# ASSESSMENT OF FERTILITY STATUS OF SOILS USED FOR CASSAVA PRODUCTION IN OWERRI, AREA OF IMO STATE, NIGERIA

**Chinyere Chikere-Njoku**
*Department Of Soil Science and Environment,*
*Imo State University, P.M.B 2000 Owerri, Nigeria*
*e-mail: chikerenjoku@gmail.com*

## ABSTRACT

*The fertility status of soils used for cassava production in Owerri area of Imo State Nigeria was assessed. Composite samples were collected from ten different sites at 0-15 cm and 15 -30 cm depth. Soil samples were prepared and analyzed in the laboratory using standard methods. Data generated were statistically analyzed using the co-efficient of variation and standard deviation. Results showed that the soils varied from sandy loam to sandy clay loam and strongly acidic (mean pH. 5.68). Apart from base saturation which is high. 77.93 g/kg (0-15cm) 79.18 g/kg (15-30 cm) other parameters were low in organic matter (OM) 1.05% (0-15 cm), 1.21% (15.30 cm), total nitrogen (N) 0.09 % (0.15 cm), 0.11 % (15-30 cm), exchangeable  potassium (k), 0.19 cmoI/kg (0-15cm), 0-23 cmol/kg (15-30 cm), available phosphorus (p) 12.95 mg/kg (0-15 cm), 17.46 mg/kg (15-30 cm) Calcium (ca) 2.49 cmol/kg (0-15cm), 3.31 cmol.kg (15-30 cm), Magnesium  (mg) 1.39 cmol/kg (0-15 cm), 2.10 cmol/kg), Sodium (Na) 0.13 cmol/kg (0-15 cm), 0.16 cmol/kg (15-30 cm). The result indicates that the fertility status of the study area is low and requires intensive fertility restoration programme for soil health improvement. To boast high crop yields, and productivity of cassava in the study area, a combination of organic and inorganic fertilizers are recommended.*
**Keywords**: soils, fertility status, soil productivity, cassava yields, Owerri.

## INTRODUCTION

Soil fertility is the inherent ability of soil to supply nutrients for plant growth and development in adequate and required proportion without any detrimental or toxic effect (Esu, 2010). Igbokwe (1982) had identified soil properties such as pH, cation exchange capacity (CEC) and percentage base saturation (BS) as important indices in the determination of the degree of soil fertility.

Cassava (*Manihotesculentus*) is an important staple crop globally for generating income and food security (Abua*et al*., 2010). About 160 million people, or 40% of the Nigerian population,

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consume cassava as a staple food (Nweke, 2002). Cassava plays a crucial role as energy food, available all year round year round availability, tolerant to stress and suitability for most present farming systems, (Nweke, 2002). In recent time, there have been decrease in the yield of  cassava which can be  traced  to the poor  nutrient  status of  soil, lack of scientific research information for  effective  soil  management,  excessive  rainfall  and  leaching,  nutrient  depletion,  rapid mineralization of soil organic matter and excessive cultivation of  land due  to increase in human population (IITA, 1995).

According  to  Howeler(2002),  cassava  has  a  higher  tolerance  for  much  lower  critical  level of available phosphorus than less mycorrhizal dependent crops like maize and beans and is able to grow relatively well on soils with a weak capacity to supply phosphorus. It is also well adapted to acidic soils due to its tolerance to low pH and exchangeable aluminum. It can tolerate more water stress and high water use efficiency than many other crops, (El-Sharkawy, 2004).

However, studies on fertility status of soils used for cassava production in Owerri, Imo State is relatively  scarce.  Thus,  this  study  was  conducted  to  assess  the  fertility  status  of  soils predominantly used for cassava production in Owerri and to generate suitable recommendation for improved soil and cassava production capacity of the soils.

## MATERIALS AND METHODS
### Study Area

 The study was conducted in Owerri, Imo State lying between latitudes $5^o20$'N and $6^o55$'N and longitudes $6^o35$'E and $7^o08$'E. The area is underlaid by coastal plain sands, and is generally low-lying and dominated by low lands. The climate is humid tropical with rainy season of about 9 months with 3 dry months, in a year. Mean annual rainfall is about 2,500 mm, temperature is $27^oC$ and  relative  humidity  of  about  85%.  It  has  typical  rainforest  vegetation  with  plants arranged  in  tiers  with  oil  palms  (*Elaeisguineensis*)  as  one  of  the  dominant  plant  species. Agriculture is the major occupation of the people in the area.

