Assessment of Soil and Crop Qualities under Different Management Systems around Lokoja Metropolis, Central Nigeria

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Authors’ contributions

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

Article Information

DOI: 10.9734/AJOPACS/2020/v8i130105

Editor(s):
(1) Dr. Thomas F. George, University of Missouri-St. Louis, One University Boulevard St. Louis, USA.

Reviewers:
(1) Adeniyi Sulaiman Gbadegesin, University of Ibadan, Nigeria.
(2) Ahmed Karmaoui, Morocco.

Complete Peer review History: http://www.sdiarticle4.com/review-history/55054

Received 22 December 2019
Accepted 29 February 2020
Published 03 March 2020

ABSTRACT

Soil quality is an essential factor in Agricultural sustainability and its combination with water and human factors substantially determine the quality of the output (crop) within a particular ecosystem. The goal was attained through: identification of the extant management systems; determination of some key properties in the soil, water and vegetable in the area; comparison of the heavy metals content of plants and soil to confirm whether the concentration of metals in soil is in available form for plant uptake. A total of twenty farm plots were sampled randomly at both upland and lowland areas. Soil, plant and water samples were collected and tested for both micro and macro elements. The results of the analysis revealed that the soils possess moderately acidic pH (6.0) with permissive rate of EC (0.45 mmhos/cm), low N (0.08%), very high P content (27.1 mg/kg), very high values of OC (1.65%), cation exchange indicates low levels of Na (0.2 cmol/kg), medium Ca (6.0 cmol/kg), very high K (3.7 cmol/kg), high Mg (4.3 cmol/kg), medium ECEC (16.0 cmol/kg) using FAO 2006. The results of the water analysis show that Cd, Fe, Pb and Mn are within the recommended threshold while Cu, Ni, Zn are above the threshold. No significant difference in the following soil chemical properties: pH, EC, %OC, %TN, Na, K, Mg, Ca, TEB, Exchange acidity, ECEC, Cu and Ni. Conversely, Fe, Mn, Zn, Pb and Cd show significantly higher value between the

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lowland and upland areas. Upland areas show significantly higher values in few heavy metals. It was concluded that regular monitoring of the macro and micro elements is critical to sustainable productivity.

**Keywords:** Management; heavy metals; upland; lowland; sustainability.

### 1. INTRODUCTION

Soil quality is the ability of a soil to perform functions that are essential to people and the environment. Soil quality emphasizes several features, such as: Dynamic, management, properties such as nutrient status, salinity, and water-holding capacity. These properties are assessed in the context of the inherent capability of a particular soil.

The ability of soil to continue providing essential services in the face of disturbance, whether natural or human induced, is essential to maintain or improve soil quality over time. A soil is not considered “healthy” if it is managed for short term productivity at the expense of future degradation [1].

Soils are characterized by a high degree of variability due to the interplay of physical, chemical, biological and anthropogenic processes that operate with different intensities and at different scales [2,3]. Maintaining or improving soil quality can provide economic benefits in the form of increased productivity, more efficient use of nutrients and pesticides, improvements in water and air quality, and lessening of greenhouse gas emissions [4]. The dynamic soil nature describes the condition of a specific soil due to land use and management practices and it is measured by using various chemical, physical and biological indicators [5-8].

Human population pressures upon land resources have increased the need to assess impacts of land use change on soil quality (Islam, et al. 2000). How we manage the soil and what we put on it determine the level of treatment required to make our water supplies safe and enjoyable and our agricultural land good for consumption. Land-use can be referred to as the use into which a piece of land is put. It centres on the human activities that relate to a particular parcel of land. Land use varies from one place to another be it a country, state, city or local government area. Land use planning according to soil suitability is a well-known technology for long term sustainable land management. However change in time and space and the suitability use may also have to be reviewed [9].

Soil, under normal conditions of equilibrium, where the rate of loss equals that of soil formation, is regarded as a renewable resource. But, it can be rendered non-renewable by several human activities that characterize the present civilizations. The most common processes of soil degradation includes; depletion in soil fertility, deterioration of soil structure and texture leading to compaction and accelerated erosion, nutrient imbalance caused by salt accumulation or leaching, and build-up of organic or inorganic pollutants [10].

