Soil suitability assessment for Coconut (*Cocos nucifera* Linn) cultivation at Udo, Ovia Southwest Local Government Area of Edo state. A Technical report

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Abstract

Coconut, often called the "tree of life," offers immense economic and health benefits, yet its cultivation in Nigeria is hindered by limited production. A soil suitability assessment was conducted at Udo, Ovia Southwest Local Government Area of Edo State, Nigeria, to evaluate the potential for coconut cultivation and provide necessary recommendations. The study analyzed soil physical and chemical properties, climatic conditions, and site suitability, revealing that the soils are marginally suitable due to high acidity and low fertility. Amendments such as lime application, fertilization with N:P:K:Mg 12:12:17:2, and proper planting techniques are recommended to enhance soil conditions. The results suggest that with appropriate soil management practices, the Udo soils can support successful coconut cultivation.

Keywords Coconut cultivation, soil suitability, Udo, Nigeria, soil acidity, fertility enhancement, NPK fertilizer, climatic conditions, tropical agriculture, economic palms.

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Background:
Coconut is fondly referred to as the tree of life because of its myriad number of uses. It is one of the most economic palms in the world today (Osayande *et al*., 2020). The sap from the nut commonly referred to as coconut nut water contains a lot of essential amino acids that some researchers believe could possess anti-aging properties besides other health benefits such as its use as cure for asthma, as it is believed to improve the health of the human lungs. The cultivation of coconut has before now been in the coastal alluvial soils of Southern Nigeria where annual rainfall ranges between 2500 mm and 3500 mm (Osayande et al., 2016). The high demand for coconut products especially its copra and oil has greatly heightened the cultivation of Coconut in Nigeria. Presently, the demand for coconut products currently outweighs its production in the country. This short fall in the production of coconut in Nigeria is currently being bridged by expanding cultivation coconut into areas of lesser rainfall volume by adequate soil management practices.
In view of this, a soil suitability assessment study was conducted at Udo, Ovia Southwest Local Government area of Edo state.
The objective was to determine the suitability of the soils to coconut cultivation and offer recommendations and amendment processes where necessary. The study specifically determined if the following conditions for coconut cultivation in Nigeria are met. These include:

1. Right type of site for coconut cultivation
2. Climatic conditions required for coconut cultivation
3. Soil analytical result: suitability and amendment
4. Use of the right variety of coconut for planting

Methodology:
A site suitability assessment for coconut cultivation was carried out at Udo, Ovia Southwest Local Government Area of Edo state to determine its suitability for coconut cultivation. The land was approximately 4 hectares and a reconnaissance survey was carried out to determine the soil forming factors responsible for the variations in soil properties and overall heterogeneity of the site. Notes were made of such factors with a view to reducing their heterogeneity, thereby increasing their suitability for coconut production.
Soil sampling:
In the course of the reconnaissance survey, a chance profile was spotted. The expanded profile was originally dug for the collection and storage of water. With less variation spotted (The land being already under arable cultivation) the profile pit, measuring 300 cm x 180 cm, sufficiently revealed the morphological characteristics and the intrinsic properties of the soils. The soils were sampled from the bottom of the profile pit to the top based

on horizon differentiation. Thus, soils were collected at 0 - 30cm, 30 - 70cm, 70 – 180 cm and 180 – 300 cm. The soils were taken to the laboratory for further analysis.

Soil preparation for analysis:
The soils were spread on air drying trays and air dried for 3 days at room temperature. Roots were removed while crumbs were crushed. The soils were sub sampled and analyzed for soil pH, organic carbon, total nitrogen, available phosphorus, exchangeable potassium, calcium, magnesium, sodium, hydrogen and aluminium. Effective cation exchange capacity was determined as the summation of exchangeable cations and acidity. These parameters beside climatic considerations have been shown to be the ones required for determining the suitability of coconut cultivation in any given location (Mathes *et al*., 1989)

Observations/findings:

1. **Right type of site for coconut cultivation:**

The site was flat and devoid of mountains and rock outcrops. This makes the site suitable on visual assessment for coconut cultivation. Furthermore, the site has been under intensive and continuous arable crop cultivation and contained crops like maize and cassava which are two major arable crops, besides pineapple that are cultivated in the area.

