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Research Article

Suitability Evaluation of Soils for the Cultivation of Okro (*Abelmoschus esculentus L.*) Fluted Pumpkin (*Telferia occidentalis F.*) in Port Harcourt, Rivers State

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Abstract

The study was conducted to assess the suitability of soils for the cultivation of okro and fluted pumpkin in Rivers State University Teaching and Research Farm, Port Harcourt, Nigeria. Three mapping units were identified, and the suitability of the soils was determined using pertinent suitability standards. Data from three pedons were evaluated for morphological, physical and chemical properties of the soils. Soil colour ranged from very dark to grayish brown (10YR 3/2) and yellowish red (5YR 5/8), and texturally ranged from loamy sand to sandy clay loam and structurally, from friable to sub angular blocky, well drained and deep. Results obtained revealed that soils of the study area were very low in pH and varied from 4.77-5.29 (strongly acidic). The soils were generally low in organic carbon (0.12-1.17 gkg), organic matter (0.20-2.02 gkg), nitrogen (0.003-0.022 gkg), soluble potassium (0.05-0.15 Cmol/kg) and sodium (0.17-0.31 Cmolkg). Available phosphorus varied from 6.32-31.92 mgkg. The soils were marginally suitable (S3) for the cultivation of okro and fluted pumpkin in all pedons due to limitations in fertility and climate (pH, cation exchange capacity and mean annual rainfall). Appropriate measures should be taken in order to improve and maintain the fertility of soils for the cultivation of these three crops of interest (okro and fluted pumpkin) in the study area.

Keywords

Cultivation, Fluted Pumpkin, Okro Suitability Evaluation, Soils

1. Introduction

Soils are non-renewable resources that support a wide array of ecosystem and their functions. Soil mapping enhances assessment of spatial variability in the development and properties of soils as a function of climate, topography and vegetation [12, 15] Land use for agricultural crop production requires delicate care and good management unlike many other uses of land. Detailed information on the kinds of soil, their distribution and properties are very important for a successful crop production in a given environment [14]. It is essential to determine the suitability of a given piece of land before utilizing such land. Inadequate soil information on the degree of its suitability constitute a set back to the achievement of global food security particularly in developing countries like Nigeria. Soil suitability evaluation involves analyzing the fitness of the soil and its ability to provide optimal nutrient requirement for effective crop production. In other words, assessing the suitability of agricultural land will enhance optimum crop development and maximum productivity [14]. In order to assess the

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suitability of soils for effective crop production, soil requirements of crops must be known. Since land will be used according to its capability, land evaluation provides avenue for sustainable land use. This therefore, makes it mandatory to carry out land suitability assessment in order to ensure that the selected sites are suitable to sustain long term production of crops. Thus, comprehensive information on the biophysical resources and their major limitations to the cultivation of the crops and how to optimize land use and increase food production are necessary. The Teaching and Research Farm has been under intensive crop cultivation for decades. This arise due to increase in population and agricultural production must increase massively to feed the growing population and satisfy the high demand of raw materials for industries. The Teaching and Research Farm has been under intensive crop cultivation since inceptions of the Rivers State University, Port Harcourt, but there is no or little information on land suitability evaluation of the Teaching and Research Farm for the cultivation of some crops. Therefore, this study aimed at the mapping and suitability evaluation of the soils Teaching and Research Farm for the cultivation selected crops such as okro and fluted pumpkin in Port Harcourt.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at the Rivers State University Teaching and Research Farm, Port Harcourt Nigeria. The Teaching and Research Farm belong to the Faculty of Agriculture, Rivers State University, Port Harcourt, Nigeria. This land has been under intensive cultivation since the establishment of the university, It lies between latitude 4° 40^{1}50”N and 4°51^{1}40’’N and longitude 6°57^{1}30’’ °E and 7° 5^{1} 0’’ °E. It has a mean annual rainfall of 2000 – 3000mm and mean annual temperature of 25 – 28°C [9, 16]. The relative humidity varied between 70 – 85% depending on season of the year. The study area also experienced a period of low precipitation (dry season) commonly called harmattan period. The vegetation of the study area as described by [9, 16] is that of the humid tropical ever green, but tremendously altered as a result of continuous cropping system normally practiced in the area. The study area is underlain by the coastal plain sands and alluvium of marine deposits [16].

