# QUALITY STUDY OF SOIL IN TAKUM LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA.

BY

**DAHIRU AHMED DAN’AZUMI**

**M. TECH/CH/07/0312**

**A THESIS SUBMITTED TO THE DEPARTMENT OF CHEMISTRY, SCHOOL OF PURE AND APPLIED SCIENCES, FEDERAL UNIVERSITY OF TECHNOLOGY YOLA, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY (M. TECH) DEGREE IN ANALYTICAL CHEMISTRY.**

**SUPERVISOR: DR. S.A. OSEMEAHON**

**MARCH, 2011.**

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# DECLARATION

I Dahiru Ahmed Dan'Azumi hereby declare that this research work was carried out and written by me under the supervision of Dr. S.A. Oseameahon. No research of this type has been conducted in the area and presented before in any previous form for any higher degree. References cited were dully acknowledged.

Dahiru A. DanAzumi Date
(Student)

Dr. S.A. Oseameahon Date
(Supervisor)

# CERTIFICATION

# DEDICATION

I dedicate this research work to the following people who mean so much to me:-

i. My late father Mal. Dan’Azumi A. Adi who so much believed in seeking knowledge for me and my beloved mother Haj. Hadiza Ajuji for being my mother.
ii. My wife Haj. Atika A. Sale for her infinite love, care, understanding, tolerance and being my wife. My sons and daughters, Imam, Amal, Nu’uman and Nu’aymat respectively and
iii. All the progressive minded persons in the world.

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# ABSTRACT

The analysis conducted on the physical and chemical properties of soil samples in Takum Local Government Area of Taraba State was to assess and evaluate its quality and pollution load. The soil in the area is found to be friable, loose, and smooth with dark brown or black and reddish brown colour. The soil is high in organic matter probably due to the low acidic nature of the soil. The physical properties vary and indicate good structure, permeability and dissolved solute. The high conductivity values $7.2 \times 10^2$-$4.1 \times 10^3$S/CM. could be due to the presence of mobile ions in the soils. The study shows the pH values ranges from 6.2-6.6. Density ranges from 1.12-1.60g/cm$^3$, specific gravity ranges from 1.21-1.80. Elements like Ca, Fe, K, Mg and Na were found in all the soil samples. Cr & Zn were found in some southern samples while Cd, Cu and Pb were not found in any of the samples. However, the soil in the study area is assumed to be relatively rich in essential elements but safe of some trace metals.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Origin of Soil

There are several definitions of soil. “To many people who do not live on the land, soil appears, to be an inert, uniform, dark-brown coloured, uninteresting materials in which plants happen to grow. In fact, little could be further from the truth” (Knapp, soil processes, 1979). Hence soil originates from bedrocks and decayed organic materials.

Soil is the loose materials that covers the land surfaces of earth and supports the growth of plants (Christopher, 2008). Soil is the mineral and organic materials on the surface of the earth that serves as a natural medium for growth of plants and acts as the base for human activities (Nyle et al, 1999). Soil forms the thin surface layer of the earth’s crust, it provides the foundation for plants and consequently, animal life on land. However, the most widely accepted scientific definition is that by J. Joffery (1949) who stated that: “The soil is the natural body of animal, minerals and organic constituents differentiated into horizons of variable depth which differ from the material below in morphology, physical make-up, chemical properties and composition, and biological characteristics” (David, 2004).

Soil actually constitutes a living system, combining with air, water, and sunlight to sustain plant life. Life on earth depends on soil. The study of different soil types and their properties is called soil science or pedology (David W. 2004).

Thus, soil quality is directly related to the ability of a soil to supply elements essential for crops growth, development and maturation for high yield (Greenland, 1981). However, soil is a complex commodity and indeed knowledge is needed to help us understand what is taking place below our feet and how we can improve the ability to grow land maintained it as a source of portable water.

## 1.2 Soil Formation

Soil formation is a continual and gradual process that process through the combined effects of five soil-forming factors; as follows, parent materials, climates, living organisms, topography, and time. Each combination of the five factors produces a unique type of soil that can be identified by its characteristics layers, called horizons. Soil formations also known as pedogenesis (from the Greek Words Pedon, for ground, and genesis, meaning “Birth” or “Origin” (Christopher, 2008).

Soil is formed by a number of evolutionary changes taking place most of the time. The most important is the weathering. Once rocks are formed and exposed, they are subjected to erosion and the movement of rock fragment in the formation of soil (Goss, 2001). The first stage in the formation of soil is the weathering of parent rock to give a layer of loose, broken materials known as regolith. Regolith may also be derived from the deposition of aluminum, draft, looses and volcanic materials.

### 1.2.1 Physical Weathering

The physical disintegration of parent materials by the effect of water, ice, wind, heat and cold result in loosening and breaking up rocks are worn by water, wind and ground to bits by the slow movement of glaciers. The action of rain water, snow, slug, wind and flowing water and also alternate freezing and thawing effects (Goss, 2001).

### 1.2.2 Chemical Weathering

Chemical weathering involves various processes such as oxidation, carbonation, hydrolysis and hydration. The decomposition of organic matter produces a weak acid. Gross (2001) maintained that all the above mentioned factors are instrumental in the fragmentation/disintegrating of rocks, which is the primary stage of soil formation and that plant roots explore the small fissures in the rock and make them wide open. The plants die and bacteria work on their remaining and after thousand years a living soil develops (David, 2004). Rain water is a weak acid (carbonic acid), which dissolves limestone, plant roots also produce weak acid and oxygen reacts with many rocks to make them crumble.

## 1.3 Soil Surface Reactions and Transfer Processes

Many soil processes occur at the surface where the soil solution meets solid, air, or living cells. Surface reactions include the adsorption of both ions and neutral molecules from solution onto the soil colloids (Michael, 1999). These reactions allow plant nutrients, toxins and other pollutants to be largely held rather than leaching freely as water passes through the soil. Adsorption processes are reversible, thus a reverse of adverted nutrients can be mobilized by desorption as nutrients become depleted from the soil solution. Other surface reactions are diffusion, the crystallization of new solids from solution, and the dissolution of soil materials (weathering). Surface reactions are coupled with transfer processes; they modify each other (Nyle et al., 1999). Transfer processes move heat, water, gasses, dissolved substances and even particulate solids in soil and the soil plant atmosphere system. These movements vary in scale and speed (Michael, 1999).

### 1.4 Soil Composition

Soils comprises a mixture of inorganic and organic components:- minerals, air, water, plant and animals materials. Minerals and organic particles generally compose roughly 50 percent of a soils volume. The other 50 percent consists of pores-open areas of various shapes and sizes. The soil consists of solid, liquid as soil solution and gas (soil air) phases. The solid phase is composed of 45% inorganic, 5% organic matter, 25% air and 25% water (Nyle et al., 1999).

#### 1.4.1 Inorganic Materials (Mineral Matter)

The mineral component of soil is made up of an arrangement of particles that are less than 2.0mm (0.8in) diameter. These assorted minerals particles ultimately releases the chemicals on which plants depend for survival, such s potassium, calcium, magnesium, phosphorus, sulphur, iron and manganese (Christopher, 2008). The soil minerals are obtained mainly by the weathering of parent rocks, as such weathering is the major process by which nutrients, essentials for plant growth are released. However, primary minerals are those resistant to chemical weathering but vulnerable to physical weathering. These minerals, such as quartz (sand), retain the chemical characteristics of the original parent mineral after being separated from it by certain factors. Secondary minerals are thee which have been broken down and altered by various processes of chemical weathering; oxidation, reduction, carbonation hydrolysis and hydration.