2. **Climatic conditions of the area (Rainfall and temperature):**

The annual rainfall in that zone as reported by NIFOR ranges between 2155 mm to 2500 mm per annum while monthly temperatures are between 21 and 25 ^{0}C.

Soil analytical result: suitability and amendment:
The soil analytical result is shown in Table 1:

Soil pH (H_2O):
The soil pH ranged from 4.70 to 5.24 with a mean of 5.00 (Table 1). This showed that the soils of the area currently selected for coconut cultivation is acidic. The pH of the soils is too acidic for coconut cultivation and needs to be amended to between 5.50 and 6.50 to reduce re-supplying after transplanting the coconut seedlings in the field.

Soil Organic carbon (SOC): Soil organic carbon ranged from 0.59 to 2.22% with a mean of 1.11%. Soil organic carbon at the top soil (0 – 30 cm) was sufficient and could explain the maize greenery observed at the time of sampling. Soil organic carbon decreased with increasing soil depth (Table 1). And was moderate in the entire area.

Total nitrogen (TN):
This ranged from 0.09 to 0.22% with a mean of 0.14%. Total nitrogen decreased with soil depth and was also sufficient at the top soil (0 – 30 cm) but moderate in the entire area.

Available phosphorus:
This ranged from 6.84 to 7.49 mgKg^{-1} with a mean of 7.05 mgKg^{-1} . Available P increased with soil depth (Table 1) and was low in the soils.

Exchangeable Ca^{2+}:
This ranged from 3.43 to 4.80 cmolkg^{-1} with a mean of 3.90 cmolkg^{-1} (Table 1). Exchangeable calcium was sufficient in the soils.

Exchangeable Mg^{2+}
This ranged from 0.27 to 1.02 cmolkg^{-1} with a mean of 0.76 cmolkg^{-1}. (Table 1) Exchangeable magnesium was sufficient in the soils.

Exchangeable K^+ and Na^+:
Both exchangeable cations were low in the soils. Mean exchangeable K^+ was 0.01 cmolkg^{-1} while mean exchangeable Na^+ was 0.08. Exchangeable Na^+ ranged from 0.05 to 0.14 cmolkg^{-1} (Table 1)

Exchangeable H^+ and Al^{3+}:
These two exchangeable cations were high in the soil and was responsible for the acidity of the soils. Exchangeable H^+ values increased with soil depth and ranged from 0.09 to 0.10 cmolkg^{-1} with a mean of 0.09 cmolkg^{-1} (Table 1). Exchangeable Al^{3+} ranged from 0.70 cmolkg^{-1} to 1.90 cmolkg^{-1} with a mean of 1.23 cmolkg^{-1}.

Table 1: Physical and chemical properties used for assessment of the suitability of the soils to coconut cultivation

Soil horizons (cm)	Soil pH (H_2O)	Org. C (%)	Total N (%)	Avail P (mg/kg)	Ca^{2+} ←	Mg^{2+}	K^+	Na^+	H^+ cmol/kg	Al^{3+}	ECEC →	Sand ←	Silt (%)	Clay →	Texture
0-30	4.70	2.22	0.22	6.84	4.80	0.85	0.01	0.05	0.08	1.50	7.31	70.22	11.46	18.32	Sandy Loam
30-70	4.70	0.98	0.13	6.84	3.43	0.27	0.01	0.14	0.09	1.90	5.85	52.22	4.54	43.24	Sandy Clay
70-180	5.07	0.65	0.11	7.04	3.66	1.02	0.01	0.06	0.10	0.70	5.55	40.76	24.92	34.32	Clay Loam
180-300	5.24	0.59	0.09	7.49	3.69	0.88	0.01	0.06	0.10	0.80	5.54	40.76	24.32	34.92	Clay Loam
Mean	**5.00**	**1.11**	**0.14**	**7.05**	**3.90**	**0.76**	**0.01**	**0.08**	**0.09**	**1.23**	**6.06**	**50.99**	**16.31**	**32.70**	

