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Review on the Effects of Land Use on Soil Physical and Chemical Properties in Ethiopia

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Abstract
Land use is one of the main chauffeurs of many processes of environmental change, as it influences basic resources within the landscape, including the soil resources. Changes in land practice and soil management practice can have a marked effect on soil physical and chemical properties. Depend on the land use soil chemical and physical properties has different effects either positive and negative effects. The purpose of this review paper is to review the effects of land use on the soil physical and chemical properties in Ethiopia. Conversion of land use types from one to another has adverse effects on soil properties, especially overgrazing and cultivation of deforested land. Therefore, the proper soil and water conservation practice are important in the different area to enhance soil fertility and crop productivity. The results of different studies indicate that soil on bulk density (BD), particle density (PD) and total porosity (TP) of the cultivated land is highest than that of forest land. But the grassland had lower bulk density than the cultivated land which could be due to restricted grazing at the grassland to harvest fodder and free grazing on crop lands after harvest and continuous ploughing at the same depth of cultivated lands. Different finding suggested that the highest soil pH values of 5.61 and 5.52 in surface soil were found under the grassland; whereas, the lowest pH and also the organic matter of cultivated soil is low from that of forest land and grass land.From the results of the review it was possible to conclude that conversion of forest lands to cultivated and grasslands had detrimental effects on the soil physio-chemical properties under subsistence farming systems of the different area. It is, therefore, recommended that appropriate and integrated land management options for different land use systems are required to sustain agricultural productivity while protecting the environment. Generally, Land use has great effects on soil physical and chemical properties by different it may affect positively or negatively.
Keywords: Land use type, soil physical and chemical properties
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1. 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, U.O, Iren, O.B, chikere Njoku 2016).

Land use is one of the main drivers of many processes of environmental change, as it influences basic resources within the landscape, including the soil resources(Paz González et al. 2014). Changes in land use and soil management practice can have a marked effect on soil organic matter(Bahilu et al. 2016).

Land-use practices affect the distribution and supply of soil nutrients by directly altering soil properties and by influencing biological transformations in the rooting zone. Although, its consequences vary, land conversion frequently leads to nutrient losses when it disrupts surface and mineral horizons (for example, by mechanical disturbance) and reduces inputs of organic matter(Semahugne W 2008).

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(Alemayehu Kiflu and Sheleme Beyene 2013).

The difference in soil properties among land use and land covers is highly significant at 0-15 cm depth than at 15-30 cm depth. The recommended assessment of land use and land covers at homestead level and sharing experiences for expansion of Agro forestry type of land use between Gedeo and Guji Oromo people are central for sustainable management of natural resources of the watershed(G. Selassie and Ayanna 2013).

In Ethiopia, soil degradation due to inappropriate land use system is threatening the livelihood of millions of people.Similarly, large areas of land at Bako Agricultural Research Center, western Ethiopia, are abandoned within less than threedecades of continuous cultivation. Although, the knowledge of important soil quality indicators is vital for replenishing andmaintaining soil fertility, little information is available in western Ethiopian Alfisols. Therefore, the study was undertakento investigate the important soil quality indicators under different land use systems to provide base line data for futureresearch(Kidanemariam et al. 2012).

In Ethiopia, rapid population growth and environmental factors lead to the conversion of natural forestland and grass- land into cultivated farmland (Tesfahunegn 2016). Such land use changes have contributed to soil degradation and soil loss by deteriorating the soil physical and chemical properties ((Karltun et al ,2013).

Effects of land use changes on the dynamics of selected soil properties ties (Karltun et al., 2013). Soil compaction, the loss of soil structure, soil organic matter (SOM) degradation, undulating terrain, highly erosive rainfall, and inappropriate farm- ing practices make soil highly vulnerable to erosion. Soil erosion is highest in cropland (42 Mt ha−1 average annual rate) compared with 5 Mt ha−1 from grassland. Soil degradation causes the loss of fertile topsoil and reduces the productive capacity of the land. The country lost an estimated USD1 billion per year from both on-site and off-site changes (Bewket, W. and Teferi 2009).

Conversion of land use types from one to another has adverse effects on soil properties, especially overgrazing and cultivation of deforested land. Therefore, the proper soil and water conservation practice are important in the study area to enhance soil fertility and crop productivity(Tufa*etal* 2019).