**Sampling Sites**: Ten locations were chosen for the study. They include Amakohia, Akwakuma, Egbu, Orji, Uratta, Emii, Emekuku, Naze, Nekede and Oforola. At each study site an area measuring 10m x 10m was mapped out. Soil samples were collected randomly from soil depths of, 0-15cm and 15-30 cm respectively. A total of twenty (20) samples were used for the study. The soil samples were air dried and sieved with 2 mm sieve.

### Laboratory Analysis

Particle size distribution was determined by hydrometer method (Gee and Or., 2002). Bulk density was determined by oven-drying the samples to constant weight at $105^oC$ and bulk density computed as described by Klute (1996). The soil pH was determined in both distilled water and 0.1N KCL solution (Mclean, 1982). The soil organic carbon was determined by digestion

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method (Nelson and Sommers, 1982). While, the soil organic matter content was obtained by multiplying organic carbon values by 1.724. Total nitrogen was determined in accordance with Bremner and Mulvaney, (1982). The extractable phosphorus was determined by Bray II method as described by Nelson and Sommers (1982). The exchangeable cations were obtained by the method described by Thomas (1982). Potassium, and sodium ions were determined using the flame photometer method while magnesium, and calcium ions were determined using the atomic absorption spectrophotometer (AAS).

**Statistical Analysis**

Data collected were analyzed using simple descriptive statistics such as arithmetic means, Standard Deviation (SD) and Coefficient of Variation (CV).

**Results and Discussion**

Result of soil physical properties at 0-15cm and 15-30 cm depths are shown in Table 1. Particle size distribution was dominated by the sand fractions in all the study areas. Texture of the surface soils was generally sandy loam, while that of subsurface was sandy clay loam. High proportion of sand may be attributed to property inherited from the parent material.  Sand content of the soils in south-eastern region of the country is characteristic of sand formed on unconsolidated coastal plain (FDALR. 1987) Akamigbo and Asadu (1986) observed that textures of soils in southeastern Nigeria are related to their parent materials. Silt fraction ranged from 5.00 -8.00% with a mean of 7.30% in surface soil and 4.00-8.00 % with a mean of 6.20% in subsurface. Clay fractions at surface soil ranged from 12.40% -20-40% with a mean of 25.39%. Highest clay fraction of 30.40% was observed in the subsoil and lowest clay contents of 12.40% in surface soil. This finding agreed with the report of Ukaegbu and Akamigbo (2005) that clay contents in the subsoil are higher than in the topsoil. Bulk density varied little across the two depths and ranged from 1.59-2.01 g/cm$^3$ with a mean of 1.80 g/cm$^3$ in the surface soil, subsurface ranged from 1.87-2.44 g/cm$^3$ with a mean of 2.04 g/cm$^3$. These results may be due to the slaking siltation and compaction of soil. Ahukaemere*et al*., (2012) observed consistently higher bulk density in continuously cultivated land.

The chemical properties of the soil showed little variation at both depths with co-efficient of variation of 0.03-55.55% (Table 2). The pH ranged from 4.86-5.56 with a mean of 5.29 at 0-15 cm depth while at 15-30 cm depths pH ranged  from 5.17 -5.44 with a mean of 5.29. The pH of soils evaluated were qualified as strongly to moderately acidic. The observed pH in the study area might be associated with removal of bases through crop harvest and leaching of basic cations (Abua*et al*., 2010). The content of organic carbon had mean value of 1.2 % in the surface, and 1.05 % in the subsurface soil and were rated low. Chude*et al*., (2011). This can be attributed to the generally low nutrient content of the parent materials ( Coastal Plain Sands) and to the strongly acidic chemical condition of the soils as well as to high rainfall and temperature

