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Land suitability evaluation and management of ultisols for some tree crops cultivation in South South Nigeria.

Okunsebor F. E., and Umweni A. S.

Department of Soil Science and Land Management, University of Benin, Nigeria

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Corresponding Author's E-mail Address:
faith.okunsebor@uniben.edu
+2348033886575
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ABSTRACT

A rigid grid soil survey was done on 115.5 hectares of land in Ultisols of South Southern Nigeria at a detailed scale to evaluate its suitability for the cultivation of some tree crops (Cocoa, Plantain, Cashew, Pawpaw and citrus). Mapping units were delineated on the basis of morphological characteristics examined at 100 m along traverses which were cut at intervals of 100 m from a predetermined baseline. The soils were classified according to local series and USDA soil taxonomy. Four mapping units were delineated and represented by a pedon. All the pedons were classified as Ultisols. Land suitability evaluation showed that all the pedons (115.5ha) were marginally suitable for Cocoa cultivation due to limitations in climate; pedons 1(19.4ha) and 4 (50.3ha) were marginally suitable for plantain cultivation due to limitations in fertility, while pedons 2(18.3) and 3(27.5ha) were moderately suitable for plantain cultivation due to limitation in climate. Pedon 1 was currently not suitable for citrus, pawpaw and cashew due to limitation in fertility; pedons 2, 3 and 4 were marginally suitable for citrus pawpaw and cashew due to limitations in climate and fertility characteristics. Amendment with organic fertilizers is recommended for the cultivation of Citrus and Plantain. However, the other crops may only be cultivated when there is enough economic justification.

1.0. Introduction

Lands have been utilized intensively for all purposes at the expense of their suitability capability, thereby resulting in land degradation and altering of the natural ecological conservatory balances in the landscape (Senjobi, 2007). Land suitability assessment distinguishes the actual land suitability carried out under conditions of current land use without input and the potential land suitability performed under conditions after given improvements such as fertilizer increase, irrigation and terraces management depending on the type of limiting factors. Assessment of land suitability is done by matching the land quality and land characteristics (physical and chemical properties of the land) as a parameter to the criteria of the land suitability classes, which have been prepared based on terms of use or growing crops or evaluated agricultural commodities (FAO, 1976; Peter and Umweni 2020).

Land users and planners need basic soil information on problems, potential and suitability of soils for various crops, for sustained agricultural production. Soil suitability classifications are based on knowledge of crop requirements, prevailing conditions and applied soil management methods (Ande, 2011). It provides information on suitability evaluation which should guide in choice of crops that would be economically suitable in a particular land.

The concept of sustainable agriculture involves producing quality crops in an environmentally friendly, socially acceptable and economically feasible way (Addeo et al., 2001). Tree crops are edible fruits, nuts or legumes that can serve as food for humans, livestock or wildlife. They include; cocoa, plantain, cashew, pawpaw, citrus and cash-

ew. The establishment of tree crops plantation mimics natural rainforest vegetation and is probably the only sustainable landuse in the tropics (Aruleba and Ayodele (2015). Inadequate information on the degree and extent of soil suitability for their cultivation is a major setback in achieving global food security, especially in developing countries like Nigeria, where the population is continually increasing.

Ultisols are low activity clay soils of tropical climate region with low exchangeable base status (IUSS, 2015). Thus, a study of this nature will provide land users with the needed information on the type to tree crop to be cultivated and the management practices to be adopted on Ultisols for maximum output. Several procedures have been used for physical land evaluation (Sys *et al*., 1991); they include Fasina *et al* (2007) for evaluation of Cocoa, Bhermana *et al.*, (2013) for Cashew, Sys (1985) as modified by Aruleba and Ayodele (2015) for Pawpaw, Plantain, Citrus, Avocado pear etc. The objective of this study was to evaluate some Ultisols in Iguzama community of Edo state for some tree crops (Cocoa, Plantain, Cashew, Pawpaw, Citrus and Cashew) cultivation using parametric and non-parametric (limitation) approaches.

2.0. Materials and Methods

2.1. Study Site

This study was done on a 1I5.5-hectare land at Iguzama community in Ovia North East Local Government Area of Edo State. The site lies within latitudes 6.42196° N and 6.42791° N and longitudes 5.48272° E and 5.48844° E.

