NUTRIENT STATUS OF SOIL UNDER DIFFERENT LAND USES TYPES IN THE UNIVERSITY OF BENIN, BENIN CITY

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EDO STATE, NIGERIA.

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A PROJECT SUBMITTED TO THE DEPARTMENT OF SOIL SCIECNE AND LAND MANAGEMENT, UNIVERSITY OF BENIN,

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CERTIFICATION

This is to certify that this research project; "**Nutrient Status of Soil under Different Land Uses Type in the University of Benin"**, was carried out by EMEKA JOHN MBAOMA of the Department of Soil science, Faculty of Agriculture, University of Benin, Benin City, Edo state, Nigeria.

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DEDICATION

This work is dedicated to God Almighty, my all sufficient Father, whom in his in infinite mercies and divine guidance kept me this far, and also to Mr. Felix Elimuya and family, Mr. Richard Mbaoma and family and to my loving Mbaoma-Godsons' family for their support, given to me all throughout my stay in the University of Benin, Benin City, Edo state, Nigeria.

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ABSTRACT

This research work was conducted in the University of Benin, Benin City, with the aim to determine plant nutrient status under different land use types within the Ugbowo campus of the University of Benin, Benin City, Edo State, Nigeria. Soil samples were collected from twelve (12) sites, (three each) from four (4) different land use types, namely: Arable land, Fallow land, Grazing land, and Forest land at depths of 0-15 cm and 15-30 cm. Soil samples from same land use and same depth were bulked to make composite samples which were taken to the laboratory for analysis using standard procedures. Some of the parameters analyzed for are, the Soil pH, Total Organic Carbon (TOC), Total Nitrogen (N), Available Phosphorus (P), Exchangeable Acidity, Exchangeable Base (BS), particle size distribution, Electrical conductivity, Potassium (K) calcium (Ca), Magnesium (Mg) and Effective Cation Exchange Capacity (ECEC).

Results showed that the top soils belong to the textural class of loamy sand. Sand content decreased with depth in all land uses while clay content increased with depth. pH was least in arable land, having pH 4.93 and highest in grazing area, having pH 6.2. pH decreased with depth in all land uses except in grazing area, where it increased. TOC, N, P, K, Ca, Mg, Na and sand content, all had their highest values in the top 15 cm of the soils but decreased down the profile while H, Al, and clay values increased with depth. Grazing area had the highest amount of nutrients, which are; TOC (25.21 g/kg), available P (16.45 mg/kg), K (1.60 cmol/kg), Ca (1.31 cmol/kg) and Na (0.21 cmol/kg), while the forest had the highest concentration of N (1.93 g/kg). Arable land had the least concentration of nutrients.

CHAPTER ONE

1.0 INTRODUCTION

Food growing biomass and biofuel production, carbon storage, the hosting of soil biodiversity, filtering of water and cycling of nutrients as well as the provision of raw materials are among the factors contributing to the increasing pressure on soil, therefore, the natural and archaeological heritage of soil is also being jeopardized. (Conacher *et al.,* 1995). Soil is the upper layer of earth that may be dug or plowed and in which plants grow (Mirriam-Webster, 2019). According to (Geertrui, 2015), soil is a finite, non-renewable resources which continues to degrade, affecting their ability to function and deliver services.

(Senjobi and Ogunkunle, 2011) stated that, lands have been utilized intensely for all purposes at the expense of their stability which have resulted in massive land degradation. Land use in a particular location is based on the extent to which the land characteristics match the use land will be put into. In Nigeria, there is noticeable evidence of land degradation as a result of the use the land is put into (Aruleba, 2004, Senjobi, 2007). The increasing intensity of land use may cause erosion and soil compaction through change in soil physical and chemical properties (Caravaca *et al.,* 2002*).*

Soil fertility maintenance is a major concern in tropical Africa, particularly with the rapid population increase which has occurred in the past few decades; the population increase affected the use of lands for different purposes, with each land use having its effects on the soil and environment. (Mulongey and Merck, 1993). It is noted that long practices of deforestation and or replacement of natural forest, by agro ecosystem and uncontrolled over grazing have been the major cause for soil erosion and climate change (Bernoux *et al.,* 1998). While land use is one of the main drivers of environmental change leading to global warming and climate change according to (Karlen et al., 2003), (Castro et al.,2002) indicated that, land use influences soil aggregation, aggregate stability and overall soil health.

1.1 OBJECTIVE

The objective of this study, is to determine the nutrient status of the soil under various land uses within the ugbowo campus of University of Benin, Benin City, Edo State.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 LAND.

This is the solid part of the surface of the earth, (Mirriam-Webster 2019). It is the solid surface of the earth that is not permanently covered by water (Michael *et al.,* 2013). According to UN1994*,* FAO/UNEP 1994), it is delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere, immediately above or below this surface, including those of the near surface climate, the soils and the terrain forms, the surface sedimentary layers and the associated ground water reserve, the plant and animal populations, human settlement pattern and physical results of past and present human activities. Agricultural Land is the land that is arable and regularly tolled for the production of annual field crops, with or without irrigation (UN 1994, FAO/UNEP 1994). The vast majority human activity throughout history has occurred in land areas that support agriculture habitat and various natural resources. (Michael *et al.,* 2013)

2.2 SOIL

Soil is defined as the upper layer of the earth that may be dug or ploughed and in which plant grows it is the superficial unconsolidated and usually weathered part of the mantle of the earth, (Mirrian-Webster, 2019). (Brady *et al*., 2008), posited that soil is the collection of natural bodies occupying parts of the earth's surface that is capable of supporting plants growth and that has properties resulting from the integrated effects of climate and living organisms acting up on parent materials, as conditioned by topography over periods of time . It is a solid natural body that contain a mixture of minerals, organic matter, gasses liquid and countless organisms (Christensen*,* 2001).

