kandiudalf (Plinthosol), Aquic Kandiudalf (Acrisol), Aquic Kandiudalf (Luvisol) and Aquic Kanhapludalf (Acrisol).

Land Suitability Evaluation (LSE)

Two methods Non-parametric (limitation) and Parametric (Index of Productivity) were used for evaluating soil suitability for oil palm and coconut. This was done according to FAO (1976) framework for rain-fed agriculture and guidelines provided by Sys (1985) and Djeanudin (2003) for land suitability evaluation (Table 1 and 2). Pedons were placed in suitability classes by matching their qualities and characteristics with the requirements for oil palm and coconut production. The aggregate suitability class of the pedons was indicated by the most

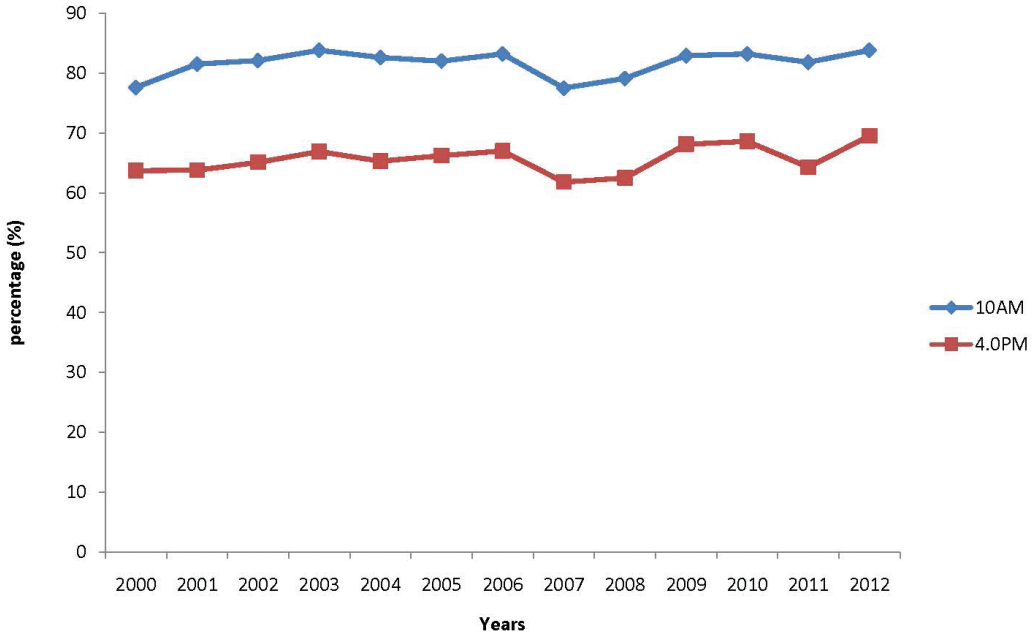


Figure 4: Relative Humidity of the Study Area **(Source:** NIFOR Meteorological station)

limiting (poorest) characteristics of that pedon. The groups of land qualities considered for the evaluation were climate (c), topography (t), drainage characteristics (w), soil physical characteristics (s), and soil chemical fertility (f). The soil fertility (f) was assessed using the soil nutrients. In computing the potential suitability for oil palm and coconut production, the fertility factors that can be amended by fertilizer addition and management practices were excluded. These factors include the level of available macro nutrient (N, P, K and Mg) and the organic matter content of the soil.

Parametric Method: The parametric land evaluation (Index of Productivity), consists of numerical rating of different land characteristics according to numerical scale between the maximum and the minimum value. The climatic indices as well as the land index were calculated from these individual ratings. The actual or current (IPc) and potential (IPp) suitability were computed using the square root model of Storie (Storie, 1976).

IPc = A [SQRT (B/100 x C/100 x F/100)] ---------- (Equ. 1) (Sys, 1985)

Where:

SQRT is square root, A is the overall least characteristic rating and

B, C ---- F are the least ratings of characteristics for each land quality group.

