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Soil Fertility Evaluation for Cashew Production at Iyapo Farm Estate, Offa, Kwara State

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cashew (*Anacardium occidentale* L) is an important commodity crop with great potential as a foreign exchange earner. It is grown principally for it nuts and apple and is a hardy crop which is adapted to a wide range of agro-ecologies. The increase in the price of cashew nuts globally, has resulted in increased interest in the cultivation of cashew. The Management of Iyapo farms limited in its desire to key into this sector requested the technical assistance of Cocoa Research Institute of Nigeria (CRIN) to carry out soil fertility evaluation of the 50 hectares of land proposed for establishment of cashew. The farm was divided into three main sections (A, B and C) based on topography and four land use types (water logged, cassava plot, previously cultivated land and excavated land). Section A was parallel to River Oyun followed by section B in the middle of the farm, while the last section C ran parallel to the road from Ijagbo town. The land use types were scattered within the three blocks. The water logged area was however confined only to section A which was close to river Oyun.

Soil samples were collected at soil depths of 0-20 cm and 20-40 cm soil depth and at a distance of 20 m apart. The soil collected was put in nylon bags and properly labelled. Soil samples collected

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were air dried, passed through 2 mm sieve and analyzed for some of its physical and chemical properties. In section A, total soil nitrogen at 0-40 cm soil depth ranged between 0.07 g kg^{-1} to 0.18 g kg^{-1} with a mean value of 0.11 gkg^{-1} soil while mean soil available phosphorus at 0-40 cm soil depth was 3.16 mg kg^{-1} The exchangeable potassium content across 0-40 cm soil depth ranged between 0.09cmol kg^{-1} to 0.35 cmol kg^{-1} with a mean value of 0.25 cmolkg-^{1} and 0.19 cmol kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. In section B, nitrogen across the various soil depths ranged between 0.04 gkg^{-1} to 0.12 gkg^{-1} with nitrogen content of the soil decreasing with increasing soil depth. This falls below the soil critical level of 1 gkg^{-1} required for cashew and was grossly inadequate to meet nitrogen need for cashew. There is need for nutrient supplementation as nitrogen fertilizer is required to meet the nitrogen needs of the cashew. Similarly, phosphorus was also inadequate across the soil depths with a range of 2.47 $mgkg^{-1}$ to 4.51 $mgkg^{-1}$ across the various soil depth and a mean value of 3.24 $mgkg^{-1}$ and 2.65 $mgkg^{-1}$ for 0-20 cm and 20-40 cm soil depths respectively. This was below the soil critical value of 3.7 $mgkg^{-1}$. There is therefore need to apply phosphorus fertilizer to boost cashew productivity.
Soil exchangeable potassium was adequate across the various soil depths with a range of 0.13 to 0.20 cmol kg^{-1} and a mean value of 0.18 cmol kg^{-1} and 0.16 cmol kg^{-1} for 0-20cm and 20-40 cm soil depths respectively. There is no need for potassium fertilizer application. The results above indicated that sections A, B and C requires 180 kg ha^{-1} of urea and 31.5 kg of Single Super Phosphate (SSP). The cassava plot and previously cropped bare land requires 189 kg ha^{-1} urea and 9.9 kg ha^{-1} SSP, while the excavated land requires 194.2 kg urea 25.8 kg SSP and 32.28 kg MOP. Cashew should not be grown on the water-logged section.

Keywords: Cashew; Soil fertility; nutrient management; fertilizer; yield.