of the area, (FDALR, 1987). Total nitrogen content of the soils ranged from 0.08% to 0.16% at the surface with mean value of 0.11% and 0.05% to 0.14% at subsurface with a mean 0.09%. This observation is consistent with the findings of Ukaegbu and Akamigbo (2005) who reported average total N percentage of 0.08 in soils of the cross river coastal plain sands. Onyekwere*et al*. (2003) pointed out that low total nitrogen level of soils must be a reflection of the organic carbon content in the soil as observed in the present study. However, the total nitrogen of all sites are generally low compared to the rating of soils of southeastern Nigeria. Available phosphorus content in both surface and subsurface soils, respectively of (10.02- 23.10 mg/kg) is considered high. The high level of P in this study was surprising and may be related to high use of phosphatic fertilizers as revealed by the rural farmers at the time of my interaction with them. The proportions of exchangeable bases (Ca, Mg, Na and K) were low across the test soils. Low levels of Ca, Mg and K have been reported for most Nigerian soils (Uzoho*et al*., 2007) and are attributed to losses from leaching due to the high tropical rainfall as well as low content of the elements in the parent rock. However, critical values of exchangeable cations have been reported by various researchers. For instance, Adeoye and Agboola (1984) reported critical values of 2.0, 0.4 and 0.20 cmol/kg for Ca, Mg and K respectively. However, on comparative, basis the high level of exchangeable Ca, and Mg over K and Na agreed with the findings of Pitty (2014), who stated that Ca and Mg are predominant cations in soils as a result of their strong adsorption and rapid release into the soil system through soil mineral weathering. The Ca: Mg ratio, K:Mg ratio in the surface and subsurface soil is low, ranged from 1:1-2:1, K:Mg 1:2-1:10 respectively. University of Missouri  (1991) reported that the  Ca:Ma, K:Mg ratio of most fertile soils ranges from 5:1 to 8:1 but in low fertile soils, the ratio could be as low as 2:1.

The cation exchange capacity in the surface soil ranged from 3.50-9.36 cmol/kg with a mean value of 6.36 cmol/kg, in the subsurface the range is 4.45 to 5.94 cmol/kg with a mean of $5.0 \pm$ 0.49 cmol/kg and standard deviation of 0.49. However, the cation exchange capacity values obtained in this study were below the value of 20 cmol/kg reported as being suitable for crop production (FAO, 1995). The base saturation level of the surface soils ranged from 65.0-89.35g/kg with a mean value of 79.18 g/kg and standard $79.18 \pm 7.66$ g/kg deviation of 7.66 while in the sub-surface soils base saturation ranged from 72.6-82.7 g/kg with mean value of 77.93 g/kg and standard deviation of $77.93 \pm 3.4$g/kg. Thus, the base saturation was high implying saturation of the soil exchange complex with bases. In the contrary, the low cation values recorded in these soils might be as a result of rapid crop uptake of the cations or possible losses through leaching due to excessive rainfall characteristics of the area.

## CONCLUSION AND RECOMMENDATIONS

Soils of the study area are mainly loamy sand at the surface, sandy clay loam at subsurface and strongly to moderately acidic in all the pedons. All the fertility indices which include organic matter content, total nitrogen, effective cation exchange capacity and basic cations except base

saturation were found to be entirely low compared with known fertility standards. For the fertility status of the soils to be improved, for better productivity, appropriate inorganic fertilizers and manures should be properly applied, liming and mulching should also be recommended.

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## Table 1: Soil Physical Properties of the Study Area