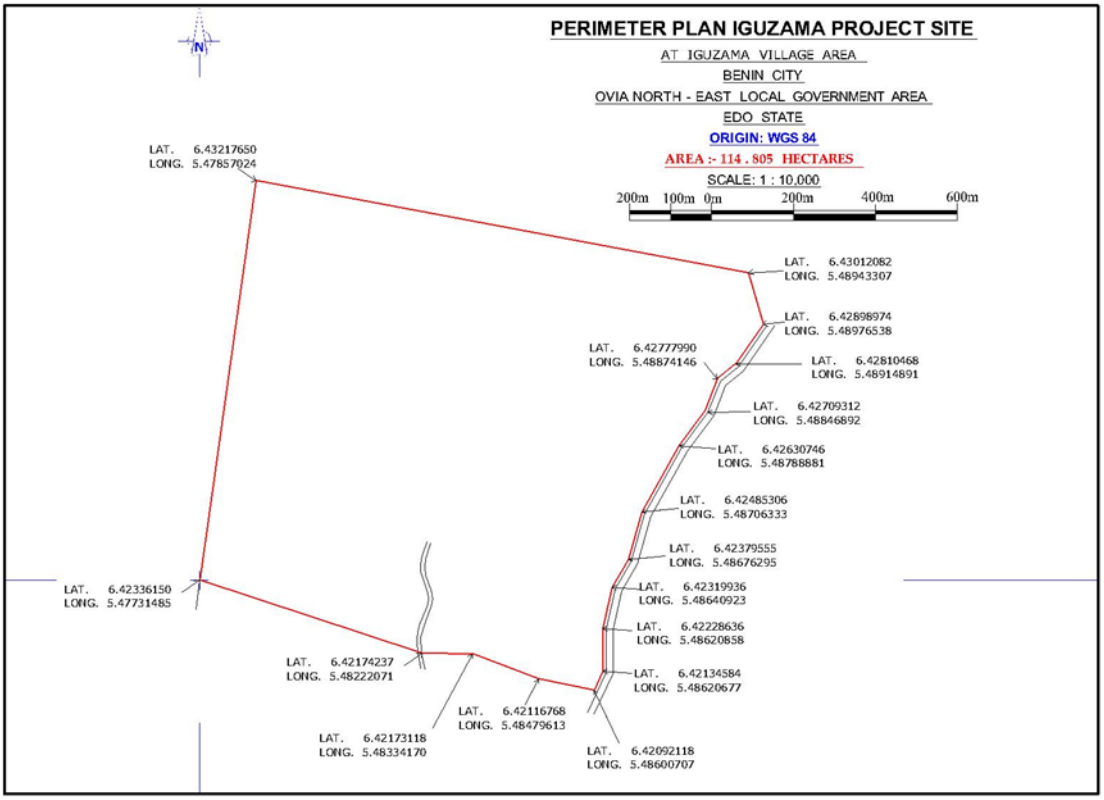

Fig.1: Perimeter plan of the study area

The annual rainfall is within the range of 1500 mm to 2500 mm with an average of 1900 mm per annum. The average annual temperature is 23-37°C. Some of the crops grown include maize, cassava, leafy vegetables and Oil palm.

The area is situated in the rainforest zone, with two distinct climatic seasons, namely, the rainy and dry seasons. The rainy season is between April and October with a 2-week break in August. The dry season lasts from November to April, with a cloudy, humid and dusty harmattan period between December and January.

Generally, the soils of the area were derived from the coastal plain sands (unconsolidated sands and Sandy clay) which are formations of sedimentary rock (Umweni, 2007). The topography is flat (0-2%) throughout the study area.

2.2. Field Studies

The soil survey process was by the rigid grid method at a detailed scale on 115.5 hectares of land. Traverses were cut at intervals of 100 m from a pre-determined baseline, with the transverses running in both vertical and horizontal directions, making a total of 10 traverses. Auger borings were done at 100 meters apart along the traverses; auger samples were observed at depth intervals of 0-30 cm, 30-60 cm, 60-90 cm and 90-120 cm respectively and were appropriately described morphologically on the field (soil colour, texture by feel, presence or absence of mottles, presence or absence of concretions, and so on). Areas with similar properties were put together to form the various mapping units; four (4) mapping units were delineated.

Each mapping unit was represented by a pedon that was described according to FAO, (1976) and identified horizons and layers were sampled from bottom to top. The samples were properly bagged, labelled and taken to the laboratory for analysis.