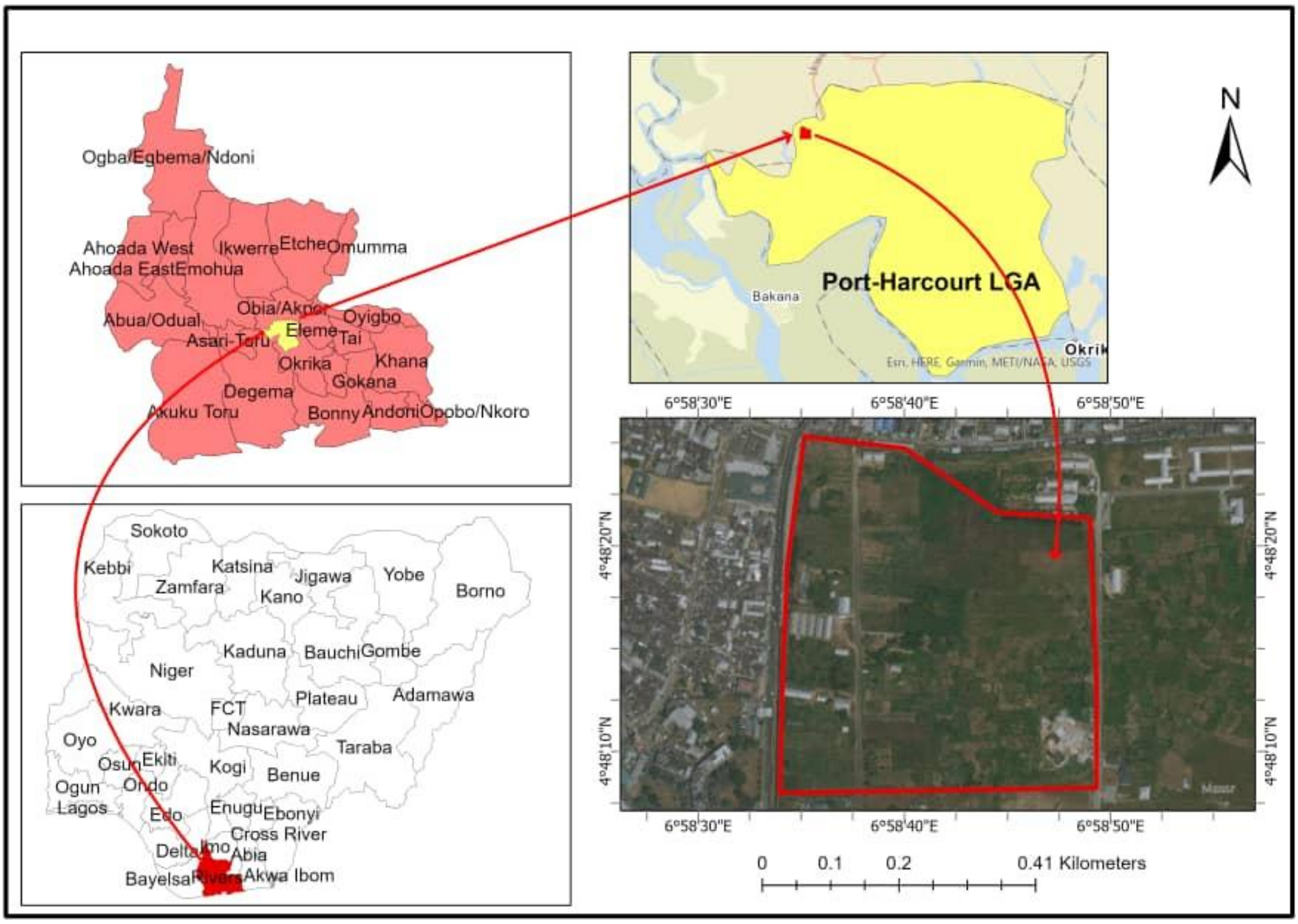

Figure 1. Map of the Study Area.

