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Effect of Enset(Enset Venitercusem) Based Land Use on Soil Properties in Southern Ethiopia : A Review

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ABSTRACT

Land use influences soil characteristics and governs sustainable use of soil resources in an Ethiopia. The acidic soils in highland areas of Ethiopia limit crop productivity due to unfavorable soil conditions for the plant growth. A choice of land use that alleviates the soil acidity and improves soil properties may go a long way in maintaining soil quality and its productivity potential. Therefore, this review was focused principally on the potential land use minimizing the ill effect of soil acidity and improving the soil from the prevalent enset, grassland and cereal based land uses in Southern, Ethiopia. Soil nutrient and organic matter depletion, acidification and soil erosion losses as result of inappropriate land use practices have become major cause of concern for agricultural soils in the Ethiopian highlands. Different research result indicated in Ethiopia the enset based land use type significantly decreased soil acidity (pH and exchangeable acidity) and improved other physical (bulk density, total porosity, soil moisture content) and chemical (contents of organic matter, total N, available P and exchangeable basic cations, Cation exchange capacity, percent base saturation and contents of acidic cations) characteristics compared to grassland and cereal based cultivated land. The grassland use also effected significant improvement in soil characteristics, except content of available P, compared to cereal based land use.

Keywords: Land Use, Soil Acidity, Soil Depth, Soil Properties

I. INTRODUCTION

Land use is defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Ufot et al., 2016). Successful agriculture requires the sustainable use of soil resource, because soils can easily lose their quality and quantity within a short period of time for many reasons. Agricultural practice therefore requires basic knowledge of sustainable use of the land. A success in soil management to maintain the soil quality depends on the understanding of how the soil responds to agricultural practices over time. Recent interest in evaluating the quality of our soil resource has been simulated by increasing awareness that soil is critically important component of the earth's biosphere, functioning not only in the production of food and fiber but also in the maintenance of local, regional, and worldwide environmental quality (Alemayehu and Sheleme ,2013).

Land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization, and leaching, etc. (Celik, 2005; Liu et al., 2010). As a result, it can modify the processes of transport and re-distribution of nutrients. In non-cultivated land, the type of vegetative cover is a factor influencing the soil organic carbon content (Liu et al., 2010). Moreover, soils through land use change also produce considerable alterations (Fu et al., 2000), and usually soil quality diminishes after the cultivation of previously untilled soils (Neriset al., 2012). Thus, land use and type of vegetation must be taken into account when relating soil nutrients with environmental conditions (Liu et al., 2010.

The associations of soil properties also vary with soil depth. The studies by FantawYimeret al. (2007) and Eyayu Mollaet al. (2009) have shown variations in soil parameters with soil depth under different land uses in south eastern and western Ethiopia, respectively. These studies support the idea that soil properties react to depths across the various land use types.

Soil acidity is one of the main factors that limits and prevents profitable and sustained agricultural productivity in many parts of the world .It is estimated that approximately 50% of the worlds' arable soils are acidic and may be subjected to the effect of aluminum (Al) toxicity of which the tropics and subtropics account for 60% of the acid soils in the world (Sumner and Noble, 2003).

Soil acidity affects the growth of crops because acidic soils contain toxic levels of aluminum and manganese and are characterized by deficiency of essential plant nutrients such as P, N, K, Ca, Mg, and Mo (Wang et al., 2006). The cause of soil acidity could be the type of parent materials from which the soils are formed, leaching of base forming cations, continuous use of acid forming fertilizers such as Urea and DAP. In the tropics, the soil acidity is aggravated by leaching or/and continuous removal of basic cations through crop harvest. At pH below 5, aluminum is soluble in water and becomes the dominant ion in the soil solution. In acid soils, excess aluminum primarily injures the root apex and inhibits root elongation. The poor root growth leads to reduced water and nutrient uptake, and consequently crops grown on acid soils are challenged with poor nutrients and water availability. The net effect of which is reduced growth and yield of crops (Eshetu, 2011).

The pH of the soil solution has a deep influence on nutrient availability, nutrient uptake and ion toxicity to plants. The vast majority of soils cultivated for crop production around the world fall within the neutral, slightly acid and slightly basic pH range (i.e. pH 6-8).This is the general range where nutrient availability is optimal. However, there are soils where the pH falls far from this normal range and these, if not corrected to an adequate range, can pose adverse health effects on plants. Soils that are highly acidic (pH <5.5) or highly alkaline (pH >8) present a range of challenges for the plant, including nutrient availability, ion toxicities, and nutrient imbalances influencing the ion relations and nutrition within the plant itself (Steve Grattan, 2012 and Pushpa et .al, 2015).

It also affects the abundance and activity of soil organisms responsible for transformations of nutrients (De Boer and Kowalchuk, 2001; Nicol et. al, 2008).

Enset (Enset ventricosum) was selected as one of the land uses in the study because it is as old as agriculture in different parts of southern Ethiopia and used as a staple food. The cereal is grown everywhere in the Ethiopia and selected as the second land use. The collective grassland areas formed another important land use system for the sake of comparison for review. The aim of the paper was to review the effect soil properties under different land uses in southern Ethiopia

II. METHODS AND MATERIAL

2.1 Overview of Land use

Land use is the arrangements; activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Ufot et.al,2016).Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. Land use by humans has a long history, first emerging more than 10,000 years ago (Andrea et. al, 2019).

Soil nutrient and organic matter depletion, acidification and soil erosion losses as result of inappropriate land use practices have become major cause of concern for agricultural soils in the Ethiopian highlands (Elias 2002; IFPRI, 2010). In particular, due to the land form of occurrence (high to mountains relief hills with moderately steep slopes) and intensive cereal cultivation and cattle grazing, Nit sols have become disposed to degradation in spite of their high structural aggregate stability to resist erosion (FAO 2001; Elias 2016). Land use changes and cultivation of fields without adequate conservation practices, low levels of fertilizer application and failure to recycle crop residues are among the causal factors.

In some parts of the Ethiopian highlands, steep slopes with gradients as steep as 50% are cultivated without installing adequate conservation measures due to population increase (Assen and Tegene, 2008). Often, resource-poor farmers have a short time horizon, i.e., they are primarily concerned with the crop and animal production of the forthcoming season than the long-term productivity of the soil. Longer-term processes that adversely affect agricultural sustainability such as depletion of soil organic matter and nutrient stocks are less visible and perhaps less notable by farmers (Hailu et.al, 2015; Elias 2016).

