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Assessment of The Variation of Soil Fertility and Ph across Some Communities in Nsukka, Enugu State, Nigeria

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Abstract: The aim of this research work was to study the variation of soil pH and fertility level in some communities or towns in the Nsukka area of Enugu State. The research was conducted using an experimental research method. The reading of the soil fertility and the pH values of twenty towns in Nsukka selected randomly was taken using a 2-in-1 soil pH and fertility tester. The results show the pH and the corresponding values of the fertility level of the locations such as Opi, AguAmube, Oloto I, Oloto II, etc. The result also discussed some of the crops that will be suitable in the experiment areas based on the pH values, such as yam, maize, cassava, pepper, etc. Based on the results, it was concluded that there is a variation in the pH and soil fertility levels across various towns in Nsukka. It was also concluded that if manure is to be added to the land to increase the crop yield, the quantity of manure to be applied at AguAmube will be more than the quantity to be applied to other areas in the study locations as indicated in the bar chart where its fertility level is the least among the twenty experiment locations. It was recommended that similar work be done in other areas where farming is the major occupation to enable people to know the type of crop to plant in some areas as well as knowing the place to apply manures or not.This result will provide crucial data to guide farmers on optimal crop selection, fertilizer application, and soil management practices, ultimately supporting sustainable agriculture, improving crop yields, and informing policy decisions for the region's agricultural development.

Keywords*: Crop, manure, fertility level, pH level, variation.*

I. INTRODUCTION

Soil fertility is the process in which soil can support plant growth and supply the necessary nutrients needed for the optimal performance or production of the crop. It also refers to the ability of the soil to sustain agricultural plant growth. Soil pH is the measure of the degree of the acidity or alkalinity of the soil. It ranges from 0 to 14, with 0 – 6 being acidic, 7 being neutral, and 8 – 14 being basic or alkaline. According to the Food and Agriculture Organization (FAO) (2021), soil pH (which is an expedite measure of soil reaction) is a measure of the acidity or alkalinity in the soil. Mathematically, pH is the negative $\log_{10}$ of the activity of hydrogen ions (H^+). Soil pH is important due to its influence on several soil factors that affect plant growth, such as the availability and dynamics of plant nutrients and toxicants as well as some biological processes and soil structure. It is also an important parameter for amelioration of problematic soils.

Soil fertility depletion and increased acidity are often driven by land management practices, particularly the conversion of land from its natural state. The variation in soil acidity and fertility depletion across different land use types highlights how land use changes can aggravate soil degradation, especially at the soil surface. Several studies have shown that converted lands such as those used for cultivation, eucalyptus plantations, and grazing tend to have lower soil pH, reduced base saturation, higher exchangeable acidity, and altered micronutrient levels compared to undisturbed, natural ecosystems like forests (Kebebew et al., 2022 and Regasa et al., 2024).

Soil testing is essential in order to determine the soil's nutrient content and determine deficiencies that need to be remedied so that growth and yield may be maximized (Rashid and Rafique, 1998). Applying fertilizer without fertilizer recommendations may have harmful effects, as the nutrients present in the soil may exceed the nutrients required (Lani et al., 2014). As stated by Rathore et al. (2025), soil quality and spatial variability of soil properties are essential considerations for sustainable nutrient management, particularly at the farm level. Soil, which is composed of mineral matter, organic matter, water, and air, exhibits complex physical and chemical properties that directly influence its fertility. It plays a crucial role in agricultural productivity by providing nutrients and a medium for plant growth.

A. Statement of the problem

Farming is a major source of livelihood in some rural and semi-urban communities in Nigeria, and its success depends greatly on the quality of the soil, especially soil pH and fertility. In the Nsukka area of Enugu State, farmers often experience uneven and sometimes low crop yields, even though the climate and farming practices are similar across communities. This challenge is largely linked to the absence of local, reliable information on soil pH and fertility differences among farmlands. As a result, many farmers apply manure or fertilizers based on experience rather than soil testing, which can lead to poor yields and gradual soil degradation. Although soil testing is important for sustainable farming, it is not commonly practiced in the area. This makes it difficult for farmers to choose suitable crops and apply the right amount of manure. Therefore, assessing soil pH and fertility across Nsukka communities is necessary to provide practical information that can help improve farming decisions and crop productivity.

B. Aim of the study

The aim of this study is to assess the variation in soil pH and soil fertility levels across selected communities in Nsukka area of Enugu State, Nigeria, in order to provide information that will support appropriate crop selection and effective soil management practices.

C. Objective

i. Determine the soil pH levels of farmlands in selected communities within Nsukka area of Enugu State.
ii. Evaluate the variation in soil fertility levels across the selected communities and identify locations with relatively high or low soil fertility.