2.2. Field Study

A detailed soil survey was carried out on the 30 hectares of land covering the Teaching and Research Farm. The land area was geo-referenced and digitized in an Arc map environment to form the shape field of the study area. The digitized map was gridded using the rigid grid method of detailed soil survey measuring 100m × 100m (1 ha) per auger boring point. Thirty (30) auger boring points were identified, and auger boring was done at depth intervals of 0 – 30cm, 30 – 60cm, 60 – 90cm and 90 – 120cm. Soil samples were described in the field. Soil morphologically properties were ascertained in situ using soil colour, texture (by hand feeling), structure, drainage, presence of absence of mottles, concretions and other morphological properties. Soils with identical properties were assembled to form mapping units. And from the grouping based on similarities, soil mapping units were identified and delineated. Soil profile pit of 2m x 2m x 2m was dug in each of the mapping unit (pedon) and described starting from bottom to top according to [17]. Soil samples were be collected from various horizons identified within the profile pit of each soil unit. The samples were bagged labelled and taken to soil science laboratory for analysis.

2.3. Laboratory Analysis

The soils collected were oven dried and air dried at room temperature, crush to pass through a 2mm mesh sieve and was used to determine particle size analysis, bulk density, pH, total nitrogen, organic carbon, available phosphorus and exchangeable cations (Ca, Mg, Na, K) in the soil. Thus, Particle size distribution was determined using the hydrometer method as described by [22]. Soil texture (proportion of sand, silt and clay) was determined using Textural triangle. Bulk Density was determined using the clod method by [10]. Total Porosity was calculated with the values of the bulk density using the method outlined by [22]. Soil colour was determined using the Munsell Colour Chart; while soil pH was determined by using glass electrode pH meter as described by [24]. Organic carbon was determined by using the method as described by [7]. Determination of the ratio of organic matter content of the soil was expressed as a percentage of the mass of organic matter in a given mass of soil to the mass of the dry soil solids. Total nitrogen was determined using Macro Kjedahl digestion distillation method [8]. Available phosphorus was determined by using the [23] method. Electrical conductivity was measured using an electrical conductivity meter. Exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) were all determined using the Ammonium acetate saturation method by [24]. Effective Cation Exchange Capacity (ECEC) was calculated by adding total exchangeable bases and total exchangeable acidity, and Percentage Base Saturation was calculated by expressing the total exchangeable bases as a function of cation exchange capacity. Exchangeable acidity was determined using the EDTA Titration method [24].

Land Suitability Evaluation

The suitability of soils for the cultivation of okro and fluted pumpkin was assessed using the principal of limiting condition or factor [6]. The soils will be placed in suitability classes by matching their characteristics with requirements of the crops and overall suitability soils [4, 6].

The potentials and limitations of five land qualities/characteristics (climate, topography, wetness, soil physical properties and soil fertility) in determining the suitability of the soils identified in the study site for the cultivation of okro and fluted pumpkin the crops of interest and was evaluated using [11] as modified by [17]. Land suitability classes were obtained by matching some of the land qualities with the land use requirements for each community crop produced in the study area. Aggregate suitability class of each mapping unit will be obtained in line with the law of minimum which states that "performance is always determined by the least favourable characteristic or plant nutrients in the lowest supply" [5].

Table 1. *Soil- site suitability criteria (crop requirement) for Vegetables (Fluted Pumpkin Telferia occidentalis F).*

Suitability Rating						
Land quality/soil-site characteristics		**Unit**	**S1**	**S2**	**S3**	**N**
Climate (c)	Mean temperature in growing season	ºC	25-28	29-32 20-24	33-36 15-19	<15 <36
	Total rainfall	Mm	600-750	500-600 750-1000	450-500 >1000	
	Rainfall in growing season	Mm	>150	120-150	90-120	
	Length of growing season	Days	>150	120-150	90-120	
Topography (t)	Slope	%	1-3	3-5	5-10	>10
Wetness (w)	Soil drainage	Class	Highly suitable	Moderate	Imperfect	Poor