A more positive approach should, therefore, take into considerations of the spatial diversities in soil nutrient stocks and land use practices, which are factors driving crop demand for soil nutrients (Elias 2016).

The anthropogenic changes in land use have altered the characteristics of the earth's surface, leading to changes in soil physico-chemical properties such as soil fertility, soil erosion sensitivity and content of soil moisture .These changes may be caused by soil compaction that reduces soil volume and consequently lowers soil productivity and environmental quality (Abad et al., 2014). Soil physical and chemical properties have been proposed as suitable indicators for assessing the effect of land-use changes and management (Janzen et al., 1992; and Alvarez, 2000). This approach has been used extensively by several authors to monitor land-cover and land-use change patterns (Schroth et. al, 2002; Walker and Desanker, 2004; Yao et. al, 2010).

Soil depth (top and sub soil) shows variation on the associations of soil properties. So far, very few quantitative studies have been done to assess the effects of soil depth on soil properties in Ethiopia. Of these, studies by (Fantaw et. al, 2007; Eyayu et .al, 2009) have reported variations in soil parameters with soil depth under different land uses in south eastern and western Ethiopia, respectively. Evaluating land use induced changes and soil depth on soil properties in different parts of the region is essential for understanding the impact of agro-ecosystem transformation on soil productivity and to come up with appropriate and sustainable soil and land management options.

2.1.1 Enset land use

Enset is widely cultivated in the highlands of southern and south eastern Ethiopia. About more than20 percent population of the country concentrated in the highlands and depends up on Enset. It is used for human food, fiber, animal forage, construction materials, medicines, and means of earning cash income and insurance against hunger (Asres and Omprakashr, 2014). Enset plant cover the largest share in Dawuro zone and the total population depends on Enset plant for their food for the level of consumption in household and for marketing. Enset plant grown in all of the zone Woreda including Loma at different agro-ecology and the large share is located in high and middle altitude (Dega and Woyna

Dega) and the fewer shares located in low altitude (kola) (Alemayehu ,2017).

In addition to food and economic value, Enset improves Soil condition by mitigating local climate change, increasing soil fertility and it ameliorates unsuitable soil condition (Abraham et. al., 2012) .As the Chakore and Mekuria, (2015) finding, the mean pH value obtained underneath the enset was 6.94 while that obtained from annual crop land was 6.17, that mean the soil from the enset and annual crop land was nearly neutral and slightly acidic, respectively. Also the Authors, approved that Enset protects the soil from erosion and degradation of soil because of its canopy leaves, abundant accumulation of litter, addition of farm yard manure and house refuse because of the Enset farm is near to the home. Enset land had highest pH values as compared to other land uses types in Central and Southern Ethiopia by ameliorating soil acidity (Hailes-ilassie et.al, 2005, Alemayehu, 2013 and Getahun, 2014).

2.2.2 Cereal land use

A cereal is any grass cultivated (grown) for the edible components of its grain. The term may also refer to the resulting grain itself (specifically cereal grain). Cereal grain crops are grown in greater quantities and provide more food energy worldwide than any other type of crop and are therefore staple crops. Edible grains from cereal crops families, such as wheat, barely, oat, maize, sorghum, millet, teff and others (IDRC, 2016).Cereal farm soils in organic C, total N, total P, and exchangeable basic cations which all together are very important for plant growth and productivity. Crop nutritional management must be oriented so as to achieve economically convenient yields for the producer along with an efficient use of resources and concern for the environment. The use of information about soil chemical properties and experience of the behavior of each species under fertilization conditions with variations in soil chemical properties allow adjusting nutrient rates for different production situations. The basic information about the nutritional requirements of the main cereals cultivated in the world important for nutritional management strategies, and the nutritional value of using residues. This information is a guide for the producer to determine a nutritional management strategy using information provided by analyzing soil chemical properties for different productivity (Hirzel and Undurraga, 2013). Soil acidity affects the growth of crops because acidic soil contain toxic levels of aluminum and manganese and characterized by deficiency of essential plant nutrients such as P,N, K, Ca, Mg, and Mo (Wang et .al, 2006) .Different land use have different level of soil acidity. Getahun et.al,(2014) reported that the soil pH was lowest in cereal lands as compared to Enset land use. Another Authors, Chakore and Mekuria, (2015) showed pH under Cereal land (cropped land) slightly acidic and the Enset land is nearly neutral.

2.2.3 Grass land use

Grassland is another land use system selected for the sake of comparison. It is Protects soil from wind and water erosion. Grass land Provides high quality, relatively inexpensive feed for livestock and wildlife. It was Provides wildlife habitat. Helps maintain soil fertility because it encourages higher levels of soil organic matter than row crops (Wikipedia, the free encyclopedia, 2012). Grass lands to forest conversions currently affect some of the areas and have the potential to modify many soil properties. The optimum soil pH for grassland is at or above 6.3 (Alfredsson H et.al, 1998). The soil pH could be categorized as slightly acidic under maize field whereas that of grassland was moderately acidic (Alemayehu and Sheleme, 2013). The above authors showed that the highest pH = 6.47 and lowest pH = 5.29, were obtained in subsurface of grass land and surface layers of cultivated land, respectively. The range of pH in surface and subsurface layers of all land use types were strongly acidic to slightly acidic. SudarshanKharaletal et.al,(2018) by using grassland, forest land, upland, low land, and vegetable farms in

Dhading district of Nepal obtained the soil pH was neutral in vegetable farms(6.61), whereas the rest of the land-use systems had acidic soils including grass land.

2.2 Acidic soils

Acid soils (pH<7) are common in humid regions. In these soils, the concentration of H^+ ions exceeds that of OH^- ions. Most plants grow best in soils with a slightly acidic reaction. In this pH ranges nearly all plant nutrients are available in optimal amounts. Soils with pH<6 will more likely be deficient of some of available nutrients for optimal plant growth. Calcium, magnesium, and potassium are especially deficient in acidic soils. In strongly and very strongly acidic soils, Al, Fe, Mn may exist in toxic quantities because of their increased solubility. In addition, these elements will react with phosphates to form insoluble phosphates, on phosphate retention and fixation (Kim, 2010).