Using this method, each characteristic was first rated as follows: No limitation: 100 – 95, (S11), Slight limitation: 94 – 85, (S12), moderate limitation: 84 – 60, (S2), severe limitation: 59 – 40, (S3), very severe limitation: 39 – 0, (N), can be corrected: 39 – 20, (N1), can't be corrected: 19 – 0 (N2). The index of productivity for each pedon is expressed from the rating of each characteristic of the land qualities of each group using the lowest rating. The index of productivity was interpreted into suitability class using the following rating.

Highly suitable (S1) = 100 – 75, moderately suitable (S2) = 74 - 50, marginally suitable (S3) = 49 - 25 and Non-suitable (N) = 24 – 0 (Ogunkunle, 1993).

Table 1: Land and climatic characteristics for suitability classes for oil palm cultivation

	SUITABILITY CLASSES					
Land & climatic characteristics	**S11**	**S12**	**S2**	**S3**	**N1**	**N2**
Score (%)	95 – 100	85 – 95	60 – 85	40 – 60	25 – 40	0 – 25
Climate						
Mean ann. rainfall(mm)	> 2000	>1,700 – 2000	>1,450 – 1700	>1,250 – 1450	-	< 1,250
Length of dry season(months)	> = 1	1 – 2	2 – 3	3 – 4	-	> 4
Mean ann. Temp (° C)	> 29	27 – 29	24 – 27	22 24	-	< 22
Topography (T)						
Slope(S) (%)	0 – 4	4 – 8	8 – 16	16 – 30	-	> 30
Wetness (w): Flooding	F0	F0	F1	F2	-	F3
Drainage	perfect	Mod. To Well	-	Poor, aeric	Poor drainable	Very poor not drainable
Soil Physical Characteristics (S)						
Texture	CL,SCL, L	CL,SCL, L	SCL – L	SCL – LFS	ANY	C,CS
Structure	Blocky	Blocky	-	-	-	Massive Single Grain
Coarse fragmentation (vol. within 100 cm (Z)	> 3 – 10	10 -15	15 – 35	35 – 55	-	> 55
Depth (cm)	> 100	90 – 100	50 – 90	25 – 50	-	< 25
Fertility Characteristics(F)						
CEC (meq/ 100g)	> 16	15 – 16	< 15	-	-	-
Base Saturation (BS %)	> 35	20 – 35	< 20	-	-	-
pH	5.5 – 6.0	5.5 – 6.0	6.0 – 6.5	6.5 – 7.0	< 4, > 7.0	< 4, > 7.0
Organic matter (% OC, 0 - 15cm)	> 1.2	1.2 – 0.8	< 0.8	-	-	-
Salinity & Alkalinity(N)						
EC mmhos/cm	< 1	<1 – 2	>2 – 3	>3 – 4	> 4 - 8	> 38

Legend: FO =No flooding, F1= 1 - 2 flooding months in ≥ ten years, F2 = not more than 2-3 months in 5 years out of 10, F3 = 2 - 4 months every year, F4 = > 4 months in almost every year (**Source: Sys, 1985).**

RESULTS AND DISCUSSION

Climate (c): The climatic parameters considered were annual rainfall, length of dry season, mean annual temperature and relative humidity (Table 1). In the study area, annual rainfall is

Table 2: Land and climatic characteristics for suitability classes for coconut (*Cocos nucifera L*)

	Land suitability class			
Landuse requirement /characteristics	S1	S2	S3	N
Annual mean temperature (tc)				
Annual mean temp	25 – 28	28 – 32 23 – 25	32 – 35 20 – 23	> 35 <20
Water availability (wa)				
Mean annual rainfall (mm)	2000 – 3000	1300 – 2000 3000 – 4000	1000 – 1300 4000 – 5000	<1000 >5000
Dry months (month)	0 – 2	2 – 4	4 – 6	>6
Humidity (%)	>60	50 – 60	<50	-
Oxygen availability (oa)				
Drainage	Good moderate	Mod. Poor	Poor. Mod. Rapid	Very poor. rapid
Rooting condition (rc)				
Soil texture	Fine, slightly fine, medium	Slightly fine	Very	Coarse
Volume of coarse material (%)	<60	15 -35	35 -55	>55
Soil depth (cm)	<140	75 - 100	50 - 75	<50
Peat				
Thickness (cm)	>60	60 – 140	140 – 200	>200
Nutrientretention (nr)				
CEC clay (cmol/kg)	-	-	-	-
Base saturation (%)	>20	≤20	-	-
pH H_2O	5.2 – 7.5	4.8 – 5.2 7.5 – 8.0	>8.0	
Organic carbon (%)	>0.8	≤0.8		
Toxicity (xc)				
Salinity (ds/m)	<12	12 – 16	16 -20	>20
Erosion hazard (eh)				
Slope (%)	<8	8 -16	16 -30	>30
Erosion hazard	Very low	Low moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	Fo	-	F1	>F1
Land preparation (lp)				
Surface stoniness (%)	<5	5 – 15	15 – 40	>40
Rock out crops (%)	<5	5 -15	15 – 25	>25

