Comparison of the Suitability of Contiguous Fallow-forest Lands for Cassava, Yam, Cocoyam and Sweet Potato Production in Nsukka, Southeastern Nigeria

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Abstract. This analysis compared the suitability of contiguous fallow-forest lands for cassava, yam, cocoyam and sweet potato production in Nsukka, south-eastern Nigeria. The fallow plots were brought into cultivation in 1998 under the IITA-UNN long-term collaborative research. The sole cassava plots were grown to cassava only continuously for five years and then left to fallow. Soil samples were collected from 0-20 cm depth in triplicates using an auger and core sampler from the seven representative fallow plots previously grown to sole cassava from 1998–2003 and under fallow till date as well as the adjacent forest land. The objective was to use the soil qualities as recovered during the fallow period and those from the original adjacent forest to determine their current suitability for the production of the four crops. Using the FAO's principle of limiting conditions revealed that after 13 yrs of fallow, the plots grown to sole cassava was classified as highly suitable (S1) for sweet potato production but moderately suitable (S2) for cassava, yam and cocoyam production. The remnant forest land was highly suitable for sweet potato production but moderately suitable for cassava, yam and cocoyam production. The dominant soil limitations are organic matter, low cation exchange capacity and exchangeable potassium for both cassava and yam production. The major limitations to cocoyam production are low available phosphorous, base saturation and soil pH. If these constraints are addressed adequately by soil nutrient management programmes all the plots will scale up to S1 class for the four crops.

Keywords: fallowing; nutrient sustainability; cassava; cocoyam; yam; sweet potato.

Introduction

Soil fertility depletion is a major problem in tropical Africa, resulting to decline in per capital food production as crop lands have a negative nutrient balance, due to crop harvest, leaching and low inputs applied to the soil [1, 2,]. The fertility status of any soil deteriorate with changes in land use especially when the natural ecosys-

tem (forest) is converted to crop land and continuous cultivation of such lands are involved [25]. This manifests as changes in soil properties such as nutrient content (N, P, K, Ca, Mg, S etc), pH, organic matter, CEC, structure etc [9, 6, 10]. Cropping a land without nutrient replenishment adversely affects the physico-chemical properties of the soil [18] which according to [16] contribute significantly to crop yield. Food crops grown on millions of hectares of soils all over the tropics no longer perform optimally well because most of the soils do not contain enough essential nutrients resulting in poor yields and subsequently the starvation of the people [41]. These yield reductions are mostly due to nutrient deficiencies resulting from decreases in soil organic matter content [42] and depletion of soil nutrients reserve during the cropping season. However, yield reductions are not only caused by poor nutrients status of the soils but also due to inappropriate land utilization types. Growing a crop on a land without due assessment of its suitability for such use, leads to suboptimal soil productivity and low yield as crop requirements are not often related to the land's potential capacity [26].

Fallowing is one method used in restoring the fertility status of degraded farmlands [17]. Its effect cannot be overemphasized in the improvement of agriculture because fallowing a soil gives it the potential to capture nutrients and make them available for crops; it reduces weeds, pest and disease infestations, restores soil organic matter and rehabilitates the population of soil organisms reduced during the cultivation period [50]. Long fallow period was found to increase the yield and protein content of wheat and its benefits extended beyond the next crop planted in the area. In the tropics, decision on land utilization types lies solely on the hands of the land owners who are mostly peasant farmers and not on the outcome of professional land evaluation, thus resulting to suboptimal land productivity and poor yield as land potential qualities are not often related to the crop growth requirements [26]. Therefore, assessment of soil physicochemical properties with respect to land utilization types is useful and paramount for sustainable agricultural productivity [49]. Generally, a sound understanding of land use effects on soil properties provides an opportunity to evaluate the sustainability of land use systems [53] and their suitability for a defined use so as to optimize and sustain agricultural productivity.