Suitability Rating						
Land quality/soil-site characteristics		**Unit**	**S1**	**S2**	**S3**	**N**
			(100-75%	(74-50%);	(49-25%);	24-0%).
Soil physical properties (s)	Texture	Class	Sl, l, cl, scl	ls, sicl, sic, sc, c (m/k)	C (ss)	ls, s
	coarse fragments Effective soil depth	Vol. (%)	<15	15-35	>35	<25
		Cm	>75	50-75	25-50	
Fertility (f)	Ph	1-2.5	6.0-7.0	5.0-5.9;	<5	
	CEC	cmol (p+)/kg	>15	7.1-8.5	>8.5	
	$CaCO_3$ in root zone	%		10-15	<10	
Soil toxicity (n)	Salinity (EC saturation extract)	dSm^{-1}	Non-saline	Slightly saline	Strongly saline	
	Sodicity (ESP)	%	Non-sodic	Slightly sodic	Strongly sodic	

Highly suitable (IP=100-75%), Moderately Suitable (I) = 74-50%); = marginally suitable (IP=49-25%); = Not suitable (24-0%). Source: Modified from NBSS&LUP, 1994 as modified by Peter et al 2022.

Table 2. Soil- site suitability criteria (crop requirements) for okra production Abelmoschus esculentus L.

Land quality/site Characteristics	**Suitability rating S1 S2 S3 N**			
Climate (c)				
Mean temp. in growing Season (°C)	25 – 28	29 – 32	33 – 36	<15
		20 – 24	15 – 19	>36
Mean annual rainfall (mm)	600 – 750	500 – 600	450 – 500	-
		750 1000	>1000	
Length of growing season (Days)	>150	120 -150	90 – 120	-
Topography (t)				
Slope (%)	1 – 3	3 – 5	5 – 10	>10
Wetness (w)				
Soil drainage	Well drained	Moderate	Imperfect	Poor
Soil physical characteristics				
Texture	SL, L, CL, SCL	LS. SiCL, Sic, c (m/k)	C (ss)	S
Coarse fragments (vol.%)	<15	15 – 35	>35	>25
Effective depth (cm)	>75	50 – 75	25 – 50	-
Fertility				
Ph	6.0 – 7.5	5.0 – 5.9	<5	-
		7.6 – 8.5	>8.5	-
CEC (cmol/kg)	>15	10 – 15	<10	-
$CaCO_3$ (%)	Non calcareous	Slightly calcareous	Strongly calcareous	-

Source: NBSS & LUP, 1994

3. Results and Discussion

3.1. Morphological Properties of the Study Area

Morphological properties of the soil are presented in Table 2. A variation in soil colour were observed in the study area, the colour in pedon 1 varied from very dark grayish brown (10YR 3/2) to reddish yellow (7.5YR 3/4) at the surface and dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6), pedon 2 soil colour varied from very dark brown (10YR 2/2) to yellowish red (5/8 5YR) while it varied from very dark brown (7.5YR 2.5/2) to yellowish red (5YR 5/8) in pedon 3. The very dark grayish brown coloration at the top surface horizon is due to accumulation organic matter. This is in line with the report of Iroh and Peter 2019 who reported that the dark coloration of soil in the surface level is due to the presence of organic matter in the soil. Soil boundaries varied from clear to diffuse in all pedons. Textural class of the soil ranged from loamy sand to sandy clay loam. The textural class is due to parent materials from which the soils were formed, this is in conformity with the report of Peter and Lucky (2022) who stated that parent material greatly influence the textural properties of soils formed in an area. Soil structure of various horizons varied greatly down the depth and changed from friable to sub angular blocky in pedon 1 and fine grains to sub angular block in pedon 2 and 3. The soils were well drained and have many medium root to very few medium root, the boundaries are clear and diffused in all pedons.