Soil properties, vary across a landscape and the variability is related primarily to differences in a particular soil forming factors, such as soil topography or parent material. The influences of these soil-forming factors in a landscape determine the sets of individual soils that tend to occur together in sequence across a landscape [11]. But the amount of available essential plant nutrients in the soil is one measure of soil fertility.

Plant nutrients are designated as macro- or micronutrients depending, on the relative amounts needed by plants. The macronutrients are required in much larger quantities than the micronutrients. It is essential to note that not all nutrients present in the soil are available to plants. Plant growth therefore depends on the rate at which a soil supplies essential elements in a form, which it can absorb, and not on the total quantities present in the soil [12]. Loss of nutrients from the soil may, be due to one or more of the following factors; leaching, erosion, crop removal, continuous cultivation and excessive irrigation and drainage.

Soil quality indicators may be used as an indirect measure of soil function, serving to assess soil quality or health and its direction of change with time, by linking functional relationships among measurable attributes and monitoring for sustainable land management, including environmental impacts [12,10]. For most natural environments such as soils, it is known that quantitatively soil properties within a site on the landscape are relatively similar. It is noted that spatial characterization of soil properties is necessary in order to locate homogenous areas to be carefully managed for agricultural
sustainable development [13-15]. Environmental degradation is largely caused by man’s activities. The result is that the ecosystems are altered and possibly damaged irreparably. Understanding about our local environment is important as poverty is closely linked to environmental degradation when the environment becomes degraded; all forms of life are threatened. We need to ensure that our activities do not damage the diversity and integrity of nature and that resources are used in a sustainable manner. (United Nations/International Strategy for Disaster Reduction) [16].

Inappropriate land use changes may affect physical, chemical, and biological properties of soil which may lead to land degradation and soil quality deterioration [17] (Awdenegest, et al. 2013). Assessing soil quality involves measuring soil physical, chemical, and biological properties and using these measured values to detect changes in soil as a result of land use change or management practices [18].

Maintenance of soil quality has been considered as a key component of agricultural sustainability and a goal of most farmers, environmental scientists and policymakers [19,20,21]. Studying land degradation through soil quality approach, may reveals soil functioning system within the ecosystem, which is necessary for sustainable management of land resources [22]. Knowledge and assessment of changes (positive or negative) in its status with time is needed to evaluate the impact of different management practices [23]. Selection of key indicators and their critical limits (threshold values), which must be maintained for normal functioning of the soil, are required to monitor changes and determine trends in improvement or deterioration in soil quality for various agro-ecological zones for use at district, national and global levels. Many soil indicators interact with each other, and thus, the value of one is affected by one or more of the selected parameters [24]. Farmers in Lokoja employ different management practices in the cause of producing their crops. This work is intended to reveal the impact of these different management practices on the sustainability of food production and the quality of the food produced in the area.

1.1 Aim and Objectives of the Study

The aim of this work is to generate data and information about how the quality of soils under different agricultural management systems for vegetable production has impacted on the sustainability and quality of plants in the area.

The objectives of the study are to:

► Identify the different agricultural management systems for vegetable grown in the study area.
► Determine some key soil properties (physical, chemical and biological).
► Determine and compare heavy metal contents in soil and crop samples in farm plots with rating schemes for foliar examination of micronutrients in crops.
► Determine the quality of the irrigation water source used and to compare the value with the WHO Standard.
► Identify, if any, some potential health and environmental implications of the observed conditions of the soil, plants and water samples in the study area.

2. MATERIALS AND METHODS

In order to build up a comprehensive picture of what might be happening in terms of soil quality and heavy metal accumulation in agricultural land use, the following strategy was employed: A total of twenty (20) farm plots were selected with ten (10) each from upland and lowland areas. Soil and Plant samples were collected and tested for micro and macro elements. The water for irrigating the farmlands were collected and tested for micro elements [25]. This approach provided basic data on soil quality and the heavy metal status of soils and crops in the area. Acknowledging, however that under field conditions, it is very difficult to distinguish the source of one or more heavy metals that may be present in excessive concentrations in a particular crop. In a field situation there may be more than one contaminating sources and not all can be easily taken into account [25].