1. INTRODUCTION

Cashew is an important commodity crop with great potentials as foreign earner and source of industrial raw materials with the prospect of becoming a major commercial tree crop in Nigeria. Cashew as a result of its wide adaptation is often grown in very poor soils and this has affected its survival and establishment [1,2]. Cashew is a commodity crop of international recognition for its numerous importance, food security, foreign exchange earnings, and forestation with its roles in mitigating the adverse effects of climate change. It is a hardy crop which survives where most tree crops cannot thrive [3]. Hence, it is cultivated in a variety of ecological zones of Nigeria which connotes a wide variety of soil. It is often grown on poor soils and this has affected its survival and adaptability. Cashew nuts production has the potential of increase in Nigeria if available resources are adequately annexed. Particularly important is the financial resources needed to boost cultivation and perform marketing functions that can further facilitate cashew production couple with appropriate record keeping for sustainability. Cashew nuts are among the healthiest and most popular nuts in the world and regular consumption can contribute to the reduction of risks of cardiovascular diseases [4]. The cashew apple is an edible fruit rich in vitamin C, sugars and contains considerable amount of tannins (35%, less in the yellow) and minerals, mainly calcium, iron and phosphorous [5]. The fruit can be improved on for consumption and trade by removing the undesirable tannins and processing the apples into value-added products, such as juices, syrups, canned fruits, pickles, jams, chutneys, candy and coffee. The nuts are also processed for other value- added products [5]. Cashew however grows optimally with corresponding economic returns under ideal soil condition and proper management. Good soil management is a criterion for good quality and high yield of both cashew nuts and apples. This is however lacking in cashew production in Nigeria. Some of the components of good soil management include proper site selection and use of fertilizer. Proper site selection is critical in cashew production. This is because cashew production is a long term investment. Site selected for cashew production site should be deep soil (1-1.5 m), well drained with steady and continuous supply of nutrients [6].

Iyapo farm is interested in establishing about 50 hectares of cashew. Soil fertility evaluation is therefore crucial to ensure appropriate recommendation of soil management practice to enhance establishment and yield of cashew. The objective of this work is to carry out soil fertility assessment of Iyapo farm for cashew cultivation.

2. MATERIALS AND METHODS

2.1 Study Site

Kwara state is located between latitude 7°N and longitude 3°E and 7°E. It is geographically located at the Southern border of River Niger and in the Southern Guinea Savanna. The average annual rainfall in the State is 1202.4mm with two peaks in July and September and a dry spell in August, known as August break. The rainfall starts in late April and ends in October. The Average monthly temperature is fairly constant. However, February, March and April are the hottest months, while June to September have the lowest maximum temperature which coincides with the peak of the dry and wet seasons respectively [7].

2.2 Parent Materials

Kwara State has two distinct geologies. The soils were formed from basement complex rocks metamorphic and igneous rocks) which is about 95% and sedimentary rock along the Niger River bank which is about 5% of the total area. The metamorphic rocks include biotite gneiss, quartizite, augite gneiss and grantitic gnesis. The intrusive pegmatite and vein quarz.