2.3. Laboratory Analysis

The soil samples collected from each layer were air-dried and passed through a 2mm sieve. Particle size analysis was by Hydrometer method (Gee and Or, 2002). Organic matter was by the Hydrogen peroxide and dispersion with sodium hexa-metaphosphate (IITA, 1979). Available phosphorus was by the Bray-II method (Olsen and Sommers, 1982). pH was by Glass electrode pH-meter in soil; soil and water. Exchangeable Bases (Na, K, Ca, Mg) was extracted with normal neutral Ammonium acetate (NH4OAC) buffered at pH 7.0. Na and K were determined by Flame photometer; Ca and Mg were determined by atomic absorption spectro-photometer. Total Nitrogen was determined by the Macro-Kjedahl method (Bremner and Mulvaney, 1982). Exchangeable Acidity (H^+ and Al^{3+}) was by the Titration method (Anderson and Ingram, 1993). Organic Carbon was determined by the Walkley-Black method (Page,1982). Effective Cation Exchange Capacity (ECEC) was by Summation of exchangeable bases and exchangeable acidity (Tan, 1996).Base Saturation was calculated by dividing the sum of exchange bases (Na, K, Ca and mg) by the ECEC and multiplying the quotient by 100.

2.4. Soil Classification

Soil classification was done using the USDA soil taxonomy (Soil Survey Staff, 2014) and locally according to Ogunkunle (1983).

2.5. Land Suitability Evaluation

Land suitability evaluation was done by both parametric and limitation methods. The limitation method was based on FAO (1976) frame work for rain-fed agriculture and guidelines provided by Sys (1985) as modified by Aruleba and Ayodele (2015) for Pawpaw, Plantain and Citrus. Pedons were placed in suitability classes by comparing their land qualities and characteristics with the guideline. The suitability class of a pedon (aggregate suitability) is that indicated by the most limiting (poorest) characteristics of that pedon. This was done in accordance with the principle of the law of minimum, which states that performance is always determined by the least favourable factor or plant nutrient in the lowest supply (FAO, 1984).

For Parametric method, scores were given to the quality of each pedon and suitability was calculated as index of productivity using the square root model of Storie(1976)

$$IPc = A \sqrt{(B/100 * C/100 * D/100 * E/100)} \text{-------(Equ. 1) (Sys 1985)}$$

(c) (t) (w) (s) (f)

Where A is the overall least characteristic rating, c = climate, t = topography, w = wetness, s = slope,

f = fertility.

Using this method, each characteristic was first rated as follows: No limitation: 100-85, (S1); Moderate limitation: 84-60 (S2); Severe limitation: 59-40 (S3); Very severe limitation 39-0 (N). The index of productivity for each pedon was expressed from the rating of each characteristics of the land qualities of each group, using the lowest rating. The index of productivity was rated into classes as follows:

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

3.0 Results and Discussions

3.1. Soil Classification

Pedons 1 and 2 were classified as Rhodic Kandiudults; Pedons3 and 4 were classified as Typic Rhodudults by USDA soil taxonomy (Soil Survey Staff, 2014). Locally, all the pedons were classified as Orlu series. (Ogunkunle 1983)

Land Suitability Evaluation

Limitation Approach

CLIMATE: According to the guidelines provided by Fasina*et al*., (2007) for Cocoa, Bhermana*et al.*, (2013) for Cashew, Sys (1985) as modified by Aruleba and Ayodele (2015) for Pawpaw, Plantain and Citrus; the annual rainfall of the study area is 1900mm (NIFOR, 2013). This according to the guideline falls in class S_1 (highly suitable) for citrus, cocoa and cashew; moderately suitable for plantain and Marginally suitable for pawpaw. The mean annual temperature of the study site ranges from 23ºC to 37ºC with a mean of 30ºC and this placed all the crops in class S_1 (highly suitable). Length of Dry months rated cocoa and cashew marginally suitable while others were crops Moderately suitable. On the basis of the length of rainy season, cashew was rated marginally suitable; cocoa was also rated marginally suitable on Relative humidity (75-89%).

TOPOGRAPHY:

The topography of the study area was highly suitable (S1) for all the crops, according to the guidelines, as the slope of the study area ranged from 0-2%.

WETNESS:

The results show that the study area has no flooding problem, it is well-drained and results obtained from the guidelines showed that the study area falls under $S1_1$ (Highly suitable) for all the crops.