### 1.4.2 Organic Material

Organic materials constitute another essential component of soils. They are mainly derived from decaying plants and animals or from the secretions of living organisms, fallen leaves, decaying grasses and roots are the main sources of humus. These minerals become part of a cycle of decomposition and decay, a cycle that provides important nutrients to the soil. In general soil fertility depends on a high content of organic materials. Humus is a major source of nutrients and it combines with clays-humus complex. They clay-humus complex is essential for a fertile soil as it provides high water and nutrients-holding capacity. Humus act as cement, binding the soil particles together and thus reducing the risk of erosion by improved cohesion. Ultimately, the decay of plants and animals materials results in the formation of a dark or dark brown colour organic matter known as humus. Humus, unlike plant residue, is generally resistant to further decomposition (Christopher, 2008).

### 1.4.3 Soil Water

Soil water carries out the essential function of bringing minerals to plants. It is also important because it affects the upward and downward movement of the nutrient mineral it provides a solvent for plant and nutrients, to controls soil temperature, it helps in the development of horizons, and determines the incidence of erosion the amount of water in a soil at a given time can e expressed as:-

$$WaR-(E+T+D)$$

(Input)-(Outputs)

where W = water in soil
R = rainfall/precipitation
T = transpiration
a = proportion to
E = evaporation
D = drainage

Drainage depends upon the balance between the water retention capacity and the infiltration rate. This is controlled by the soil texture and structure (David, 2004). Soil water can be classified according to the tension at which it is held, and it is measured in atmosphere of pressure (ATM). When plant losses more water through transpiration than it can take up through its roots it is said to suffer water stress and it begins to wilt.

### 1.4.4 Soil Air

The air in the soil fills the pore spaces left unoccupied by soil moisture. It is essential for plant growth and living organisms compared with atmospheric air, air in the soil contain more carbon dioxide, release by plants and soil biota, and more water vapour, but less oxygen, as this is consumed by bacteria biota need oxygen and give of carbon dioxide. These gases are exchange through the process of diffusion (Michael, 1999). Fertile soils permits an exchange of soil air between plant and the atmosphere, as oxygen diffuses, unto the soil through the pores and is used by roots for respiration. In turn, the resulting carbon dioxide diffuses through pore spaces and returns to the atmosphere. This exchange is most different in soils with high degree of porosity. The human activities, burrowing of earthworms an other soil inhabitations provides natural and beneficial form of soil aeration (Christoper, 2008).

### 1.5 Soil Characteristics

Scientist can learn a lot about the soil composition and origin by examining various features or characteristics of the soil, colour, texture, aggregation, porosity, ion contents, density, pH, conductivity and pollution.

#### 1.5.1 Colour

Soils come in a wide range of colour-shades of blown, red, orange, yellow, gray, and even blue or green. Colour alone does not affect a soil, but it is often a reliable indicator of other soil properties (Christopher, 2008). Soil colour indicates many soil features and it helpful in determining soil properties (Miller et al; 1990).

In the surface soil horizon, a dark colour usually indicates the presence of organic matter. Soils with significant organic material content appear dark brown or black. The most common soil hues are in the red to yellow range getting their colour iron oxide minerals coating soil particles. Red iron oxide dominates highly weathered soils. Soils frequently saturated by water appear gray, blue or green because the mineral that give them the red and yellow colour have been leached away.

### 1.5.2 Soil Texture

The term “texture” refers to the degree of coarseness or fineness of the minerals of matter in the soil. It is determinate by the proportion of sand, silt and clay particles. It is also the relative percentage of each particles size in a soil. Soil texture controls the size and spacing of soil pores; it directly affects the soil water contents, water flow and extends of aeration. It also controls the availability and retention of nutrients within the soil (David, 2004).

### 1.5.3 Soil Structure

It is the aggregation of individual particles, which gives the soil its structure. In undisturbed soils, these aggregates form different shapes known as Peds. Aggregation occurs as a result of complex chemical forces acting on small soil components or when organisms and organic matter in soil act as glue binding particles together. In soil structure plant roots can obtain oxygen from large pores and water from the smaller pores and also their mineral nutrients are obtained from the breakdown of humus (Goss, 2001).

### 1.5.4 Soil Porosity

Soil porosity refers to the relative spaces or pores that exist between different soil types. Soil Scientists refer to the size, number and arrangement of these pores as the soil's porosity. Porosity greedily affect water movement and gas exchange well aggregated soils have numerous pores, which are important for organisms that live in the soil land require water and oxygen to survive to transport of nutrients and contaminates will also affected by soil structure and porosity (Christopher, 2008).

### 1.5.5 Soil Ion Content

Soil also has chemical characteristics. The surface of certain soil particles, particularly the clays, held groups of atoms known as ions. These ions carry charges as negative and positive, the negative ions (called anions) attracts positive ions (called cations). The chemical reactions in cation exchange make it possible for calcium an the other element, to be changed into water-soluble forms that plants can use for food. Therefore, a soils cation exchange capacity is an important measure of its fertility.

### 1.5.6 Soil Temperature

Incoming radiation can be absorbed, reflected or emitted by the earth’s surface. The top sol, especially if vegetation covers is limited, heats up more rapidly then the subsoil during the daytime and loses heat more rapidly at night. A “warm” soil will have greater biota activity, giving a more rapid breakdown of organic matter; it will be more likely to contain nutrients because the chemical weathering of the parent materials will be faster, and seeds will germinate more readily in it than in a “cool” soil the relative amount of leaf absorbed by the soil determined the soil temperature (Greenland et al, 1981).

### 1.5.7 Soil Density

The density of soil’s is inclusive of the soil pore spaces and it content (gases, plant and animals). Generally, soil with low buil density has better physical condition than these with higher densities (Greenland, 1981). Texture and structure of soil, its total pore space and organic matter content are all related to the bulk densities (Michael, 1999). The density of soil is expressed in one of two ways viz. (1) The density of soil (particle density) particles of the soil and (2) The density of the whole (bulk density).

### 1.5.8 Soil pH

Soil pH refers to the soils acidity or alkalinity the perpetual hinges, on the concentration of hydrogen ions in solution. Soil pH provides various clues about soil properties and is easily determined (Miller et al, 1990). If the pH of soil is too high or low, the nutrient, are either locked in to the soil particles or are washed out from the soil by rain. Even applications of fertilizer to much soil are useless and wasted. pH is found to be the most soil and soil based compost (Eswaran et al, 1999).

## 1.6 Soil Pollution

A pollutant is defined as something that contaminates or degrades air, soil or water (Hornby, 2005). Some heavy metals in the environment can be toxic to both plants animals. Heavy metals in soils can be in a series of complex chemical and biological interactions including human activities, oxidation, reduction, precipitation, desorption, dissolution, volatilization and surface phase complexion (Bolt et al., 1991). Metals contaminate soils are frequently deficient with respect to a number of essential elements such as N, P, and K (Nyle et al., 1999). Soil pollution may be defined as the presence of substances in the soil resulting in man-made activities or from natural processes that causes adverse effects to human health, property and the environment (Bolt et al., 1991).