2.3 CONCEPT OF LAND USE

Land use is the management and modification of natural environment or wilderness into built environment such as fields, pastures, settlement and managed wood land. (FAO 1997), Ameztegui *el al., (*2016) defined land use, as the modification of the natural environment or wilderness for use by man such as for settlements, semi-arable habitats which include arable fields, pastures and managed woods, industrial use, construction of transportation facilities and recreational use among others.

2.4 AGRICULTURAL LAND USE

Land can be used agriculturally to

i) . Provide sites for crop agriculture, grazing, fish pond establishment and afforestation.

ii). Provide physical support and food for plants which is in turn the basis of animal nourishment.

iii). Provide raw materials for industrial production and consumption.

The use of land is important and inevitable, especially with the exploding population and with this, an increased demand of her resources (Sunada *et al,* 2012)

2.5 TYPES OF LAND USE

There are two major kind of land use and they are: Multiple land use and Compound land use.

2.5.1 Multiple Land Use. This can be referred as the use of land aimedproduct and or services at generating more than one type of product or services. It is when more than one kind of use is made simultaneously of the same piece of land (Chabra *et al.,* 2006). (FAO, 2019) noted that a timber plantation can be used simultaneously as recreational area.

2.5.2 Compound Land Use

Compound land utilization type is made up of more than one kind of use undertaken on areas of land which for purposes of evaluation are treated as a single unit. The different kind of uses may occur simultaneously in different areas of land within the same organizational unit or in time sequence (eg. as in crop rotation). Mixed farming involving grazing and both arable use is a typically example of compound land utilization (FAO, 2019).

2.6 SOIL PHYSICAL PROPERTIES

Soil physical properties affects movement of air, water and dissolved chemicals through soil as well as conditions affecting germination, root growth, and erosion processes. Soil physical properties form the foundation of several chemical and biological processes, which may further be governed by climate, land scape position and land use. (Mangi *et al.,* 2018).

2.6.1 Soil structures

It is the spatial arrangements and of individual particles, their aggregates, and of pore's which plays a multifaceted key role in the factors determining crop and vegetation performance (Brussard and Kooistra, 1993).

2.6.2 Soil Texture

Soil texture is what determines to a certain extent the number of physical and chemical properties of soils. It affects the infiltration and retention of water, absorption of nutrient, microbial activities, soil aeration, tillage and irrigation practices (Gupta, 2004). The rate of increase in stickiness or ability to mold as the moisture content increase, depend on the clay and silt content, the organic matter content of the soil and the degree to which clay particles are bound together into stable granules (White, 1997). Weil (2002) posited that over long period of time pedogenic processes such as erosion, deposition, eluviation and weathering can change the texture of various soil horizons

2.6.3 Soil Total Porosity

Forth (1990) stated that as soil particles vary in size and shape, pore spaces also vary in size shape and direction. In soils with the same particles density, the lower the bulk density, the higher the percent total porosity. There is close relationship between relative compaction and the macro-pore spaces of soils (Ike and Aremu, 1992). Accordingly, tillage reduces the micropore spaces and produces a discontinuity in pore space between the cultivated surface and the subsurface soils. (Aremu, 1992). Considering the surface soils, it was observed that the total porosity of soils usually lies between 30% and 70% (Forth, 1990). And from research findings, Wakens (2001) stated that, lowest total porosity (36.2%) was observed on the abandoned research field, 41% was observed on the land left fallow for twelve years and the highest being (56.7%) was recorded on the farmers field.

2.6.4 Soil Bulk Density

Soil bulk density increase in the 0-10 cm and 10-20 cm layers relative to the length of time the soils where subjected to cultivation (Mulugeta 2004). It was reported that bulk density was higher at the surface than the subsurface horizons in the abandoned and lands a left fallow for years (Wakene, 2001). Particles density is the mass or weight of a unit volume of soil solids. It affects soil porosity, aeration and rate of sedimentation of particles. The main particle density of most mineral soils is about 2.60 to 2.75g/cm^3, but the presence of iron oxide and heavy minerals increase the average value of particle density, and the presence of organic matter lowers it (Hillel, 1980).

2.6.5 Soil Water Content

Available soil water is that portion of stored soil water that can readily be absorbed by plants. Soil water enhances various soil physiochemical reactions and supplies essentials nutrients for plants and animals including micro and macro organisms residing in soil in order that they can carry out their own activities (Tisdale *et al*., 1995). Tekilu (1992), said that soil with high amount of clay, have higher amount of water both at 1/3 and -15 bars than soils with low amount of clay content and thus, water retention capacity of a soil is a function of silicate clay and amorphous materials.