**Soil sampling procedure:** Twenty (20) Soil samples were collected at a standard depth of 0-15cm, Ten (10) soil samples each from upland and lowland and tested for the following elements (Soil textural class, Electrical Conductivity, pH, Organic Carbon, Phosphorus, Total Nitrogen, Exchangeable Cations (Ca, Mg, K and Na), Total Exchangeable Bases, Exchangeable Acidity, Effective Cation Exchange Capacity, Fe, Pb, Cu, Cd, Zn Ni and Mn).
Plants sampling procedure: Plant tissue analysis were used to complement soil analysis in order to obtain detailed information on the health of the soil from which plants draw nutrients. Plant tissue analysis was required to explain nutrient disorder and survey of nutrient deficiency among others. Since nutrients concentration in plant tissue is a reflection of available nutrient in soils, plant tissue analysis is a better measure of soil-plant interaction than soil test alone. In addition, micro nutrient deficiencies are better diagnosed by plant analysis than soil tests. Therefore, soil test combined with plant tissue analysis provides a more effective evaluation of soil-plant nutrient environment. The sampling guide for field crops in the savanna as reported by Agbenin, [26] was used [25].

Water sampling procedure: Three (3) Water samples used for irrigation agriculture were collected. That is, at the points where the farmers use the water to irrigate their farms.

Laboratory analysis of soil samples: The soil samples from the various farm plots were collected, labeled and stored in polythene bag and were taken to the laboratory for analysis [25]. The soil sample collected from representative soil of the sample areas were air dried, crushed with the aid of wooden roller, sieved through 2 mm sieve and stored in plastic container with covers for subsequent physical and chemical analysis [27]. Particle size distribution was determined using hydrometer method [28]. Soil Textural class were determined using the USDA soil textural classification. Soil pH was measured in a soil-water ratio of 1:1 with the aid of glass electrode pH method (Maclean, 1982). Organic Carbon was determined by wet dichromate and oxidation method (Nelson and Sommer, 1982). Exchangeable bases (Ca, Mg, and Na) were extracted with IN NH4 OAC buffered at pH 7 (Thomas, 1982). The Ca and Mg were determined using atomic absorption spectrophotometer [29]. K and Na were read on the flame photometer. Exchangeable acidity was extracted with IN KCL (Thomas, 1992). IN was determined by liberation with 0.05N NaOH using phenolphthalein as indicator. Nitrogen was determined by macro-kjedahl method (Bremmer and Mulvaney, 1982). Effective cation exchange capacity (ECEC) was calculated by the summation of exchangeable base (Ca, Mg, K, and Na) and exchangeable acidity (Carter, 1993).

Total Phosphorus was determined by per chloric acid (HClO4) digestion method (Murphy and Riley, 1962). Available P was estimated by Bray P – 1 (Bray and Kurtz, 1945). Extractable micronutrients (Mn, Fe, Zn and Cu) were determined by double anil method [29]. Dithionate extractable Fe and Al (free Fe and Al Oxide soils) were determined by methods of Muhra and Jackson (1960).

Conversions between values of organic carbon and organic matter was made using Van Bemmelen factor of 1.724 on the assumption that, on average, SOM contains 58% of Organic Carbon. Statistical analysis of data: General linear model procedure of SPSS 17.00 version was used to test the effects of different management systems on soil and crop qualities [29]. Significant means was separated using least significant difference. Pearson correlation procedure of the same software was used to determine the relationship between soil and crop qualities for each management system [25].

2.1 The Study Area

Lokoja is located between latitude 7°45'N and 7°52’N and longitude 6°41'E and 6°45'E. Lokoja lies at the confluence of western bank of river Niger at an altitude of 125 meters above means sea level. The north-western side of the city is situated at the foot of a ridge (Patti ridge) with an altitude of between 400-1500 meters above means sea level with area of about five hundred and seventy seven square kilometres. River Niger occupies substantial parts of low land areas while the other part is partly taken over by Patti ridge and other numerous smaller ridges. There are two distinct seasons in Lokoja; dry and wet seasons. The wet season starts in April and end in October while the dry season starts from November and ends in March. The highest average monthly temperature is 38°C which is usually recorded in March [25].

Lokoja is underlain by undifferentiated Precambrian igneous and metamorphic rocks basement complex (Buchanan, 1955). The soil has both sandy and clay deposit. The soil is characterised by low water holding capacity, this encourage infiltration; however, the clay soil beneath causes water log during rainy season which encourages runoff generation.