The cause of soil acidity could be the type of parent materials from which the soil are formed, leaching of base forming cations, continuous use of acid forming fertilizers such as Urea and DAP . In the tropics the soil acidity is aggravated by leaching or/and continuous removal of basic cations through crop harvest. At pH below 5, aluminum is soluble in water and becomes the dominant ion in the soil solution. In acid soils, excess aluminum primarily injures the root apex and inhibits root elongation .The poor root growth leads to reduced water and nutrient uptake, and consequently crops grown on acid soils are antagonized with poor nutrients and water availability. The net effect of which is reduced growth and yield of crops. Soil acidity is expanding both in scope and magnitude in Ethiopia severely limiting crop production (Wassie, Shiferaw, 2011 and Eshetu, 2011).

Active versus potential acidity: A number of compounds contribute to the decomposition of acidic and basic soil reactions. Inorganic/organic acids, produced by the decomposition of organic matter, are common soil constituents that may affect soil acidity. The H^+ ions may be present in soils as adsorbed H^+ ions in the soil solution. The portion of H^+ ions adsorbed by the clay complex becomes exchangeable H^+ ions. The exchangeable H^+ ions dissociate into free H^+ ions, and the amount adsorbed is usually in equilibrium with the amount free in solution. The chemical conditions created produce a chemical environment showing two types of soil acidities (Kim, 2010).

The types of H^+ ions and the degree of ionization and dissociation into the soil solution determine the nature of soil acidity. The adsorbed, reserve or exchangeable H^+ ions are the reasons for the development of potential, reserve, or exchangeable acidity. The magnitudes of the later can be determined by the titration of the soils the free H^+ ions create the active acidity. Active acidity is measured and expressed as soil pH. This is the type of soil acidity up on which plant growth reacts. However, the tendency exists today to call this exchange acidity salt replaceable acidity which is especially to exchangeable Al^{+3} that can be replaced by un buffered salt solution (e.g. KCl) (Kim, 2010).

Brady and Weil (1996) reported a third type of soil acidity which they called residual acidity**.** It is defined as soil acidity that remains after active and exchangeable acidity has been neutralized. They believe that residual acidity is associated with aluminum hydroxide ions and with Al^{3+} and H^+ ions that are bound in non-exchangeable forms by organic matter and silicate clays. Kim (2010) calls this the remaining soil acidity that cannot be replaced by an un buffered salts solution.

Exchangeable acidity: Exchangeable hydrogen (H) together with exchangeable Aluminum (Al) is known as soil exchangeable acidity. Soil acidity occurs when acidic H^+ ion occurs in the soil solution to a greater extent and when an acid soluble Al^{3+} reacts with water (hydrolysis) and results in the release of H^+ and hydroxyl Al ions into the soil solution (Rowell, 1994; Brady and Weil, 2002). When exchangeable acidity is concentrated in appreciable amounts in the soils with pH range of 4-5 and lower, it produces strongly acidic soil condition (Rowell, 1994). Foth and Ellis (1997) stated that during soil acidification, protonation increases the mobilization of Al and Al forms serve as a sink for the accumulation of H^+. The concentration of the H^+ in soils to cause acidity is marked at pH values below 4 while excess concentration of Al^{3+} is observed at pH below 5.5 (Nair and Chamuah, 1993).

Getahun (2014) stated that the high soil exchangeable acidity in the cultivated and grazing lands than forest land might be associated with the occurrence of lower soil pH in both land use types. The observed high exchangeable acidity in the soils of cultivated land uses were due in part to plant uptake of exchangeable basic cations and in part to mixing up with soil to lower depth through tillage, ploughing and losses through leaching.

2.3. Effect of land use on soil properties

2.3.1 Soil physical properties

2.3.1.1. Soil texture

Soil textures one of the inherent soil physical properties less affected by management. It comprises three components sand, silt and clay. Soil texture determines a number of physical and chemical properties of soils. It affects the infiltration and retention of water, soil aeration, absorption of nutrients, microbial activities, and tillage and irrigation practices. (Khadka,et.al,2016).Although soil texture is considered as a permanent property, Wakene (2001) indicated that management systems may contribute indirectly to changes in particle size distribution particularly in the surface horizons as a result of clay removal through sheet and rill erosion, and mixing up of soils of the surface and subsurface horizons during mechanical tillage activities. Habtamu, et.al, (2014) showed that clay content increased while sand and silt contents decreased with increasing soil depths. Gebeyaw, (2007) also indicated that the proportion of sand and silt fractions decreased with soil depth except for sand in the forest land and silt in the cultivated land soils. Chemada et.al, (2017) stated that the clay content of cultivated land was increased from the surface to subsurface soil layer due to the long period of cultivation. Additionally, Gebrelibanos and Assen (2013) reported that lower clay and higher sand content was found in the surface layer and higher clay contents was found in the subsurface layer of cultivated land than the others adjacent natural forest, plantation forest and grazing lands.

2.3.1.2. Soil bulk density

Soil bulk density is the mass of a unit volume of dry soil and required for the determination of compactness, as a measure of soil structure, for calculating soil pore space and as indicator of aeration status and water content (Barauah and Barthakulh, 1997). Bulk density also provides information on the environment available to soil microorganisms. White (1997) stated that values of bulk density ranges from < 1 g/cm3 for soils high in OM, 1.0 to 1.46 g/cm3 for well-aggregated loamy soils and 1.2 to 1.8 g/cm3 for sands and compacted horizons in clay soils. A typical clay soil has a bulk density around 1.1 g/cm3; a sandy soil's bulk density is approximately 1.3 g/cm3; compacted soils may have a bulk density as high as 1.8 g/cm3 (Minitoba, 2008). Bulk density of soil changes with the change in total pore space present in the soil and it gives a good estimate of the porosity of soil. Bulk density normally decreases as mineral soils become finer in texture. Soils having low and high bulk density exhibit favorable and poor physical conditions, respectively. Bulk densities of soil horizons are inversely related to the amount of pore space and soil OM (Brady and Weil, 2002; Gupta, 2004). Any factor that influences soil pore space will also affect the bulk density. For instance, intensive cultivation increases bulk density resulting in reduction of total porosity. The study results of Woldeamlak and Stroosnijder (2003) and Mulugeta (2004) revealed that the bulk density of cultivated soils was higher than the bulk density of forest soils. Soil bulk density increased in the 0-10 and 10-20 cm layers relative to the length of time the soils were subjected to cultivation (Mulugeta, 2004). Similarly, Ahmed (2002) reported that soil bulk density under both cultivated and grazing lands increased with increasing soil depth. On the other hand, Wakene (2001) reported that bulk density was higher at the surface than the subsurface horizons in the abandoned and lands left fallow for twelve years. Again, Takele et. al, (2014) and Abad et .al,(2014) suggested that the bulk density of cultivated land was higher than that of adjacent grazing land and forest lands at soil depth of 0-30 cm. The changes in the physical soil attributes on the farm fields can be attributed to the impacts of frequent tillage and the decline in OM content of the soils.