Legend: FO =No flooding, F1= 1 - 2 flooding months in ≥ ten years, F2 = not more than 2-3 months in 5 years out of 10, F3 = 2 - 4 months every year, F4 = > 4 months in almost every year **Djaenudin *et al* (2003) modified**

not a limiting factor to oil palm cultivation. The result of matching the climatic characteristic (Rainfall) with the requirement for oil palm and coconut cultivation (Table 1, 2) rated the entire area 100% suitable for oil palm and coconut cultivation. This is because annual rainfall amount which is (> 1700 mm) is equivalent to the optimal crop requirement i.e. > 1700 mm (Sys, 1985 and Djaenudin, 2003). Length of dry season (2-3 months) is sub optimal (75%) for both oil palm and coconut compared with the requirement (< 1month) for oil palm and 0 – 2 months for coconut. Also, the mean annual temperature and relative humidity are optimum and rated (100%) for oil palm and coconut cultivation.

Topography and soil wetness (w): The topography of the entire study area was optimum (< 4%) and suitable for oil palm and coconut

Table 3: Summary of Land Qualities and Characteristics

Pedons	Annual rainfall (mm)	Number of dry months (mth)	Temp (0^0)	Slope (%)	Drainage	Texture	pH	OC (%)	BS (%)	ECEC (cmol/kg)	N (%)	P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)
A	1595 – 2127.2	1 - 3	34.9 °C,	< 3%	WD	S-SCL	4.5-6.9	0.06-0.7	60.3-96.2	3.7 – 7.8	0.003-.049	0.42-11.6	0.05-.35	1.28-2.16
B	1595 – 2127.2	1 - 3	34.9 °C,	< 3%	WD	LS-SCL	4.7-6.3	0.35-141	60.4-94.6	4.5 – 7.4	0.02-0.09	1.73-7.01	0.13-.22	1.44-2.32
C	1595 – 2127.2	1 - 3	34.9 °C,	< 3%	MWD	S-SCL	4.7-57	0.22-1.66	41.4-97.9	5.1 – 9.4	0.22-1.66	1.65-8.57	0.02-.45	0.16-2.00
D	1595 – 2127.2	1 - 3	34.9 °C,	< 3%	WD	S-LS	4.9-6.9	0.16-2.34	36.6-96.6	3.6 – 8.1	0.01-0.14	10.69-8.1	0.01-.13	0.16-1.24
E	1595 – 2127.2	1 - 3	34.9 °C,	< 3%	PD	S-SCL	4.6-6.5	0.1-3.23	77.3-94.5	7.7 – 25.6	0.00-0.21	0.17-11.7	0.04-.42	1.12-8.24

OC= organic carbon, BS=base saturation, ECEC= effective cation exchange capacity, N=nitrogen, P= phosphorus, K= potassium, Mg= magnesium, WD= well drained, MWD= moderately well drained, PD= poorly drained, S= sand, LS= loamy sand, SCL=sandy clay loam

cultivation and rated 100 %. In terms of soil wetness (drainage) three out of the five pedons (A, B and D) were rated as optimum for oil palm and coconut cultivation, pedon C was good to moderate, while pedon E was marginal for oil palm and coconut cultivation due to poor drainage.