2.7 SOIL CHEMICAL PROPERTIES

Brandy *et al.,* (2002) stated that chemical reactions that occur in the soil, affects processes leading to soil development and soil fertility build up. Soil chemical properties are the most important among the factors that determines the nutrient supplying power of the soil to the plants and microbes.

2.7.1 Soil Organic Matter

Soil organic matter is defined as any living or dead plant and animal materials in the soil and it comprises a wide range of organic species, such as humic substance, carbohydrates, proteins, and plant residues (Dudal *et al.,* 1993). Soil organic matter arises from debris of green plants, animal residues and excreta that are deposited on the surface and mixed to a variable extent with the mineral component (White, 1997). Foth, (1990) posited that the distribution of organic matter, expressed as organic carbon, is 38% in trees and ground cover, 9% in forest floors and 52% is in the soil including the roots plus the organic matter associated with soil particles. Oldman (1993) argued that, biological degradation is frequently equated with the depletion of vegetation cover and organic matter in the soil, but also denotes the reduction of beneficial soil organisms that is important indicator of soil fertility. Miller *et al.,* (2001) posited that uncultivated soils have higher soil organic matter (both on surface and in soil) than those soils cultivated for years.

Land management practices which reduce soil fertility, will seriously decrease it chemical activity and also its ability to hold plant nutrients (Assefe, 1978).

2.7.2 Soil Reaction (pH) and Electrical conductivity

Usually expressed as soil pH value; soil reaction is the degree of soil acidity or alkalinity, which is caused by particular chemical, mineralogical, and or biological environment. Soil reaction also affects nutrients availability and toxicity, root growth and microbial activity (Miller *et al.,* 1995).

Descriptive terms used to refer or commonly associated with certain pH ranges are

i. Extremely acidic (pH <4.5),
ii. Very strong acidic (pH 4.5-5.0),
iii. Strongly acidic (pH 5.1-5.5),
iv. Moderately acidic (pH 5.6- 6.0),
v. Slightly acidic (6.1-6.5),
vi. Neutral (pH 6.6-7.3),
vii. Slightly alkaline (pH 7.4-7.8),
viii. Moderately alkaline (pH 7.9-84),
ix. Strongly alkaline (pH 8.5-9.0) and

x. Very strongly alkaline (pH >9.1). Foth *et al.,* 1997.

Land use type has great effects on soil pH and electrical conductivity as the relative amount of H and Ai ions in the different land use will eventually determine their acidity or alkalinity (Gebeyaw, 2007).

It was noted by Gebeyaw (2007), that grazing land is always associated with having high amount of E.C (electrical conductivity) and this he said, is due to the high amount of Na^{+} content in such land use and also, arable land with low value. Of EC is attributed to base forming cat ions (Ca^{2+} and Mg^{2+}).

2.8 FERTILE SOIL

A fertile soil, is soil that can supply nutrient for plant use at the adequate requirement, it has an abundance of nutrients for plants, including nitrogen (N), phosphorus (P), potassium (K) and abundance minerals, including Zinc (Zn), Manganese (Mn)., Chlorine (Cl), Molybdenum (Mo) and Organic matter. Its pH ranges from 5.5-6.2 and it possesses good drainage

(Ecochem, 2014).

2.8.1 Land Use Effect on Soil Fertility

Land use influences basic soil resources and is considered as one of the main drivers of many processes of soil change. (Antonio *et al.,* 2014). The impact of land use changes on soil can occur so unnoticed that land managers hardly contemplate initiating ameliorative measures (Antonio *et al.,* 2004). Basic remedy to ameliorating the effect of land use on soil fertility, could be simply by Forest conversion to cropland and reduction of tillage intensity in some region, while abandonment of agricultural fields can be a major remedy in other regions (Antonio *et al.,* 2014*)*.

2.8.2 Effects of Industrialization on Soil Fertility

Amundson *et al.,* (2015) posited that, industrial activities have been the biggest contributor to the problem of declining soil fertility in the last century, especially due to increased mining and manufacturing activities. Mucus *et al., (*2015) Argued that whither it is crude oil, iron ore, or coal, the by products are contamination and they are not disposed off in a manner that can be considered safe to the environment and its underlying soils. As a result, the industrial waste lingers in the soil surface for a long time making it unsuitable for use.

2.8.3 Effect of Construction And Infrastructural Development on Soil Fertility.

Prior to any construction work, the topsoil is always removed or excavated and carted away, this greatly affects or invariable led to the removal of almost all important soil parameters, ranging from organic matter to soil microbes and even plants that may be present or found. It is this top soil that is rich in organic matter (Yihenew *et al., 2015*). In soil where construction is carried out, there is reduced fertility due to the removal of its protective cover by excavation (Yihenew *et al.,* 2015). This removal leads to the destruction of soil microbes which helps the soil in maintaining her fertility, structure and to respond to disturbance (Griffith *et al*., 2013). More so, Woldeamlak, (2003) stated that, the finer soil particles in this construction excavated area when not properly managed, will be removed by erosion, thereby increasing the proportion of the coarser particles in the soil, similarly it will also result in reduction of soil pH, hence the soils in the area become more acidic (Alemayehu *et al*., 2013). Tromp-van *et al., (2006)* noted that by these construction activities, living organisms from bacteria to animals and plants present in the soil, some of them which include ants, bacteria fungi ,micron anthropoids, nematodes, earth worms, springtails protozoans, termites and yeast which play important roles in soil nutrient cycling and development are easily disturbed or destroyed, with their elimination / disturbance capable of leading to undesirable changes in soil moisture relations, soil structure, soil fertility and plant and animal communities.