The exchangeable acidity values further confirmed the need to lime the soils. Coconut grows on both acidic and alkaline soils but perform much better when the soil pH is slightly acidic (5.50 – 6.50) rather than acidic (soil pH 4.00 – 5.00). They don't grow in very acidic (soil pH 3.00 - 4.50) soils (Osayande *et al*., 2016b)

Effective Cation Exchange Capacity (ECEC):

This was very low in the soils and confirmed the need to boost the nutrient status of the soils through appropriate fertilization. The values ranged from 5.54 to 7.29 $cmolkg^{-1}$ with a mean of 6.06 $cmolkg^{-1}$ (Table 1).

Soil Textural Class:

The soil textural class varied with soil depth from Sandy Loam (SL) at the top soil to Clay Loam at the sub soil (Table 1). The textural class is highly suitable for coconut cultivation because it will allow for high percolation of water.

Right type of variety:

The green West African Tall is the best variety of coconut planted in tropical West Africa. Its extensive root system makes it adaptive under a variety of soils with wide variations in properties. It also gives high meat yield compare to all other varieties.

Table 2: Fertility rating of soils of Udo for coconut cultivation

Fertility parameters	**Fertility Indices**			**Fertility status of soils of Udo for Coconut cultivation**
	Low	Moderate	High	Fertility class
Soil pH	< 4.5	4.5 – 5.5	5.5 – 6.5	Moderate
Organic matter (%)	< 1.5	1.5 – 2.0	> 2.0	Low
Total nitrogen (%)	< 0.15	0.12 – 0.15	> 0.15	Moderate
Available phosphorus ($mg\ kg^{-1}$)	< 16.00	10.00 – 16.00	> 16.00	Low
Calcium ($cmol\ kg^{-1}$)	< 3.0	2.5 – 3.0	> 3.0	High
Magnesium ($cmol\ kg^{-1}$)	< 0.3	0.2 – 0.3	> 0.3	High
Potassium($cmol\ kg^{-1}$)	< 0.2	0.1 – 0.2	> 0.2	Low
Sodium	< 0.4	0.3 – 0.4	> 0.4	Low
ECEC ($cmol\ kg^{-1}$)	>15	10.00 - 15.00	> 15	Low

Recommendations:

(1) It is recommended that holes dug for coconut planting should be 50 cm X 60 cm and must not exceed 60 cm of soil depth. This area of soil depth is the zone of illuviation of eluviated materials as depicted in the soil properties from the different horizons.

(2) Before planting, it is recommended that 50 grams of $CaCO_3$ plus 500 g of rock phosphate be applied in the planting hole to reduce the soil acidity and enhance root early development and proliferation. Besides, early root development reduces mortality and the cost of resupplying of dead coconut seedlings.

(3) Planting must be carried out in early or late May with seedlings protected with wire collars to avoid devastation by rodents

(4) The fertility class showed low fertility status for organic matter, potassium, sodium and ECEC which means that N:P:K:Mg 12:12:17:2 fertilizer will be adequate for coconut cultivation in the soils. The rates of application should increase with age of the coconut. 1.00 – 1.500 Kg of NPKMg per coconut

seedlings should be applied immediately after planting. The rate can be increased to between 2.00 – 2.500 Kg of the fertilizer at the fourth year of planting.

Conclusion:

Soil suitability assessment was conducted at Udo community for the cultivation of Coconut seedlings. The results after considering both soil analytical and morphological results showed that the soils were marginally suitable for the cultivation of coconut with a few fertility amendments in the area of soil acidity and fertility enhancement of the major nutrients through the application of N:P:K:Mg 12:12:17: 2 fertilizer

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