SOIL PHYSICAL CHARACTERISTICS:

The soil depth was greater than 100 cm in all the Pedons, which according to the guidelines is highly suitable for all the crops cultivation. Soil texture of the study area ranged from Sand to Sandy clay loam and this laced all the pedons in suitability class S_2 (moderately suitable) for Cocoa and Cashew, while others were rated S1 (highly suitable).

FERTILITY CHARACTERISTICS: This refers to the chemical fertility of the soil regarding the properties that are easily altered (actual) and the requirements for potential fertility as it affects the production of these tree crops (pawpaw, plantain citrus, cocoa and cashew).The guidelines [Fasina*et al*., (2007) for cocoa, Bhermana *et al.*, (2013) for cashew, Sys (1985) as modified by Aruleba and Ayodele (2015) for pawpaw, plantain and citrus], showed that Base saturation, which ranged from 18.57-89.00%, in all the pedons, placed all the crops in suitability class S_1 (highly suitable). Organic carbon/organic matter (0-30cm) 6.18- 21.15gkg^{-1} / 6.33-37.27gkg^{-1} rated all the crops S1 (highly suitable) in all the pedons. ECEC range of 1.87 –

Table 1: Some soil physical and chemical properties of the pedons

Horizon	Depth (cm)	pH H_2O	OC ←	OM gkg^{-1}	TN →	P $mgkg^{-1}$	Ex-change. Acidity $cmolkg^{-1}$	K $cmolkg^{-1}$	Ca $cmolkg^{-1}$	Mg $cmolkg^{-1}$	Na $cmolkg^{-1}$	ECEC $cmolkg^{-1}$	ECEC (Clay)	BS %	Clay ←	Sand gkg-1	Silt →	TC
A	0-13	4.2	13.17	23.21	19.00	122.50	1.20	0.16	0.99	0.17	0.07	2.59	39.97	53.65	64.8	895.2	40.0	S
Bt1	13-44	4.4	7.58	13.36	10.10	28.75	1.40	0.13	0.30	0.09	0.03	1.94	12.53	27.86	154.8	825.2	20.0	SL
Bt2	44-80	3.8	5.59	9.85	33.10	13.75	2.40	0.12	0.30	0.10	0.03	2.95	15.14	18.57	194.8	785.2	20.0	SL
Bt3	80-149	4.4	3.99	8.79	44.50	33.75	1.40	0.13	0.40	0.09	0.03	2.05	8.05	31.59	254.8	725.2	20.0	SCL
A	0-12	5.3	21.15	37.27	13.70	82.50	1.20	0.16	3.37	0.13	0.08	4.93	110.04	75.68	44.8	915.2	40.0	S
AB	12-58	5.2	6.98	12.30	15.50	33.75	0.20	0.09	1.39	0.17	0.03	1.87	22.05	89.32	84.8	895.2	20.0	S
Bt1	58-125	4.9	5.59	9.85	8.90	21.25	0.40	0.14	1.78	0.17	0.04	2.53	10.77	84.22	234.8	755.2	10.0	SCL
Bt2	125-174	5.1	3.99	7.03	1.80	92.50	0.40	0.10	0.99	0.12	0.03	1.64	6.69	75.66	244.8	735.2	20.0	SCL
A	0-14	5.3	20.35	35.86	73.00	45.00	0.60	0.15	3.66	0.18	0.03	4.62	103.12	87.02	44.8	915.2	40.0	S
Bt1	14-41	4.5	11.77	20.74	8.90	28.75	1.80	0.13	0.58	0.15	0.08	2.75	16.69	34.46	164.8	815.2	20.0	SL
Bt2	41-90	4.7	5.39	9.50	9.50	71.25	2.00	0.11	0.59	0.14	0.03	2.88	12.81	30.65	224.8	755.2	20.0	SCL
Bt3	90-176	4.6	3.99	7.03	11.30	21.25	1.20	0.13	0.68	0.10	0.05	2.17	9.65	44.60	224.8	755.2	20.0	SCL
A	0-11	4.8	14.36	25.31	11.90	10.00	0.60	0.10	1.58	0.18	0.03	2.50	33.42	76.00	74.8	875.2	50.0	S
Bt1	11-40	4.5	6.98	12.30	11.90	58.75	2.00	0.14	0.75	0.14	0.04	3.08	16.67	34.99	184.8	795.2	20.0	SL
Bt2	40-91	4.7	6.18	10.90	7.20	125.00	1.80	0.13	0.74	0.12	0.04	2.84	11.15	36.66	254.8	725.2	20.0	SCL
Bt3	91-136	4.7	3.59	6.33	10.10	21.25	2.00	0.15	0.71	0.12	0.03	3.01	11.37	33.60	264.8	705.2	30.0	SCL