2.3.1. 3 Particle density

Particle 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 mean particle density of most mineral soils is about 2.60 to 2.75 g/cm3, but the presence of iron oxide and heavy minerals increases the average value of particle density and the presence of OM lowers it (Hillel, 1980). According to Ahmed (2002), the surface soil layer had lower particle density value than the subsoil horizons and the higher particle density (2.93 g/cm3) was obtained at the subsoil horizons in different land use systems at different elevation. This is attributed to the lower OM content in the subsoil than in the surface horizons.

NYLE C.BRADY, 1990, the spaces occupied by air and water between particles in a given volume of soil are called pore spaces. The percentage of soil volume occupied by pore space or by the interstitial spaces is called porosity of the soil. It depends upon the texture, structure, compactness and organic content of the soil. Porosity of the soil increases with the increase in the percentage of organic matter in the soil. Porosity of soil also decreases as the soil particles become much smaller in their dimension because of decrease in pore spaces. It also decreases with depth of the soil. The pore spaces are responsible for better plant growth because they contain enough air and moisture. Percentage of solids in soils can be determined by comparing bulk density and particle density and multiplying by hundred. Its value generally ranges from 30% in compacted subsoil to70% in well-aggregated, high-OM surface soils (Brady and Weil, 2008). Kimmins, (1997) reported that porosity is a critically important parameter of soil because it influences the movement of water and gases, which in turn determine the activity of roots and soil organisms. Total porosity decreasing with an increase in depth is apparently due to increasing bulk density with depth (Zeleke and Kibebew, 2009).

2.3.1.4 Soil moisture

Soil water enhances various soil physicochemical reactions and supplies essential nutrients for plants and animals including micro and macro organisms residing in soils to carry out their own activities (Tisdale et. al, 1995; Brady and Weil, 2002). The portion of stored soil water that can readily be absorbed by plants is said to be available water. The increases of these three components of soil moisture with depth were correlated positively with the clay fractions of the soils, which increased with profile depth. Ahmed H, (2002) who reported that soil water content increase with depth for soils under different management practice. Variation in topography and land use affects the distribution of soil moisture (Brady and Weil, 2002).

2.3.2 Soil Chemical Properties

2.3.2.1 Total Nitrogen (N)

Nitrogen (N) is the fourth plant nutrient taken up by plants in greatest quantity next to carbon, oxygen and hydrogen, but it is one of the most deficient elements in the tropics for crop production (Mesfin, 1998).Most of soil N is in organic form (NH_2^-) and is only made available to plants through mineralization to inorganic $NH4^+$and $NO3^-$and its contents of soils are also needed for the evaluation of C: N ratios of soils (Brady and Weil, 2008). The total nitrogen content of a soil is directly associated with its OC content and its amount on cultivated soils is between 0.03% and 0.04% by weight (Mengel and Kirkby, 1987). Nitrogen was high in the surface horizons and showed a systematic decrease with depth of the profiles (Demelash, 2010). Selassie et .al, 2015, reported total nitrogen content was significantly different among land management practices. Physical soil conservation measures added with manure gave higher TN compared to other measures and the non-conserved lands. Mulugeta and Karl, (2010) cited Selassie et. al, 2015, stated that physical SWC measures alleviated with nitrogen fixing plants have given much higher TN than other biological measures. They also reported the non-conserved land had the smallest mean value of TN compared to the conserved catchment. Gebeyehu, Tilahun and Yeshaneh, (2015) as slope percentage increase the amount of the total nitrogen decreased in the highest (0.104%) and the lower (0.091%) TN values were observed at higher slope (51-64%) and lower slope (10-24%), respectively. In other words, the TN content of a soil is directly associated with its OC content (Mengel and Kirdy,1996,Worku and Hailu,2017) reported the result of soil total nitrogen showed a significant variation with respect to treatments. Nigussie and Kissi (2012), Ufot et.al, (2016) and Chemada et.al, (2017) stated that the higher total N was obtained under forest land compared to the adjacent grazing and cultivated lands.

2.3.2.2 Soil OM

SOM 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 substances, carbohydrates, proteins, and plant residues (Foth and Ellis, 1997).Soil organic carbon influences the chemical, biological, and physical properties of the soil in ways that are almost universally beneficial to crop production. The most common sources of SOM in farming are crop residues, cover crop residues, manures, and composts. Organic matter has been termed as the lifeblood of soil. It has tremendous impact on the chemical, physical, and biological properties of soil. In most tropical environments, the change of forest land to agricultural land results in a decline of the soil OM content to a newer, lower equilibrium (Woldeamlak and Stroosnijder, 2003). Most cultivated soils of Ethiopia are poor in OM contents due to low amount of organic materials applied to the soil and complete removal of the biomass from the field (Yihenew, 2002), and due to severe deforestation, steep relief condition, intensive cultivation and excessive erosion hazards (Eylachew, 1999)

Uncultivated soils have higher in soil OM (both on surface and in sub soil) than those soils cultivated years (Miller and Gardiner, 2001). In the forest, there is a continuous growth of plants and additions to the three pools of OM: standing crop, forest floor and soil. In the grassland ecosystems, much more of the OM is in the soil and much less occurs in the standing plants and grassland floor. Although approximately 50% of the total OM in the forest ecosystems may be in the soil, over 95% may be in the soil where grasses are the dominant vegetation (Foth, 1990).

Habtamu, et al. (2014) observed the highest (4.6%) Organic carbon on the surface layer of forest land and lowest (1.0%) in the subsurface layer of cultivated land that showed an increase of 34.76% which might be due to high OM content and its oxidation on the surface layer of forest and cultivated lands, respectively. Guo and Gifford (2002) indicated that soils lost 42 - 59% of their soil OC stock upon conversion from forest to crop land in northeastern China and others. Silmara R. Bianchi et al.(2006) stated conversion factor assumes organic matter contains 58 % organic carbon. However this can vary with the type of organic matter, soil type and soil depth.