2.EFFECTS OF LAND USE ON SOIL PHYSICAL AND CHEMICAL PROPERTIES

2.1 Effects of Land Use on Soil Physical Properties

According to the finding of (G. Selassie and Ayanna 2013)the results of soil analyses on bulk density (BD), particle density (PD) and total porosity (TP) of different land usesystems at the two sites are presented based on this finding . The highest BD (0-15 cm) was found in the cultivated land at bothAbechikeli Mariam (1.41 Mg m-3) and Aferfida Georgis (1.40 Mg m-3) followed by the soil under Eucalyptusplantations. In contrast, the lowest BD values of 1.18 and 1.08 Mg m-3 were observed under the natural forest at therespective sites. The high bulk density under cultivated lands was due to the trampling effects.

Table 1:- The Interaction effects of land use with soil depth on soil physical properties in Warandhab area.

Land use type	Sand (%)*		Silt (%)*		Clay (%)*		BD (gcm^{-3})*		FC (%)*		PWP (%)*		AWHC (%)*	
	Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)	
	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
Cultivated land	28.33c	21.00d	27.00b	20.33c	44.67c	58.67a	1.36ab	1.45a	34.17e	40.91c	25.80cd	29.95a	8.37e	10.96d
Grass land	35.00b	27.67c	29.00ab	22.33c	36.00d	50.00b	1.04c	1.17bc	35.16d	40.83c	23.14e	25.06d	12.02d	15.77c
Forest land	51.00a	33.00b	31.00a	31.00a	18.00e	36.00d	1.09c	1.14bc	43.87b	47.13a	26.66c	28.39b	17.21b	18.74a
LSD(0.05)	2.90		2.95		3.09		0.26		0.85		2.23		1.25	
SEM(±)	0.800		0.274		0.156		0.079		0.291		0.364		0.384	

The soil physical properties are rather affected by differing managements. Especially, Eucalyptus saligna plantation is found to have high infiltration capacity and lower moisture content as compared to others. While grazing land is found to have lower infiltration capacity as compared to natural forest. Eucalyptus saligna plantation has more or less similar infiltration capacity with natural forest. High mean bulk density of grazing land and farm land could be due to the pulverizing effects of tillage on farm and high cattle trampling on grazing land especially during wet season. This implies that soil physical properties are more susceptible to effects for the reason of varying managements on the soil with andic characteristics(Fikadu *etal* , 2012).

Soil texture

The soil texture of the different land use types and the upper layers of the different horizons were found to be the same except for that of grassland soil (15 to 30 cm depth), which was clay loam. This suggests that the different land use types did not have effect on the soil texture of the study area, since texture is an inherent soil property that not influenced in short period of time(Alemayehu K and Sheleme B , 2013).

According to (Tufa, *etal* 2019) the interaction of land use types with soil depth, the highest (34.3%) and the lowest(21.3%)value of sand was found on the surface (0-20 cm) soil layer of cultivated and forest lands, respectively.

Table 2:- Interaction effects of land use types and soil depth on selected soil physical properties on Jila Kerensa kebele.

	Sand (%)		Silt (%)		Clay (%)		BD (g cm^{-3})		TP (%)	
	Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)	
Land use types	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
Grass	25.0	24.7	26.0	25.0^{b}	49.0	50.3^{a}	1.09^{c}	1.1^{d}	58.8^{a}	58.5^{a}
Cultivated	34.3	26.3	26.7	22.7^{b}	39.1	51.0^{a}	1.38^{a}	1.36^{a}	47.8^{c}	48.56^{d}
Forest	21.3	25.3	32.7	38.0^{a}	46.0	36.7^{b}	1.15^{b}	1.16^{c}	56.5^{b}	55.9^{b}
Grazing	27.7	25.0	28.7	30.7^{ab}	43.7	44.3^{ab}	1.39^{a}	1.34^{b}	47.6^{c}	49.4^{c}
CV (%)	19.62	18.24	20.55	16.05	17.05	12.51	0.64	0.67	0.61	0.55

There was a significant interaction between the LULC and elevation and the silt percentage of silt (p = 0.001). This means the difference between the LULC at the higher elevations was significantly different from the lower elevations. Further analyses were therefore done separately for each elevation. Both the LULC ($p < 0.001$) and depth ($p = 0.006$) had a significant effect on the silt percentage at the higher elevation. Tukey's multiple 95% comparison test showed that the forest significantly differed from bare land ($p < 0.001$), farm land ($p = 0.004$) and grass land ($p = 0.017$). Thus, forest land was 60% more than bare land and 30% more than both farm land and grass land at this higher elevation. But at the lower elevation, for silt there was a significant difference among the LULCs(Sebhatleab , 2014).