Table 2: Suitability evaluation by limition approach

Land Characteristics	1					2					3					4				
Pedon																				
CROPS	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw
CLIMATE (c)																				
Rainfall (mm)	S3	S2	S1	S1	S1	S3	S2	S1	S1	S1	S3	S2	S1	S1	S1	S3	S2	S1	S1	S1
Length of rainy season										S3					S3					S3
Dry season (months)	S2	S2	S2	S3	S3	S2	S2	S2	S3	S3	S2	S2	S2	S3	S3	S2	S2	S2	S3	S3
Temperature (°C)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Relative Humidity (%)				S3					S3					S3					S3	
TOPOGRAPHY(t)																				
Slope (%)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
WETNESS (w)																				
Drainage	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Flooding	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
SOIL PHYSICAL CHARACTERISTICS (s)																				
Texture	S1	S1	S1	S2	S2	S1	S1	S1	S2	S2	S1	S1	S1	S2	S2	S1	S1	S1	S2	S2
Soil depth	S1	S1	S1	S2	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1		S1
SOIL FERTILITY (f)																				
Base Saturation (%)	S1	S1	S1	S1		S1	S1	S1	S1		S1	S1	S1	S1		S1	S1	S1	S1	
Organic matter	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
ECEC, Clay ($cmolkg^{-1}$)	S1	S1	S1	S2	S3	S1	S1	S1	S2	S3	S1	S1	S1	S2	S3	S1	S1	S1	S2	S3
Soil Ph	NS	S3	NS		N	S1	S1	S3		S2	S1	S1	S3		S2	S3	S3	S3		S3
AGGREGATE SUITA-BILITY CLASS																				
Actual suitability	NS(f)	S(f)	NS(f)	S3(c)	N (f)	S3(c)	S2(c)	S3(f)	S3 (c)	S3(c, f)	S3 (c)	S2(c)	S3(f)	S3(c)	S3(c,f)	S3 (c, f)	S3(f)	S3 (f)	S3(c)	S3(c,f)
Potential suitability	S3(c)	S2(c)	S2 (c)	S3(c)	S3 (c)	S3(c)	S2(c)	S2 (c)	S3 (c)	S3 (c,f)	S3 (c)	S2(c)	S2 (c)	S3(c)	S3 (c,f)	S3 (c,)	S2(c)	S2 (c)	S3(c)	S3 (c,f)
SIZE (Ha)			19.4			18.3					27.5					50.3				
% COVERAGE			16.8			15.8					23.8					43.5				

S1=Highly suitable ; S2=Moderately suitable; S3= Marginally suitable, N/NS= Not suitable

Table 3: Summary of suitability evaluation for all the pedons (Parametric method)