Lokoja was projected to have about 313,000 people in 2010. The socio-economic activities of the people include farming, fishing, hunting, trading, and banking. The crops grown by the farmers around the city are Yam, Cassava, Maize, Rice, Beans, Beni seed and vegetables.
Fig. 1. Map of the study area
3. RESULTS AND DISCUSSION

3.1 Soil Textural Class

The textural class of the soils in the study location is presented in Table 1. Using the USDA soil textural classification, the soils in the lowland areas are sandy loam while the upland areas are sandy clay loam.

The implication of the textural classification is that the soil of the study area is good for agricultural purposes. The soils are well drained and capable of supporting different types of crops.

3.2 Soil and Plant Chemical Properties

Soil: The results revealed soil pH of 6.0 indicating moderately acidic reaction for the soils (Table 2). Soil total N of 0.08% is low using soil fertility class of Enwezor, et al. [30] total N less than 0.15% is classified low. On the other hand, the soils possess very high values of organic carbon (1.65%). The observed soil P value of 27.1 mg/kg is high. According to Enwezor, et al. [30] P values above 20 mg/kg is considered as high P content when Bray 1-P method is used for determination of soil P as employed in this study. Similarly, FAO (1980) and Chaneton and Avado [31] showed that soil fertility class with P values above 25 mg/kg is very high. FAO (2006) ranges of exchangeable cation in soil is used in this study for the interpretation of cation exchange results. The results reveals low levels of Na (0.2 cmol/kg), medium Ca (6.0 cmol/kg), very high K (3.7 cmol/kg), high Mg (4.3 cmol/kg), medium ECEC (16.0 cmol/kg). Electrical conductivity of 0.45 mmhos/cm is within the permissive rate (< 0.75 mmhos/cm) of FAO standards (FAO, 1976).

Plant: The results of plant analysis which indicated values of 11.55% for total N and 52.5 mg/100 g are considered low. Also the values recorded for the basic cations, Na, K, Mg and Ca all fall within the threshold for safe human nutrition according to White and Brown (2010).

| Elements                  | Test values          |
|---------------------------|----------------------|
| pH                        | 6.0                  |
| EC (Ms/cm)                | 0.45                 |
| % Organic Carbon          | 1.65                 |
| % Total Nitrogen          | 0.08                 |
| P (Unit: Soil = mg/kg; Plant = mg/100 g) | 27.1 | 11.55 |
| ECEC (cmol/Kg)            | (mg/100 g)           |
| Na                        | 0.2                  |
| K                         | 3.7                  |
| Mg                        | 4.3                  |
| Ca                        | 6.0                  |
| Total exchangeable bases  | 14.29                |
| Exchangeable Acidity      | 1.44                 |
| Effective cation exchange capacity | 16.0 | - |

| Elements | Test values          |
|----------|----------------------|
| P. I. farm | Tube well | Stream |
| Fe       | 6.66 | 6.74 | 0.42 | 0.28 | 0.44 |
| Pb       | 2.58 | 0.13 | 0.24 | 0.16 | 0.28 |
| Cu       | 5.11 | 5.22 | 2.8  | 2.2  | 3.2  |
| Cd       | 0.41 | 0.01 | 0.01 | 0.01 | 0.01 |
| Zn       | 3.97 | 2.80 | 3.13 | 2.86 | 2.93 |
| Ni       | 0.43 | 0.19 | 1.86 | 0.48 | 1.24 |
| Mn       | 2.09 | 2.24 | 0.02 | 0.01 | 0.02 |
### Table 4. Comparison of soil chemical properties in study locations

|          | pH | EC (Ms/cm) | % OC | Na  | K   | Mg  | Ca  | TEB | Ex. Acidity | ECEC |
|----------|----|------------|------|-----|-----|-----|-----|-----|-------------|------|
| Lowland  | 5.9| 0.48       | 1.71 | 0.25| 4.40| 4.98| 6.56| 16.20|1.30         |17.50 |
| Upland   | 6.1| 0.41       | 1.60 | 0.23| 3.09| 3.67| 5.39| 12.38|1.57         |13.94 |
| LSD      | 0.29|0.15        |0.75  |0.09 |1.54 |1.45 |1.67 |4.491 |0.42         |4.09  |
| P Value  | 0.161<sup>NS</sup>|0.302<sup>NS</sup>|0.744<sup>NS</sup>|0.593<sup>NS</sup>|0.087<sup>NS</sup>|0.071<sup>NS</sup>|0.147<sup>NS</sup>|0.087<sup>NS</sup>|0.184<sup>NS</sup>|0.080<sup>NS</sup>|