### 1.6.1 Sources of Soil Pollution

Soil pollution is one of the treat to environment suitability. Soil may be polluted by both natural resources and human activities (David, 2004). Human activities can causes an over abundance or depletion of metals in the soils (Acton et al, 1995). Human activities like mining, industrialization, road construction, agriculture and other anthropogenic activities can cause degradation and pollution of the soil. Soil can be polluted through the following processes, absorption, desorption, infiltration, deposition, acidification, oxidation, reduction, leaching, adsorption, etc. (Bolt et al., 1991).

### 1.6.2 Effects of Soil Pollution on Plants and Animals

The deposition of metals in the soil could be nutritive or harmful to both plants and animals (Clarke, 1971). Metals contaminated sols are frequently deficient in respect to a number of essential elements (Winterhalder, 1984). Toxic soil reduces crop yield. The pH of soil is affected when the soil is contaminated. Certain metals eg. Lead Pb at critical level is harmful to human beings (Slovic et al, 1971). Cadmium causes acute gastritis with vomiting and diarrhea (Kirk et al, 1971). Soil pollution causes not only physical disabilities but also psychological and behavioural disorder in people (Acton et al., 1995).

## 1.7 Statement of the Problem

The selected study area is inhabited by people commonly engaged in farming activities. This led to the decrease in the soil fertility, as compared to the fallowed farms.

Thus, studying the quality of soil is a task in this millennium. The nutrient level and pollution load has to be assessed to make appropriate suggestions or advice on how the soil quality can be effectively managed, improved and controlled for option result and better crop yield.

## 1.8 Significance of the Study

The study of this magnitude on soils is very important, based on the global warming effects and the influence of human activities on today's soil properties. The result of these investigations will provide a ground for appropriate policy formulation by the government for effective soil management and control. It would also assist the agriculturalist, environmentalist and soil scientist for further study.

## 1.9 Scope and Limitation

The study is limited to physico-chemical properties of soil in Takum Local Government Area. The essential elements of interest are K, Na, Mg, and Ca. The pollutant elements to be considered are Fe, Cr, Ni, Pb, Mn, Cu, and Zn. The physical properties of interests are color, texture, pH, conductivity, density and specific gravity.

## 1.10 Aim and Objectives

The work is aimed at studying the quality and pollution load of the soil in the area by determining-

i. The physico-chemical properties of the soil in the area.

ii. The essential elements in the soil of the area.

iii. Toxic/heavy metals in the soil of the area and.

iv. To give appropriate suggestions when the need arises.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Soil Type and Importance

Soil is a thin layer on the surface of the earth on which the living beings of the earth survive (Christopher, 2008). Soil can be classified into various types, based on the size of the particles it contained (David, 2004). Therefore, depending on the size of particles in the soil, it can be classified into these following types- Sandy, Silty, Clay, and Loamy.

Sandy with sizes ranges from 2.0-0.05mm, feel gritty when rubbed between the fingers. Silt with sizes ranges between 0.005-0.002mm, feel smooth but not sticky even when wet. Clay sizes ranges from <0.002mm. Feel sticky when wet and smooth. Beside this kind of classification soil can be classified as acidic or alkaline and depending on the amount of humus, organic matter and the underlying bedrock (Christopher, 2008). Every soil has its advantages and disadvantages. There are various plants that have different requirement soils.

As one of the earth's vital ecosystem, soil is essential for the continued existence of life on the planet (Michael, 1999). It is a support system for human life and determines the agricultural production capacity of the land. Soils acts as buffer and filter pollutants (Nyle, 1996). It store moisture and nutrients. They decay of organic matter by soil organisms and the releases of carbon dioxide and ions is the largest microbial processes in soil (Beljel et al, 1992). Other essential biological processes are the transformation of nitrogen, phosphorus, and sulphur compounds land the mobilization of iron. Most plants need soil to help them up to the sun, plants need nutrients element to grow, they get carbon, oxygen and hydrogen from air and water (Doran et al, 1996) but all other nutrients come from the soil. These nutrients elements needed in the largest quantities (macro elements) are carbon (c), Hydrogen (H), nitrogen (N), phosphorus (P), sulphur (S), potassium (K), calcium (Ca), and magnesium (Mg). Those required in smaller amounts are micronutrients, including iron (Fe), manganese (Mn), zinc (Zc), copper (Cu), molybdenum (Mo), boron (B), and chlorine (CL), (Michael et al, 1999 and Nyle et al, 1991).

## 2.2 The Concept of Soil Quality

The soil society of American (1995) defines soil quality as the capacity of a specific kind of soil to function, within the natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or improve water and habitation (David, 2004). Soil quality is an assessment of how soil performs all ot its function now and how those functions are being preserved for future use. It cannot determine by measuring only crop yield, water quantity, or any other single outcome (Doran et al, 1996).

Soil quality relates to the capacity of a soil to function, not only within its boundaries, but in the larger environment of which it is a part (Nyle et al., 1999). It indicates the soil fitness to serve (1) as a medium to promote the growth of plants and animals (2) as an environment buffer that assimilates and degrades environmentally hazardous compounds and (3) as a factor in enhancing the health of plants and animals. The concept of soil quality and the criteria's for its determinations are still being developed Donald (2003). However, it is already proving to be a valuable tool in alerting scientists, farmers, environmentalist, and decisions markers to the care and nurturing that soil need if their health or quantity is to be maintained (Eswaran et al, 1979). Soil quality cannot be measures directly, so we evaluate indicators, which are measurable properties fo soil or plants that provide clues about how the soil can function. Indicators can be physical, chemical and biological properties, processes or characteristic or soil. They can also be morphological or visual features of plants (Pierce et al, 1996).

However, indicators can be assessed by qualitative or quantitative techniques after measurements are made. They can be evaluated by looking for pattern and comparing results to measurements taken at a different time or field (Acton et al, 1995).

Table 2.1 Soil quality indicators

| Indicators | Relationship to soil quality |
|---|---|
| Soil organic matter (SOM) | Soil fertility, structure, erosion, nutrient retention. |
| **Physical:** Soil structure depth of sol, infiltration and bulk density, water holding capacity. | Retention and transport of water and nutrients habit for microbes, estimate of crop productivity potential, compaction, plow pan, water movement, porosity, and workability. |
| **Chemica:** pH, electrical conductivity, extractable N-P-K | Biological and chemical activity, thresholds, plant and microbial activity thresholds, plan available nutrients and potential for and P loss. |
| **Biological:** Microbial biomass C and N, potentially mineralizable N, soil respiration. | Microbial catalytic potential and repository for C and N, soil productivity and N supplying potential, microbial, microbial activity measure. |

Source: Doron et al (Eds) 1996 Modified.

Soil quantity is a sensitive indicator or natural and human-induced perturbation of the environment. Changes may affect the quality of soil monitoring changes in soil properties can assist in predicting the future value of soils for agricultural, forest and other/purposes (Piece et al, 1996).

## 2.3 Factors Affecting Soil Quality

Soils vary greatly and space overtime-scales, relevant to geo-indicators. They have both stable characteristics (eg. Mineralogical composition and relative proportions of sand, silt and clay) and those that respond rapidly to changing environmental conditions eg. pH (Klute, (eds) 1986). The latter characteristics include soil moisture and soil microbiota (eg. Nematodes, microbes), which are essential to fluxes of plants nutrients and green house gases. Soil resources are impaired and in some lost for productive use because of misuse, application of toxic materials, or poor land management system (Donald, 2003). These happen because of

i. Excessive human demand on available soil resources
ii. Lack of knowledge about individual soil properties as they relate to soil quality and land use.

iii. Lack of understanding of the impact of management activities on individual’s soils and the ability of each soil type to maintain beneficial functions.