| Sampling Site | Sand (gkg$^{-1}$) | Silt (gkg$^{-1}$) | Clay (gkg$^{-1}$) | Textural Class | Bulk Density (g/cm$^3$) |
|---|---|---|---|---|---|
| | | **(0-15cm) depth** | | | |
| Amakohia | 716.0 | 100.0 | 184.0 | SL | 1.75 |
| Akwakuma | 796.0 | 80.0 | 124.0 | SL | 1.68 |
| Egbu | 776.0 | 60.0 | 164.0 | SL | 1.82 |
| Orji | 736.0 | 60.0 | 204.0 | SL | 2.01 |
| Uratta | 716.0 | 100.0 | 184.0 | SL | 1.66 |
| Emii | 736.0 | 60.0 | 204.0 | SL | 1.95 |
| Emekuku | 776.0 | 80.0 | 144.0 | SL | 2.00 |
| Naze | 746.0 | 50.0 | 204.0 | SL | 1.77 |
| Nekede | 766.0 | 60.0 | 174.0 | SL | 1.86 |
| Oforola | 786.0 | 80.0 | 134.0 | SL | 1.59 |
| **Mean** | **75.50** | **7.30** | **17.20** | | **1.80** |
| **STD** | **2.90** | **1.77** | **3.00** | | **0.15** |
| **CV(%)** | **3.82** | **4.21** | **17.29** | | **8.01** |
| | | **(15-30cm) depth** | | | |
| Amakohia | 656.0 | 80.0 | 264.0 | SCL | 1.72 |
| Akwakuma | 696.0 | 80.0 | 224.0 | SCL | 1.98 |
| Egbu | 677.0 | 40.0 | 283.0 | SCL | 1.98 |
| Orji | 636.0 | 60.0 | 304.0 | SCL | 2.34 |
| Uratta | 696.0 | 40.0 | 264.0 | SCL | 1.87 |
| Emii | 716.0 | 60.0 | 224.0 | SCL | 2.03 |
| Emekuku | 676.0 | 80.0 | 244.0 | SCL | 2.44 |
| Naze | 696.0 | 40.0 | 264.0 | SCL | 1.89 |
| Nekede | 686.0 | 60.0 | 254.0 | SCL | 2.15 |
| Oforola | 686.0 | 80.0 | 234.0 | SCL | 1.92 |
| **Mean** | **68.21** | **6.20** | **25.39** | | **2.04** |
| **STD** | **2.27** | **1.75** | **2.74** | | **0.19** |
| **CV(%)** | **3.33** | **28.25** | **10.78** | | **9.31** |

SL= Sandy Loam, STD= Standard Deviation, SCL= Sandy Clay Loam, CV= Coefficient of Variation

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## Table 2: Soil Chemical Properties of the Study Area