|          | % TN | P | Fe | Mn | Ni | Zn | Pb | Cu | Cd |
|----------|------|---|----|----|----|----|----|----|----|
| Lowland  | 0.09 | 31.4| 6.40| 1.97| 0.43| 3.76| 2.33| 4.98| 0.38|
| Upland   | 0.08 | 22.9| 6.93| 2.21| 0.44| 4.17| 2.84| 5.24| 0.45|
| LSD      | 0.04 | 6.67| 0.25| 0.19| 0.07| 0.39| 0.15| 0.37| 0.05|
| P Value  | 0.732<sup>NS</sup>|0.018<sup>*</sup>|<0.001<sup>**</sup>|0.021<sup>**</sup>|0.536<sup>NS</sup>|0.041<sup>**</sup>|<0.001<sup>**</sup>|0.140<sup>NS</sup>|0.014<sup>NS</sup>|

Note: NS = Not significant, * = Significant at 5%, ** = Significant at less than 1%, OC = Organic Carbon, TN = Total Nitrogen, TEB = Total exchangeable bases, Ex. Acidity = Exchangeable Acidity, ECEC = Effective cation exchange capacity

### Table 5. Comparison of plant elemental content in study locations

|          | Ca  | Cd  | Cu  | Fe  | K  | Mg  | Mn  |
|----------|-----|-----|-----|-----|----|-----|-----|
|          | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) |
| Lowland  | 1861 | 0.0121 | 5.093 | 6.490 | 1485 | 482 | 2.100 |
| Upland   | 1722 | 0.0158 | 5.348 | 6.986 | 1379 | 438 | 2.384 |
| LSD      | 306.3 | 0.0036 | 0.364 | 0.258 | 122.8 | 46.5 | 0.206 |
| P Value  | 0.333<sup>NS</sup> | 0.045<sup>NS</sup> | 0.148<sup>NS</sup> | 0.002<sup>NS</sup> | 0.083<sup>NS</sup> | 0.061<sup>NS</sup> | 0.012<sup>NS</sup> |

|          | N   | Na  | Ni  | P   | Pb  | Zn  |
|----------|-----|-----|-----|-----|-----|-----|
|          | (%) | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) | (mg/100 g) |
| Lowland  | 12.94 | 6.78 | 0.185 | 57.6 | 0.083 | 2.64 |
| Upland   | 10.15 | 8.44 | 0.194 | 47.4 | 0.173 | 2.97 |
| LSD      | 3.563 | 2.953 | 0.065 | 9.39 | 0.112 | 0.477 |
| P Value  | 0.110<sup>NS</sup> | 0.235<sup>NS</sup> | 0.762<sup>NS</sup> | 0.035<sup>NS</sup> | 0.084<sup>NS</sup> | 0.146<sup>NS</sup> |

Note: NS = Not significant, * = Significant at 5%, ** = Significant at less than 1%
Table 6. Effects of management systems on soil and crop qualities

| Variables          | Constant (a) | Beta (β) | t-value | Sig.  | R     | R²    | F-stat | p-value |
|--------------------|--------------|----------|---------|-------|-------|-------|--------|---------|
| Soil qualities     | 18.268       | 1.992    | 3.698   | 0.002* | 0.657* | 0.432 | 13.678 | 0.002*  |
| Plant qualities    | 15.224       | 1.357    | 3.144   | 0.006* | 0.595* | 0.354 | 9.882  | 0.006*  |
| Cumulative overall | 33.493       | 3.348    | 3.502   | 0.003* | 0.637* | 0.405 | 12.263 | 0.003*  |

*: t-value is significant at the 0.05 level (2-tailed). *: F-stat is significant at the 0.05 level (2-tailed)