D. Research gap

Several works have examined soil pH and fertility characteristics in some parts of Nigeria and other agricultural regions; however, there is a noticeable unavailability of documented, location-specific studies focusing on Nsukka area of Enugu State. Existing research has largely concentrated on broader regional scales or on other ecological zones, leaving a gap in localized soil data for Nsukka communities. In addition, many previous studies rely on laboratory-based soil analysis, which may not be readily accessible or affordable for local farmers. There is limited research demonstrating the use of simple, field-based soil pH and fertility testing devices to assess spatial variation across multiple farmlands within the same locality. In addition, few studies directly relate measured soil pH and fertility values to practical crop suitability and manure application needs at the community level. This study therefore fills an important gap by providing empirical, field-based data on soil pH and fertility variation across selected communities in Nsukka, while linking the results to crop suitability and soil management decisions relevant to local farmers

E. Definition of some related terms

Soil pH: Soil pH is defined as the measure of the acidity or alkalinity of the soil, expressed on a scale from 0 to 14. It influences nutrient availability, microbial activity, and overall plant growth, with most crops performing best within a specific pH range.

Soil Fertility: Soil fertility is defined as the ability of soil to supply essential nutrients in adequate amounts and proper balance to support healthy plant growth and high crop yield.

Nutrient Availability: Nutrient availability is defined as the extent to which essential plant nutrients in the soil can be absorbed by plant roots. It is strongly affected by soil pH, moisture content, and soil organic matter.

Manure (or Fertilizer) Application: Manure application is defined as the practice of adding organic or inorganic materials to the soil to improve its nutrient content and enhance crop productivity. Proper application depends on existing soil fertility levels.

Soil Variability: Soil variability is defined as the differences in soil properties, such as pH and fertility, across different locations or within the same farmland. These variations affect crop performance and require location-specific soil management practices.

II. RESEARCH METHODOLOGY

The materials used for research work are a GPS receiver, a soil pH and fertility tester, and Excel software for the analysis. The data used for the work is primary data of soil pH and fertility measured from the field. The research applied an experimental research method. The reading or experiment was conducted in June, 2024, which was in the rainy season in the study area. The soil pH and fertility tester used has three probes or terminals, which can be inserted into about 2.5 cm in the soil for the reading to be taken after some minutes when the scale stops deflecting. The three readings—soil pH, soil fertility level, and the coordinate or location—were taken at the same time, and this was done in both of the two locations on the same day to avoid variation in the soil water content, which may affect the soil pH in a way. The results were tabulated and then represented in bar chart form in an Excel worksheet. Other analyses, like the determination of the maximum and minimum, were done using an Excel worksheet.

Plate 1: Photo of Soil pH and fertility meter/tester

Plate 2: Photo of the researcher during the experiment in one study location

Plate 3: Photo of the researcher during the experiment in a farm in AguAmoha community, Nsukka.

III. RESULTS AND DISCUSSION

Table 1 shows the locations of experiments in various towns in the Nsukka area of Enugu State and the measured parameters. The experiment, which comprises the measurement of the soil fertility and soil pH levels, was carried out on some farms in these areas around June 2024, which was the rainy season in the study area. The results show that in all the areas of the experiment, the minimum recorded pH was 5.9 units, while the maximum pH value was 7 units. This implies that the pH, or degree of acidity and basicity, of the area is mostly acidic, given that in the range of the pH scale from 0 to 14, the pH of 0 to 6 is acidic, the pH of 7 is neutral, and the pH of 8 to 14 is basic or alkaline. Given that the pH values in all these locations are in the range of 5.5 to 7, it means that the soil is suitable for the common crops planted in Nigeria, especially in this geographical zone of Nigeria, like maize, yam, cassava, pepper, soya beans, cowpea, … This is because, according to Ibeawuchi (2007), the pH of around 5.5 – 7.0 is suitable for maize planting; the pH of 5.5 – 6.5 is suitable for yam farming; the pH value of around 6.0 – 7.0 is suitable for pepper farming; the pH of around 4.5 – 7.0 is suitable for cassava farming; and the pH values of around 6.0 – 7.0 are suitable for cowpea and soybean farming. From the table, it can be observed that almost all the areas are suitable for yam, cassava, maize, and others except cowpea and soya beans, which, according to the suitability pH value of 6 – 7, will not be too suitable around Edem, which has the pH of 5.9 units, which is approximately 6 units.

Also, the minimum soil fertility value recorded in the entire area was 5.6 units, while the maximum soil fertility level recorded was 7.6 units. This shows that there is variation in the soil fertility in the study area. Though, this is not a surprise, as the fertility of the land will depend on several factors, especially how many times the same piece of land has been cultivated or used for farming without fallowing to enable the land to recover some nutrients. With regard to maximum and minimum values of the pH and fertility levels of the experiment areas, it shows that the range of pH in the entire area is 1.1 units while the range of soil fertility in all the areas is 2 units. This shows that the variation of soil fertility in the study area is higher than the variation of the pH value.