Cassava (*Manihot spp.*), yam (*Dioscorea spp.*), cocoyam (*Colocasia esculenta*) and sweet potato (*Ipomoea batatas*) belonging to the families of Enphorbianceae, Dioscoreae, Araceae and Solanaecae respectively, are the most important food crops grown in Nigeria as sources of food and carbohydrate. Cassava production in Nigeria is by far the largest in the world, producing ($\approx$ 52 million tonnes per yr), almost 19% of total world production [31]. Nigeria accounts for about 71% ($\approx$ 26 million tonnes) of the total world production of yam as reported by [33]. Cocoyam is the fifth most harvested corn crop in the world with the production estimate of 9 million tonnes [33]. Nigeria is the world's largest producer of cocoyam with an estimated 4.55 million metric tonnes in 2012 with about 43.1% of the total production in Africa [33]. Globally, sweet potato ranked third after Irish potato and cassava in the world's root and tuber crops [37].

There is need for the assessment of changes in soil physicochemical properties which are associated with different land uses before drawing conclusion on the potential nutrients status of soils [7] and their suitability for a defined use so as to optimize and sustain agricultural productivity. Many studies have addressed the effects of fallowing and/ or continuous cultivation on soil physicochemical properties in Nsukka, Southeastern Nigeria [13, 14]. However, studies comparing the physicochemical properties of an alfisol under fallow and adjacent forest lands and their suitability for cocoyam, cassava, yam and sweet potato production in Nsukka, Southeastern Nigeria have not been fully examined. Therefore, this study (which is part of a long-term soil fertility management experiment established in 1998 at Amagu, Edem-Nru in Nsukka) compared the physicochemical properties of an alfisol under fallow and adjacent forest lands and their suitability for cocoyam, yam, cassava and sweet potato production in Nsukka, Southeastern Nigeria.

Materials and methods

Site Description. The study area was at Amagu Edem-Nru, in Nsukka, Enugu State. It lies within the latitude 6º 52´ N and longitude 7º 23´ E in the Savannah zone of Southeastern Nigeria with an elevation of 447.2 m above sea level [43]. The climate of the area is characterized by an average annual rainfall of about 1550 mm and average temperatures (minimum and maximum) of 22 ℃

and 30 °C respectively while the average relative humidity is 60% [12]. Soils in this area are generally derived from the residua of False-bedded Sand-stone or Upper-coal Measure Formation as a result of disintegration of the rocks [10]. These geological formations give rise to the sandy and clayey soils respectively [10].The natural vegetation of Nsukka is characteristically derived Savannah agro-ecological zone with different land uses such as forestry, cultivated areas and grasslands in a soil-landscape system. Cassava, maize, yam, pigeon pea, egg plants, oil palm and pumpkins production is the dominant livelihood strategy of all members of the farming community.

Prof. Asadu et al. [17] reported that some part of a forest in Amagu Edem-Nru, in Nsukka, was cleared in January 1998 and partitioned into seven plots of 8 m by 5 m and each plot was replicated three times. Randomized Complete Block Design (RCBD) was used in establishing the trials. Seven treatments were applied: sole cassava (*Manihot esculenta* Crantz) (SC), sole pigeon pea (*Cajanus cajan*) (SP), sole maize (*Zea mays*) (SM), their combination (M+P, C+P and C+M+P) and a control plot based on the prior knowledge of the most common staple food crops grown by the local farmers. The crops were planted at a spacing of 1 m × 1 m on ridges made with hoes. The land was continuously cropped for five years (1998–2003) and afterwards left to fallow till date. Presently, the fallow plots are covered predominantly with Siam weed (*Chromolaena odorata*), guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*). There are also some shrubs and oil palm (*Elaiess guineensis*) trees that have re-established since the fallowing began.

Soil Sampling and Laboratory Analysis. Following the previous studies, the seven fallow plots were sampled each in triplicates from the fallow land; triplicate samples were also collected from the adjacent forest giving a total of twenty-four (24) samples all from 0-20 cm soil depth using an auger and core sampler. Soil samples were air dried, crushed, passed through a 2 mm sieve and analyzed using standard procedure. Soil particle size distribution was determined by the Bouyoucos hydrometic method [52]. Bulk density was determined by the core method [19]. Pore size distribution was determined using the water retention data as follows: macroporosity from the volume of water drained at 60 cm of tension/volume of bulk soil; microporosity from volume of water retained at 60 cm of tension/volume of bulk soil; and total porosity from the sum of macroporosity and microporosity [20]. Hydraulic conductivity was measured using Klute and Dirksen method [39].