3.2. Physical Properties of the Soil of the Study Area

Table 3 reveals the physical properties of the study area. The result shows the variation in sand particle from 782 - 662 g/kg in pedon 1, pedon 2 varied from 802-672 g/kg while pedon 3 varied from 832-692 g/kg. Silt particle decreased down the horizon in pedon 1 from 120-50 g/kg, increased from 80- 20 g/kg down the horizon in pedon 2 while in pedon 3, soil contains 40 g/kg of silt in each horizon. Clay particle increased from 90-310 g/kg in pedon 1, it increased from 120-310 g/kg and 130-280 g/kg in pedon 2 and 3. High sand particle at the surface is in line with the report of [1, 18] who reported that the sand particles are predominant at the surface horizons due to process of elluviation in soils [19] stated that particle size distribution provide the ability of the soil to store root zone water and air necessary for plant growth. The increase in soil particle is also influenced by the parent materials which soils are formed as stated by [19]. Soil textural class varied from loamy sand to sandy clay loam. The loamy to sandy clay loam textural class is due to parent materials from which the soils were formed, this is in conformity with the report of [18] who stated that parent material greatly influence the textural properties of soils formed in an area. Bulk density varied from 1.25-1.55 gcm^{-3} in pedon 1, 1.99-2.06 g cm,$^{-3}$ in pedon 2, while in pedon 3 it increases from 1.54 - 1.97 gcm.$^{-3}$ Bulk density in pedon 2 was higher than pedon 1 and 3. Total porosity ranged from 41-53% in pedon 1, 22-25% in pedon 2 and 26 – 42% in pedon 3. Soil porosity is essential to conduct water, air and nutrient in soil.

Table 3. Morphological Characteristics of the Study Area.

Pedon	Horizon depth (cm)	Colour (moist)	Textural class	Structure	Consistence	Drainage	Root	Boundary
		PEDON 1						
Ap	0-19	very dark greyish brown 10 YR ¾	Loamy sand	Friable	Crumby	Well drained	Many medium root	Clear
Ah	19-28	Dark brown 7.5YR 3/4	Loamy sand	Granular	Crumby	Well drained	Very few root	Diffused
AB	28-53	Dark yellowish brown 10YR4/4	Sandy loam	Blocky	Sticky and plastic	Well drained	Very few root	Clear
Bt1	53-120	Strong brown 7.5YR5/6	Sandy clay loam	Sub blocky	Sticky and plastic	Well drained	Very few root	Clear
Bt2	120-200	Reddish yellow 7.5YR7/8	Sandy clay loam	Sub blocky	Sticky and plastic	Well drained	Very few root	
	PEDON 2							
Ap	0-20	Very dark brown 10YR2/2	Loamy sand	Fine grains	Non sticky	Well drained	Many medium root	Clear
AB	20-65	Dark brown	Sandy clay	Sub angular	Slightly	Well drained	Few medium	Diffused

Pedon	Horizon depth (cm)	Colour (moist)	Textural class	Structure	Consistence	Drainage	Root	Boundary
		7.5YR3/4	loam	blocky	sticky		root	
Bt	65-200	Yellowish red 5YR5/8	Sandy clay loam	Sub angular blocky	Sticky	Well drained	Very few medium root	
				PEDON 3				
Ap	0-25	Very dark brown 7.5YR2.5/2	Loamy sand	Fine grains	Non sticky	Well drained	Many medium root	Clear
AB	25-90	Yellowish red 5YR4/6	Sandy clay loam	Sub angular blocky	Slightly sticky	Well drained	Few medium root	Diffused
Bt	90-200	Yellowish red 5YR5/8	Sandy clay loam	Sub angular blocky	Sticky	Well drained	Very few root	