Soil physical characteristic(s): The soil physical characteristics evaluated were structure, texture, volume of coarse fragment and effective soil depth. Matching the land qualities (Table 2) with the requirements for oil palm and coconut (Table 1 and 2), the soil texture was moderately suitable (85 %) for oil palm cultivation in 4 pedons (A, B, C and E) and marginal (60 %) for pedon D due to the sand to loamy sand nature of all the horizons in the pedon. In terms of coconut, 3 pedons (A, D and E) were highly suitable with respect to soil texture (Djaenudin, 2003). Considering the soil structural aggregate, the entire study area was optimum (100 %) as the structure was blocky to sub angular blocky. This corresponds with the requirement (Sys 1985) and Djaenudin *et al*. (2003) (Table 1 and 2) for both oil palm and coconut cultivation. All the pedons were very deep (> 100 cm) and optimum (100 %) with respect to soil depth. Considering the volume of coarse fragment, four out of the five pedons (A, C, D and E) were optimum and rated (100%). This is because the volume corresponds with the optimum value according to Sys (1985). However, mapping unit B was moderately suitable and rated (85 %) as reflected in the matching of land qualities /characteristics with oil palm requirement. For coconut cultivation, the entire pedons were highly suitable and rated 100 % with respect to volume of coarse fragment. This is because the volume of coarse fragment in the entire pedon was <60 % recommended by Djaenudin (2003).

Table 4: Individual and Aggregate Suitability of the Mapping Units using Parametric Method for Oil Palm

	Mapping Units				
Climate (C)	A	B	C	D	E
Ann. Rainfall	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Length of dry season	75 (S_2)	75 (S_2)	75 (S_2)	75 (S_2)	75 (S_2)
Mean Ann. Temp	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Av. Sunshine hrs/day	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Relative Humidity	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
TOPOGRAPHY (t)					
Slop	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
WETNESS (W)					
Flooding	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	59 (S_3)
Drainage	100 (S_1)	100 (S_1)	94 (S_2)	100 (S_1)	94 (S_2)
SOIL PHYSICAL					
CHARACTERISTICS (S)					
Texture	100 (S_1)	100 (S_1)	100 (S_1)	59(S_3)	100 (S_1)
Structure	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Vol. of coarse fragments (%) (100 cm)	100 (S_1)	60(S_3)	100 (S_1)	100 (S_1)	100 (S_1)
Soil depth	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
FERTILITY CHARACTERISTICS					
ECEC (cmol/kg^{-1})	59 (S_3)	59 (S_3)	59 (S_3)	59 (S_3)	59 (S_3)
BS (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
pH	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
OC (%) (0 – 15cm)	59 (S_3)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Macro-Nutrient	20 (N_1)	20(N_1)	100(S_1)	40 (S_3)	100 (S_1)
N%					
P (mg/kg)	40(S_3)	20(N_1)	20 (N_1)	100 (S_1)	40(S_3)
K (cmol/kg^{-1})	100 (S_1)	20 (N_1)	100 (S_1)	20 (N_1)	100 (S_1)
Mg (cmol/kg^{-1})	100(S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
SALINITY / ALKALINITY					
EC.	100(S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Aggregate suitability					
Potential (IPP)	**51.1 (S_2)**	**51.96 (S_2)**	**73 (S_2)**	**51.1 (S_2)**	**51.1 (S_2)**
Actual (current) (IPC)	**17.32 (N)**	**15.48 (N)**	**16.7 (N)**	**13.3 (N)**	**26.6 (S_3)**

Aggregate suitability class scores: 100 – 75 = S1, 74 – 50 = S2, 49 – 25 = S3, 24 – 0 = N

Soil fertility (f): This includes both the potential and current soil fertility. The potential fertility involves soil characteristics that cannot easily be altered. They include pH, organic Carbon, cation exchange capacity (CEC) and base saturation (BS). All the pedons had no limitation for both oil palm and coconut when base saturation was considered, therefore, they were rated (100 %) as they are above the recommended value by Sys (1985) and Djaenudin *et al.* (2003) (Table 1 and 2). Organic carbon was optimum in all the pedons when Tables 1 and 2 were matched with Table 3. Four (4) pedons (A, B, C and D) were marginal for oil palm cultivation with respect to ECEC (< 16 cmol/kg) while pedon E was optimum in terms of ECEC and suitable for oil