Soil pH was measured in water and potassium chloride (1N KCL) suspension in a 1:2.5 (soil: liquid ratio) [46]. Available phosphorus (P) was extracted with Bray (II) solution. Organic carbon content was determined using Walkley-Black's titration method [38]. Total nitrogen (N) was determined using Kjeldahl digestion, distillation and titration method as described by [21]. Exchangeable Na and K were analyzed by Flame photometer [46] while exchangeable Ca and Mg were determined by titration method using 0.1N EDTA [22]. Cation Exchange Capacity (CEC) was thereafter estimated titrimetrically using 0.1N NaOH [22]. Exchangeable Acidity (EA) was determined as described by [22]. Percentage Base Saturation was calculated as (1):

$$PBS = \frac{TEB}{ECEC} \times 100, \qquad (1)$$

where PBS – percentage base saturation; TEB – total exchangeable bases; ECEC – effective cation exchange capacity.

Land Suitability Evaluation. The suitability of the soils for the production of cassava, yam, cocoyam and sweet potato was assessed using the principle of limiting condition [28]. The soils were placed in suitability classes by matching their characteristics with the requirements of the crops and the overall suitability class of the soils was that indicated by its most limiting characteristics for the conventional approach [28]. The detailed land and soil requirements for each of the crops are presented in Tables 1–5.

Results and discussions

Physical Properties. The physical properties of the soil are shown in Table 6. Generally, both sand and clay fractions dominated over the silt fraction so that the order in magnitude is sand > clay > silt. The low silt content may be due to its low values in the parent material of the soil [4].

Table 1: Land and Soil Requirement for Cassava [51]

Land Qualities	100 – 85 (S1)	85 – 60 (S2)	60 – 40 (S3)	40 – 25 (N1)	<25 (N2)
Climate (c):					
- MAR(mm)	1000 – 1800/1800 – 2400	750 – 600/>2400	600 – 550	550 – 500	<500
- MAT(˚C)	20 – 30/0 – 18	>30/18 – 16	16 – 14	14 – 12	<12
- Soil texture	L, SCL, CL, SL, SiCL, SiC	Cs, LFs, LS, LCS,Fs	CS, S, Cs	SC, Cm	Cm, S
Fertility f:					
- CEC (Cmol/kg)	>16	>10	<10	<5	<5
- Base saturation (%)	>35	35 – 15	15 – 10	<10	<10
- Organic matter (g/kg)	>15	>8	>5	<3	<3

MAT: mean annual temperature; Cs: structural clay; Cm: massive clay; SiC: silty clay; SiCL: silty clay loam; CL: clay loam; Si: silt; L: loam; SCL: sandy clay loam; SL: sandy loam; LFs: loam fine sand; LCS: loam coarse sand; Fs: fine sand; S: sand

Table 2: Land and soil requirement for yam [51]

Land Qualities	100 – 85 S1	85 – 60 S2	60 – 40 S3	40 – 25 N1	<25 N2
Climate (c):					
- MAR (mm)	1000 – 750/1200 – 1600	750 – 600	600 – 550	550 – 500	<500
- MAT (ºC)	25 – 35	20 – 25	15 – 20	<15	<15
- Soil texture	SL, SCL, CS, SiCL, CL, L,	Cs, LFs, LS, LCs	Cs, S	SC, Cm,	Cm, S
Fertility f:					
- CEC (Cmol/kg)	>16	>10	<10	<5	<5
- Base Saturation (%)	>35	>15	15 – 10	<10	<10
- Organic Matter (g/kg)	>15	>8	<5	<3	<3

Cs: structural clay; Cm: massive clay; SiCs: silty clay; SiCL: silty clay loam; CL: clay loam; Si: silt; L: loam; SCL: sandy clay loam; SL: sandy loam; LFs: loam fine sand; LCs: loam coarse sand; Fs: fine sand; S: sand