3.3. Chemical Properties of the Study Area

Table 4 shows the results of the chemical properties of the soils in the study area. Soil pH (H_2O) value ranged from 4.84 to 5.0 in pedon 1, pedon 2 varied from 4.96 to 5.08 and 4.97 to 5.29 in pedon 3. The Soil reaction shows the soils were acidic in nature. The slightly acidic nature of the soil is due to the acidic nature of the parent material which forms the soil and high rainfall experienced in South-South region. This is in line with the report carried out by [1,2,13]. A slight variation exist in pH between each horizon in all pedon. This might be due to leaching and continuous crop cultivation [20]. Exchangeable acidity of the soils were generally moderate and ranged from 2.57 to 3.75 Cmolkg in pedon, 2.55 to 2.88 Cmolkg in pedon 2, while pedon 3 varied from 2.0 to 3.56 Cmolkg. Organic carbon ranges from 0.117 to 1.17gkg in pedon. 1.0.312 to 0.98 gkg in pedon 2 while pedon 3 varied from 0.312 to 0.99 gkg. Organic carbon in surface horizons are generally high compared to the sub surface soils. Decrease in Organic carbon content down the horizon is in conformity with the report of [3, 20]. Organic matter decreased from 2.02 to 0.117 gkg in pedon 1, 1.68 to 0.59 gkg and 1.14 to 0.54 gkg in pedon 2 and 3. Organic matter content was higher in top soil or surface soil compared to subsurface. This is due to accumulation of organic materials. Available phosphorus decreased down the profile and ranged from 6.32 to 15.45 mgkg in pedon 1, 11.93 to 15.09 mgkg in pedon 2 and 6.32 to 31.92 mgkg. Calcium varied from 2.00 to 3.00 Cmolkg-1 in pedon 1, 2.60 to 3.60 Cmolkg in pedon 2 and 2.60 to 4.80 Cmolkg in pedon 3. Magnesium varied from 0.20 to 5.60 Cmolkg in pedon 1, 1.40 to 3.20 Cmolkg in pedon 2 and decreased down the horizon in pedon 3 (8.00 -0.60 Cmolkg). Potassium ranged from 0.10 to 0.15 cmolkg in pedon 1, 0.0.5 to 0.08 Cmolkg in pedon 2, 0.06 to 0.09 Cmolkg in pedon 3. Potassium is higher in pedon compared to pedon 2 and 3. Sodium ranged from 0.18 to 0.28 Cmolkg in pedon 1, 0.17 to 0.27 Cmolkg in pedon 2 and 0.14 to 0.25 Cmolkg in pedon 3. Divalent cations are higher than monovalent cations in all profile. The presence of a higher amount of divalent cations than the monovalent cations in the soils was in conformity with [20, 21] view which implies a preferential loss of monovalent ions and at the same time greater losses of by leaching. Total nitrogen varied from 0.003 to 0.008 gkg in pedon 1, 0 to 0.008 gkg in pedon 2 and 0.003 to 0.22 gkg in pedon 3. Total nitrogen was very low in the soil of the study area due to leaching and erosion caused by heavy rainfall. Cation Exchange Capacity (CEC) varied from 2.47 to 8.91 Cmolkg, 5.22 to 6.10 Cmolkg in pedon 1 and 2, and decreased down the horizon in pedon 3 (5.49 to 10.89 Cmolkg). ECEC of the soil ranges from 5.04 to 12.05 Cmolkg in pedon 1 and decreased down the profile in pedon 2 (7.97 to 8.72 Cmolkg) and 3 (9.05 to 12.89 Cmolkg). Base saturation ranged from 23.18 to 36.5% (pedon 1), 32.9 to 36.2% (pedon 2) and 30.5 to 42.24% (pedon 3). The differences in base saturation indicated the degree of leaching. Base saturation were higher in pedon 3, compared to Pedon 1 and 2. The results were in line with the findings of [20]. Zinc varied from 1.6 -10.5 gkg in pedon 1, 1.0- 15.8 in pedon 2 and 1.1 - 11.5 gkg in pedon 3. The iron content of the soil are high (300.9 – 16924 g/kg), it is higher in pedon 1 compared to pedon 2 and 3.