Physical degradation results from land during erosion and compaction by machinery. This may alter soil structure so that infiltration capacity and porosity are decreased. Chemical degradation takes place because of desorption of soluble elements through rainwater, leaching, over cropping and overgrazing, or because of the accumulation of salts precipitated from rising groundwater or irrigation schemes. It may also be caused by sewage containing toxic metals, precipitations of acidic and other airborne contaminants, as well as by persistent use of fertilizers and pesticides (David et al, 2004).

## 2.4 Soil Quality Management

With the world’s population now upwards to 6 billion people a figure that may rise to 10 billion or more within three decades (Christopher King, 2008). Humans will depend more that ever on soil for the growth of food crops. As such soil Scientists and other professionals are developing tools and ways to measure and monitor soil quality by developing key indicators to assess soil condition or health (Lai, 1995). Soil quality faces many threats throughout the world, deforestation, overgrazing and agricultural practices that fail to conserve soil are causes of accelerated soil quality loss (Christopher, 2008). Other human activities cause damage to the soil (Lai, 1986). The activities of micro-organisms and other soil fauna serve to promote soil aggregation, leading to reduced erosion and grater measured infiltration (Lavelle, 1986). To prevent exposure of bare soil, farmers use techniques such as leaving crop residue in the soil after harvesting or planting temporary growths such as grasses. Water run off can be controlled by planting cover crops along the slope at a hill (on the contour) instead of in rows go up and down (Christopher, 2008).

Many benefits result from the maintenance of soil organic and inorganic matter. However, decreases in total soil organic matter are a result of land management and increased soil aeration is an almost universal event both in the temperate and the tropics (Post et al., 1990). A compaction rearranges soil particles, thus increase soil density and reduces porosity (Christopher, 2008) and hence preventing water movement and increasing runoff and erosion.

## 2.5 Importance of Soil Quality

The morphology and chemistry of soils determined in soil quality study may record past changes in he environment (Page et al., 1986) as for example, iron oxide that accumulated due to flooding of low-lying areas, charcoal fragments production and forest fires. The properties of older soil (peleosols) whether burned or not, are indicators of past climates and can be use to predict the impacts of future climate changes (Klute, (eds) 1986). Soils of high quality are essential for the production of a bountiful supply of safe food and fibre. High quality soil supports.

i. Recycling of plants and animals remains

ii. The store moisture and nutrients for proper plants growth

iii. They act as soil buffer and filter pollutants

iv. They are important source and sink for $CO_2CH_4$ and nitrous oxide ($NO_2$).

As soil quality improves, so also does the quality of the other resources (Donald, 2003).

## 2.6 Literature Briefs on Some Essential Elements

A quality soil is a soil that can sustain and enhance plants and animals life (Michael, 1999) the chemical elements for essential plants growth are classified into macro-elements and micro-elements as mentioned earlier.

### 2.6.1 Nitrogen

Nitrogen is an integral component of many essential plant compounds (Nyle et al., 1999). It is a major part of amino acids and many co-enzymes, plants components include the nucleic acids, chlorophyll and carbohydrates. A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients. Deficiency of nitrogen in plants result to pale yellowish green color (chlorosis) and stunted growth. The Khjeldah method is the most common method used for determining nitrogen (Jeffery et al, 1989).

### 2.6.2 Phosphorus

Phosphorus is a critical element in natural and agricultural ecosystems through the world (Nyle et al, 1999). It is a key component of cellular compounds and is vital to both plants and animals like: (Fox and Cameroon, 1992). Neither nether plant nor animals can properly grow without phosphorus (nyel et al, 1999). It is an essential component of the organic compounds often called the energy currency of the living cells (Khasawneh et al, 1980) adenosine triphosphate (ATP) synthesized through both respiration and photosynthesis. It is also a component of both (DNA) and NRA. However, too much or too little Phosphorus can have severe and widespread negative impacts on environmental quality. It can be determined in food as orthophosphate by titrimetry or colorimetric method of analysis (Kirk et al, 1991).

### 2.6.3 Magnesium

Magnesium is one of the elements that made up the chlorophyll molecule, it is required for cellular respiration. It is an active elements of many enzymes reactions and all reactions where ATP is formed (David et al, 2004). Deficiency of Magnesium results in chlorosis and poor leaf formation (Nyle 1999). Magnesium can be determined by various method of analysis, such as gravimetric, titrimetic and flame photometric (Jeffery et al, 1985).

### 2.6.4 Potassium

Of all the essential elements, Potassium is the third most likely after nitrogen and phosphorus, to limit plant productivity (Nyle, 1999). For this reasons it is commonly applied to soil as fertilizer and component of most mixed fertilizers. It helps plants adapt to environmental stress. It controls processes like energy metabolism, starch synthesis, nitrate reduction, photosynthesis and sugar degradation in plants and animals. Deficiency of Potassium results to plant having a poor growth and marginal scorching on the leaves. It can be determined by either AAS, flame photometry or flame emission (Jeffery, et al, 1989).

### 2.6.5 Sulphur

Sulphur has long been recognized as indispensable for many reactions in living cells. In addition to its vital roles in plant and animal nutrition, it is also responsible for several types of air, water and soil pollutant and is therefore of increasing environmental interest (Nyle C. 1999). It is a constituent of amino acids. Deficiency of which result in serious human malnutrition. It can be determined by atomic absorption spectroscopy, titrimetry, gravimetric (Jeffery, et al 1989).

### 2.6.6 Calcium

Calcium is one of the metal element in the body of plants that is essential for the root activity, growth and functions. It controls and regulates soil activity and determines soil acidity (Nyle 1999). It can be determined by gravimetric, titrimetric and spectroscopic methods (Jeffery et al, 1989).

### 2.6.7 Iron

Iron is a component metal element of the complex protein hemoglobin. It is useful in the activity of enzymes and co-enzymes. Iron deficiency shows an internal chlorosis, especially in younger plants leaves. It is important metal element in chlorophyll formation and photosynthesis functioning through ferrodorim. Iron is determined by gravimetric. Colometric, titrimetric, spectrophotometric and ASS (Menhan et al, 2002).,

### 2.6.8 Lead

Lead is commonly known for its toxic properties at critical levels in humans (Chahtal, 1986). Limits of lead are prescribed in the lead in food regulations 1979. It is a biochemical element in the environment being released into the system. Lead can be determined by complex reaction with reagents such as Dithizone, its widely preferred techniques are AAS (AOAC, 2002).

### 2.6.9 Sodium

This helps in the maintenance of normal acid-base balance in the soil (Nyle, 1999). Its determination requires a correct analytical procedure with the preparation of standards using purified reagents and chemicals. It can conveniently be determined by either atomic absorption spectrophotometer or flame photometry or FES using a AAS in the emission mode (Kirk et al, 1991).