Table 3 – Land and soil requirement for cocoyam production [36]

Land qualities	S1	S2	S3	NI
Temperature (˚C)	21 – 27	25 – 30	30 – 35	>35
Total rainfall (mm)	≥2000	1300 – 1999	1000 – 1299	<1000
Base saturation (%)	>60	40 – 60	20 – 39	<20
Soil pH	>5 – 6.5	4.5 – 5	4 – 4.4	<4.0

Table 4 – Land and soil requirement for sweet potato production [45]

Land qualities	S1	S2	S3	NI
Temperature (˚C)	16 – 25	26 – 30	31 – 32	>32
Total rainfall (mm)	≥1300	800 – 1300	500 – 800	<500
Base saturation (%)	50 – 80	45 – 50	45 – 40	<40
Soil pH	4.5 – 6.5	6.6 – 8.2	>8.2	>8.2

Table 5 – Suitability Classes and their Description [27]

Suitability Class	Description
Class S1: Highly Suitable	Land having no significant limitations to sustained application of a given use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.
Class S2: Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class S1 land.
Class S3: Marginally Suitable	Land having limitations which in aggregate are severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified.
Class N: Currently Not Suitable	Land having limitations which may be surmountable in time but which cannot be corrected with existing knowledge at currently acceptable cost; the limitations are so severe as to preclude successful sustained use of the land in the given manner.
Class N2: Permanently Not Suitable	Land having limitations which appear as severe as to preclude any possibilities of successful sustained use of the land in the given manner.

The textural classes (sandy loam and sandy clay loam) are within the textures representative of the soils derived from false-bedded sand stone parent materials which occupy the lower slopes of Nsukka area in Nigeria [10, 13, 14].

Table 6 – Selected physical properties

Land use	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	TC	BD (kg/m3)	Map (%)	Mip (%)	Tp (%)	Ks cm/hr
pgSC	728.50	72.80	198.70	SL	1350	9.15	48.74	57.89	64.60
pgC+M+P	735.20	59.50	205.30	SCL	1310	7.95	48.27	56.22	68.00
pgC+P	741.90	59.50	198.70	SL	1350	7.80	48.76	56.56	53.40
pgSM	741.90	59.50	198.70	SL	1420	5.70	46.39	52.09	29.40
pgM+P	755.20	39.50	205.30	SCL	1360	8.90	50.62	59.52	65.00
pgSP	768.50	26.10	205.30	SCL	1390	7.49	48.62	56.11	25.80
EP	748.50	72.80	178.70	SL	1270	6.72	47.61	54.33	70.40
Forest	721.90	46.10	232.00	SCL	1280	9.46	49.44	58.90	125.00

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.

The relatively low bulk density values recorded across both the fallow plots and forest (1270 kg/m3 – 1420 kg/m3) is attributed to reduced or no cultivation activities as earlier found by [5]. Plant performs best if bulk densities are below 1400 kg/m3 and 1600 kg/m3) for clayey and sandy soils respectively [24].

Total porosity values ranged from 57.9 % to 58.9% the values are within those described as good agricultural soils [34, 48]. The saturated hydraulic conductivity (Ks) obtained from the forest land was the highest value (125.00 cm/hr).

Fallowing has been reported to be important in the improvement of both soil properties and saturated hydraulic conductivity of soils.

Chemical Properties. The chemical properties of the soil are shown in Table 7. The pH of the soil measured in water ranged from 4.27 to 4.33, indicating an extreme acid reaction [40]. This may be due to the acidic nature of the parent material from which the soils were derived combined leaching of cations prevalent in the soils of the area which had earlier been reported [11, 13].