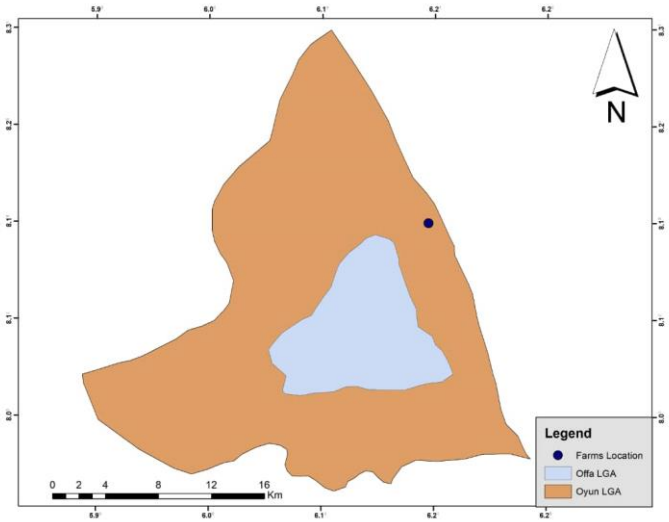

Fig. 1. Map of Kwara State showing the location of Iyapo farm

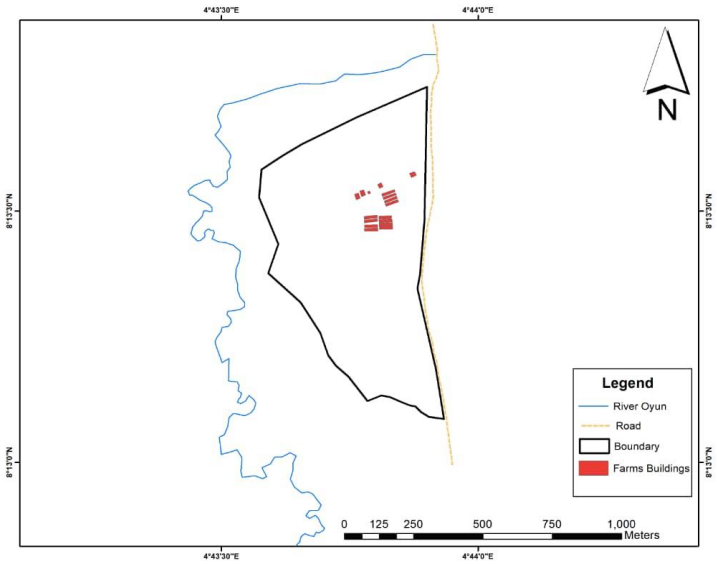

Fig. 2. Map of Iyapo farm in Kwara State, Nigeria

The farm is located at Ijagbo, Oyun Local Government area near Offa Kwara State. It is on latitude 8° 13.44¹N, longitude 0040 43.501¹ and 36.5 metres above sea level. The 49.547 hectares' farm which is located in the Southern Guinea Zone is bounded by River Oyun, a citrus farm, farm house and a road from Ijagbo at the four boundaries. The farm consisted of scattered locust bean trees, oil palm trees and a few cashew stands. Part of the farm was presently cultivated with cassava, while some had been previously cropped with maize. There was evidence of sand mining in the excavated lands, while excavation of the top soil had been carried out.

3. METHODOLOGY

3.1 Field Soil Sampling

The farm sampled was divided into three main sections (A, B and C) based on topography and land use types (water logged, cassava plot, previously cultivated land and excavated land). Section A was parallel to River Oyun followed by section B in the middle of the farm, while the last section C ran parallel to the road from Ijagbo. The land use types were scattered within the three blocks. However, the water logged area was confined only to section A which was close to river Oyun. Soil samples were collected using a soil auger at the depth of 0-20 cm and 20-40 cm and at a distance of 20 m apart. In each block, several core soil samples were collected and core soil samples from the same soil depth within each block were bulked together to give two composite samples per block. The observation spots were selected in such a way that biased points like anthills and rocky spots were avoided. The soil collected were put in nylon bags and properly labelled.

3.2 Laboratory Analysis

The composite soil samples were air dried, passed through 2 mm sieve and analysed for some of its physical and chemical properties. Particle size was determined by Bouyoucos hydrometer methods; soil pH was measured in 1:1 soil - water ratio using the EDT BA350 digital pH meter while organic carbon was determined by the wet digestion dichromate acid-oxidation method. Total N was determined using Kjeldahl digestion method and available P by Bray P1 method. Exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) were extracted with 1 N ammonium acetate (NH_4OAc) buffered at pH 7.0 [8]. Exchangeable K and Na in the extracts were read through the Jenway flame photometer (model PFP7) and Ca and Mg were read on Atomic Absorption Spectrophotometer (AAS) Buck Scientific 200A model. Exchangeable acidity was extracted with 1 N KCl and determined by titration with 0.05 N NaOH using phenolphthalein indicator [9], while total exchangeable bases was by summation of $Ca^{2+}+Mg^{2+}+K^{+}+Na^{+}$. Effective cation exchange capacity (ECEC) was by summation of exchangeable bases and exchangeable acid. Percent base saturation was calculated as follows:

$$\% \text{ Base saturation} = \frac{\text{Exchangeable bases}}{\text{ECEC}} \text{ x } \frac{100}{1}$$

The fertilizer computation was based on the chemical properties of the top soil (0-20 cm) taking into consideration that both lateral and creeping roots are housed at this soil depth.

4. RESULTS AND DISCUSSION

4.1 Soil Physical and Chemical Characteristics

Section A

Soil physical and chemical characteristics of block A is shown on (Table 1). Sand content of the 0-20 cm and 20-40 cm soil depth ranged between 662 g kg^{-1} to 762.4 g/kg and 602.4 g kg^{-1} to 742.4 g kg^{-1} respectively, with a mean value of 682.4g kg^{-1}. Sand content decreased with increasing soil depth. Silt content of the top 0-2cm soil depth ranged between 72.8g kg^{-1} to 232.8g kg^{-1} with a mean value of 160.8g kg^{-1}. The silt content of 20-40cm soil depth ranged between 132.8 to 252.8 g kg^{-1}, with a mean value of 172.8 g kg^{-1}. Silt content increased with increasing soil depth. Clay content of the soil decreased with increasing soil depth. Clay at the top 0-20cm soil depth ranged between 134.6g kg^{-1} to 152.8g kg^{-1} with a mean value of 151.8g kg^{-1}. Clay in 20-40 cm soil depth also ranged between 112.8g kg^{-1} to 164.8g kg^{-1} with mean value of 149.1g kg^{-1}. The textural class of the soil is sandy loam. Despite the high sand content of the soil, cashew thrives well on this soil because cashew is hardy and adapt to dry environment [3]. The soil is slightly acidic with soil pH increasing with increasing soil depth. At the top 0-20 cm soil depth, soil pH ranged between 6.19-6.66 with a mean value of 6.54. Cashew thrives well in soil of pH of 5-7.7. The soil pH is therefore favourable for cashew production.