### 2.7 Analytical Studies of Soil Samples

The procedure for the determination of metallic elements in the soil includes soil digestion, preparation of standard stock solutions and the subsequent serial dilution of the stock solution to various concentrations. The concentrations of elements like Fe, Zn, Pb, Cr, Ni, Mn, Ca and Mg in soil sample solution was determine by PYE Unican SP9 Atomic Absorption Spectroscopy (AAS) using the procedure adopted by Balance and Jamie, (1996). Na and K were determined by Corning 410 photometric method (Golterman et al, 1978). For the determination of trace elements levels in the soil, th analytical techniques used must be sensitive to different elements at various concentrations (Beiluonwu, 1992).

#### 2.7.1 Atomic Absorption Spectrometry (AAS)

The principles of AAD are discussed at length by many authors including (Beiluonwu, 1992). Practically, this technique involves the measurement of absorption of electromagnetic radiation characteristics of a particular element that is passed through the atoms of the same elements in the vapour phase. The techniques involve the vaporization by aspiration of a solution of the element to be determined into a flame. However, vaporization can be effected by electrical or thermal heating of a surface. When light radiation of the element, certain frequencies of the light radiation are absorbed. The degree of absorption is proportional to the concentration of the ground state atoms in vapour during the absorption, and this is the basis of the quantitative analysis of the element. The absorbed radiation excites electrons in the round state to various higher energy levels and the energy changes involve corresponds to electrometric spectrum.

The amount of light absorbed is directly proportional to the concentrations of the element in solution (Beer's law). Beer's law under line quantitative absorption method of analysis (Ogugbuaja, 2000). Quantitative approach is by standard calibration curve method. The plot of absorbencies against concentration of standard solution of the species provides a straight line from which the concentration of the unknown is extrapolated having measured the absorbance. AAS has been widely used for the analysis of heavy metals in ores, geological sample, crude oil, petroleum products, industrial products, foodstuffs, beverages, blood samples and samples from polluted environment (Beiluonwu, 1992).

### 2.7.2 Flame Emission Spectrometry (FES)

This technique involves the measurement of the emission of visible or ultraviolet light spectrum by atomized species in flames after electronic excitation. It is a useful technique for quantifying elements such as the alkali and alkaline earth metals which have low excitation energies. The principle of its operation is base upon the quantitative measurement of characteristic light emitted when a solution of the element being determined is atomized as a mist into gas flame this follows the principle based of the Beer’s law. The meter reading for the test solution is obtained and compared with the calibration graph so that the concentration of the metal ion of interest can be determined.

# CHAPTER THREE

# EXPERIMENTAL

## 3.1 Materials and Methods

## 3.2 Study Area and Locations

The study area is Takum Town Headquarter of Takum Local Government Area of Taraba State situation on longitude $7^0$45'S and latitude $10^0$59'N. Figures 3.1 and 3.2 indicates map of Nigeria showing Taraba State and map of Taraba State showing the study local government area.

## 3.3 Sampling

Soil can vary considerably in chemical, physical and biological properties, both vertically through the soil profile and horizontally, so that it may be difficult to select representative sites for quality study (Eswaran, 1997). The sampling techniques based on taking a number of sample units from the field or plot and combining them to form bulk sample representative of the field, was adopted (Scot et al, 1971). The study areas were divided into five zones. 800 meters away in each direction from the centre of the town. Samples were taken from about 10cm depth at five (5) spots at 20meters apart along the four cardinal directions.

About 10Kg soil samples were collected from each spot using a wooden hoe and were placed into a polyethene bag. The five (5) soil samples were then mixed to form a composite soil sample for each of the five zones.

### 3.3.1 Sample Preparation

The soil samples collected were first screened to remove unwanted debris (particles) and crumbles broken and were air dried and mixed. A test sample was obtained from the composite sample by coning and quartering techniques (Saxana, 1990). About 0.5g of the test sample was weighed for digestion from a representative samples.

## 3.4 Determination of Physical Parameters

### 3.4.1 Soil Texture

A less quantitative but common method of determining soil texture is the “feel” method (Michael et al., 1999). Each of the moist soil samples were rubbed until well mixed and is then squeezed between the thumb and for fingers. The process was repeated when each of the sample was air dried. Sieving and sedimentation were also carried out on the samples (David, 2004).

### 3.4.2 Soil Colour

The method adopted in Munsell (1973) was followed as the colour of each of the soil sample was determined by using the natural visual organ, the eye as the soil samples were being collected in the field. However, the air dried soil samples were collected and a little water was added to make a paste and small amount of each sample was smeared on a piece of paper and matched to a Munsell soil standard colour chart page. The soil sample colour was picked as compared to the coloured chips, through the holes pounded in the page. The chips were identified as the best colour match to the soil samples.

### 3.4.3 Density and Specific Gravity

The method adopted was similar to that of Alloway (1990). The laboratory temperature was noted. A measuring cylinder was dried in an oven and weighed using an electrical balance as $W_1$. 20cm$^3$ of distilled water was poured into a cylinder and was weighed as $W_2$. The weight of water was calculated as $W_2 - W_1 = \Delta W$. Then, the density of water is calculated using the expression:

Density of water $(\rho W) = \frac{\Delta W(g)}{20cm^3}$

Where $\rho$ = density. W = weight of water.

### Specific Gravity

5g of each soil sample was weighed and placed into a measuring cylinder that contained 20cm$^3$ of distilled water. The volume displaced by the soil sample was then calculated using the expression $\Delta V = V_2 - V_1$

Where: $V_1$ = volume of water

$V_2$ = volume of water and 5g of sample

$\Delta V$ = volume displaced by 5g of sample

Density was calculated as $\frac{Mass}{Volume} = \frac{5g}{\Delta V}$

Therefore, specific gravity = $\frac{\rho_S}{\rho_W}$

Where: $\rho_S$ = density of sample

$\rho_W$ = density of water

### 3.4.4 Soil pH Measurement

The method adopted was similar to that of AOAC (2000). pH meter was calibrated; buffer solutions were prepared by dissolving buffer tablets of (pH 9.10 and 4.00) in $10cm^3$ each of distilled water in 3 separate beakers.

i. The pH meter was checked for its good working condition.
ii. The temperatures of the buffer solutions were noted and the electrode of the pH meter was rinsed in distilled water.
iii. The pH meter was switched on and the pH of the buffer solutions were read and used to calibrate the pH meter.

**Measurement**

The sample solutions were prepared by weighing out 5g each of the sample and transferred into a cleaned $100cm^3$ beaker containing $500cm^3$ of water. The content was stirred vigorously with a glass rod, and then allowed to stand for 20 minutes for equilibration.

The probe of the PYE UNICAM pH meter was dipped into the liquid portion of the beaker not allowing it to touch the settled soil particles in the bottom of the beaker; the temperature control was adjusted to the ambient temperature.

The pH of the sample solution was read when the pointed of the instrument was steady on the screen.

### 3.4.5 Soil Conductivity

The soil sample was prepared as for the soil pH measurement.

The procedure of measurement is similar, except in the case of no deflection, the selections switch was moved to x 1000 or x 10,000 and adjusted until deflection was observed (Sexana, 1990).

The conductivity was calculated using the expression:

EC = Dr x SS

where: EC = electrical conductivity ( $\frac{\rho_S}{C_m}$),

Dr = dial reading and

SS = value of selector switch

## 3.5 Determination of Essential Elements and Heavy Metals

### 3.5.1 Digestion of Samples

The method adopted was similar to those of AOAC (2000) and Kirk et al, (1991). About 0.5g of each sample was placed into a 200cm$^3$ Khejdahl digestion flask. 5cm of conc. $HNO_3$ and $1cm^3$ conc. HCl was added (i.e the ratio 5:1). The digestion flask was heated on a heating mantle in a fume cupboard until white fumes is seen. The solution was cooled an $10cm^3$ water is added. This was filtered using Whatman filter paper (110mm) into a $100cm^3$ volumetric flask and made up to the mark with distilled water.