Table 7 – Chemical properties of the soils

Land use	pH	OC (g/kg)	TN (g/kg)	EA	Ca2+	Mg2+	Na+	K+	CEC	BS (%)	Av P (mg/kg)
				cmol/kg							
pgSC	4.33	9.80	0.98	4.80	3.73	1.20	0.02	0.12	13.20	52.20	3.73
pgC+M+P	4.30	8.90	0.70	4.93	3.67	1.20	0.01	0.05	15.47	50.80	3.10
pgC+P	4.33	10.30	0.75	4.67	4.73	1.60	0.01	0.07	13.33	57.80	3.41
pgSM	4.33	9.10	0.70	4.40	5.07	0.57	0.01	0.06	15.33	57.00	3.72
pgM+P	4.27	8.00	0.89	4.53	4.00	0.73	0.01	0.06	14.80	50.90	2.79
pgSP	4.30	11.70	0.79	5.47	4.00	1.20	0.01	0.06	12.93	47.50	3.73
EP	4.33	13.80	0.84	5.07	3.93	0.93	0.01	0.06	13.07	52.20	3.73
Forest	4.30	12.60	0.84	5.07	3.27	0.67	0.01	0.12	12.47	45.30	4.04

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.

OC: organic carbon; AvP: available phosphorus; TN: total nitrogen; EA: Exchangeable Acidity; CEC: Cation Exchange Capacity %BS: Percentage Base Saturation; H^+: exchangeable hydrogen; Al^{3+}:exchangeable aluminium;Ca^{2+}:exchangeable calcium;Mg^{2+}:exchangeable magnesium; Na^+: exchangeable sodium; K^+:exchangeable potassium.

Organic matter is generally very low in the soils according to [40] ratings (>116 g/kg very high, 58–116 g/kg high, 23– 58 g/kg medium, 12–23 g/kg low and< 12 g/kg very low). The low organic matter content of the soils in the fallow plots could be due to rapid decomposition and mineralization of organic materials contributed by sparse vegetation and high temperatures.

The nitrogen contents in all the soils were low, ranging from 0.7 to 0.98 g/kg. Most crops require values (18 g/kg N) much higher than the values obtained [44]. The low nitrogen contents are associated with the low OM contents of the soils.

Exchangeable Al is generally detrimental to plants and as soil pH decreases, exchangeable acidity (EA) increases [23] so that soils with pH values below 5.2 are likely to exhibit the AL3+ problem. The low soil organic matter levels of the soils could also have contributed to the high EA values.

The range of values of exchangeable Na (0.01 – 0.02 cmol/kg) in all the soils indicate very low concentrations which are below the critical limit for sodicity [20]. Exchangeable Ca, Mg and K were generally rated moderate, low and very low for all plots except for some of the fallow plots (SC, C+M+P, C+P, M+P, SP and EP) where Ca2+ was low. Low exchangeable bases have been attributed to leaching losses of these bases below the root zones for most crops (> 100 cm depth).

The dominant exchangeable cations in the soils tend to be mainly calcium and magnesium while low content of potassium and sodium appeared to be due to absence of minerals high in them in the parent material.

According to [40], the soils having CEC of > 25 cmol/kg, 15-25 cmol/kg, 5–15 cmol/kg and < 5 cmol/kg are classified as high, medium, low and very low respectively. Based on the above ratings, the CEC values of the soils are rated medium. M. Yakubu et al [54] opined that organic matter content of soils which normally influences the CEC is generally low and therefore the CEC values may not be attributed to the amount of organic matter but for most tropical soils the contribution of organic matter to CEC is often greater than 50 % [10, 15].

From the FAO report [29] soils with base saturation of > 50% are regarded as fertile soils while soils with less than 50% are not fertile soils. Based on this therefore, the soils are generally fertile except for SP and forest plots. The low base saturation experienced in the forest (45.3%) could be attributed to leaching of soluble cations with water down the profile.

The available phosphorus was very low (2.79 – 4.04 mg/kg) and this may be due to phosphorus fixation and the acidic nature of the soil.

Land Suitability Evaluation. The matching of the land qualities/characteristics in tables 6–7 with land and soil requirements for suitability rating for cassava, yam, cocoyam and sweet potatoes production (Table 1–4) resulted in the suitability classes shown in Tables 8–11.