Table 7. Relationship between soil and plant qualities

|                      | Plant       | Soil       |
|----------------------|-------------|------------|
| Soil quality         | Pearson Correlation | 1          | 0.960      |
|                      | Sig. (2-tailed) |            | 0.000      |
|                      | N           | 20         | 20         |
| Plant quality        | Pearson Correlation | 0.960      | 1          |
|                      | Sig. (2-tailed) |            | 0.000      |
|                      | N           | 20         | 20         |

*: Correlation is significant at the 0.01 level (2-tailed)
3.3 Heavy Metal Concentration in Soil, Plant and Water

Soil: The results of the concentration of heavy metals in the soil revealed that Cd, Pb and Ni were within the tolerable concentrations of the heavy metals (4, 84, 107 mg/kg) based on human health protection of the WHO (2006). While medium rate (2.09 mg/kg) of Mn were recorded, the concentrations of Cu, Fe, and Zn were observed to be high (5.11, 6.6 and 3.97 mg/kg respectively).

Plant: From Table 3, the results for Cd, Zn, Cu, Pb, Ni and Mn are all considered to have low values using the WHO (1996) permissible limits (0.02, 0.60, 10, 2, 10 mg/kg) for heavy metals in plants. This is indicative of the plant being safe for human consumption.

Water: The results of the water analysis shows that Cd, Fe, Pb, and Mn are within the recommended maximum concentrations of trace elements (0.01, 5.0, 5.0 and 0.2 mg/L\(^1\) respectively) using FAO (1976) recommended maximum concentrations of trace elements in irrigation waters used continuously on all soils. Conversely, Cu, Ni and Zn are above the recommended maximum concentrations of trace elements in irrigation waters accounting for 0.2, 0.2, and 2.0 mg/L\(^1\) respectively.

3.4 Comparison of Soil Chemical Properties

There is no significant difference in the following soil chemical properties in the lowland and upland areas of the study location: pH, EC, % OC, % TN, Na, K, Mg, Ca, TEB, exchange acidity, ECEC, Cu and Ni (Table 4). On the other hand, upland areas had significantly higher Fe, Mn, Zn, Pb, and Cd values. However, significant higher P values were observed in lowland areas compared to upland areas.

3.5 Comparison of Plant Elemental Content in Study Locations

Comparison of Plant Elemental Content in Study Locations is presented in Table 5. The results of the plant analysis shows that there is no significant difference in the following plant elemental content in the lowland and upland areas of the study location: Ca, Cu, K, Mg, % N, Na, Ni, Pb and Zn. Conversely, upland areas had significantly higher Cd, Fe and Mn values. Nonetheless, significant higher P values were observed in lowland areas compared to upland areas.

3.6 Effects of Management Systems on Soil and Crop Qualities

The result of the regression analysis shows that the coefficient of determination (R\(^2\)) for overall (both soil and plant qualities) is 0.405. This suggests that different management systems explain about 40.5% of the variation in both soil and plants qualities. The F-statistics shows that both soil and plant qualities are statistically significant (p<0.05). In summary, different management systems significantly influence soil and plant qualities (t = 3.502; β = 3.348; p <0.05). It is imperative to point out that different management systems play more influence on soil quality (t = 3.698; β = 1.992; p <0.05) than plant quality (t = 3.144; β = 1.357; p <0.05) because different management systems contribute about 43.2% to soil quality and contribute up to 35.4% to plant quality (Table 6).

3.7 Relationship between Variables (Correlation Analysis)

Note: A positive and significant relationship was established between quality of soil and plant quality (r = 0.960; p = 0.000). This implies that as soil quality increases, plant quality increases as well and vice versa. Or a successful increase in soil quality leads to a corresponding increase in plant quality. (They both move in the same direction) (Table 7).

Note: All the elements in soil quality have positive relationship with one another. It shows that an increase in one element leads to an increase in another element (Table 8).

Note: All the elements in plant quality have positive relationship with one another. It indicates that an increase in one element leads to an increase in another element. However, Fe has a negative and insignificant relationship with Cu. This implies that an increase in Fe leads to a decrease in Cu concentration in plant or the higher the Fe, the lower the Cu concentration in plant and vice versa (Table 9).