### 3.5.2 Preparation of Standard Stock Solution of Sodium

The method adopted was similar to that of Jeffery, 1989. 2.5g of sodium chloride was dissolved in $100cm^3$ of distilled water in a volumetric flask of $1000cm^3$ of which the volume was then rise to the mark. The stock solution contained 1.000mg Na per centimeter; $10cm^3$ of this stock solution is pipette into $100cm^3$ flask and volume rise to the mark with distilled water. In order to prepare 100ppm of stock solution from which working standard 0.5, 1,2.5, 5 and $10g/cm^3$ containing sodium ion were prepared by serial dilution.

### 3.5.3 Preparation of Standard Stock Solution of Potassium

1.91g of potassium chloride was dissolved in $100cm^3$ distilled water in a $100cm^3$ volumetric flask and made up to the mark. However, working standard solution of 0.5, 1, 2.5, and 10ppm was prepared by serial dilution.

### 3.5.4 Preparation of Standard Stock Solution of Copper

About 3.8g of $Cu(No_3)_2$ $3H_2O$ was dissolved in distilled water in a $1000cm^3$ volumetric flask and diluted to the mark. This gave 1000ppm of Cu. $10cm^3$ of the stock solution was pipette into a $100cm^3$ volumetric flask and diluted up to the mark with distilled water. This served as working standard solution and contained 100ppm Cu solution. From that solution 1.0, 0.5, 0.25, and $0.125cm^3$ were pipette into $50cm^3$ volumetric flask and diluted to the mark with distilled water respectively. These solutions contained 10, 5, 2.5 and 1.25 ppm Cu solutions respectively.

### 3.5.5 Preparation of Standard Stock Solution of Iron

About 4.7g of $FeSO_4$ $7H_2O$ was dissolved in $1000cm^3$ volumetric flask and diluted to the mark with distilled water. This gave 1000ppm of Fe stock solution. A $10cm^3$ of the stock solution was pipette into $100cm^3$ volumetric flask and diluted to the mark with distilled water. The resulting solution is 100ppm Fe. From the solution 5, 10, 15, 20 and $25cm^3$ were pipette into five $50cm^3$ volumetric flask and diluted to the mark with distilled water. These solutions contained 10, 20, 30, 40 and 50ppm of iron. That is by using the relation

$$C_1V_1 = C_2V_2 = \frac{C_2V_2}{C_1}\ V_1 = \frac{10\ x\ 50}{100} = 5cm^3$$

where: $V_1$ = volume required

$V_2$ = volume of flask

$C_2$ = desired concentration

$C_1$ = initial concentration

Using the same procedure, Mg, Zn, Pb, and Cr stock solution were prepared by weighing and appropriate amount of their salts into a litre flask dissolved and made up to the mark with distilled water stored in polythene bottles.

Table 3.1 Stock solutions value for elements used

| ELEMENTS | STANDARD SUBSTANCE OR COMPOUND USED | AMOUNT IN g DISSOLVED IN $1000CM^3$ OF WATER | CONCENTRATION |
|---|---|---|---|
| Sodium | NaCl | 2.5 | 1000ppm |
| Potassium | KCl | 1.91 | 1000ppm |
| Magnesium | $MgCl_2$ | 4.0 | 1000ppm |
| Copper | $Cu(NO_3)_2\ 3H_2O$ | 3.80 | 1000ppm |
| Lead | $Pb(NO_3)_2$ | 1.59 | 1000ppm |
| Zinc | $Zn(NO_3)_2$ | 2.95 | 1000ppm |
| Iron | $FeSo_47H_2O$ | 4.71 | 1000ppm |
| Chromium | $Cr(NO_3)_2$ | 7.32 | 1000ppm |
| Calcium | $CaCl_2$ | 2.75 | 1000ppm |

### 3.6 Determination of Potassium and Sodium Using Flame Photometer

The procedure reported by Kirk et al (1991) and Golterman (1996) was adopted. The flame photometer was checked first to ascertain its efficiency. It was switched on and allowed to warm for 20 minutes. The sodium filter was selected, fixed and adjusted to give a spectral range 766-770nm. The sensitivity of the flame photometer was set at 100% transition. Distilled water was used as the blank solution. Each of the standard solution was aspirated one after the other at least three times in order of decreasing concentration, followed by the aspiration of each of the sample solution, their absorbencies values were recorded in each case. A calibration graph was made by plotting the emission intensities of the standard solution from the calibration plot, the sodium content of each sample was determined by extrapolating from its corresponding emission intensities of the samples and was calculated. The same procedure was repeated for potassium but with potassium filter.

Amount of element (Mg/Kg) = $\frac{C_{ppm}V}{W}$

where:

Cppm = concentration of solution in each sample extrapolated from the curve.

V = volume of sample solution prepared ($100cm^3$).

W = weight of each sample used for sample solution prepared (5g)

$$\%Na = \frac{Mg/g}{1000} X\ 100$$

### 3.7 Determination of Metal in Soil Samples Using AAS

The method used was similar to that adopted in Kirk et al, (1991), Whiteside et al, (1983) and AOAC (2000). The PYE-Unican SP9 Atomic Absorption Spectrophotometer was checked and cleaned for efficiency. The oxidant and fuel used were air and acetylene. The instrument was switched on for 20 minutes to allow it warm up. The hollow cathode lamp for each metal was selected and fixed. The current and resonance line wavelength for each metal was selected and the gas control system was adjusted to give rich fuel flame. Water was used as a blank and instrument was set at zero reading. The prepared standard solutions were aspirated in order of increasing concentrations followed by the aspiration of each of the sample solutions. The absorbance readings of the standard solutions were then plotted against concentration and calibration curves of the metal were obtained. The curves were used to obtain the concentration of the elements in each sample solution by extrapolation.

However, all metals were determined using the appropriate flame, lamp, wavelength, calibration standards, dilution factors and working range as shown in Table 3.2.

Table 3.2 Elemental performance data of the hollow cathode lamps used in the AAS

| Elements | Lamp current (MA) | Band pass (nm) | Wavelength (nm) | Flame |
|---|---|---|---|---|
| Magnesium | 3.5 | 0.35 | 285.0 | Air/Acetylene |
| Copper | 3.5 | 0.35 | 324.8 | Air/Acetylene |
| Lead | 4.5 | 0.35 | 217.0 | Air/Acetylene |
| Zinc | 7.0 | 0.35 | 213.9 | Air/Acetylene |
| Iron | 11.0 | 0.35 | 248.3 | Air/Acetylene |
| Chromium | 7.5 | 0.35 | 357.9 | Air/Acetylene |
| Calcium | 3.5 | 0.35 | 271.0 | Air/Acetylene |

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Physical Properties of the Soil Samples

The results of the analysis of the physical properties of the soil samples are presented in Tables 4.1 and 4.2.