Table 4. *Physical Characteristics of the Study Area.*

Pedon	Horizon depth (cm)	sand	Silt	clay	Bulk density (gcm^{-3})	Porosity (%)
		g/kg				
		PEDON 1				
Ap	0-19	782	120	98	1.25	53
Ah	19-28	832	80	88	1.55	41
AB	28-53	752	40	208	1.54	42
Bt_1	53-120	652	40	308	1.41	47
Bt_2	120-200	662	50	288	1.48	44
		PEDON 2				
Ap	0-20	802	80	118	2.06	22
AB	20-65	692	90	218	1.99	25
Bt	65-200	672	20	308	2.05	23
		PEDON 3				
Ap	0-25	832	40	128	1.54	42
AB	25-90	682	40	278	1.96	26
Bt	90-200	692	40	268	1.97	27

3.4. Land Suitability Evaluation for Okra (*Abelmoschus esculentus L.*)

The soils were placed in suitability classes by matching their characteristics with requirements of the crops in Table 2. The limitations and potential of five land qualities in determining the suitability of the soils identified in the study site for the cultivation of okra were evaluated using, [13] as modified by [17]. Land suitability classes were obtained by matching some of the land qualities with the land use requirements of the crop and aggregate suitability class were obtained in line with the law of minimum [4, 21]. From Table 6 the soils of the study area are moderately suitable in climate, topography, wetness and soil physical characteristics but marginally suitable (S3) in terms of fertility with limitations in pH and cation exchange capacity.

Table 5. *Chemical Characteristics of Soils in the Study Area.*

Pedon Designation	Horizon Depth	pH (H_2O)	OC	OM	TN	AVIP	Ca^{2+}	Mg^{+}	K^{+}	Na^{+}	EAl^{3+}	EH	CEC	ECEC	BS %	Zn g-1	Fe
				g/kg		$mgkg^{-1}$	Cmol/kg									g/kg	
	PEDON 1																
Ap	0-19	4.84	1.17	2.02	0.003	15.45	2.20	0.40	0.12	0.27	0	3.33	2.88	6.21	47.20	6.4	4601
Ah	19-28	5.04	0.23	0.40	0.003	14.39	2.00	0.20	0.12	0.18	0	2.57	2.47	5.04	49.26	10.5	4062.5
AB	28-53	4.77	0.55	0.97	0.008	7.72	2.01	3.80	0.15	0.18	0	3.75	6.13	9.88	62.03	7.7	760
Bt1	53-12	4.86	0.39	0.67	0.003	6.33	3.0	5.60	0.10	0.27	0	3.14	8.91	12.05	74.08	1.6	1692

Pedon Designa-tion	Horiz on Depth	pH (H_2O)	OC	OM	TN	AVIP	Ca^{2+}	Mg^{+}	K^{+}	Na^{+}	EAl^{3+}	EH	CEC	ECEC	BS %	Zn g-1	Fe
				g/kg		$mgkg^{-1}$	Cmol/kg									g/kg	
	0																4
Bt2	120-200	4.88	0.12	0.20	0.003	14.04	2.20	0.80	0.12	0.28	0	3.55	3.43	6.96	51.12	1.8	13600
	PEDON 2																
Ap	0-20	4.96	0.98	1.68	0	11.93	3.00	2.60	0.06	0.17	0	2.88	5.84	8.72	66.94	1.0	4662
AB	20-65	4.-97	0.51	0.87	0.008	15.09	3.60	1.40	0.05	0.27	0	2.75	5.22	7.97	65.93	15.8	300.9
Bt	65-200	5.08	0.31	0.54	0.003	23.51	2.60	3.20	0.08	0.19	0	2.55	6.10	8.32	70.41	6.9	10670
	PEDON 3																
Ap	0-25	5.29	0.66	0.14	0.003	31.92	2.60	8.00	0.09	0.25	0	2.00	10.89	12.89	84.54	1.1	4673
AB	25-90	5.14	0.51	0.87	0.003	15.09	3.40	5.60	0.06	0.14	0	2.00	9.24	11.24	82.15	11.5	668.6
Bt	90-200	4.97	0.31	0.54	0.022	6.32	4.80	0.60	0.09	0.16	0	3.56	5.49	9.05	61.34	6.9	7584

OC= Organic Carbon OM= Organic Matter, OT= Total Nitrogen, AVIP= Available Phosphorus, Ca= Calcium, Mg= Magnesium, K=Potassium, Na= Sodium, EAl= Exchangeable Aluminum, EH= Exchangeable Hydrogen, CEC= Cation Exchange Capacity, ECEC= Effective Cation Exchange Capacity, BS= Base Saturation, Zn= Zinc, Fe= Ir