3.8 Comparison among Variables

Note: (Table 10)

Significant difference exits in Fe btw lower and upper slopes (p<0.05).
Significant difference exists in Pb btw lower and upper slopes (p<0.05).  
No significant difference in Cu btw lower and upper slopes (p>0.05).  
Significant difference exists in Cd btw lower and upper slopes (p<0.05).  
Significant difference exists in Zn btw lower and upper slopes (p<0.05).  
No significant difference in Ni btw lower and upper slopes (p>0.05).  
Significant difference exists in Mn btw lower and upper slopes (p<0.05).

Table 8. Relationship between soil qualities

|     | Fe  | Pb   | Cu   | Cd   | Zn   | Ni   | Mn   |
|-----|-----|------|------|------|------|------|------|
| Fe  |     |      |      |      |      |      |      |
| Sig. (2-tailed) | 1   | .655 | .112 | .459 | .375 | .272 | .428 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Pb  | .655 | 1    | .396 | .650 | .642 | .288 | .558 |
| Sig. (2-tailed) | .002 |    | .084 | .002 | .002 | .218 | .011 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Cu  | .112 | .396 | 1    | .831 | .783 | .700 | .672 |
| Sig. (2-tailed) | .639 | .084 |      | .000 | .000 | .001 | .001 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Cd  | .459 | .650 | .831 | 1    | .900 | .773 | .876 |
| Sig. (2-tailed) | .042 | .002 | .000 |      | .000 | .000 | .000 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Zn  | .375 | .642 | .783 | .900 | 1    | .806 | .856 |
| Sig. (2-tailed) | .103 | .002 | .000 | .000 |     | .000 | .000 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Ni  | .272 | .288 | .700 | .773 | .806 | 1    | .800 |
| Sig. (2-tailed) | .246 | .218 | .001 | .000 | .000 |     | .000 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Mn  | .428 | .558 | .672 | .876 | .856 | .800 | 1    |
| Sig. (2-tailed) | .060 | .011 | .001 | .000 | .000 | .000 |     |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |

* Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed)

Table 9. Relationship between plant qualities

|     | Fe  | Pb   | Cu   | Cd   | Zn   | Ni   | Mn   |
|-----|-----|------|------|------|------|------|------|
| Fe  |     |      |      |      |      |      |      |
| Sig. (2-tailed) | 1   | .079 | -.040| .175 | .234 | .190 | .538 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Pb  | .079 | 1    | .294 | .320 | .257 | .064 | .039 |
| Sig. (2-tailed) | .739 |    | .208 | .169 | .274 | .790 | .869 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Cu  | -.040| .294 | 1    | .739 | .369 | .456 | .390 |
| Sig. (2-tailed) | .868 | .208 |      | .000 | .109 | .043 | .089 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Cd  | .175 | .320 | .739 | 1    | .612 | .775 | .763 |
| Sig. (2-tailed) | .459 | .169 | .000 |      | .004 | .000 | .000 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Zn  | .234 | .257 | .369 | .612 | 1    | .753 | .606 |
| Sig. (2-tailed) | .321 | .274 | .109 | .004 |     | .000 | .005 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Ni  | .190 | .064 | .456 | .775 | .753 | 1    | .748 |
| Sig. (2-tailed) | .422 | .790 | .043 | .000 | .000 |     | .000 |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |
| Mn  | .538 | -.039| .390 | .763 | .606 | .748 | 1    |
| Sig. (2-tailed) | .014 | .869 | .089 | .000 | .005 | .000 |     |
| N   | 20  | 20   | 20   | 20   | 20   | 20   | 20   |

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed)
Note: (Table 11)

Significant difference exits in Fe btw lower and upper slopes (p<0.05).
No significant difference in Pb btw lower and upper slopes (p > 0.05).
No significant difference in Cu btw lower and upper slopes (p>0.05).
Significant difference exits in Mn btw lower and upper slopes (p<0.05).