Soil organic carbon content in the top 0-20cm soil depth ranged between 13.9 g kg^{-1} to 28.8g kg^{-1} with a mean value of 19.7g kg^{-1}. Organic carbon at 20-40 cm soil depth also ranged between 10.1g kg^{-1} to 22.7g kg^{-1} with a mean value of 15.35 g kg^{-1} and organic carbon content decreased with increasing soil depth. Soil organic carbon content was moderate and was sufficient to sustain cashew production. Total soil nitrogen in the top 0-20cm soil depth ranged between 0.027g kg^{-1} to 0.391g/kg with a mean value of 0.1 g kg^{-1} soil. While total N in 20-40 cm soil depth ranged between 0.07g kg^{-1} to 0.16g kg^{-1} with a mean value of 0.12g kg^{-1}. This is highly inadequate for cashew production, as this value is well below the soil critical value of 1g kg^{-1} [10] required for cashew production. There is therefore urgent need to apply nitrogen fertilizer. Soil available phosphorus decreased with increasing soil depth. Soil available phosphorus in the top (0-20 cm) soil depth ranged between 2.62g kg^{-1} to 3.82mg kg^{-1} with a mean value of 3.22mg kg^{-1}. Similarly, available phosphorus at 20-40 cm soil depth ranged between 1.78mg/kg to 4.08mg/kg with a mean value of 2.62 mg. Mean soil available phosphorus in the top 0-20cm soil depth was below the soil critical level of 3.7mg/kg phosphorus. Similarly, at 20-40 cm soil depth, soil available phosphorus also fell below the soil critical phosphorus level with a ranged of 0.09 mg kg^{-1} to 0.16mg kg^{-1} and a mean value of 2.62 mg kg^{-1}. There is need for application of phosphorus fertilizer. Mean exchangeable potassium content across 0-40cm soil depth ranged between 0.09 cmol kg^{-1} to 0.26 cmol kg^{-1} with a mean value of 0.25 cmol kg^{-1} and 0.19cmol kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. This is above the soil critical potassium level of 0.12 cmol/kg soil required for cashew production. There is therefore no need for potassium fertilizer application. Exchangeable calcium across the various soil depth was high ranging between 4.82 cmol kg^{-1} to 7.43 cmol kg^{-1} with a mean value of 6.69 cmol kg^{-1} and 5.91 cmol kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. Calcium content of the soil was adequate for cashew production as soil exchangeable calcium content was well above the soil critical calcium value of 0.8 cmol kg^{-1} soil. There is therefore no need for calcium fertilizer application. Similarly, soil exchangeable magnesium across the various soil depth ranged between 0.84 cmol kg^{-1} to 1.38 cmol kg^{-1} with mean value of 1.12 cmol kg^{-1} at 0-20 cm and 20-40 cm soil depth. Soil exchangeable magnesium was adequate for cashew production as it was well above the 0.08 cmol/kg soil recommended for cashew production. Exchangeable acidity ranged between 0.18 cmol kg^{-1} to 0.76 cmol/kg in the top 0-20cm soil depth with a mean value of 0.28 cmol/kg. Exchangeable acidity of 20-40 cm soil depth also ranged between 0.40 cmol kg^{-1} to 0.68 cmol kg^{-1} with a mean value of 0.51 cmol kg^{-1} soil.