Land Characteristics																				
PEDON		1				2					3					4				
CROPS	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw	Paw	Plt	Cit	Coa	Chw
Rainfall (mm)	59(S3)	75(S2)	100(S_1)	100(S_1)	100(S_1)	59(S3)	75(S2)	75(S2)	100(S_1)	100(S_1)	59(S3)	75(S2)	100(S_1)	100(S_1)	100(S_1)	59(S3)	75(S2)	100(S_1)	100(S_1)	100(S_1)
Length of rainy season										59(S3)					59(S3)					59(S3)
Dry season (months)	75(S2)	75(S2)	75(S2)	59(S3)	59(S3)	75(S2)	75(S2)	75(S2)	59(S3)	59(S3)	75(S2)	75(S2)	75(S2)	59(S3)	59(S3)	75(S2)	75(S2)	75(S2)	59(S3)	59(S3)
Temperature (°C)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	59(S3)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	59(S3)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	59(S3)
Relative Humidity (%)				59(S3)	59(S3)				59(S3)					59(S3)					59(S3)	
TOPOGRAPHY(t)																				
Slope (%)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)
WETNESS (w)																				
Drainage	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)
Flooding	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)
SOIL PHYSICAL CHARACTERISTICS (s)																				
Texture	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)
Soil depth	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)
SOIL FERTILITY (f)																				
Base Saturation (%)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)		100(S_1)	100(S_1)	100(S_1)	100(S_1)		100(S_1)	100(S_1)	100(S_1)	100(S_1)	
Organic matter	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)	100(S_1)
ECEC, Clay ($cmolkg^{-1}$)	100(S_1)	100(S_1)	100(S_1)	75(S2)	75(S2)	100(S_1)	100(S_1)	100(S_1)	75(S2)	59(S3)	100(S_1)	100(S_1)	100(S_1)	75(S2)	59(S3)	100(S_1)	100(S_1)	100(S_1)	75(S2)	59(S3)
Soil pH	35(NS)	59(S3)	35(NS)			100(S_1)	100(S_1)	100(S_1)		75(S2)	100(S_1)	100(S_1)	59(S3)		75(S2)	59(S3)	59(S3)	59(S3)		59(S3)
AGGREGATE SUIT-ABILITY CLASS																				
Actual (IPC)	26.9(N)	51.1(S2)	30.3(S3)	44.3(S3)	44.3(S3)	59(S2)	75.0(S2)	75.0(S2)	44.3(S3)	39.2(S3)	59(S2)	75.0(S2)	51.1(S2)	44.3(S3)	39.2(S3)	39.2(S3)	51.1(S2)	51.1 (S2)	44.3 (S3)	39.2(S3)
Potential (IPP)	59(S2)	75.0(S1)	75.0(S1)	51.1(S2)	51.1(S2)	59(S2)	75.0(S1)	75.0(S1)	51.1.(S)	51.1(S2)	59(S2)	75.0(S1)	75.0(S1)	51.1(S2)	51.1(S2)	51.1(S2)	75.0(S1)	75.0 (S1)	51.1 (S2)	51.1(S2)
SIZE (ha)	19.4					18.3					27.5					50.3				
% COVERAGE	16.8					15.8					23.8					43.5				

Paw=Pawpaw, Plt= Plantain, Cit= Citrus, Coa= Cocoa, Chw= Cashew
Aggregate suitability class scores: 100-75=S1, 74-50=S2, 49-25=S3, 24-0=N

Table 4: Aggregate suitability of the mapping units for tree crops (Pawpaw, Plantain, Citrus, Cocoa, Cashew) by both Parametric and Limitation approaches

Pedon	**USDA Classification**	**Parametric (Potential)**					**Parametric (actual)**				
		Pawpaw	Plantain	Citrus	Cocoa	cashew	Papaw	Plantain	Citrus	Cocoa	cashew
1	Rhodic Kandiudults	59(S2)	75.0(S1)	75.0(S1)	51.1(S2)	51.1(S2)	26.9(N)	51.1(S2)	30.3(S3)	44.3(S3)	44.3(S3)
2	Rhodic Kandiudults	59(S2)	75.0(S1)	75.0(S1)	51.1.(S)	51.1(S2)	59(S2)	75.0(S2)	75.0(S2)	44.3(S3)	39.2(S3)
3	Typic Rhodudults	59(S2)	75.0(S1)	75.0(S1)	51.1(S2)	51.1(S2)	59(S2)	75.0(S2)	51.1(S2)	44.3(S3)	39.2(S3)
4	Typic Rhodudults	51.1(S2)	75.0(S1)	75.0(S1)	51.1(S2)	51.1(S2)	39.2(S3)	51.1(S2)	51.1(S2)	44.3(S3)	39.2(S3)
Pedon	USDA Classification	Limitation (potential)					Limitation (actual)				
		Pawpaw	Plantain	Citrus	Cocoa	Cashew	Pawpaw	Plantain	Citrus	Cocoa	Cashew
1	Rhodic Kandiudults	S3(c)	S2(c)	S2 (c)	S3 (c)	S3 (c)	NS (f)	S3(f)	NS (f)	S3 (c)	N (f)
2	Rhodic Kandiudults	S3(c)	S2 (c)	S2 (c)	S3 (c)	S3 (c)	S3(c)	S2 (c)	S_3 (f)	S3 (c)	S_3 (c, f)
3	Typic Rhodudults	S3 (c)	S2(c)	S_3(f)	S3 (c)	S_3 (c)	S3 (c)	S2(c)	S_3(f)	S3 (c)	S_3 (c,f)
4	Typic Rhodudults	S3(c)	S3 (c)	S2(c)	S2 (c)	S3 (c)	S3 (c,f)	S3 (f)	S_3 (f)	S3 (c)	S_3(c,f)