2.8.4 Effect of Agricultural Activities on Soil Fertility.

Joseph, (2015) stated that, soil compaction, deep root removal, tillage, synthetic fertilizer, insecticides, fungicides and herbicides all damage the soil by reducing air pore size altering drainage, erosion, eliminating healthy populations of mycorrhizae, beneficial worms, insects and bacterial as well as providing a good environment for pest species to thrive without natural competition. It is now well known that modern agricultural practices have a trade -offs in terms of their impact on the environment, biodiversity and livelihoods (Prakasa, 2015).

Subba Rao, (2015) posited that, agriculture must literally go back to its roots by rediscovering the importance of healthy soil using natural sources of plant nutrition, and using mineral fertilizer wisely.

Soil and plant health is interrelated with animal/human health, whatever pollutants and contaminants added incidentally to soil, may affect the plant-animal/human system (Subba Rao, 2015). Advanced machinery and equipment and improved plant varieties are used, commercial fertilizer, pesticides, animal manures etc., are added to soil every season /year (Annangi *et al.,* 2015). These practices over time may affect the soil health and also may affect the water quality with the soil biodiversity of the area. (Annangi *et al.,* 2015).

Agricultural activity, affects soil fertility by degradation of soil texture, destruction of useful microorganisms in the soil through addition or use of chemical products (Harmachi, 2015)

The dominant features of current intensive agriculture are mono culture, continuous cropping, new seed conventional tillage, cultivation even on sloppy lands, intensive stock systems, use of unbalanced fertilizers from low to heavy varieties of limited number of crops, not only reduce biodiversity of crops but also insects and other beneficial organisms necessitating use of more pesticides. Continuous cropping without break or fallow, may exhaust soil nutrients as all nutrients cannot be replaced by fertilizer or manure (Annangi, 2015). Conventional tillage may accelerate decomposition of soil organic matter and contribute to CO2 in the environment. Cultivation on sloppy lands leads to loss of soil, water and nutrients.

Livestock enterprises contribute to methane envision. Fertilizers use is an essential component in intensive agriculture, excess use of N may lead to NO3 leaching and ground water pollution and N2O emission may contribute to the global warming. Excess P fertilizer use, may accumulate P in soil. Excess irrigation may deplete underground water resources and also cause water logging and salinization. (Subba, 2015., Bachir, 2015, Joseph ,2015., Susan *et al.,* 2015.). Those countries whose agricultural practices are limited in the sense of little or usage of pesticide/herbicides /fertilizer, who are subsistence in nature cause less impact on the quality or fertility of soils.

These nations who's rely heavily on pesticide/ herbicides/fertilizer can also do have a major impact on soil quality/fertility (George, 2015).

Despite numerous negative effects of agricultural activities on soil fertility, Balloni *et al.,* (1987) discovered that activities such as tillage, crop rotation and fertilization improve the physical condition of the soil bacteria and admits large quantities of oxygen which are necessary for growth of aerobic organism. He further argued that this treatment is of great importance in soil fertility, because they produce in the soil favorable physical and chemical conditions for plant growth and also create more favorable conditions for the activity of the microbes which effects more rapid liberation of the soil nutrients.

Biological soil fertility is also increased in soils subjected to crop rotation than in soils with monoculture, since the succession of different rhizospheric microbial production exact a positive effect on the organic matter transformation and on biological nitrogen fixation and also against the pathogenic plant microbes (Balloni *et al.,*1987).

2.9 INPROVING SOIL FERTILITY.

It's well known that food is life and we need to maintain the soil fertility if we must keep producing crops it is therefore essential that we sustain the soil fertility not just for our immediate use alone but for future use even by our children yet on unborn (Vanlauwe *et al.,* 2006). The soil is as important to human existence as the oxygen we inhale. We need to grow crops if we are to survive (Hume *et al.,* 2003).

Below are some agricultural practices that is known to improve soil fertility

i). Compost use.

ii). Fallowing.

iii). Fertilizer.

iv). Crop rotation.

v). Manure

vi). Crop residue

vii). Inter cropping

viii). Conservative agriculture

2.9.1 Compost

Compost are organic material derived from plant and animal dungs or dropping, it is organic matter that has been allowed to decomposed and recycled as a fertilizer and soil amendment.

It is very rich in nutrient and very beneficial in acting as soil conditioner, a fertilizer, and addition of vital humus and as a natural pesticide for soil. It is also said to be useful for erosion control, land and stream reclamation, wet land construction and as landfills cover (Radovich *et al.,* 2011).

2.9.2 Fallowing

Improved fallow management has the potential to capture nutrients within the system and make them available to plants, to reduce weed, pressure to restore soil organic matter, litter layers and biological activity in the surface soil and to rehabilitate soil micro and macro organisms that were reduced during the cultivation phase (Erika *et al.,* 2017). Fallow function includes weed control and the interruption of pest and disease cycles (Styger, 1990).