Section B

The sand in the top 0-20cm soil depth ranged from 762.4 g kg^{-1} to 802.4 g kg^{-1} with a mean value of 782.4 gkg^{-1}. In the 20-40cm soil depth, sand content ranged between 742.4g kg^{-1} to 782.4gkg^{-1} with a mean value of 767.4 gkg^{-1}, with sand content decreasing with increasing soil depth (Table 2). Silt in the 0-20 cm soil depth ranged between 32.8-112.8g kg^{-1} with a mean value of 82.8 gkg^{-1}. Similarly, silt in 20-40 cm soil depth ranged between 32.8 gkg^{-1} to 92.8 gkg-^{1} with a mean value of 77.8 gkg^{-1}, with silt content increasing with increasing soil depth. Clay content across the 0-40 cm soil depth ranged between 124g kg^{-1} to 224.8 gkg^{-1} with a mean value of 134.8 g kg^{-1} and 154.8 g kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. The textural class of the soil is loamy sand. This is ideal for cashew production. Soil pH content across the various soil depth ranged between 6.24-6.68 with a mean value of 6.51 at 0-20 cm soil depth and 6.57 at 20-40 cm soil depth. The soil is slightly acidic and okay for cashew production as it falls within the pH range recommended for cashew production. Soil organic carbon at the top 0-20 cm soil depth ranged between 7 g kg^{-1} to 38 g kg^{-1} with a mean value of 18.6 g kg^{-1} Soil in the 20-40 cm soil depth ranged between 3.2 g kg^{-1} to 10.5g kg^{-1} with a mean value of 7.38 g kg^{-1}. Soil organic carbon content decreased with increasing soil depth. Organic carbon in the top 0-20 cm was sufficient to sustain cashew production. However, at the lower 20-40 cm soil depth soil organic carbon was insufficient. There may be need to apply organic fertilizer in subsequent years to enhance the organic carbon content of the soil. Nitrogen across the various soil depths ranged between 0.04 g kg^{-1} to 0.12 g kg^{-1} with nitrogen content of the soil decreasing with increasing soil depth. This falls below the soil critical level of 1 g kg^{-1} required for cashew and was grossly inadequate to meet nitrogen need for cashew. There is therefore need for nutrient supplementation as fertilizer to meet the nitrogen needs of cashew. Phosphorus was also inadequate across the soil depth with a range of 2.47 mg kg^{-1} to 4.51 mg kg^{-1} across the various

soil depth and a mean value of 3.24 mg kg^{-1} and 2.65 mgkg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. This was below the soil critical value of 3.7 mg/kg. There is therefore need to apply phosphorus fertilizer to boost cashew productivity. Soil exchangeable potassium was adequate across the various soil depth with a range of 0.13 to 0.20 cmolkg-1 and a mean value of 0.18 cmol kg^{-1} and 0.16 cmol kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. There is therefore no need for potassium fertilizer application. Soil exchangeable calcium and magnesium were also adequate. Soil exchangeable calcium had a mean value of 5.54 cmol kg^{-1} and 5.59 cmol kg^{-1} in 0-20 cm and 20-40 cm soil depth respectively. This was well above the soil critical level of 0.8 cmolkg^{-1} required for cashew. Similarly, exchangeable magnesium content ranged between 0.80 cmol kg^{-1} soil and 0.94 cmol kg^{-1} soil with mean value of 0.95 cmol kg^{-1} and 0.93 cmol kg^{-1} for 0-20 cm and 20-40 cm soil depth respectively. This was also well above the soil critical value of 0.08 cmol kg^{-1} soil required for cashew production. Mean exchangeable acidity was 0.61 cmol kg^{-1} and 0.56 cmol kg^{-1} for 0-20cm and 20-40 cm soil depth respectively. This was also adequate for cashew production.

Section C

The mean sand, silt and clay at the top soil (0-20 cm) was 772.6, 97.8 and 129.8 g kg^{-1} soil respectively, while the mean sand, silt and clay at the sub soil was 747.4, 102.8 and 149.8 g kg^{-1} soil respectively (Table 3). The soil has a very high sand fraction both at the top and sub- soil. Although the sand fraction at the top soil decreased by 3.2% at the sub-soil while the silt and clay both increased by 5% and 15% respectively.

The clay soil content is below 300 g kg^{-1} soil which can be considered low and the possibility of water deficit during the dry season is there. However, cashew has ability to adapt to dry environment more than many other tree crops as soon as it survives the first two years of establishment. It is still expected that with good agronomic practices, cashew will still establish despite the level of sand in the farm.

The pH of the soil at both depths was 6.46 and falls within the acceptable range of 5.50 to 6.50 for cashew cultivation. Hence, there is no need for any form of adjustment through liming. The average organic carbon and total N at the top soil (0-20 cm) was 12.38 and 0.12 g kg^{-1} while at the sub soil (20-40 cm), the mean was 12.57 and 0.10 g kg^{-1} soil respectively. This shows that the organic carbon and the total N at the top soil were higher than the values obtained at the sub soil, the values were however moderate for good cashew cultivation. This gives the possibility of using N- fertilizer particularly of organic origin so that the soil will not be acidified if inorganic N source is used like urea and other acidifying fertilizers.