### 4.1.1 Texture and Consistency of the Soil

Based on the assessment of the soil samples, the soil in the area is said to be relatively medium in texture (Christopher, 2008). Combination of 10-20 percent clay, along with sand and silt in a roughly equal amount. The soil sample was friable, soft and smooth. Thus texture depends on consistency of soil (Michael, 1999).

### 4.1.2 Colour of the Soil Samples

The soil samples collected from the Eastern and Northern part of the studied area were found to be mostly dark brown and dark black, suggesting the presence of organic matter (Christopher, 2008) and also the presence of non-hydrated iron oxide minerals.

However, samples A, B, D, E were reddish brown found in the Western, central and Southern part of the studied area respectively, indicating the presence of hematite (Ahn, 970) and goethite ($Fe_2O_3H_2O$) and ferrous iron. Some samples indicated reddish gray or blue colour which also suggests the saturation of the soil with water (Christopher, 2008). Soil colour indicates many soil features and is helpful in determining soil properties (Miller and Donahue, 1990).

### 4.1.3 Density and Specific Gravity of the Soil Samples

The density and specific gravity of the soil samples ranged from 1.12-1.60g/cm$^3$ and 1.21-1.80 respectively. The density of soil is inclusive of the soil pore spaces and its content (gasses, plants and animals). Most soils reported are with density ranges from 0.7-1.70g/cm$^3$ (Redujevic et al, 1999). Soil degradation and compaction re-arranges soil particles, thus increases soil density and reduces porosity and hence prevent water movement, increased run-off and erosion (Christopher, 2008). However, the soil density and its specific gravity are within the recommended values.

### 4.1.4 The pH of the Soil Samples

The pH values of the soil samples are presented in Table 4.2. The pH value ranged from 6.2-6.6 showing that the soil is slightly acidic (Sexana, 1990). The pH of a soil would often determine whether certain plants could be grown successfully (Christopher, 2008). Based on pH requirements for plant nutrients availability in the soil, the current pH values of the soil in the study area is within the pH requirement value for plant growth. However pH 6.5 is found to be the pH which most soils and soil based composes are adjusted (Goss, 2001).

### 4.1.5 Conductivity of the Soil Samples

The conductivity values of the soil samples are also shown in Table 4.2. The values range from $7.2\text{x } 10^2 – 4.20 \text{ x } 10^3$ uS/Cm. The conductivity values are due to the concentration of mobile ions, therefore a soil cation exchange capacity is an important measure of its fertility. The soil samples show a suitable conductivity values for plant growth (Radujevic et al, 1999).

## 4.2 Chemical Properties of the Soil Samples

The metals contents of the soil analyzed are shown in Tables 4.3. 4.4 and 4.5. The standard calibration curves used for the extrapolation of the concentration of each of the metals are shown in appendix viii.

### 4.2.1 Sodium and Potassium Content in the Soil Samples

The contents of the sodium in the soil samples analyzed range between 116-521mg/kg with a mean value of 316mg/kg while the amount of potassium concentration in the soil samples range from 76-316mg/kg with a mean value 194.4mg/kg.

### 4.2.2 Calcium and Magnesium Content in the Soil Samples

The amount of calcium in the soil sample range from 640-1200mg/kg with a mean value of 840.0mg/kg while that of magnesium range from 392.0-844mg/kg with a mean value of 482.7mg/kg.

### 4.2.3 Iron

The iron content in the soil samples range from 2666.0-3973.6mg/kg with mean value of 3257.8mg/kg. The high value of iron content in the soil analyzed could be responsible for the colour observed.

### 4.2.4 Zinc

Zinc was found only in the Eastern and Southern samples. The amount of zinc content in the soil sample range from 50.8-53.2mg/kg with mean value of 49.2mg/kg. The values of zinc concentration in the soil sample of the study area are within the range of 5-100mg/kg reported by Alloway (1990), to be normal for a farming soil.

### 4.2.5 Copper, Cadmium, Chromium and Lead

Cr was found only in the Southern portion of the soil samples with 50.1mg/kg value. However, Cu, Cd, Pb, were not found in any of the soil samples from the study area. This could perhaps be due to their low levels in the soil below the detection limits of the AAS instruments used for the analysis.

Table 4.1 Colour of soil in the study area (when collected)

| SAMPLES PORTION | SOIL COLOUR | STANDARD NOTATION |
|---|---|---|
| East A | Dark brown | 7.5YR4/4 |
| B | Very dark brown | 7.5YR3/2 |
| C | Reddish brown | 5YR5/3 |
| D | Dark brown | 5YR3/4 |
| E | Dark brown | 7.5YR4/4 |
| West A | Dark reddish brown | 5YR5/4 |
| B | Dark brown | 5YR2.5/1 |
| C | Dark reddish brown | 5YR5/4 |
| D | Reddish gray | 7.5YR7/2 |
| E | Black green brown | 5YR5/1 |
| Centre A | Dark brown | 7.5YR4/4 |
| B | Very dark brown | 7.5YR3/2 |
| C | Reddish brown | 5YR5/3 |
| D | Dark brown | 5YR3/4 |
| E | Dark brown | 7.5YR4/4 |
| North A | Dark brown | 5YR5/4 |
| B | Reddish brown | 5YR2.5/1 |
| C | Black brown | 5YR5/4 |
| D | Reddish brown | 7.5YR7/2 |
| E | Reddish brown | 5YR5/1 |
| South A | Pinkish gray | 7.5YR4/4 |
| B | Grayish blue | 5YR4/4 |
| C | Reddish brown | 7.5YR5/4 |
| D | Reddish brown | 5YR4/4 |
| E | Light brown | 5YR2/4 |

Table 4.2 Physical properties of the soil samples from the study area

| Samples | pH | Density ($g/cm^3$) | Specific gravity | Conductivity ($x10^3$Us/cm) |
|---|---|---|---|---|
| Eastern | 6.3 | 1.30 | 1.21 | 1.47 |
| Western | 6.4 | 1.12 | 1.55 | 1.72 |
| Central | 6.6 | 1.60 | 1.80 | 1.11 |
| Northern | 6.2 | 1.40 | 1.45 | 0.72 |
| Southern | 6.5 | 1.25 | 1.60 | 0.90 |

Table 4.3 Concentration of sodium and potassium in soil samples from the study area (mg/kg)

| Samples | Na | K | Ratio N:K |
|---|---|---|---|
| Eastern | 268.0 | 156.0 | 2.1 |
| Western | 532.0 | 212.0 | 2.1 |
| Central | 116.0 | 76.0 | 2.1 |
| Northern | 268.0 | 212.0 | 1.1 |
| Southern | 396.0 | 316.0 | 1.1 |

| | | |
|---|---|---|
| Range = | 532-116 | 316-76 |
| Mean value = | 316.0 | 194.4 |

Table 4.4 Calcium and magnesium contents in (mg/kg) of the digested solution of the soil samples determine by AAS

| Samples | Ca | Mg | Ratio Ca:Mg |
|---|---|---|---|
| Eastern | 960.0 | 452.0 | 2.1 |
| Western | 660.0 | 399.0 | 2.1 |
| Central | 1200.0 | 844.0 | 1.1 |
| Northern | 840.0 | 392.0 | 3.1 |
| Southern | 640.0 | 425.0 | 1.1 |

Range = 1200-640 844.0-392.8 3.1-1.1

Mean = 840.0 482.68

Table 4.5 Concentration of Fe, Zn and Cr in the soil samples of the study area (mg/kg)

| Samples | Fe | Zn | Cr |
|---|---|---|---|
| Eastern | 3973.6 | 50.8 | - |
| Western | 3038.4 | 50.0 | - |
| Central | 3492.8 | 47.2 | - |
| Northern | 2666.2 | 45.0 | - |
| Southern | 3118.0 | 53.2 | 50.0 |

Range = 2666.0-3973 50.8-53.2 50.0

Mean value = 3257.76 49.2

The dash (-) mean, “not detected” in the samples.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 Summary

Soil is that loose material that covers the land surfaces of earth and supports the growth of plants (Christopher, 2008). Thus, soil quality is directly related to the ability of a soil to supply elements essentials for crop growth, development, maturations and also support healthy living for both plants and animals (Greenland, 1981). However, the analysis conducted on the soil shows variation in the values of the physic-chemical parameters and also the distribution of the elements. The soil is relatively rich with essential elements and is considerably safe for healthy living.