Conversion factors can be as high as 2.50, especially for sub soils.
As on the study of selases et .al, (2015) stated in the lowest SOC (0.650%) was recorded in continuous and intensive lower slope cultivated fields, whereas the highest SOC (1.88%) in recently cultivated higher slope as compared to other slopes might be due to addition of soil organic matter (SOM) foliage. The lowest SOC in the lower slope cultivated land, on the other hand, could be due to reduced inputs of organic matter, reduced physical protection of SOC as a result of tillage and increased oxidation of SOM. Soil organic matter (OM) contents between the managed and non-managed plots were also significantly different. Tadele et. al, (2011) showed on his study there is variations in mean value of OM could have attributed to the effect of management practices implemented and biomass accumulated.

Selassie et al, (2015) reported physical soil conservation measures complemented with organic manure application raised soil OM content better than soils with only soil bund construction. Mohammed (2003) reported that manure addition had significantly increased the amount of OM level.

2.3.2.3 Carbon to Nitrogen ratio (C: N)

C: N is a ratio of the mass of carbon to the mass of nitrogen in a substance (USDA, 2011). According to Brady and Weil (2002), the C:N ratio in the furrow slice (upper 15 cm) of arable soil commonly ranges from 8:1 to 15:1 the median being between 10:1 to 12:1.Carbon (C) to nitrogen (N) ratio (C/N) is an indicator of net N mineralization and accumulation in soils. Organic matter rich in carbon provides a large source of energy to soil microorganisms. Consequently, it brings population expansion of microorganism and higher consumption of mineralized N. Dense populations of microorganisms inhibit the upper soil surface and have an access to the soil N sources. If the ratio of the substrate is high there will be no net mineralization and accumulation of N (Attiwill and Leeper, 1987). They further noted that as decomposition proceeds, carbon is released as CO2 and the C/N ratio of the substrate falls. Conversion of carbon in crop residue and other organic materials applied to the soil into humus requires nutrients (Lal, 2001).

Plant residues with C/N ratios of 20:1 or narrower have sufficient N to supply the decomposing microorganisms and also to release N for plant use. Residues with C/N ratios of 20:1 to 30:1 supply sufficient N for decomposition but not enough to result in much release of N for plant use the first few weeks after incorporation. Residues with C/N ratios wider than 30:1 decompose slowly because they lack sufficient N for the microorganisms to use for increasing their number, which causes microbes to use N already available in the soil (Miller and Gardiner, 2001). They have further stated that the wider the C/N ratio of organic materials applied, the more is the need for applying N as a fertilizer to convert biomass into humus. Microbial respiration (soil respiration) is defined as oxygen uptake or CO2 evolution by bacteria, fungi, algae and protozoans, and includes the gas exchange of aerobic and anaerobic metabolism (Anderson et.al, 1982). According to the same authors, soil respiration results from the degradation of organic matter (for example mineralization of harvest residues). This soil biological activity consists of numerous individual activities; the formation CO2 being the last step of carbon mineralization. Conditions that favor growth of microorganisms will favor fast decomposition rates: continuous warm temperature, wetness, clay types of texture, suitable soil pH (slightly acidic), and adequate nutrients and absence of other decomposition inhibitors such as toxic levels of elements (aluminum, manganese, boron, chloride), soluble salts, shade, and organic phytotoxines (Miller and Gardiner, 2001). Foth (1990) suggested that low soil temperature, by decreasing the rate of decomposition, appeared to have had an important effect on OM content of the soil.

2.3.2.4 Soil reaction (pH)

PH is a measure of the concentration of H^+ ions in the soil solution or in other words a measure of acidity or alkalinity of a soil. According to Tamirat, (1992) it is mostly related to the nature of the parent material, climate, OM and topographic situations. This soil property can be referred to as a "master variable" because it regulates almost all biological and chemical reactions in soils (Brady and Weil, 2008).

Soil reaction is one of the most unsettled physiological characteristics of the soil solution because availability of nutrients and both soil micro-organisms and higher plants respond so markedly to their chemical environment (Miller and Kissel, 2010; Abdenna et. al, 2013).

Most plants and soil organisms prefer pH range between 6.0 and 7.5. Soil pH is the first parameter to be considered in soil fertility evaluation (Shimeles et. al, 2012). PH values increased with soil depth because less H^+ ions are released from decreased OM decomposition, which is caused by decreased OM content with depth (Herrera, 2005).

The relatively higher pH values (neutral to slightly alkali soils) observed in the soils are due to the low rainfall amount as well as its erratic distribution which is insufficient to leach the basic cations appreciably to depths below the surface soil layers (Samuel ,2006).

Agoume and Birang, (2009) reported that pH of the soil as affected by land use system of an Oxisol in the Humid Forest zone of the Southern Cameroon. In other study conducted by Nega and Heluf,(2013) they found that pH the soil was affected by the interactions of land use changes and the soil depths in Western Ethiopia. Alemayehu and Sheleme, (2013) also found an increment of soil pH at two depths (0-15) and (15-30cm) under enset cultivation followed by maize cultivations.

2.3.2.5 Available phosphorus

Phosphorus is a major essential plant macro nutrient which is needed for plant growth and development. Extensive cultivation of crops along with natural hazards causes depletion of natural phosphate content in the soil (Koralage et. al,2015). It exists in soil at stable chemical compounds and available at any time. Phosphorus deficiency limits plants production (Selassie et.al, 2015). The main sources of plant available P are the weathering of soil minerals, the decomposition and mineralization of Soil organic matter and commercial fertilizers.

Following N, P has more wide spread influence on both natural and agricultural ecosystems than any other essential elements. In most natural ecosystems, such as forests and grasslands, P uptake by plants is constrained by both the low total quantity of the element in the soil and by very low solubility of the scarce quantity that is present (Brady and Weil, 2002). Phosphorus (P) is one of the less mobile plant nutrients in soil and it can be rendered unavailable to plants by fixation and precipitation as insoluble P compounds in most soils. Barber (1984) reported that soils have significant amount of P which is not immediately available to crops and only a small fraction becomes available during crop season. Alemayehu and Sheleme (2013) reported that in all topographic positions and both depths (0-15cm and 15-30cm), highest value of available P was found under enset farms followed by maize and grassland soils The higher available P content at both depths under enset is likely the consequence of long-term manure and house refuse applications and the associated increase in microbial activity. Available P ranged from 2-7 ppm and classified as a low to medium (Mesfin, 2015). Available P indicates a soil P fraction that can be utilized by plants; the sum of water soluble and citrate soluble P. The dynamics of soil P could be affected by land use changes, which often involves changes in vegetation cover, biomass production and nutrient cycling in the ecosystem (Wakene, 2003).