In the croplands of Cheketa Area, the soil constitutes on the average 48% clay, 27% sand and 24 % silt. While in the croplands of Gololcha Area the soil constitutes on the average 46 % sand, 27 % s clay and 27% silt.

ANOVA further ensures soil texture is significantly changing within land uses of in the study areas within the watersheds(Worku etal ,2014).The results of the study revealed that the textural class of all the land use types was clay. Indicating the similarity in parent material. However, clay content in the surface layer (0-20 cm) of the soils varied significantly ($P < 0.05$) among the land use types (Yitbarek ,2013).

Bulk densities

The grassland had lower bulk density than the cultivated land which could be due to restricted grazing at the grassland to harvest fodder and free grazing on crop lands after harvest and continuous ploughing at the same depth of cultivated lands(G. Selassie and Ayanna 2013). The soil bulk density value was significantly ($P \leq 0.001$) affected by land use and by their interaction effects,whereas it was significantly affected by soil depth at $P \leq 0.01$. Considering the main effects,the highest (1.37 g cm-3) mean value of bulk density was recorded on the cultivated land and the lowest(1.10 g cm-3) mean value was found under the grassland The reason for the lowest soil bulkdensity of the grassland could be due to the higher clay content and less disturbance of the soil undergrassland.

The higher bulk density of soil in cultivated land might be due to the practice of ploughing incultivated soil, which tends to lower the quantity of OM of that soil through animal trafficking and expose thesoil surface to direct strike by rain drops(Tufa, *etal* 2019).

Bulk density was only measured in the upper soil layer (0 - 30 cm). The ANOVA result indicates that there was a significant effect of LULC on bulk density ($p < 0.001$). Among the LULC classes bulk density for forest was significantly different from farm land ($p < 0.001$) and bare land ($p = 0.02$). Grass land was also significantly different from farm land ($p = 0.005$). The farm land had the highest average bulk density and forest land the lowest of all LULC types. Farm land had a 0.3 g/cm3 higher BD than forest land and a 0.2 g/cm3 higher BD than grass land(Sebhatleab ,2014).

The finding of (DENG et al. 2016)shows that with different land uses and subsequent cultivation, the bulk density of soils were decreasedwhile the soil porosity and maximum water holding capacity were increased compared with bare land.

Soil Color

Soil color helps to indicate OM content, water content, and oxidation states of iron and manganese oxides in the soil. In Ameleke, there is a difference in soil colour between different land uses. 2.5YR2.5/4 and 10YR3/3 from crop lands, 10YR2/1 and 2.5Y3/2 from agroforestry land and 5YR4/3 from grass lands were identified. On agroforestry land the soil has relatively black color and at the same time the soil has high organic matter content. On crop land soil has dark reddish-brown color. It seems that there is oxidation of iron on cropland use. The soil has reddish black and grayish color on shrub land(Worku 2014).

2.2 Effects of Land Use on Soil Chemical Properties

Land use/cover changes from natural forest to different land uses types and the resultant deterioration expected for soil chemical properties are found to be resistant to change on soil with andic nature(Fikadu *etal* , 2012).

Table 3:- Interaction effects of land use and soil depth (cm) on some chemical properties of soils in Warandhab area.

Land use type	pH (H_2O)*		pH (KCl)*		SOM (%)*		Total N (%)*		C/N ratio*		AvP (mg kg^{-1})*		EA ($cmol_{(+)} kg^{-1}$)*	
	Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)		Soil depth (cm)	
	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
Cultivated land	5.29f	5.72d	4.17e	4.43d	3.60d	1.83f	0.18d	0.09f	11.60bc	11.65a	16.00a	14.67b	0.27a	0.20ab
Grass land	5.99b	6.47a	4.83b	5.59a	6.21b	3.30e	0.31b	0.17e	11.60bc	11.58c	4.00c	1.67d	0.20ab	0.10b
Forest land	5.36e	5.83c	4.42d	4.60c	8.37a	4.75c	0.42a	0.24c	11.59bc	11.62b	14.67b	2.67d	0.17ab	0.17ab
LSD(0.05)	0.02		0.01		0.11		0.01		0.02		1.13		0.11	
SEM(±)	0.005		0.003		0.032		0.002		0.007		0.389		0.026	

Soil Organic matter and Soil Organic carbon

According to the finding of (Yitbarek , 2013)the soil organic matter OM content of cultivated landwas significantly lower than forest and grazing lands.