The mean available P at both depths was 4.03mg kg^{-1} soil. The value is moderate for cashew production as this could fall below 3.7 mg kg^{-1}. There is need for routine management of the P through the use of natural rock phosphate (Sokoto rock phosphate) but if this is not available, single super phosphate could also be used as recommended in the findings of [11].

Similarly, the level of exchangeable K across the depth was 0.22 cmol kg^{-1} soils. The mean exchangeable cashew at the top soil was 6.68 cmol kg^{-1} soil, while at the subsoil was 6.52 cmol kg^{-1} soil. The value of exchangeable calcium at the top soil decreased by 2.4% when compared with the value of exchangeable magnesium that was 1.03 cmol kg^{-1} soil which is moderate. The Ca/Mg ratio was 6.38. This value maintains the normal relationship provided for productive soil. This indicates that the soil matrix maintains a proper balance and hence there is no likelihood of nutrient imbalance in the soil. It is instructive that there is no need for adjustment in the content of the soil total N, available P and exchangeable potassium. These three major nutrients give the direction for the productivity of soil when pH is within the appropriate range of 5.50 to 7.50.

The mean value of N across the two soil depths was 0.11g kg^{-1}. This value is below the soil critical value of 1g kg^{-1}. The average value of soil available P of 4 mg kg^{-1} soil is higher than the soil critical value of 3.7 mg kg^{-1} soil. Similarly, the value of K was above the soil critical value for cashew production. Hence, there is no need for P and K fertilizers as at now. However, nitrogen fertilizer will be required for optimum production.

Table 1. Physical and chemical properties of soils of section A at Iyapo farm Estate Offa, Kwara State

	Soil physical properties									Soil chemical properties		
Location	**Soil depth (cm)**	**Sand (gkg^{-1})**	**Silt (gkg^{-1})**	**Clay (gkg^{-1})**	**pH**	**Org.C ($g\ kg^{-1}$)**	**Total.N ($g\ kg^{-1}$)**	**Avail.P ($mg\ kg^{-1}$)**	**Exch.K ($cmol\ kg^{-1}$)**	**Exch.Ca ($cmol\ kg^{-1}$)**	**Exch.Mg ($cmol\ kg^{-1}$)**	**Exch.acidity ($cmol\ kg^{-1}$)**
A1	0-20	762.4	72.8	164.8	6.19	20.0	0.027	3.47	0.35	7.43	1.38	0.76
A2	0-20	662.4	172.8	164.0	6.61	28.8	0.183	3.62	0.22	7.58	1.04	0.18
A3	0-20	642.4	232.8	134.6	6.32	16.2	0.128	2.82	0.22	6.20	1.22	0.48
A4	0-20	682.4	164.8	152.8	6.35	13.9	0.053	2.98	0.20	5.53	0.83	0.56
Total	0-20	2749.6	643.2	607.2	25.47	78.9	0.391	12.89	0.99	26.74	4.47	1.12
Mean	**0-20**	**687.4**	**160.8**	**151.8**	**6.37**	**19.7**	**0.10**	**3.22**	**0.25**	**6.69**	**1.12**	**0.28**
A1	20-40	742.4	144.8	112.8	6.38	17.4	0.091	4.08	0.26	6.43	1.32	0.68
A2	20-40	642.6	192.8	164.8	6.62	22.7	0.145	2.76	0.26	6.55	1.21	0.60
A3	20-40	602.4	252.8	144.8	6.65	11.2	0.070	1.84	0.15	5.82	1.10	0.40
A4	20-40	722.4	132.8	144.8	6.50	10.1	0.162	1.78	0.09	4.82	0.84	0.44
Total	20-40	2709.8	691.2	599.2	19.51	61.4	0.468	10.46	0.76	23.62	4.47	2.12
Mean	**20-40**	**677.45**	**172.8**	**149.8**	**4.80**	**15.35**	**0.117**	**2.62**	**0.19**	**5.91**	**1.12**	**0.51**

Table 2. Physical and chemical properties of soils of section B at Iyapo farm Estate Offa, Kwara State