Table 5: Aggregate Suitability of the Mapping Units for Oil Palm Cultivation using Parametric and Non-Parametric Approaches

Pedon	USDA Name	Parametric potential	Non-parametric limitation (Potential)	Parametric Current	Non-Parametric limitation (Current)
A	Rhodic Kanhapludalf	S2 (51.1)	S3fc	N1 (17.32)	Nf
B	Plinthic Kandiudalf	S2(51.9)	S3fsc	N1 (15.48)	Nf
C	Aquic Kandiudalf	S2 (73.1)	S3fwc	N1 (16.88)	Nf
D	Aquic Kandiudalf	S2 (51.7)	S3fsc	N1 (13.3)	Nf
E	Aquic Kanhapludalf	S2(51.1)	S3w	S3 (26.6)	S3f

a: Aggregate suitability class scores: 100 – 75 = S1, 74 – 50 = S2, 49- 25 = S3, 24 – 0 = N.

b: c = Climatic limitation; f = Fertility limitation; w= wetness limitation, s = Soil physical characteristic limitation.

palm cultivation (Sys 1985; Rankine and Fairhurst, 1999). The soil pH was optimum for both oil palm and coconut (5.5 - 6.9) and rated 100 % (Hartley, 1988; Rankine and Fairhurst, 1999; Djaenudin *et al.,* 2003 and Sys, 1985).

The current (or actual) soil fertility refers to chemical properties that are easily altered (exchangeable K, total N available P and Mg) in addition to potential fertility stated above (Ogunkunle, 1993). With reference to Table 3 (Chemical properties), P required for oil palm production showed that pedons (A, B, C and E) had limitation (< 12 mg/kg) with respect to available P while pedon D is optimum (> 20 mg/kg) thus rated 100% (Rankine and Fairhurst,1999). Exchangeable K is optimum (> 0.3 cmol/kg) thus rated (100 %) in pedons A, C and E and not suitable (N) in pedons B and D due to its deficiency (< 0.25 cmol/kg). However, exchangeable Mg was optimum (> 0.25 cmol/kg) in all the pedons (Rankine and Fairhurst, 1999). In terms of total nitrogen, two out of the five pedons (C and E) were optimum (> 0.25%) for oil palm cultivation (Rankine and Fairhurst, 1999); while pedon A, B, and D were marginal to not suitable. Table 3 shows the individual scores of the land characteristics (all the pedons evaluated are presented here). This is the result of matching the land qualities with land requirements. Four of the 5 mapping unit/pedons representing 91.9 % are currently not suitable while 1 representing 4.2% is marginally suitable. Potentially, they are all moderately suitable for oil palm and coconut cultivation (Tables 5 and 7).Table 5 shows the summary of the suitability classes for potential and current evaluation for oil palm by both the parametric and limitation methods for the five pedons.

Parametric Evaluation

The results in Table 5 showed that by the parametric method, potentially, the entire pedons (A, B C, D and E) covering 2, 093.98 hectares were moderately suitable (S2). The results of the parametric method confirm that of the non-parametric approach particularly for current suitability. The potential evaluation is based on the assumption that fertility aspect can always be taken care of, but this may not be so in many situations. The observed disparity indicates the ba-

Table 6: Land and climatic characteristics for suitability classes for coconut (*Cocos nicifera L*)