The soil OM content of cultivated land was depleted by 32.98% as compared to the forest land. Similarly, decline in soil OM contents by 63.04% (A. Mojiri 2012)by 50.4% (L. Mulugeta 2005)and by 43.2% (M. Eyayu, *etal* , 2009)were observed due to deforestation and subsequent cultivation. The relatively low soil OM under cultivated soils as compared to native ecosystems could be attributed to intensive cultivation, which aggravated oxidation of organic carbon corroborating previous findings.

Organic matter concentrations in soils varied among different land uses in thefollowing order: forestland> upland, tea garden> wasteland, orchard land. Total P declined in the order: tea garden> upland> orchard land> wasteland> forest land and available P in the order: tea garden, orchard> upland> forest land> wasteland. The order for both total and available N was: forestland> tea garden> orchard land, upland > wasteland and for available K was orchard land> upland> tea garden> forestland, wasteland(Zhang, He, and Wilson 2004).

Table 4: - Effects of land use on contents of organic matter and nutrients of the soil

Land uses	Forest Land	Tea Garden	Upland	Orchard	Waste Land
Sample number	12	8	9	5	10
Organic matter (g kg^{-1})	40.4	23.1	23.9	18.9	19.9
Available K (mg kg^{-1})	120	147	184	233	103
Total P (g kg^{-1})	0.67	1.21	1.13	0.97	0.85
Available P	10.6	52.1	33.2	51.0	6.8
Total N (g kg^{-1})	1.49	1.29	0.97	1.05	0.83
C/N	15.6	11.4	14.2	10.5	12.8
Alkaline hydrolysable N (mg kg^{-1})	159	135	112	105	96
ECEC ($cmol_c$ kg^{-1})	7.79	7.28	7.76	7.50	7.17
Base saturation (%)	39.3	28.5	51.4	58.0	42.1

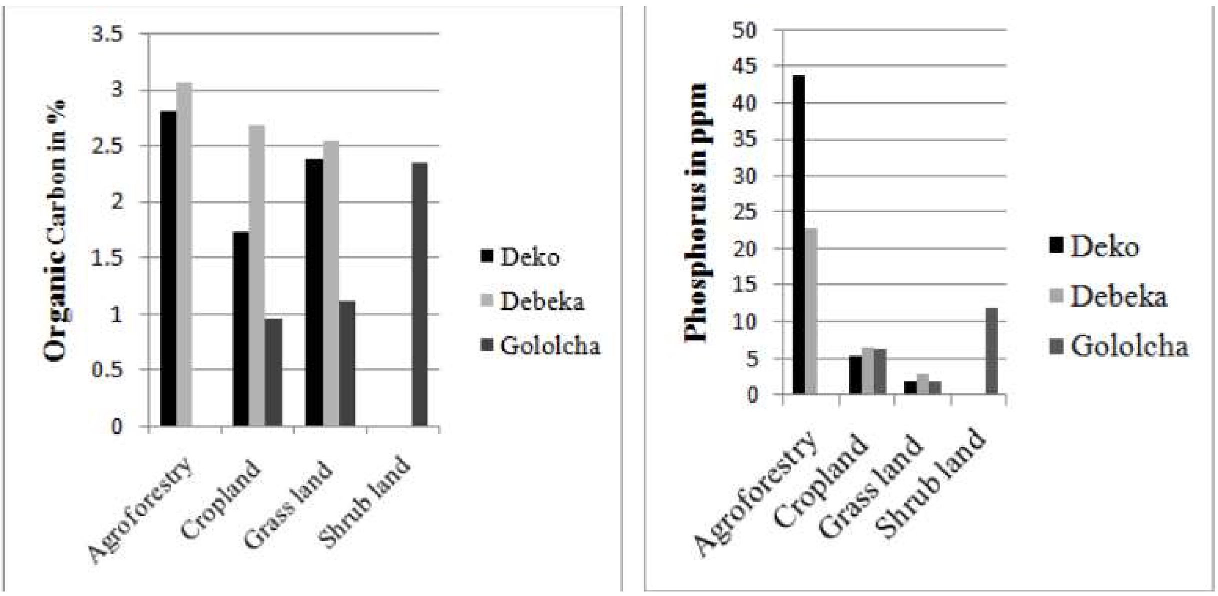

Figure 1:- Comparison of some soil properties under different land use and land cover types of Deko, Debeka and Gololocha areas at 0-15 cm soil depth(Workuetal,2014).