| Site | pH (H₂0) | OC (g/kg) | TN (g/kg) | P (cmol/kg) Mg/mg | K (cmol/kg) | Ca (cmol/kg) | Mg (cmol/kg) | Na (cmol/kg) | CEC (cmol/kg) | TEA (cmol/kg) | BS (%) | Ca:Mg | K:Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(0-15cm)- depth** | | | | | | | | | | | | | |
| Amakohia | 5.83 | 1.27 | 0.08 | 20.10 | 0.27 | 2.18 | 1.60 | 0.10 | 5.25 | 1.10 | 97.0 | 2:1 | 1:5 |
| Akwakuma | 5.46 | 1.15 | 0.10 | 21.06 | 0.31 | 4.45 | 2.60 | 0.22 | 8.48 | 0.90 | 89.3 | 2:1 | 1:10 |
| Egbu | 5.63 | 0.79 | 0.14 | 15.07 | 0.19 | 3.50 | 2.60 | 0.12 | 7.91 | 1.50 | 81.0 | 1:1 | 1:10 |
| Orji | 5.92 | 1.25 | 0.10 | 11.49 | 0.26 | 3.20 | 1.60 | 0.15 | 6.41 | 1.40 | 81.2 | 2:1 | 1:10 |
| Uratta | 5.74 | 1.02 | 0.15 | 22.04 | 0.27 | 5.10 | 2.60 | 0.24 | 9.36 | 1.10 | 88.2 | 2:1 | 1:10 |
| Emie | 6.21 | 1.50 | 0.13 | 10.50 | 0.21 | 2.60 | 1.60 | 0.13 | 5.94 | 1.40 | 76.4 | 2:1 | 1:10 |
| Emekuku | 5.42 | 1.10 | 0.06 | 13.10 | 0.15 | 2.30 | 1.60 | 0.16 | 4.30 | 1.70 | 65.0 | 2:1 | 1:10 |
| Nazie | 5.20 | 1.15 | 0.12 | 23.10 | 0.25 | 1.50 | 2.60 | 0.12 | 5.31 | 0.90 | 75.10 | 2:1 | 1:10 |
| Nekede | 5.62 | 1.62 | 0.05 | 17.06 | 0.15 | 3.10 | 1.60 | 0.14 | 7.10 | 1.62 | 85.2 | 2:1 | 1:10 |
| Oforola | 5.75 | 1.30 | 0.16 | 21.10 | 0.24 | 5.15 | 2.60 | 0.21 | 3.50 | 0.50 | 70.5 | 2:1 | 1:10 |
| **Mean** | **5.68** | **1.21** | **0.11** | **17.46** | **0.23** | **3.31** | **2.10** | **0.16** | **6.36** | **1.21** | **79.18** | | |
| **STD** | **2.83** | **2.35** | **3.75** | **4.65** | **0.054** | **1.25** | **0.53** | **0.048** | **1.87** | **4.65** | **7.66** | | |
| **CV(%)** | **5.00** | **1.94** | **0.03** | **26.63** | **23.48** | **37.78** | **25.14** | **30.00** | **29.40** | **26.65** | **0.09** | | |
| **(15-30cm)- depth** | | | | | | | | | | | | | |
| Amakohia | 5.50 | 1.20 | 0.09 | 17.03 | 0.18 | 2.40 | 1.20 | 0.16 | 4.84 | 0.90 | 81.4 | 2:1 | 1:5 |
| Akwakuma | 5.89 | 1.10 | 0.08 | 16.15 | 0.16 | 2.20 | 1.40 | 0.13 | 4.63 | 0.80 | 82.7 | 2:1 | 1:10 |
| Egbu | 5.18 | 0.75 | 0.11 | 14.06 | 0.23 | 2.80 | 1.20 | 0.14 | 5.67 | 1.30 | 77.0 | 2:1 | 1:10 |
| Orji | 5.64 | 1.11 | 0.09 | 7.24 | 0.24 | 2.00 | 1.20 | 0.11 | 4.45 | 0.90 | 79.7 | 2:1 | 1:5 |
| Uratta | 5.23 | 0.93 | 0.14 | 17.01 | 0.17 | 2.40 | 1.40 | 0.14 | 5.10 | 1.10 | 78.4 | 2:1 | 1:5 |
| Emie | 5.77 | 1.20 | 0.14 | 7.90 | 0.21 | 2.60 | 1.60 | 0.13 | 5.94 | 1.40 | 76.3 | 2:1 | 1:10 |
| Emekuku | 5.42 | 1.15 | 0.06 | 13.05 | 0.15 | 3.00 | 1.30 | 0.12 | 4.62 | 0.60 | 80.2 | 2:1 | 1:10 |
| Nazie | 5.61 | 0.65 | 0.10 | 10.02 | 0.26 | 2.50 | 1.50 | 0.16 | 5.35 | 1.60 | 76.5 | 2:1 | 1:10 |
| Nekede | 5.56 | 1.30 | 0.05 | 12.03 | 0.10 | 2.30 | 1.40 | 0.15 | 4.81 | 1.60 | 74.5 | 2:1 | 1:10 |
| Oforola | 5.15 | 1.18 | 0.07 | 15.02 | 0.20 | 2.70 | 1.60 | 0.10 | 4.75 | 1.31 | 72.6 | 2:1 | 1:10 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 5.58 | 1.05 | 0.09 | 12.95 | 0.19 | 2.49 | 1.38 | 0.13 | 5.01 | 1.05 | 77.93 |
| **STD** | 1.48 | 0.21 | 0.030 | 3.59 | 0.47 | 0.29 | 0.15 | 0.02 | 0.89 | 0.34 | 3.14 |
| **CV(%)** | 25.52 | 20.00 | 33.33 | 27.72 | 24.74 | 11.65 | 10.87 | 15.0 | 9.78 | 32.88 | 4.02 |

OC= organic carbon, TN= total nitrogen, AVP: available phosphorus, Exch. K = exchangeable potassium, Exch Ca= exchangeable calcium, Exch. Mg= exchangeable magnesium. Exch. Na= Exchangeable Sodium, CEC = cation exchange Bsat= base saturation, Ca:Mg Calcium: Magnesium Ratio, K:Mg- Potassium: Magnesium Ratio.