Table 8 – Suitability Class Scores and Aggregate Suitability Classification of the Soils for Cassava Production

Land use	MAR (mm)	MAT (ºC)	Texture	CEC (Cmol/kg)	BS (%)	OM (g/kg OC)	ASC
pgSC	S1	S1	S1	S2	S1	S2	S2
pgC+M+P	S1	S1	S1	S2	S1	S2	S2
pgC+P	S1	S1	S1	S2	S1	S2	S2
pgSM	S1	S1	S1	S2	S1	S2	S2
pgM+P	S1	S1	S1	S2	S1	S2	S2
pgSP	S1	S1	S1	S2	S2	S2	S2
EP	S1	S1	S1	S2	S2	S2	S2
Forest	S1	S1	S1	S2	S1	S2	S2

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.MAR: Annual Rainfall; MAT: Mean Annual Temperature; BS: Base Saturation; CEC: Cation Exchange Capacity; OM: Organic Matter; C: Carbon; ASC: Aggregate Suitability Class; S1: Highly suitable; S2: Moderately suitable; S3: Marginally suitable.

Table 9 – Suitability Class Scores and Aggregate Suitability Classification of the Soils for Yam Production

Land use	MAR (mm)	MAT (ºC)	Texture	CEC (Cmol/kg)	BS (%)	OM (g/kg OC)	ASC
pgSC	S1	S1	S1	S2	S1	S2	S2
pgC+M+P	S1	S1	S1	S2	S1	S2	S2
pgC+P	S1	S1	S1	S2	S1	S2	S2
pgSM	S1	S1	S1	S2	S1	S2	S2
pgM+P	S1	S1	S1	S2	S1	S2	S2
pgSP	S1	S1	S1	S2	S1	S2	S2
EP	S1	S1	S1	S2	S1	S2	S2
Forest	S1	S1	S1	S2	S1	S2	S2

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.MAR: Annual Rainfall; MAT: Mean Annual Temperature; BS: Base Saturation; CEC: Cation Exchange Capacity; OM: Organic Matter; C: Carbon; ASC: Aggregate Suitability Class; S1: Highly suitable; S2: Moderately suitable; S3: Marginally suitable.

All the fallow plots and the forestland were classified as moderately suitable (S2) for yam and cocoyam production (Tables 8 and 9). Organic matter, CEC and exchangeable potassium are the dominant limitations.

Table 10 shows the suitability classes of the soils for the production of cocoyam. All the fallow plots previously grown to SC, C+M+P, C+P, SM, M+P, SP, and the remnant forestland (EP) were rated moderately suitable (S2). The major limitations to cocoyam production was low base saturation and soil pH.

All the fallow plots (SC, C+M+P, C+P, SM, M+P, SP, and EP) and forest plot were rated are highly suitable (S1) for sweet potato production. Aluminium toxicity, exchangeable potassium, base saturation, total nitrogen and organic matter were the identified dominant constraints.

Table 10 – Suitability Class Scores and Aggregate Suitability Classification of the Soils for Cocoyam Production

Land use	MAR (mm)	MAT (ºC)	BS (%)	Soil pH	ASC
pgSC	S2	S1	S2	S3	S2
pgC+M+P	S2	S1	S2	S3	S2
pgC+P	S2	S1	S2	S3	S2
pgSM	S2	S1	S2	S3	S2
pgM+P	S2	S1	S2	S3	S2
pgSP	S2	S1	S2	S3	S2
EP	S2	S1	S2	S3	S2
Forest	S2	S1	S2	S3	S2

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.; MAR: Annual Rainfall; MAT: Mean Annual Temperature; BS: Base Saturation; Soil pH; ASC: Aggregate Suitability Class; S1: Highly suitable; S2: Moderately suitable; S3: Marginally suitable.