2.3.2.6 Cation exchange capacity (CEC)

The Cation exchange capacity (CEC) of soils is defined as the capacity of soils to adsorb and exchange cations (Brady and Weil, 2002). Cation exchange capacity is an important parameter of soil because it gives an indication of the type of clay minerals present in the soil, its capacity to retain nutrients against leaching and assessing their fertility and environmental behavior. Generally, the chemical activity of the soil depends on its CEC.

The CEC of a soil is highly affected by the amount and type of clay, and amount of OM present in the soil (Curtis and Courson, 1981). Soils with large amounts of clay and OM have higher CEC than sandy soils low in OM. In surface horizons of mineral soils, higher OM and clay contents significantly contribute to the CEC, while in the subsoil particularly where Bt horizon exist, more CEC is contributed by the clay fractions than by OM due to the decline of OM with profile depth (Foth, 1990; Brady and Weil, 2002).

Habtamu, et.al, (2014) observed the highest (32.2 cmol (+) kg-1) Cation exchange capacity was recorded on the surface layer of forest land while lowest (21.6 cmol (+) kg-1) on the surface layer of cultivated land which might be due to high OM content on the surface layer of forest land but low OM, high leaching of basic cations and clay from cultivated land.

As the Lechisa, et.al, (2014) report, the CEC of the soil of all land use types at 20-30 cm was significantly higher than both 0-10 cm and 10-20 cm soil layers in all land use types, generally the present study found that, CEC of the soil of different land use types was low in the top layer except for forest land which was higher in 10-20 cm depth. The decrease in CEC from the bottom to the top soil layer might be attributed to the increase in clay contents with depth. As per the ratings recommended by (Hazelton and Murphy, 2007) overall mean CEC value of forest land was moderate whereas grazing land and cultivated land were classified as low status of CEC value. The Author, Wasihun, (2015) indicated that the highest CEC (32.27 Cmol/kg-1 soil) was registered in grazing land use types soil while the lowest (22.53 Cmol/kg-1) was recorded in cultivated land soil. An exchangeable Cation is one that is held on a negatively charged surface and displaced by another Cation. Cations removed from the exchange sites often are replenished rapidly from other sources, such as OM decomposition, mineral weathering, or release of ions fixed within the layers of clay minerals.

Generally, processes that affect texture (such as clay) and OM due to land use changes also affect CEC of soils. The mean values of CEC were highly significantly different among land management practices. High organic matter and clay contents increase CEC in soils (Yihenew and Getachew, 2013). Similarly, Mulugeta and Karl, (2010)) agreed the idea that high clay soils can hold more exchangeable cations than a low clay containing soils. The mean value of the same parameter from managed plots was higher than that of the non-managed plot. The variation was reported to be due to the soil OM content difference.

Therefore, it is necessary to study and evaluate soil chemical properties to avoid soil nutrient depletion, degradation, and to sustain production.

2.3.2.7 Exchangeable Basic cations.

Soil parent materials contain potassium (K) mainly in feldspars and micas. As these minerals weather, the K ions get released and become either exchangeable or exist as adsorbed or as soluble in the solution (Foth and Ellis, 1997). Unlike N and P, K causes no off-site environmental problems when it leaves the soil system. It is not toxic and does not cause eutrophication in aquatic systems (Brady and Weil, 2002).

Wakene (2001) reported that the variation in the distribution of K depends on the mineral present, particles size distribution, degree of weathering, soil management practices, climatic conditions, degree of soil development, the intensity of cultivation and the parent material from which the soil is formed. In the work of Yitbarek, et.al. (2013) and Duguma et. al, (2014) whose findings was reported that the exchangeable K of soil is higher in the forest land than cultivated and grazing lands.

Exchangeable sodium (Na) alters soil physical and chemical properties mainly by inducing swelling and dispersion of clay and organic particles resulting in restricting water Permeability , air movement , crust formation and nutritional disorders (decrease solubility and availability of calcium (Ca) and magnesium (Mg) ions) (Sposito, 1989). Moreover, it also adversely affects the population, composition and activity of beneficial soil microorganisms directly through its toxicity effects and indirectly by adversely affecting soil physical and as well as chemical properties. In general, high exchangeable Na in soils causes soil Sodicity which affects soil fertility and productivity. Negassa, (2001) reported that intensive cultivation and continuous use of inorganic fertilizers in the cultivated fields that will enhance loss of base cations through leaching, erosion and crop harvest.

In arid and semi-arid regions soil has less potential to be affected by leaching of cations than do soils of humid and humid regions (Jordan, 1993). Soils under continuous cultivation, application of acid forming inorganic fertilizers, high exchangeable and extractable Al and low pH are characterized by low contents of Ca and Mg mineral nutrients resulting in Ca and Mg deficiency due to excessive leaching (Gebeyaw, 2007).

Exchangeable Mg commonly saturates only 5 to 20% of the effective CEC, as compared to the 60 to 90% typical for Ca in neutral to somewhat acid soils (Brady and Weil, 2002). In the work of Alemayehu and Sheleme, (2013) in their results, they revealed that the exchangeable Ca contents of soil was higher on the surface soil layer than the subsurface soil layer due to the association of biological accumulation with biological activity and accumulation from plant residues.

However, Bore and Bedadi, (2015) reported that the exchangeable Ca was increasing with increasing soil depth since it is susceptible and possibility of easily leach downward by runoff and water percolation. The exchange complex was dominated by Ca followed by Mg, K and Na, indicating productive agricultural soils (Bohn, et.al,2001). Exchangeable Mg and Ca distribution was decreased with increasing soil depths. The top 0-10 cm depth was higher in both exchangeable Mg and Ca than the other two depths in all land use types. The higher content of Ex. Mg and Ca in the surface is probably due to forest litter and dead plant accumulation (Lechisa et.al, 2014).

2.3.2.8 Available micronutrients

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. The micronutrients are, Copper (Cu), Iron (Fe), Manganese (Mn), and Zinc (Zn). Recycling organic matter such as grass clippings and tree leaves is an excellent way of providing micronutrients (as well as macronutrients) to growing plants (Brady 2002).