## 5.2 Conclusion

From the result of analysis conducted on the soil samples in Takum Local Government Area, the result indicates variation in the values of the physic-chemical properties (eg. Mineralogical composition and relative proportion of organic matter) in the soil and also indicate various in distribution of essential and non-essential elements in the soil of the area of study. The values of the physical parameters studied viz texture, consistency, colour, pH, conductivity, density and specific gravity were within recommend values acceptable for normal plant growth (Nyle et al, 1999) and (Winterhalder, 1984).

The elements studied were NA< K, Ca, Mg, Fe and Zn as essential elements for plants growth. Cu, Cr, Cd, and Pb were also determined as the non essential elements. Their concentrations differed from each other probably due to differences in their natural abundance and contributions from anthropogenic activities, plant uptakes and removal, erosion, leaching and deposition etc.

However, trace elements were naturally at low levels or absent probably due to the scavenging abilities of iron and manganese compounds (Alloway, 1990). The analysis showed that the soil in the area is not contaminated by the toxic element analyzed but rather relatively rich in essential elements.

## 5.3 Recommendations

Soil faces many threats all over the world through deforestation, overgrazing, primitive agricultural practices, anthropogenic activities and however with the increasing need to produce greater amount of food, shelter and fibre for the growing world’s population, it has become necessary to develop an appropriate technology to maintain and improve soil quality.

This involves proper awareness and sensitization on the importance of soil and good government policies on soil usage, conservation and management system. Most of the threats to soil can be ameliorated. The two tiers of government should also encourage and support research works in soil analysis within the state to assess and ascertain the quality of the soil and its pollution load for maximum agricultural production and life sustainability. Soil management and pollution control should be observed. Soil as one of the earth's vita (eco-system) is essential for the continued existence of life on the planet. Soil fertility can be improved by addition of fertilizers.

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# APPENDICES

Appendix I: Detection limit (µg.ml$^{-1}$) or metals by AAS and AES

| Limits | AA | AE |
|---|---|---|
| <10$^{-4}$ | - | Cs, Li, Na |
| <10$^{-3}$ | Ag, Ca, Cd, Mg | Sr |
| <10$^{-2}$ | Au, Be, Co, Cr, Cu, Fe, K, LI, Mn, Na, Ni, Pb, Rb, Sr, Zn | Al, Ba, Cr, Cs, Cu, Fe, Ga, In, K, Mg, Mn, Rb, V |
| <10$^{-1}$ | Al, As, BA< Bi, Cs, Ga, Ge, K, Mo, Pt, Sb, Se, Si, Su, Ti, Tl, U | As, Be, Co, Mo, Ti, V |
| <1 | Hg | Ge, Ni, Pb, Sn |

a-Galen (1975)

Appendix II: Standard acceptable limits for trace metals in soil

| Metals | Normal range (mg/kg) | Critical (mg/kg) |
|---|---|---|
| Ag | 0.10-8 | 2 |
| As | 0.1-4 | 20-50 |
| Au | 0.01-0.02 | - |
| Cd | 0.01-20 | 3-8 |
| Co | 0.5-6.5 | 25-50 |
| Cr | 5-1500 | 75-100 |
| Cu | 2-250 | 60-125 |
| Mn | 20-1000 | 1500-3000 |
| Ni | 2-750 | 100 |
| Pb | 2-300 | 100-400 |
| Sb | 0.2-10 | 5-10 |
| Zn | 1-900 | 70-400 |

a-Sexana (1990)

Appendix III: Emission intensities of Na and K in soil samples solutions

| Samples | Na | K |
|---|---|---|
| Eastern | 0.3 | 0.2 |
| Western | 0.2 | 0.2 |
| Central | 0.3 | 0.3 |
| Northern | 0.2 | 0.3 |
| Southern | 0.4 | 0.2 |

Appendix IV: Concentration of Na and K (in ppm) in the soil samples from study area

| Samples | Na | K |
|---|---|---|
| Eastern | 0.99 | 0.70 |
| Western | 0.69 | 0.48 |
| Central | 0.98 | 0.42 |
| Northern | 0.78 | 0.39 |
| Southern | 1.30 | 0.40 |

| | | |
|---|---|---|
| Range = | 0.69-1.30 | 0.39-0.70 |
| Mean = | 0.948 | 0.478 |

Appendix V: Absorbance reading for standard solutions of the metals determined from the soil samples

| Concentration in ppm ($mg/cm^3$) | Ca | Cu | Cr | Fe | K | Mg | Na | Pb | Zn |
|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.50 | - | 0.028 | 0.010 | 0.012 | 0.30 | 0.22 | 0.20 | 0.001 | 0.032 |
| 1.00 | - | 0.056 | 0.020 | 0.023 | 0.50 | 0.054 | 0.30 | 0.005 | 0.060 |
| 2.50 | 0.008 | 0.228 | 0.083 | 0.049 | 1.30 | 0.108 | 0.85 | 0.011 | 0.130 |
| 5.00 | 0.014 | 0.378 | 0.101 | 0.96 | 2.60 | 0.215 | 1.50 | 0.023 | 0.260 |
| 8.00 | 0.024 | - | - | - | - | - | - | - | - |
| 10.00 | 0.034 | 0.757 | 0.121 | 0.189 | 5.20 | 0.430 | 3.00 | 0.047 | 0.420 |

Appendix VI: Absorbance reading for digested soil samples solutions for the different metals

| Samples | Ca | Cr | Fe | Mg | Pb | Zn |
|---|---|---|---|---|---|---|
| Eastern | 0.005 | - | 0.085 | 0.032 | - | 0.004 |
| Western | 0.008 | - | 0.145 | 0.033 | - |  |
| Central | 0.009 | - | 0.149 | 0.030 | - | - |
| Northern | 0.006 | - | 0.150 | 0.041 | - | - |
| Southern | 0.006 | 0.001 | 0.145 | 0.040 | - | 0.005 |

Appendix VII: Concentration of metals (in ppm) in the soil samples as extrapolated from respective calibration curves

| Samples | Ca | Cr | Fe | Mg | Zn |
|---|---|---|---|---|---|
| Eastern | 1.650 | - | 4.300 | 0.998 | 0.130 |
| Western | 2.100 | - | 4.300 | 1.064 | - |
| Central | 2.700 | - | 4.532 | 0.792 | - |
| Northern | 1.650 | - | 6.200 | 0.798 | - |
| Southern | 2.400 | 0.532 | 5.131 | 0.732 | 0.125 |