Table 11 – Suitability Class Scores and Aggregate Suitability Classification of the Soils for Sweet Potato Production

Land use	MAR (mm)	MAT (ºC)	BS (%)	Soil pH	ASC
pgSC	S1	S2	S1	S1	S1
pgC+M+P	S1	S2	S1	S1	S1
pgC+P	S1	S2	S1	S1	S1
pgSM	S1	S2	S1	S1	S1
pgM+P	S1	S2	S1	S1	S1
pgSP	S1	S2	S1	S1	S1
EP	S1	S2	S1	S1	S1
Forest	S1	S2	S1	S2	S1

Note: pgSC= previously grown to Sole Cassava; pgC+M+P = previously grown to Cassava + Maize + pigeon pea pgM+P: previously grown to Maize and Pigeon pea; pgSP: previously grown to Sole Pigeon pea; pg M+P= previously grown to Maize +pigeon pea; EP: Control Plot; TC: Textural Class; BD: Bulk Density; Map: Macroporosity; Mip: Microporosity; Tp: Total Porosity; Ks: Saturated hydraulic conductivity; SCL: Sandy Clay Loam.MAR: Annual Rainfall; MAT: Mean Annual Temperature; BS: Base Saturation; Soil pH; ASC: Aggregate Suitability Class; S1: Highly suitable; S2: Moderately suitable; S3: Marginally suitable.

Generally, the low pH values of the soils also pose a limitation to the production of the four crops (cassava, yam, cocoyam and sweet potato) and this can be mitigated by liming and by use of tolerant cultivars.

Conclusion and recommendation

The suitability assessment of Alfisols of Southeastern Nigeria for cassava, yam, cocoyam and sweet potato carried out in this study showed that the climatic characteristics such as mean annual temperature, mean annual rainfall and sunshine hours, and soil texture were generally optimum for cassava, yam, cocoyam and sweet potatoes cultivation. However, based on the FAO's principle of limiting conditions only the plots previously grown to sole cassava and the remnant forestland were classified as highly suitable (S1) for sweet potato production All the plots were classified as moderately suitable for cassava, yam and cocoyam production with low soil pH, CEC and base saturation as major constraints identified. To enhance the productivity levels of these lands for optimum cassava, yam, cocoyam and sweet potatoes production these constraints need to be adequately addressed through liming and nutrient application.

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Сравнение пригодности смежных лесных участков, вспаханных под пар, для выращивания культур маниока, батат, кокосового ямса и сладкого картофеля в провинции Nsukka, юго-восточная Нигерия

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Аннотация. Данное исследование сравнивало пригодность смежных возделанных лесных участков для выращивания маниоки, батата, кокосового ямса и сладкого картофеля в провинции Nsukka, юго-восточная Нигерия. Болотные участки были культивированы в 1998 году в рамках долгосрочного совместного исследования IITA-UNN. Участки использовались только для выращивания маниоки в течение пяти лет, а затем их оставляли под паром. Образцы почвы были собраны с глубины 0-20 см в трех экземплярах с использованием бура и керноотборника на семи возделанных участках-образцах, ранее используемых для выращивания только маниоки в 1998-2003 и находящихся под паром до настоящего времени, а также на прилегающих лесных участках. Цель состояла в том, чтобы исследовать свойства почвы данных участков восстанавливаться в период нахождения по паром, а также свойства почвы прилегающих лесных участков с целью определения их пригодности для текущего производства четырех культур.

Использование принципа FAO предельных условий показало, что после 13 лет парования, участки, используемые для выращивания только маниоки, классифицировались как очень подходящие (S1) для выращивания сладкого картофеля, но умеренно подходящие (S2) для маниоки, батата и кокосового ямса. Остальные лесные угодья очень хорошо подходили для выращивания сладкого картофеля, но умеренно подходили для выращивания маниоки, батата, кокосового ямса. Доминирующими ограничениями почвы являются органические вещества, низкая емкость катионного обмена и обменный калий, как для выращивания маниоки, так и батата. Основными ограничениями для производства кокосового ямса являются низкое содержание фосфора, насыщенность почвы и уровень pH почвы. Если эти ограничения надлежащим образом учитываются программами обработки почвы питательными веществами, все участки будут масштабироваться до класса S1 для четырех культур.

Ключевые слова: пар; питательная устойчивость; маниока; кокосовый ямс; сладкий картофель.