2.9.3 Fertilizer trees.

These are trees that capture nitrogen from the air and transport it to the soil through their roots and falling leaves. They are trees used in agroforestry to improve the condition of soils used for framing (Langford, 2011). These trees are also known to help in capturing nutrients from deep in the soil, bring them up to the surface for crops with roots that cannot reach that depth. They are useful for preventing fertilizer erosion, soil degradation and related desertification and improving water usage for crops (Langford, 2011).

2.9.4 Crop rotation

Crop rotation, is the practice of growing of different crops in succession on a piece of land to avoid exhausting the soil and to control weeds, pests and disease (Oxford dictionary' online) it's the practice of growing a series of dissimilar or different types of crops in the same area in sequenced season. It help in reducing soil erosion and increase soil fertility and crop yield (Anderson, 2005)

2.9.5 Manure

They are basically animal dung use for fertilizing land. Green manure is another form of manure and can maintain or improve soil fertility. Green manure fixes nitrogen (N) into the soil (Rosenani *et al.*, 2003).

2.9.6 Crop residues.

These are non-economic plants that are left in the field after harvest and remains that are generated from packing seed or that are discarded during crop processing (Indra *et al*., 2015). Crop residues contribute Nitrogen to the soil as increases Nitrogen recovery (Rosenani *et al.,* 2003).

2.9.7 Inter Cropping

Inter cropping especially legumes with cereals has a potential to not only increase soil fertility but also a potential for increasing forage and consequently livestock production in sub-Saharan African. Inter cropping forage legumes and cereals generally result in higher fodder protein yield.

It help to conserve moisture, soil fertility and close integration of livestock and arable farming (Oram, 1981).

2.9.8 Conservative Agriculture

This is a concept for resources-saving agricultural crop production that strives to achieve acceptable profit together with high and sustained production level while concurrently conserving the environment. (FAO, 2007)

2.10.0 CATEGORIES Of LAND USE UNDER STUDY.

i). ARABLE LAND

ii). FOREST LAND

iii). FALLOW LAND

iv). GRAZING LAND

2.10.1 Arable Land

These are land that is capable of being ploughed and used to grow crops. Arable land is the land under temporary agricultural crops (multiple cropped areas are counted only once), temporary meadows for mowing or pasture land under market, kitchen garden and land temporary fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category (FAOSTAT, 2015). Erostate (2015) similarly refers to actual rather than potential use, "land worked (ploughed or tilled) regularly generally under a system of crop rotation (Schuk *et al.,* 2014),

2.10.2 Forest Land

A forest is a large area dominated by trees. Hundreds of more precise definitions of forest are used throughout the world, incorporating factors such as trees density, function According to widely used Food and Agriculture Organization (FAO) definition, forests covered 4billion hectares (15 million square miles) or approximately 30% of the world's land area in 2006. (UNEP 2010) Forest is the dominant terrestrial ecosystem of earth, and is distribution around the globe (Pan *et al.,* 2013). Forest account for 75% of the gross primary production of the earth's biosphere, and contain 80% of the earth's plant biomass. Net primary production is estimated at 21.9 gigatonnes carbon per year for tropical forest, 8.1 gigatonnes for temperate forests and 2.6 gigatonnes for boreal forest (Robert *et al.,* 2013). Human society and forests influence each other in both positive and negative ways, forest provide ecosystem services to humans and serve as tourist attraction. Forests can also affect people's health. Human activities, including harvesting forest resources can negatively affect forest ecosystems (Vogt *et al.,* 2007).

2.10.3 Fallow Land.

This is farmland that has no crop on it usually for a year, to recover its fertility to grow crops (Kody, 2017). It is a piece of land that is left with no crops on it for a season in order to let it recover its fertility. It is also regarded as a land plowed but not seeded for one or more growing seasons as to kill weeds or make the soil richer (Somander, 2019).

2.10.4   Grazing Land.

This is also called pasture land. They are basically enclosed tracts of farmland grazed by domesticated livestock, such as horses, cattle, sheep or swine. The vegetation of tended pasture forage, consist mainly of grasses with an interspersion of legumes and other forbes (non grass herbaceous plant). Pasture is typically grazed throughout the summer in contrast to meadow which is ungrazed or used for animal fodder (Gulman *et al.,* 1905).

Grazing or pasture lands in the narrow sense, are distinguished form range lands by being managed through more intensive agricultural practices of seeding, irrigation, and the use of fertilizers, while rangelands grow primary native vegetation, managed with extensive practices like controlled burning and regulated intensity of grazing. Soil type, minimum annual temperature, and rainfall are important factors in pasture management (Elfyn,1958).

CHAPTER THREE

3.0 MATERIALS AND METHODS.

3.1 Study Area

This study will be carried out in Ugbowo campus of the University of Benin, Benin City, in Edo State, Nigeria. The area is situated or lies between latitude 6º 23' 26" and 6º 24' 37" North and longitude 5º 36' 09" and 5º 36' 25" East (Ogeh and Ogwunike, 2006). It is a segment of the coastal plain sand commonly referred to as acid sand of Nigeria. The soil type in this area is ultisol Rhodic paleudult (Molindo *et al.,* 2010). The natural climate is humid tropics, the natural vegetation is rain forest, the rainy season is bimodal with peak in July and September. Average rainfall is between 1500-2500mm annually, mean, maximum and temperature are 31 and 21ºC, the soil has been mapped as ultisol with Rhodic palcudult as the modal profile (Ogeh and Ogwurike, 2006).