Copper (Cu) is taken up as Cu^{2+},.Cu is a part of plastocyanin, which forms a link in the electron transport chain involved in photosynthesis. Cu is not readily mobile in the plant and its movement is strongly dependent on the Cu status of the plant. Fe is absorbed by plant roots as Fe^{2+}, and to a lesser extent as Fe chelates. For efficient utilization of chelated Fe, separation between Fe and the organic ligand has to take place at the root surface, after the reduction of Fe^{3+} to Fe^{2+}.Absorbed Fe is immobile in the phloem. Fe is generally the most abundant micronutrients with a dry-matter concentration contain about 100 μg/g (ppm).Manganese (Mn) is taken up by plants as the divalent ion Mn^{2+}.It is known to activate several enzymes and functions as an auto-catalyst. Zn is taken up as the divalent Cation Zn^{2+}, (FAO, 2006).

According to available micronutrients, Study conducted by Wasihun et.al, (2015) at Itang-Kir Area of Gambella Region, Ethiopia, higher extractable micronutrient cations (Fe, Mn, Zn and Cu) were available in grazing land use compared to cultivated land. Laiho et.al, (2004) also studied the variability in extractable micronutrient (Fe, Mn and Zn) within floristically defined peat land sites.

III.CONCLUSION

Review was conducted to evaluate the effect of land use on soil fertility under enset, grassland and cereal crop land in Ethiopia. The land use has profound effect on soil properties and productive use of soil resources. The soils of high lands of Ethiopia acidic in nature and are characterized by low soil fertility and crop productivity. The choice of a land use that is productive in nature would go a long way in ensuring sustainable management of soil resources in Ethiopia. The objective of this paper was, therefore, to review the effects of enset, cereal and grassland based land uses on soil properties in Southern Ethiopia, so as to future outline a potential land use for the southern highlands of Ethiopia.

The enset based land use indicated significant improvement in physical and chemical characteristics of soil governing overall soil fertility and productivity. There was decrease in bulk density, increase in total porosity and increase in moisture content under enset based land use compared to grassland and cereal based land use. As for chemical characteristics, there was increase in soil pH, decrease in exchangeable acidity, increase in soil organic matter, increase in total N, increase in available phosphorus, increase in exchangeable basic cations (Ca, Mg, K), increase in Cation exchange capacity, increase in percent base saturation and decrease in acidic cations (Fe, Mn, Zn).

The grassland also had more favorable soil physical and chemical properties than cereal based cultivated land. There was decrease in bulk density, increase in total porosity, increase in soil moisture content, increase in soil pH, decrease in exchange acidity, increase in organic matter content, increase in total N, increase in basic cations (K, Na, Mg), increase in CEC, increase in percent base saturation and decrease in acidic cations (Fe, Mn, Zn) compared to cereal based cultivated land.

IV. Conflicts of Interest

The authors declare that they have no conflicts of interest regarding publication of this paper.

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VI. REFERENCES

[1]. Abad, J.R.S., Khosravi, H., Alamdarlou, E.H., 2014. Assessment the effects of land use changes on soil physicochemical properties in Jafarabad of Golestan Province, Iran. Bulletin of Environment, Pharmacology and Life Sciences 3(3): 296 - 300.

[2]. Abraham Shum bolo, YishakGecho and Melese Tora (2012).Diversity Challenges and Potentials of ENSET (Enseteventricosum) Production: In Case of Offa District, Wolaita Zone and Southern Ethiopia. Food Science and Quality Management ISSN 2224-6088 (Paper), ISSN 2225-0557.

[3]. Ahmed Hussein, 2002.Assessment of Spatial Variability of Some Physicochemical Property of Soil under Different Elevations and Land Use systems in the Western slopes of Mount

Chilalo, Arisi. MSc Thesis, Alemaya University, Ethiopia

[4]. Alemayehu Kiflu and Sheleme Beyene, 2013 Effects of different land use systems on selected soil properties in South Ethiopia. Journal of Soil Science and Environmental Management, Vol. 4(5), pp. 100-107.

[5]. Alfredsson H., Condron L.M., Clarholm M. and Davis M.R. 1998.Changes in soil acidity and organic matter following the establishment of conifers on former grassland in New Zealand.Forest Ecology & Management112: 245–252.Google Scholar.

[6]. Andrea, 2019, Archaeological assessment reveals Earth's early transformation through land use. Science

[7]. Asres and Omprakashr, 2014

[8]. Assen M, AmdTegene B (2008) Characteristics and classification of the soilsof the plateaof Siemen Mountains National Park. SINET Ethiopia J Sci 31(2):89–102

[9]. Baruah TC, Barthakur HP (1997) A textbook of soils analysis.Vikas Publishing House, New Delhi

[10]. Brady N.C and R.R Weil., 2002.The Nature and Properties of Soils.(13thed). Pearson Prentice Hall Inc. 4: 137-142,152-154,168-185,227,487, 17:756-791

[11]. Brady, N.C. and R.R. Weil, 2008.The nature and properties of soils, (14thed).Pearson Prentice hall.Upper Saddle River, New Jersey Columbus, Ohia, USA, 965 pp.

[12]. Celik I (2005).Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. Soil Tillage Res. 83:270–277.

[13]. ChakoroTamire and MekuriaArgaw, 2015.Role of Enset (Enseteventricosum (Welw.)Cheesman) in Soil Rehabilitation in Different Agro-ecological Zones of Hadiya, Southern Ethiopia.American Journal of Environmental Protection. Vol. 4, No. 6, 2015, pp. 285-291.

[14]. Chemada, M., Kibret, K., Fite, T., 2017. Influence of different land use types and soil depths on selected soil properties related to soil fertility in Warandhab Area, HoroGuduruWallaga Zone, Oromiya, Ethiopia. International Journal of Environmental Sciences and Natural Resources 4 (2): 555634.

[15]. Elias E, 2002.Farmers perceptions of soil fertility change and management. In: SOS-Sahel and institute for sustainable development, Addis Ababa

[16]. Elias E, 2016 and IFPR, 2010.Soils of the Ethiopian highlands: geomorphology and properties. ALTERA Wageningen University Research Centre, the Netherlands. ISBN: 978-99944-952-6-9

[17]. Eshetu Lemma, 2011. Assessment of Soil Acidity and Determination of Lime requirement for Different Land Use Types: The Case of Degem Woreda, North Shoa Zone, Northwestern Ethiopia. Environmental Science Program.

[18]. EyayuMolla, HelufGebrekidan, TekaliignMamo and Mohammed Assen (2009). Effects of land use change on selected soil properties in theTaraGedam Catchment and adjacent agro-ecosystems, north-west Ethiopia, Ethiopian Journal of Natural Resources 11(1): 35-62.