Table 1: The locations of experiments in various towns in Nsukka area of Enugu state and the measured parameters.

S/N	Name of location	Soil fertility	Soil pH
1	AguAmube, Eziane Nsukka	5.6	6.8
2	Aglican road, Nsukka	6.8	6.9
3	Ikenga junction	6.0	7.0
4	Ugbowi	6.0	6.9
6	Oloto 1	6.9	6
7	Oloto II	7.6	6.8
8	Oba Achara	7.6	7.0
9	Opi	6.2	6.9
10	Idobala	6.0	6.8
11	Ikpa market	6.0	6.8
12	Orba junction	6.2	6.9
13	Izewani	6.7	6.8
14	Nguru	6.6	6.9
15	Alor-uno	6.0	6.8
16	University of Nigeria Nsukka farm	5.9	6.0
17	Obimo	6.0	6.9
18	Barracks junction	6.2	6.8
19	Ebiri-miri	6.1	6.8
20	Edem	6.3	5.9

Fig. 1 shows a bar chart illustrating the soil pH and soil fertility levels of different farmlands across the Nsukka area of Enugu State. From the figure, it is clear that soil conditions are not the same across the twenty (20) study locations. Both soil pH and fertility levels vary from one farmland to another, even though the areas are within the same geographical region. These differences suggest that local soil conditions play an important role in determining how well crops grow in each location. The figure also shows that farmlands in Oloto II and Oba Achara have noticeably higher soil fertility levels compared to the other locations. This means that crops planted in these areas are likely to grow better and produce higher yields, provided other factors such as rainfall and farming practices remain similar. Farmers in these locations may therefore experience better harvests than those farming in areas with lower soil fertility.

On the other hand, the farmland at AguAmube stands out as having the lowest soil fertility level among all the study locations, as shown by the shortest fertility bar in the chart. Crops grown in this area are likely to struggle due to limited nutrient availability, which may result in poor growth and reduced yields. This indicates that AguAmube requires more attention in terms of soil improvement to support productive farming. Furthermore, the figure suggests that although fertilizer or manure application can help improve crop yield in all the locations, the amount required will not be the same everywhere. Areas with higher fertility, such as Oloto II and Oba Achara, would need smaller amounts of manure, while AguAmube would require a larger quantity to make up for its low fertility level. Overall, the results emphasize the importance of understanding local soil conditions and applying soil management practices that are suited to each specific farmland rather than using a uniform approach across all locations.

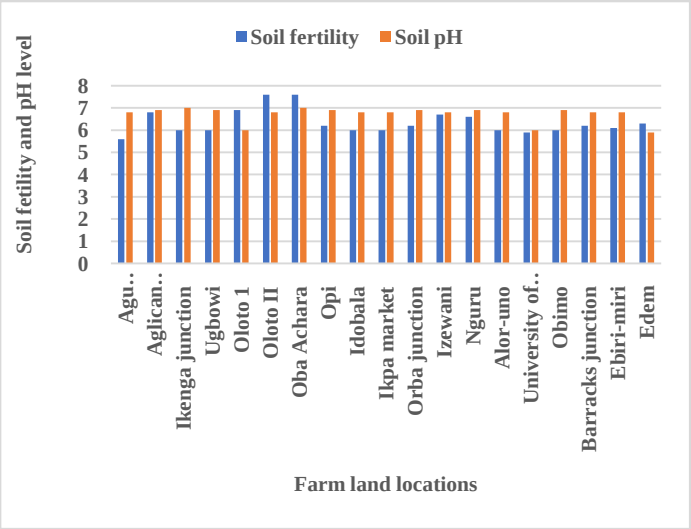

Fig. 1: The bar chart representation of the pH and soil fertility of various experiement locations or farmlands in Nsukka area of Enugu state

CONCLUSION

This research was done using an experimental research method. The reading of the soil fertility and the pH values of twenty towns in Nsukka selected randomly was taken using a 2-in-1 soil pH and fertility tester. The results show the various values of the pH and the corresponding values of the fertility level. The result also discussed some of the crops that will be suitable in the experiment areas based on the pH values, such as yam, maize, cassava, pepper, etc. From the results, it can be concluded that there is a variation in the pH and soil fertility levels across various towns in Nsukka. It can also be concluded that though the soil fertility of almost all the locations is good for farming, if manure is to be added to increase the crop yield, the quantity of manure to be applied at AguAmube will be more than the quantity to be applied to other areas in the study locations, as indicated in the bar chart where its fertility level is the least among the twenty experiment locations. The result of this work will provide crucial data to guide farmers on optimal crop selection, fertilizer application, and soil management practices, ultimately supporting sustainable agriculture, improving crop yields, and informing policy decisions for the region's agricultural development.

RECOMMENDATIONS

Similar work is recommended in other areas where farming is the major occupation to enable people to know the type of crop to plant in some areas as well as knowing the place to apply manures or not.

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