3.2 Field work

The field work was carried out on four land use types namely, Arable land, Forest land, Grazing land and Fallow land. For each land use, three spots were carefully selected (replicates) and soil samples were taken at two depths, 0-15 cm and 15-30 cm, using a soil auger.

The spots selected are:

Arable Land: Soil sample were taken from Field Experimentation (AGR305) plot; Field Practical Training (FPT) plot and Final Years Special Project Field.

Forest Land: Soil samples were taken from Forestry Arboretum in Faculty of Agriculture; the teak plantation by Vice Chancellor's lodge and the Park and Gardens Mini forest.

Grazing Land: Samples were taken from three spots in the cattle shed beside the vice Chancellor's lodge.

Fallow Land: Samples were collected from fallow fields within the Ugbowo campus.

3.3 Sample Collection

Soil sample were collected in each of the selected land use type at two different depth namely 0-15 cm, 15- 30 cm with a soil sugar.

This was replicated three times. During collection, of samples, old manures, dead plants, furrow, and compost pits were excluded.

Samples from same land use type and depth were bulked together to form a composite sample. Composite samples were air-dried, mixed well and passed through a 2mm sieves for analysis of selected soil physical and chemical properties.

3.4. Soil Laboratory Analysis

The analysis of the soil for their chemical and physical properties was carried out at the faculty of Agriculture main laboratory. Standard procedures were used in the analysis.

3.4.1 pH

The pH of the air dried soil was determined using a glass electrode pH meter at ratio 1:1 and (20 g soil to 20 ml distilled water)and in 1N KCl solution at a ratio of 1:2 soil to water suspension according to Mclean, (1982) method.

20 g of air dried soil was weighed into 100 ml beaker, 20 ml of distilled water was added and the mixture was stirred intermittently for 30 minutes with a stirring rod. The pH meter was standardized with buffer pH 4.0 and 9.0, before the pH of the soil was taken. The reading was taken by dipping the electrode into the liquid part the mixture and the reading recorded.

3.4.2 Organic Carbon Content

This was determined by the chromic acid wet oxidation procedure of Walkley and Black as described by (Black 1965).

1g air dried soil was weighed into 250 ml conical flask, 10ml of 1N potassium heptaoxodichromate (vi) ($K_2Cr_2O_7$) solution was added using a 10 ml pipette and the flask gently swirled to effect proper mixing. Thereafter, 20 ml of concentrated tetraoxosulphate (vi) acid (H_2SO_4) was added violently but carefully to avoid dissipation of heat of the reaction and to enhance complete oxidation, after 30 minutes, 100 ml of distilled water was added with 100 ml measuring cylinder followed by 6 drops of ferroine indicator. The content of the flask was titrated with 0.5N iron (ii) tetraxosulphate (vi) pentahydrate solution ($FeSO_4.5H_2O$) the colour changed from dirty brown to a wine color. A blank titration was carried out (without soil samples). Thus, organic carbon is calculated as;

$$\frac{(Bml-Tml) \times 1.33 \times 0.03f \times N}{\text{Weight of soil sample}} \times \frac{100}{1}$$

Where B(ml)= titre value of blank

T(ml)= titration value

N= normality of $FeSO_4$ Solution

3.4.3 Total Nitrogen

1 g of finely ground soil sample was weighed into a micro kjedahl flask followed by 1.33 g of catalyst mixture. Few drops of distilled water was added to moisten the soil/catalyst mixture. 10 ml concentrated H_2SO_4 was added and the flask was heated in a fume cupboard until digestion was completed and the digest had become green in colour. The flask was cooled slightly and the content diluted to about 50mls with distilled water. The digest was filtered through whatman No. 42 filter paper into 100ml volumetric residue and filter paper several times with aliquot of distilled water.

The nitrogen in the filtrate was determined by the alkaline phenate procedure of Fiore and O'Brien (1962). A set of standard were prepared and the nitrogen content used for the extrapolation of nitrogen content of the samples.

3.4.4 Available Phosphorus Determination

The available phosphorus in the soil samples was determined using Bray and Kurtz (1945) solution. Here a 5 g soil sample that passed through 2 mm sieve was weighed into a shaking bottle and suspension was shaken for 1 minute. The suspension was then filtered through Whatman 42 filter paper. The phosphorus content of the filtrate was determined using the colorimetric molybdenum blue procedure of Riley Murphy (1992). The phosphorus content was extrapolated from a standard curve alongside the samples.

3.4.5 Exchangeable Acidity Determination

10 g soil sample was shaken with 100 ml 1N Kcl for 1 hour on a reciprocal shaker and thereafter filtered through what man No 1 filter paper. 25 ml aliquot of the filtrate was pipetted into a 250 ml conical flask and titrated to a permanent pink end point using 0.01N NaOH and 4 drops of phenolphthalein indicator. Results were expressed as $Cmolkg^{-1}$.

Calculation

$$Meq/100g = \frac{N \times V \times 100}{2.5}$$

Where

N=Normality

V= Litre Volume

2.5= Weight of soil in aliquot meq/100=$cmolkg^{-1}$.