	Soil physical properties									Soil chemical properties		
Location	**Soil depth (cm)**	**Sand ($g\ kg^{-1}$)**	**Silt ($g\ kg^{-1}$)**	**Clay ($g\ kg^{-1}$)**	**pH**	**Org.C ($g\ kg^{-1}$)**	**Total .N ($g\ kg^{-1}$)**	**Avail .P ($mgkg^{-1}$)**	**Exch .K ($cmol\ kg^{-1}$)**	**Exch.Ca ($cmol/kg^{-1}$)**	**Exch. Mg ($cmol\ kg^{-1}$)**	**Exch acidity ($cmol\ kg^{-1}$)**
B1	0-20	802.4	32.8	164.8	6.24	18.1	0.119	4.51	0.17	5.53	0.97	0.62
B2	0-20	782.4	92.8	124.8	6.57	38.0	0.075	2.93	0.17	5.03	0.91	0.68
B3	0-20	782.4	92.8	124.8	6.53	7.00	0.067	2.47	0.17	5.53	0.95	0.64
B4	0-20	762.4	112.8	124.8	6.65	11.2	0.091	3.05	0.20	6.05	0.96	0.48
Total	0-20	3129.6	331.2	539.2	26.0	74.3	0.352	12.96	0.71	22.14	3.74	2.42
Mean	**0-20**	**782.4**	**82.8**	**134.8**	**6.51**	**18.6**	**0.088**	**3.24**	**0.18**	**5.54**	**0.95**	**0.61**
B1	20-40	782.4	92.8	124.8	6.63	10.5	0.101	3.05	0.20	5.28	0.97	0.88
B2	20-40	782.4	92.8	124.8	6.31	6.10	0.083	3.10	0.13	5.93	0.94	0.36
B3	20-40	762.4	92.8	144.8	6.66	3.20	0.039	2.82	0.13	5.86	0.80	0.56
B4	20-40	742.4	32.8	224.8	6.68	9.70	0.062	2.47	0.17	5.28	0.97	0.44
Total	20-40	3069.6	311.2	464.4	26.2	633.4	0.285	11.43	0.63	22.32	36.8	2.23
Mean	**20-40**	**767.4**	**77.8**	**154.8**	**6.57**	**158.4**	**0.07**	**2.56**	**0.16**	**5.59**	**0.92**	**0.56**

Table 3. Physical and chemical properties of soils of section C at Iyapo farm Estate Offa, Kwara State

	Soil physical properties								Soil chemical properties			
Location	**Soil depth**	**Sand (g kg^{-1})**	**Silt (g kg^{-1})**	**Clay (g kg^{-1})**	**pH**	**Org. C (gkg^{-1})**	**Total N (cmol kg^{-1})**	**Avail P (cmol kg^{-1})**	**Exch K (cmol kg^{-1})**	**Exch Ca (cmol kg^{-1})**	**Exch Mg (cmol kg^{-1})**	**Exch acidity (cmol kg^{-1})**
C1	0-20	782.4	92.8	124.8	6.48	18.10	0.167	3.74	0.30	5.27	1.16	1.08
C2	0-20	782.4	92.8	124.8	6.51	12.00	0.048	3.97	0.13	5.03	0.72	0.80
C3	0-20	802.4	172.8	24.8	6.47	14.30	0.111	4.90	0.28	9.13	1.04	0.72
C4	0-20	722.4	132.8	144.8	6.34	5.10	0.137	2.75	0.24	7.32	1.22	0.68
Total	0-20	3,089.6	391.2	519.2	25.8	49.50	0.463	15.06	0.95	26.75	4.14	2.56
Mean	**0-20**	**772.4**	**97.8**	**129.8**	**6.45**	**12.38**	**0.12**	**3.77**	**0.24**	**6.68**	**1.04**	**0.64**
C1	20-40	762.4	112.8	124.8	6.46	12.40	0.128	4.49	9.29	6.42	1.24	0.44
C2	20-40	782.4	92.8	124.8	6.67	10.50	0.045	4.20	0.11	6.18	0.55	0.76
C3	20-40	702.4	92.8	204.8	6.18	16.20	0.099	4.04	0.24	6.88	1.11	0.84
C4	20-40	742.4	112.8	144.8	6.56	11.20	0.115	4.43	0.24	6.61	1.20	0.60
Total	20-40	2989.6	411.2	599.2	25.87	50.30	0.287	17.16	0.85	26.09	4.10	2.64
Mean	**20-40**	**747.4**	**102.8**	**149.8**	**6.47**	**12.57**	**0.10**	**4.29**	**0.21**	**6.52**	**1.03**	**0.60**