[19]. FantawYimer, Ledin, S. and Abdu Abdelkadir (2007).Changes in soil organic carbon and total nitrogen contents in three adjacent land use types in the Bale Mountains, south eastern highlands of Ethiopia.Forest Ecology and Management 242: 337-342.

[20]. FAO (2001) Lecture notes on the major soils of the world. In: ISRIC-ITC-Catholic University of Leuven World soil resources Report No 94. Food and Agriculture Organization, Rome

[21]. Foth, H.D. and B.G. Ellis, 1997.Soil fertility, (2nd Ed). Lewis CRC Press LLC, USA, pp 290.

[22]. Fu B, Chen L, Ma K, Zhou H, Wang J 2000. The relationships between land use and soil conditions in the hilly area of the loess plateau in northern Shaanxi, China. Catena 39:69-78.

[23]. Gebeyaw T. 2007. "Soil Fertility Status as Influenced by Different Land Uses in Maybar Areas of South Wello zone, North Ethiopia". M.Sc. thesis, Haramaya University, Ethiopia.

[24]. Gebrelibanos, T., Assen, M., 2013. Effects of land-use/cover changes on soil properties in a dry land watershed of Hirmi and its adjacent agro ecosystem: Northern Ethiopia. International Journal of Geosciences Research 1(1): 45-57.

[25]. Getahun et. al, 2014. Impacts of Land Uses Changes on Soil Fertility, Carbon and Nitrogen Stock under Smallholder Farmers in Central Highlands of Ethiopia: Implication for Sustainable Agricultural Landscape Management around ButajiraArea.New York Science Journal 2014; 7(2)

[26]. Habtamu A., Heluf G., Bobe B., Enyew A... 2014. Fertility Status of Soils under Different Land uses at Wujiraba Watershed, North-Western Highlands of Ethiopia. Agriculture, Forestry and Fisheries. Vol. 3, No. 5, , pp. 410-419.

[27]. Haileslassie, A., Priess, J., Veldkamp, E., Teketay, D., Lesschen, J.P. 2005. Assessment of soil nutrientdepletion and its spatial variability on smallholders'mixed farming systems in Ethiopia using partialversus full nutrient balances. Agric. Ecosyst.Enviro., 108: 1–16.

[28]. Hailu H, Mamo T, Keskinen R, Karltun E, Gebrekidan H, Bekele T (2015) Soilfertility status and wheat nutrient content in Vertisol cropping systems ofcentral highlands of Ethiopia. Agric Food Secur 4(19):1–10. Doi: 10.1186/40066-015-0038-0

[29]. Hirzel and Undurraga, 2013.Nutritional Management of Cereals Cropped under Irrigation Conditions http://dx.doi.org/10.5772/56095.

[30]. IDRC, 2016.International Development Research Centre".Archived from the original

[31]. Janzen, H.H., Campbell, C.A., Brandt, S.A., Lafond, G. P., Townley-Smith, L., 1992. Light fraction organic matter in soils from long-term crop rotations. Soil Science Society of America Journal 56: 1799-1806Khadka, et.al, 2016

[32]. Kim H.Tan.2010.Principles of soil environmental chemistry.CRCpress.NewYork.

[33]. Kimmins, J.P., 1997. Forest ecology Prentle-Hall, upper Saddle River, New Jersey, USA

[34]. Liu XL, He YQ, Zhang HL, Schroder JK, Li CL, Zhou J, Zhang ZY (2010).Impact of land use and soil fertility on distributions of soil aggregate fractions and some nutrients. Pedosphere 20(5):666–673

[35]. Manitoba, 2008.Soil Management Guide. Agriculture, Food and Rural Initiatives, revised. Covering new ground. Pp 1-153

[36]. MulugetaLemenih, 2004. Effect of land use change on soil quality and native flora degradation and restoration in the Highlands of Ethiopia: Implications for sustainable land management. Doctoral thesis.Swedish University of Agricultural Sciences.

[37]. Nair, K.M. and G.S. Chamuah, 1993. Exchangeable aluminum in soils of Meghalaya and management of Al3+ related productive constraints.J.Indian Soc. Soil Sci. 4(1/2):331-334.

[38]. Neris J, Jiménez C, Fuentes J, Morillas G, Tejedor M (2012).Vegetation and land-use effects on soil properties and water infiltration of Andisols in Tenerife (Canary Islands, Spain). Catena 98:55–62.

[39]. Rowell, D.L., 1994. Soil science: Methods & Applications. Addison Wesley Longman

[40]. Schroth, G., D'Angelo, S.A., Teixeira, W.G., Haag, D., Lieberei, R., 2002. Conversion of secondary forest into agroforestry and

monoculture plantation in Amaziona: consequences for biomass litter and soil carbon stocks after 7 years. Forest Ecology and Management 163(1-3): 131-150.

[41]. SudarshanKharal et al.2018. Assessment of Soil Fertility under Different Land-Use

[42]. Takele, L., Chimdi, A., Abebaw, A., 2014. Dynamics of Soil fertility as ınfluenced by different land use systems and soil depth in West Showa Zone, Gindeberet District, Ethiopia. Agriculture, Forestry and Fisheries 3(6): 489-494.

[43]. Ufot, U.O., Iren, O.B., ChikereNjoku, C.U., 2016. Effects of land use on soil physical and chemical properties in Akokwa area of Imo State, Nigeria.International Journal of Life Sciences Scientific Research 2(3): 273-278.

[44]. WakeneNegassa, 2001. Assessment of important physicochemical properties of Dystric Udalf (Dystric Nitosols) under different management systems in Bako area, western Ethiopia. M.Sc. Thesis Submitted to School of Graduate Studies, Alemaya University, Ethiopia. 93p.

[45]. White, R.E., 1999. Principles and practices of soils science: The soil is the natural resource. Cambridge University Press, UK. 348p

[46]. Yao, M.K., Angui, P.K.T., Konaté, S., Tondoh, J.E., Tano, Y., Abbadie, L., Benest, D., 2010. Effects of land use types on soil organic carbon and nitrogen dynamics in MidWest Côte d'Ivoire. European Journal of Scientific Research 40(2): 211 – 222

[47]. ZelekeTeshome and KibebewKibret, 2009. Characterization of the existing soil management groups in terms of their physical and hydraulic properties at Metahara sugarcane plantation. Proc. Ethiop. Sugar.Ind. Bienn. Conf., 1:93-104

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