The difference is very strong between agroforestry and cropland. They are relatively highest on soils of agroforestry (the overall mean being 2.4±1.0 for OC and 4.3±1.8 for OM) and shrub lands (the overall mean being 2.06±0.63 for OC and 3.56±1.08 for OM) than soils in cropland (1.49±0.73 for OC and 2.57±1.26 for OM) and grazing lands (1.71±0.81 for OC and 2.95±1.48 for OM). It implies there is more supply of litters and return of OM to the soils under agroforestry and shrub land system and low OC on crop lands is due to removal of biomass from the field(Worku *etal* , 2014).

Cation Exchange Capacity

Cation exchange capacity of the soils under all land uses was high (P. Hazelton *eatal 2007 .)*, although cultivated land showed significant (P < 0.001) difference with the other land use types . The low CEC in cultivated land was in line with the low clay and organic matter contents of the soils under this land use. The soil CEC values in agricultural land uses decreased mainly due to the reduction in organic matter content (Yitbarek 2013).

Relatively, highest cation exchange capacity (CEC) values were observed under grassland (27.53 cmol (+)/kg) followed by that of enset (23.73 cmol (+)/kg) at both sampling depth. In accordance with the organic carbon content, CEC values of the soil decreased consistently from grassland to enset and maize(Beyene, 2013).

Soil PH

The soil pH values of the study site were generally slightly alkaline and lower pH values were observed in forest land and grass lands, not bare soils. This may have been due to the organic matter decomposition and moisture to mobilize the cations to neutralize the alkaline soil by reducing pH(Sebhatleab 2014).Soil acidity is also a consequence of the leaching of basic cations in soils due to high rainfall, which results in rapid erosion. Cultivated land is characterized by the acidifying effects of acid-forming nitro- gen fertilizer, poor nutrient cycling, and the mining of basic cations through harvested crops, soil erosion, and acid rain(Adugna and Abegaz 2016).The pH value under enset was found to be the highestfollowed by maize in both sampling depths. The soil pH could be categorized as slightly acidic under enset and maize fields whereas that of grassland was moderately acidic, following(Beyene 2013).

The increasing trend of soil acidity and under the cultivated and the abandoned lands showed thatintensive cultivation and continuous use of acid forming inorganic fertilizers on acid soils aggravates soil acidity(Wakene N and Heluf G, 2001).

Available Phosphorus

The content of available P in the cultivated land appeared to be significantly higher than the other two land use types. The higher in available P contents in soils of cultivated land were due to continuous application of mineral P fertilizer for few years as indicated by different farmers in the area(Fite 2017).Among the land use systems, the natural forestland contained relatively higher concentration of AP as a result of high organic matter which released phosphorus during its mineralization. AP in all land use systems decreased with increasing soil depth. This could be due to the increased clay and reduced OM content with increasing depth of the soil(G. Selassie and Ayanna 2013).

The mean available P content was significantly ($P \leq 0.05$) different among the land use systems. In all topographic positions and both depths, highest value of available P was found under enset farms followed by maize and grassland soils(Alemayehu. K and Sheleme.B , 2013). The content of total phosphorus in tea garden was 0.60 g kg-1, which was significantly higher than that in the vegetable land, sweet potato land, bare land, eucalyptus forest land and grass land(DENG et al. 2016).

3. CONCLUSION

The results of this review suggest that many soil properties are influenced by land use. Means the inappropriate land use management led to disturbance of soil nutrient status, indicating that the soil condition in the cultivated land is getting below the condition of soils under forest and grazing lands. Therefore, reducing concentration of cultivation, approving integrated soil fertility management and application of organic fertilizers could maintain the existing soil condition and replenish degraded soil properties.

Land use change is a dynamic specifically deforestation has been a global concern, with an adverse implication for human livelihood systems. Long -term land use and land cover (LULC) dynamics information is essential to understand the trends and make necessary land management interventions. The changes in land use aggravate land degradation and consequently it declines soil chemical and physical properties. The land use change observed in Ethiopia has a negative impact on the environment settings. Deterioration of forest, shrub and grass lands accelerates soil erosion and subsequently results in declines of agricultural productivity as cultivated land expansion at the expense of natural vegetation accelerate soil erosion. Decision makers should give due attention to the problems and make suitable interventions. Maximizing agricultural productivity by intensification with technology, creating off/non-farm job opportunities in the rural villages and encouraging community participation in the protection of the destruction of forest, shrub and grass lands as well as rehabilitating of bare lands need to be considered.

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