	Land suitability class				
Landuse requirement /characteristics	**A**	**B**	**C**	**D**	**E**
Annual mean temperature (tc)					
Annual mean temp	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Water availability (wa)					
Mean annual rainfall (mm)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Dry months (month)	85 (S_2)	85 (S_2)	85 (S_2)	85 (S_2)	85 (S_2)
Relative Humidity (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Oxygen availability (oa)					
Drainage	100 (S_1)	100 (S_1)	94 (S_2)	100 (S_1)	94 (S_2)
Rooting condition (rc)					
Soil texture	100 (S_1)	59(S_3)	100 (S_1)	100 (S_1)	100 (S_1)
Volume of coarse material (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Soil depth (cm)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Peat					
Thickness (cm)					
Nutrientretention (nr)					
ECEC (cmol/kg^{-1})	59 (S_3)	59 (S_3)	59 (S_3)	59 (S_3)	59 (S_3)
BS (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
pH H_2O	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
OC (%) (0 – 15cm)	59 (S_3)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Macro-Nutrient					
N%	20 (N_1)	20(N_1)	100(S_1)	40 (S_3)	100 (S_1)
P (mg/kg)	40(S_3)	20(N_1)	20 (N_1)	100 (S_1)	40(S_3)
K (cmol/kg^{-1})	100 (S_1)	20 (N_1)	100 (S_1)	20 (N_1)	100 (S_1)
Mg (cmol/kg^{-1})	100(S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Toxicity (xc)					
Salinity (ds/m)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Erosion hazard (eh)					
Slope (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Erosion hazard	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Flooding hazard (fh)					
Flooding	100 (S_1)	100 (S_1)	94 (S_2)	100 (S_1)	94 (S_2)
Land preparation (lp)					
Surface stoniness (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Rock out crops (%)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)	100 (S_1)
Aggregate suitability					
Potential (IPP)	**54.3**	**53.3**	**77.4**	**54.3**	**77.7**
Actual or Current (IPC)	**10.9**	**10.90**	**9.6**	**10.9**	**19.22**

sic differences between the two methods. Thus, while just one characteristic that is not suitable placed the pedon into N classes (not suitable) by the non-parametric method. The parametric method, being truly an aggregate of the whole, takes other characteristics into consideration in arriving at the final suitability class.

CONCLUSION

The parametric approach revealed that 2,015.24 hectares representing 95.9% were moderately suitable (S2) potentially for oil palm and coconut; currently, 1,926.28 hectares representing 95.5% were not suitable (N1) while only 88.96 hectares representing 4.4% were

Table 7: Aggregate Suitability of the Mapping Units for coconut Cultivation using Parametric and Non-Parametric Approaches

Pedon	USDA Name	Parametric potential	Non-parametric limitation (Potential)	Parametric Current	Non-Parametric limitation (Current)
A	Rhodic Kanhapludalf	S2 (54.3)	S3fc	N1 (10.9)	Nf
B	Plinthic Kandiudalf	S2(53.3)	S3fsc	N1 (10.9)	Nf
C	Aquic Kandiudalf	S1 (77.4)	S3fwc	N1 (9.6)	Nf
D	Aquic Kandiudalf	S2 (54.3)	S3fsc	N1 (10.9)	Nf
E	Aquic Kanhapludalf	S1(77.7)	S3w	N (19.2)	S3f

a: Aggregate suitability class scores: 100 – 75 = S1, 74 – 50 = S2, 49- 25 = S3, 24 – 0 = N.

b: c = Climatic limitation; f = Fertility limitation; w= wetness limitation, s = Soil physical characteristic limitation.

marginally suitable (S3) for oil palm and coconut production. With Non parametric approach, 2,015.24 hectares representing 95.9% were marginally suitable (S3) potentially for oil palm and coconut; currently, 1, 926.28 hectares representing 95.5% were not suitable (N1) while only 88.96 hectares representing 4.4 % were marginally suitable (S3) for both crops.

The study revealed that fertility (ECEC, exchangeable K, total N, and available P), drainage, climate (length of dry season) and soil physical characteristics (sandy texture and flooding) were the limitations for the suboptimum level of production of the land for oil palm. In terms of coconut, fertility (ECEC, exchangeable K, total N, and available P) and flooding were the major limitation. Furthermore, the study shows that oil palm and coconut can be adapted to a similar environment in terms of climatic and edaphic factors as expressed in their aggregate suitability classes in this ecology.

Therefore, it is suggested that site specific fertilizer protocol should be developed and applied at the recommended rate for both oil palm and coconut to enhance production on a sustainable basis. In addition, appropriate drainage should be considered in area with high flooding condition. Also, planting of cover crops and application of organic residue like empty oil palm fruit bunches (efb) should be considered especially in area with sandy texture for oil palm.

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