Table 4. Physical and chemical properties of water logged cassava plots previously cultivated and excavated land at Iyapo farm in Offa, Kwara State

	Soil physical properties								Soil chemical properties			
Location	**Soil depth (g kg^{-1})**	**Sand (g kg^{-1})**	**Silt (g kg^{-1})**	**Clay (g kg^{-1})**	**pH**	**Org. C (g kg^{-1})**	**Total N (g kg^{1})**	**Avail P (mg kg^{-1})**	**Exch K (cmol kg^{-1})**	**Exch Ca (cmol kg^{-1})**	**Exch Mg (cmol kg^{-1})**	**Exch. Acidity (cmol kg^{-1})**
Water-logged	0-20	642.4	192.8	164.8	6.78	5.40	0.065	3.51	0.09	5.03	0.91	0.40
Water-logged	20-40	582.4	232.8	184.8	6.67	15.40	0.144	3.39	0.17	5.51	0.83	1.36
Cassava	0-20	742.4	92.8	124.8	6.56	12.40	0.082	5.12	0.22	8.76	1.02	0.44
Cassava	20-40	762.4	92.8	144.8	6.54	1.70	0.056	3.04	0.15	5.87	0.94	0.70
Cultivated	0-20	782.4	72.8	144.8	6.52	7.00	0.075	3.10	0.17	5.27	0.92	0.56
Cultivated	20-40	762.4	92.8	144.8	6.69	6.60	0.063	5.83	0.22	5.01	0.96	0.64
Excavated	0-20	722.4	112.8	164.8	6.56	5.40	0.050	2.12	0.09	6.61	0.81	0.68
Excavated	20-40	742.4	132.8	124.8	6.75	12.00	0.039	3.34	0.09	5.58	0.77	0.64

Table 5. Fertilizer recommendation for different land use types in Iyapo farm

Land Use Types	N, P and K Required		Fertilizer Recommendation			
	N(kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O(kg ha^{-1})	Urea	SSP	MOP
Sections A, B and C	82.8	5.6	-	180	31.50	-
Cassava farm and previously cultivated bared land	84.78	1.97	-	189	9.9	-
Excavated land	87.4	5.10	22.97	194.2	25.8	38.28

The sand content of the waterlogged area of the farm which occupied about 1/32 of the farm land (1.56 hectares) was lower than the other land use types - cassava, previously cultivated and excavated land. This might be due to washing away by erosion and the portion of the top soil was higher in sand content. Clay +silt content of the water- logged surface soil (0-20cm) was higher than other land use types. This might be the reason for more water retention which led to water logging because of poor drainage. The water logged portion was situated in the section area of the farm parallel to the major stream at the boundary of the farm. Exchangeable Ca and Mg contents were adequate for cashew in the water - logged area of the farm. The total nitrogen, available phosphorus and exchangeable potassium content were slightly below the amount required by cashew. Fertilizer will be required to supply the deficient N, P and K in that portion of the land [12].

4.2 Cassava Plot on the Land

The sand content of the top soil of the cassava plot was higher than water-logged and excavated portion of the land. The pH was slightly acidic. All the major nutrients except nitrogen were adequate and slightly above the amount required for cashew. There will be need for supplementation with nitrogen fertilizers.

4.3 Cultivated Soil

The previously cultivated bare soil portion of the land had lesser amount of available P, exchangeable K and Mg in the top soil compared to the sub soil. This might be due to leaching and or run off. Total nitrogen and phosphorus in the previously cultivated bare land were low and below the critical values required by cashew. This implies that nitrogen and phosphorus fertilizers will be applied.

4.4 Excavated Land

Total nitrogen, available phosphorus and exchangeable potassium were slightly below the critical nutrient values required by cashew in the excavated land. Exchangeable calcium and magnesium content of the soils were adequate and grossly above the critical values required. N, P and K fertilizer will be required for application on cashew to be planted on excavated land.

5. CONCLUSION

The various land use types, section (A, B and C) requires 180 kg ha^{-1} of urea and 31.5 kg ha^{-1} of Single Super phosphate (SSP) for optimum productivity. The cassava plot and previously cropped bare land requires 189 kg ha^{-1} urea and 9.9 kg ha^{-1} SSP, while the excavated land requires 194.2 kg ha^{-1} urea, 25.8 kg ha^{-1}, SSP and 32.28 kg^{-1}ha MOP. Cashew should not be grown on the water-logged section.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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