3.4.6 Exchangeable Base (Ca, k and mg) determination

Calcium and magnesium were determine volumetrically by the EDTA titration procedure described by black (1965).

10 g of air cried soil was weighed into shaking bottle. 70 ml of 1N ammonium acetate solution of pH 7 was added with 100 ml measuring cylinder to extract the exchangeable bases. The bottle was covered tightly and shaken for 1 hour on reciprocal shaker thereafter, the soil suspension was filtered through whatman No 42 filter paper into 100 ml volumetric flask and residue washed into three 10 ml aliquots of 1N ammonium acetate of pH 7 solutions.

25 ml aliquot of the filtrate was withdrawn with pipette into 250 ml conical flask, 20 ml of concentrated ammonia solution was added followed by 6 drops of eriochrome black T indicator, the content of the flask was titrated with 0.01 ml of disodium salt of ethylene diamine tetraacetic acid (EDTA) solution and the colour change was sky blue colour as end point.

Potassium was determined from the filtrate by flame photometry as described by black (1965).

3.4.7 Particle size determination

The particle size distribution was determined by the hydrometer method (Boyoucos, 1951) as modified by Gee and Bauder (1986).

50 g of air dried soil was weighed into shaking bottles and 20 ml of 10% calgon solution (sodium hexameta phosphate) was added to soil. Then 50 ml distilled water was added and shaken for 1 hour on a reciprocal shaker. The sample was transferred quantitatively into 100ml measuring cylinder and made up to mark with distilled water. The first reading was taken when the cylinder was dropped on the platform within 40 seconds, the percentage silt + clay was determined with in the 40 seconds.

The second reading was taken after 2 hours. The percentage clay was determined after 2 hours.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Effect of land use types on soil chemical properties

The physical and chemical properties of the soil under different land uses in Ugbowo campus of University of Benin, Benin City are shown in Table 1.The pH of the top 0-15 cm of the soils range from very strongly acidic (4.5), in fallow land to moderately acidic (5.5) in forest land. Arable land and grazing land were slightly acidic with pH values of 5.9 and 6.2 respectively. It was also observed that pH values decreased in the soils with depth in some of the land uses. While fallow land recorded 5.0, in the 15-30cm depth, grazing land recorded 6.5. Forest land and Arable land recorded a slight increase of 5.2 and 5.3 in their pH values in the 15-30cm depth compared to their respective values in their 0-15cm depth. This is in accordance with the findings of Michael *et al*., 2010 who reported that soils under forest land uses have higher pH values than cultivated soils. The total Organic carbon (C) in the soils decreased with soil depth in both Forest and arable land use types. In the 0-15cm depth, the grazing land (8.1795 g/kg) had the highest Carbon (C) whereas the fallow land, had the lowest Organic carbon of (2.5935g/kg). The total Organic Carbon (C) decreased in the following order in the 0-15cm and 15-30cm depth:

Grazing Area > Arable Land > Forest land > Fallow site, and

Grazing Area > Arable Land > Fallow land > Forest land

The total nitrogen (N) in the soil increased with depth in all the land use types; however the highest total nitrogen value (31.29g/kg) and lowest value (15.12g/kg) were obtained at the grazing land and forest land respectively in their 15-30cm depth. Although, it was observed that in the 0-15cm depth, fallow land had the lowest Nitrogen (N) of 5.04g/kg value while grazing land had the highest value of 14.07g/kg respectively.

In all the land use types the, the Nitrogen content decreased in the following order in their 0-15cm depth,

Grazing Land > Forest Land > Arable Land > Fallow Land,

While it decreased in the following order in their respective 15-30cm depth:

Grazing Land > Arable Land > Fallow Land > Forest Land.

The Total Nitrogen (N.) increased with depth in all the land uses, while the Available Phosphorus P increased in all the land uses except in Arable land use total Potassium (K.) content increased with depth in all the land uses with the exception of arable land.

The Exc. acidity increased with depth in the Grazing land and showed a decrease in the, forest, arable and fallow lands.

The Calcium (Ca.) content in all the land uses decreased slightly with depth with an exception of the fallow land. The highest calcium value (0.0287 cmol/kg) was obtained at the grazing land while the lowest value (0.0015 cmol/kg) was obtained at the fallow land. The topsoil of most of the land use types studied had the highest value of calcium except the fallow land

The magnesium content (Mg) increased with depth in both the forest and the Grazing land and decreased slightly in both the Fallow and the arable land use. The highest value (15.4726 cmol/kg) was obtained in the grazing land while the lowest value (2.4875 cmol/kg) was obtained at the fallow land in their 15-30cm depth respectively.

The Sodium (Na) content for the grazing, fallow and arable land use types was highest at the depth 15-30cm, and lowest at the depth 0-15 cm, with the forest land depicting a deviance. The grazing land had the highest sodium content (1.2826 cmol/kg) and the arable land had the lowest sodium content (1.2435 cmol/kg). The sodium content (Na) decreased as follows in the various land use types in the following order:

Grazing land > Fallow land > Forest land > Arable land.

The Electrical Conductivity and Exchangeable Cation (ECEC) increased with depth in the Grazing and Forest land and decreased in both the Fallow and Arable land. It was noted by Gebeyaw, (2007), that grazing land is always associated with having high amount of E.C (electrical conductivity) which is due to the high amount of Na+ content in such land use.