Table 10. Differences in the concentration of elements (Soil)

| Management systems | N  | Mean     | Std. Dev. | t-value | Df  | p-value | Sig. level |
|--------------------|----|----------|-----------|---------|-----|---------|------------|
| Fe                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 6.4160   | 0.25483   | 3.22    | 18  | 0.002*  | Sig.       |
| Upper slope        | 10 | 6.9270   | 0.35151   |         |     |         |            |
| Pb                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 2.3300   | 0.06944   | 7.696   | 18  | 0.000*  | Sig.       |
| Upper slope        | 10 | 2.8370   | 0.19642   |         |     |         |            |
| Cu                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 4.9750   | 0.27496   | 1.231   | 18  | 0.234   | Not Sig.   |
| Upper slope        | 10 | 5.2130   | 0.54610   |         |     |         |            |
| Cd                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 0.3780   | 0.03327   | 3.003   | 18  | 0.008*  | Sig.       |
| Upper slope        | 10 | 0.4450   | 0.06223   |         |     |         |            |
| Zn                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 3.7620   | 0.36058   | 2.29    | 18  | 0.034*  | Sig.       |
| Upper slope        | 10 | 4.1720   | 0.43652   |         |     |         |            |
| Ni                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 0.4250   | 0.07920   | 0.576   | 18  | 0.572   | Not Sig.   |
| Upper slope        | 10 | 0.4440   | 0.06802   |         |     |         |            |
| Mn                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 1.9740   | 0.23996   | 2.471   | 18  | 0.024*  | Sig.       |
| Upper slope        | 10 | 2.2140   | 0.19173   |         |     |         |            |

*. t-value is significant at the 0.05 level (2-tailed)

Table 11. Differences in the concentration of elements (Plant)

| Management systems | N  | Mean     | Std. Dev. | t-value | Df  | p-value | Sig. level |
|--------------------|----|----------|-----------|---------|-----|---------|------------|
| Fe                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 6.47200  | 0.276759  | 3.537   | 18  | 0.002*  | Sig.       |
| Upper slope        | 10 | 6.98600  | 0.366854  |         |     |         |            |
| Pb                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 0.08300  | 0.006944  | 1.976   | 18  | 0.064   | Sig.       |
| Upper slope        | 10 | 0.17880  | 0.153173  |         |     |         |            |
| Cu                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 5.09300  | 0.260344  | 0.682   | 18  | 0.504   | Not Sig.   |
| Upper slope        | 10 | 5.20800  | 0.464992  |         |     |         |            |
| Cd                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 0.01210  | 0.004095  | 1.754   | 18  | 0.096   | Sig.       |
| Upper slope        | 10 | 0.01580  | 0.005266  |         |     |         |            |
| Zn                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 2.63500  | 0.486627  | 1.617   | 18  | 0.123   | Sig.       |
| Upper slope        | 10 | 2.97000  | 0.438710  |         |     |         |            |
| Ni                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 0.18500  | 0.065362  | 0.302   | 18  | 0.766   | Not Sig.   |
| Upper slope        | 10 | 0.19400  | 0.068020  |         |     |         |            |
| Mn                 |    |          |           |         |     |         |            |
| Lower slope        | 10 | 2.10000  | 0.224697  | 2.789   | 18  | 0.012*  | Sig.       |
| Upper slope        | 10 | 2.38400  | 0.230661  |         |     |         |            |

*. t-value is significant at the 0.05 level (2-tailed)

Table 12. Differences in the concentration of soil and plant qualities

| Variables | Management system | N  | Mean     | Std. Dev. | t-value | Df  | p-value | Level |
|-----------|-------------------|----|----------|-----------|---------|-----|---------|-------|
| Soil      | Lower slope       | 10 | 20.2600  | 1.06687   | 3.698   | 18  | 0.002   | Sig.  |
|           | Upper slope       | 10 | 22.2520  | 1.32769   |         |     |         |       |
| Plant     | Lower slope       | 10 | 16.5801  | 1.02747   | 3.144   | 18  | 0.006   | Sig.  |
|           | Upper slope       | 10 | 17.9366  | .89794    |         |     |         |       |

*. t-value is significant at the 0.05 level (2-tailed)
Note: (Table 12)
Significant difference exits in soil quality btw lower and upper slopes (p<0.05).
Significant difference exits in plant quality btw lower and upper slopes (p<0.05).

4. CONCLUSION
Management system was found to have a significant influence on the quality of soil and invariably plant in the study area. The soil and plants properties were discovered to be within the acceptable threshold of the critical levels set by the FAO/WHO. However, it was recommended that, due to dynamism of the properties, regular monitoring of the properties of soil, plant and water be undertaken to avert any human health disaster arising from consumption of crops in the area.

ACKNOWLEDGEMENT
The authors are grateful to the Tertiary Education Trust Fund (TETFUND) for providing sponsorship for this research.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

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