3.5. Land Suitability Evaluation for Fluted Pumpkin (*Telferia occidentalis F.*)

The suitability of soils for production of fluted pumpkin was assessed using the principal of limiting condition or factor [6]. The soils were placed in suitability classes by matching their characteristics with requirements of the crops in Table 1. The limitations and potential of five land qualities in determining the suitability of the soils identified in the study site for the cultivation of fluted pumpkin were evaluated using, [11] as modified by [17]. Land suitability classes were obtained by matching some of the land qualities with the land use requirements of the crop and aggregate suitability class were obtained in line with the law of minimum. From Table 7 the soils of the study area are moderately suitable in climate, topography, wetness and soil physical characteristics but marginally suitable in terms of fertility with l.

Table 6*. Land suitability requirements for Okra (Abelmoschus esculentus L).*

Land quality/soil-site characteristics		Pedon 1	Pedon 2	Pedon 3
Climate (c)	Mean temperature in growing season °C.	25-28 (S1)	25-28 (S1)	25-28 (S1)
	Mean annual rainfall (mm)	2000-3000 (S3)	2000-3000 (S3)	2000-3000 (S3)
Topography (t)	Slope. %	< 4 (S1)	< 4 (S1)	< 4 (S1)
Wetness (w)	Soil drainage	Well drained (S1)	well drained (S1)	well drained (S1)
Soil physical Characteristics	Texture	sl, scl (S1)	slc (S1)	slc (S1)
	Effective depth (cm)	200 (S1)	200 (S1)	200 (S1)
Fertility (f)	pH (H_2O)	4.87 (S3)	5.0 (S2)	5.13 (S2)

Land quality/soil-site characteristics		Pedon 1	Pedon 2	Pedon 3
	CEC Cmol kg^{-1}	4.32 (S3)	3.43 (S3)	8.54 (S3)
Aggregate Suitability Class		S3 (f)	S3 (f)	S3 (f)

S1= highly Suitable, S2= moderately suitable, S3= marginally suitable, scl= sandy clay loam, sl= sandy loam

Table 7. Land requirements land suitability for Fluted Pumpkin (Telfaria occidentalis F.).

Land quality/soil-site characteristics		Pedon 1	Pedon 2	Pedon 3
Climate (c)	Mean temperature in growing season °C.	25-28 (S1)	25-28 (S1)	25-28 (S1)
	Mean anual rainfall (mm)	2000-3000 (S1)	2000-3000 (S1)	2000-3000 (S1)
Topography (t)	Slope. %	< 4 (S1)	< 4 (S1)	< 4 (S1)
Wetness (w)	Soil drainage	Well drained (S1)	well drained (S1)	well drained (S1)
Soil physical Characteristics	Texture	sl, scl (S1)	slc (S1)	slc (S1)
	Effective depth (cm)	200 (S1)	200 (S1)	200 (S1)
Fertility (f)	pH (H_2O)	4.87 (S3)	5.0 (S2)	5.13 (S2)
	CEC Cmol kg^{-1}	4.32 (S3)	3.43 (S3)	8.54 (S3)
Aggregate Suitability Class		S3 (f)	S3 (f)	S3 (f)

S1= highly Suitable, S2= moderately suitable, S3= marginally suitable, Scl = sandy clay loam, sl= sandy loam.

4. Conclusion

From the suitability evaluation of soils of the study area, soils represented by pedon 1, 2, and 3 when placed on suitability class showed the soils are marginally suitable for the cultivation of okra, tomatoes and fluted pumpkin but there are severe limitations in fertility (pH and cation exchange capacity) which are responsible for inadequate production of *Abelmoschus esculentus* and *Telfaria occidentalis*. The limiting factors are triggered by continuous cultivation, leaching, improper management practice and continuous use of inorganic fertilizers in the study area.

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Conflicts of Interest

The authors declare no Conflict of Interest.

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