The Base Saturation (BS) increased with depth in Forest, Fallow and Arable Land and decreased slightly in the Grazing land.

Distinctively the BS increased in the following order in their respective depths.

Fallow < Forest < Arable< Grazing.

Distinctively the BS increased in the following order in their respective depths.

Fallow < Forest < Arable< Grazing.

THE EFFECT OF LAND USE ON PARTICLE SIZE DISTRIBUTION OF SOIL

The result of the particle size distribution under the different land use types are presented in Table 2. The results showed that the texture of all the land use types were predominantly sandy having a sand percentage ratio ranging from 90.4317% (in both Forest, Fallow and Arable land) to 89.4510% (in Grazing land); Clay fraction/ percentage ranged from 9.2941% (in Grazing land) to 8.3137% (in Forest, Fallow and Arable lands) and Silt percentage ratio of 1.2549% was recorded in virtually in all the land use types in their 0-15cm depth and varies in percentage ratio ranging from 4.1961% (in Forest land) to 2.2349% (in fallow land) to 1.2549% (in Arable land) to 0.2745% in (Grazing land) in their respective 15-30cm depth . It could be deduced, that the similarity in the textural class in the land use types mentioned herein could be attributed to the fact that soil texture is not readily influenced by soil management or land use types (Oyedele *et al.,* 2009).

TABLE 1: CHEMICAL PROPERTIES OF SOIL UNDER DIFFERENT LAND USE TYPES

Land Use Types	Depth	pH H2O	Org g/Kg	Total N g/Kg	Avail P Mg/Kg	Exc. Acidity Cmol/Kg	K Cmol/Kg	Ca Cmol/Kg	Mg Cmol/Kg	Na Cmol/Kg	ECEC	BS
FOREST	0-15	5.5	4.9875	7.245	55	1.44	0	0.01584	6.16915	1.26347	8.88847	83.7992
	15-30	5.2	0.7980	15.12	57.50	1.36	0	0.01435	7.52902	1.25565	10.1590	86.6129
GRAZING	0-15	6.2	8.1795	14.07	402.50	0.32	0.52689	0.02871	14.6766	1.25217	16.8044	98.0957
	15-30	6.5	8.1795	31.29	405.00	0.80	0.42967	0.02871	15.4726	1.28261	18.0136	95.5589
FALLOW	0-15	4.5	2.5935	5.04	11.25	1.60	0	0.00099	3.74793	1.24696	6.59587	75.7424
	15-30	5	4.9875	22.96	25.00	1.12	1.39642	0.00149	2.48756	1.26	6.26546	82.1242
ARABLE	0-15	5.9	6.5835	6.23	402.50	1.12	0.05115	0.02376	14.0299	1.21913	16.4439	93.1890
	15-30	5.3	5.5860	28.91	355.00	0.40	0	0.01980	7.01492	1.24348	8.67821	95.3908

Table 2: THE EFFECT OF LAND USE ON PARTICLE SIZE DISTRIBUTION OF SOIL

Sites	Depth (cm)	Clay →	Sand %	← Silt
Forest Land	0-15	8.3137	90.4313	1.2549
	15-30	8.3137	87.4902	4.1961
Grazing Land	0-15	9.2941	89.4510	1.2549
	15-30	10.2745	89.4510	0.2745
Fallow Land	0-15	8.3137	90.4314	1.2549
	15-30	6.3529	91.4118	2.2353
Arable Land	0-15	8.3137	90.4314	1.2549
	15-30	10.2745	88.4706	1.2549

Source: Authors' Fieldwork. 2019.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The Fallow land had the lowest values of nutrients, it is characterized by its high percentage ratio of its sandy soil content, with a very low amount of clay soil and very little amount of grass/ plants cover. The fallow land understudied, is found to be always undergoing vegetative cover removal in form of clearing, exposing the land to direct impact of climate encouraging leaching and destroying the microbial environment. Furthermore, the high nutrient uptake of these vegetative cover before they are cleared/removed and leaching can be said to be the major cause of nutrient depletion.

The Forest land was found to be very fertile due to the low agricultural activities and high amount of decomposed organic matter in form of the leaves and other debris under the canopy of the trees planted in the system. This canopy prevents these ambient environments from the direct impact of elements of climate and create environment that favours and encourages the activities of micro-organisms.

The Grazing land appeared to be the most fertile which can be attributed to the accumulation of organic matter from the decomposition of organic waste/dropping and dung from the grazing animals, low silt, and the low rate at which nutrient is lost since there is no agricultural activities and plants removing nutrients.

5.2 Recommendation

From this study, it is clearly discovered that the act of leaving a land fallow and also constantly removing /clearing of its vegetative cover is seen to be counterproductive to the original intention of practicing land fallowing, thus, any land being left fallow, no form of agricultural activity (vegetative removal/clearing) should take place. Proper and effective fallow period should be maintained to enable nutrient retention and conservation

Conclusively, in other to help increase or replenish the nutrient content depleted due to crop removal and tillage in the arable land, agricultural practices like soil conservation system e.g., cover cropping, mulching, shifting cultivation, and crop rotation should be encouraged and additional input of organic or inorganic fertilizer can be used where required to improve soil fertility.

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