Aggregate suitability class scores: 100-75=S1, 74-50=S2, 49-25=S3, 24-0=N
S1=Highly suitable; S2=Moderately suitable; S3= Marginally suitable, N/NS= Not significant-

4.93 cmolkg^{-1} for all the pedons Placed cocoa in Suitability class S2 (moderately not suitable); cashew in suitability class S3 (marginally suitable), while pawpaw, plantain and citrus were rated highly suitable (S1) in all the pedons. pH (3.8-5.3) ranged from extreme to moderate acidity, a situation that is expected of acid sands (soils developed from coastal plain sand). In Pedon 1, pH (3.8-4.4) rated pawpaw, citrus and cashew as not suitable (NS), but marginally suitable (S3) for plantain; this agrees with the findings of Aruleba and Ayodele (2015) who also reported similar results on fruit crops. Pedons 2 and 3 were highly suitable (S1) for pawpaw and plantain (4.5-5.3), moderately suitable for cashew (S2) and marginally suitable for citrus (S3); Pedon 4 (4.5-4.8) was marginally suitable for all the crops, except cocoa, whose guideline (Fasina*et al*., [2007]) did not include pH in the evaluation.

On actual suitability ratings (table 2) pawpaw, citrus and cashew were not Significant [NS (f)] in Pedon 1 (19.4ha) representing 16.8% of the study area, because of limitations in fertility characteristics (soil pH); plantain [S3(F)] and cocoa [S3 (c)] were marginally suitable because of limitations in fertility and climate respectively. In pedons 2,3 and 4 (96.1ha) representing 83.20% of the study area, cocoa was marginally suitable [S3(c)] because of limitation in climate; cashew was marginally suitable [S3 (c,f)] because of limitations in climate and fertility ; citrus was marginally suitable [S3 (f)] because of limitation in fertility characteristics. pawpaw was marginally suitable [S3 (c)] due to limitations in climate (pedon 2), which represents a mapping unit with an area coverage of 18.3 hectares and 15.8% of the study area; [S3 (c,f)] climate and fertility (pedon 3- 27.5 ha/23.8% of the study area), [S3 (f) fertility (pedon 4) which amounts to 50.3 hectares and 43.5% of the study area.

Potential suitability rating was marginal [S3(c)] for pawpaw, cocoa and cashew with major limitations in climate; plantain and citrus were rated moderately suitable (S2) in all the pedons (115.5 ha) due to limitations in climatic characteristics, based on the guidelines.

Parametric approach

The actual (current) suitability rating (table 3) showed that the entire study area was moderately suitable (S2) for citrus and plantain and marginally suitable (S3) for cocoa and cashew. Pedon 1(19.4ha) was not suitable for pawpaw cultivation, pedons 2 and 3 (45.8 ha) were moderately suitable for pawpaw cultivation while Pedon 4 (50.3 ha) was marginally suitable. Potential rating showed that the entire study area (115.5 ha) was highly suitable (S1) for plantain and citrus but moderately suitable for Pawpaw, Cocoa and Cashew.

The disparity in aggregate suitability ratings by both approaches (Parametric and limitation) as shown in table 4, indicates differences in the approaches; while just a characteristic that is not suitable places a pedon in the not suitable class (N) under the limitation approach, the parametric approach considers all the characteristics. Thus, the parametric approach is truly an aggregate of the whole, in arriving at the final suitability class.

Conclusion

Potential suitability rating under the limitation approach showed that the entire study area (115.5 ha) was moderately suitable (S2) for citrus and plantain; marginally suitable (S3) for cocoa and cashew, while pedon 1(19.4ha) was not suitable for pawpaw, pedons 2 and 3 (45.8 ha) were moderately suitable and Pedon 4 (50.3 ha) was marginally suitable for pawpaw cultivation. Potential rating by parametric approach, showed that the entire115.5 hectares was highly suitable (S1) for plantain and citrus but moderately suitable for pawpaw, cocoa and cashew cultivation.

Though parametric and limitation approaches gave different aggregate suitable classifications for both actual (current) and potential ratings, major limitations in fertility status were expressed by both methods, indicating the low status of basic cations in Ultisols. Thus, Amendment with organic fertilizers is recommended for the cultivation of plantain and citrus. However, the other crops may only be cultivated when there is enough economic justification.

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