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Original Research

Evaluating the effects of Land Use Types on Selected Soil Physicochemical Properties in Bako Tibe District, Western Oromia, Ethiopia

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Abstract

Understanding the effects of land use types on soil physicochemical properties is essential for the sustainable utilization of soils. This study evaluated the effects of land use types on selected soil physical and chemical properties. Eighteen (18) composite soil samples were collected from three different land use types (forest, cultivated and grazing lands) under two soil depths (0-20 and 20-40 cm) with three replications. Texturally, sandy clay loam under cultivated and sandy clay under grazing land. The mean bulk density of the soils ranged from 1.02 to 1.14 gcm^{-3}. The maximum pH (6.40), OM (6.05%), total N (0.28%), CEC (19.17$cmolckg^{-1}$), exchangeable Ca (7.5$cmolckg^{-1}$), Mg (4.17$cmolckg^{-1}$), Available P (8.0 $mgkg^{-1}$) and K (1.39 $cmolckg^{-1}$) were recorded under the forest land, while the minimum results were conducted under the cultivated and grazing lands. Change of land use types has significant impacts on soil properties, especially extreme grazing and cultivating of land. Therefore, this study recommended that conversion of land use from one land use type to other with proper reclamation is important to enhance and improve soil properties for sustainable crop production.

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INTRODUCTION

In Ethiopia rapid population growth and environmental factors lead to the conversion of natural forestland and grassland 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). Soil compaction, the loss of soil structure, soil organic matter (SOM), undulating terrain, highly erosive rainfall, and inappropriate farming practices make soil highly vulnerable to erosion.

Land use changes that involve the conversion of natural forests to farmlands and open grazing are widely practiced in the highlands of Ethiopia (Kiflu and Beyene, 2013). Lack of adequate nutrient supply, the depletion of SOM, and soil erosion are major obstacles to sustained agricultural production (Kassie *et al*., 2008).

The physical and chemical tests provide information about the capacity of soil to supply mineral nutrients (Ganorkar and Chinchmalatpure, 2013). There are various techniques for soil fertility evaluation, among them soil testing is the most widely used in the world (Havlin *et al*., 2010). Soil productivity in Africa is declining as a result of inappropriate land use that lead to soil erosion and fertility depletion (Abreha, 2013).

In Sub-Saharan Africa (SSA), soil fertility depletion is the fundamental cause for declining per-capital food production as a result of a negative nutrient balance, with annual average losses ranging from 1.5-7.1 tons per ha per year of nitrogen (N), phosphorus (P) and potassium (K) mainly due to crop harvest, soil erosion, leaching and low inputs applied to the soil (Adesodu *et al*., 2007). Nutrient depletion in cultivated lands of Ethiopia highlands may be due to limited recycling of dung and crop residues to soils, overgrazing (Lalisa *et al.,* 2010;

Taye and Yifru, 2010). Sustainable land use for agricultural practice requires basic knowledge about practices (Takele *et al*., 2014).

The potential status of soil nutrients under different land use systems can be identified by evaluating soil physicochemical properties (Admas, 2018). The land use change and its management can have a significant effect on soil fertility status (Gebeyaw, 2007). Inappropriate land use and land cover has been changed like deforestation, overgrazing, and expansion of agricultural lands have left the land barren, which reduces the biomass availability of nutrients and soil moisture (Mao & Zeng, 2010).

The soil productivity decrement due to land use change may result from three processes cropping, erosion and leaching (Amusan *et al*., 2001). Wakene and Heluf, (2006) reported that the effect of land use change on soil quality in eastern Wallega zone near to Bako Tibe District and found that the essential macro nutrients are influenced by different land use systems. Similarly, Achalu *et al.* (2012) studied the soil physicochemical properties at Guto Gida district of Eastern Wollega and reported that OC contents in cultivated and grazing lands depleted respectively by 54.62 % and 49.89%, the percent Al saturation in cultivated land increased by 65.62% and 28.57% in grazing land. Nega, (2006) reported that, cultivated fields in the Bila Sayo nowadays, called 'Gudeya Bila' districts suffered from soil degradation and a decline in soil fertility as compared to the other land use classes. Bako Tibe District has thirty-two kebeles, the livelihood of which is highly dependent on agriculture.

Only a few research activities have been undertaken regarding soil physicochemical properties concerning land use types in the district. The Bako Tibe District has different formation and land use systems. There is lack of information on the status of soil fertility despite the availability of research centers near to the district. To use proper soil reclamation measures for sustainable soil resource utilization and to improve crop productivity information about the effects of different land use types on soil properties is very important. Therefore, this study was conducted to investigate the impact of land use types on selected physiochemical properties of soils under three land use types of Bako Tibe district, western Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

The research was conducted in Bako Tibe District, West Shewa Ethiopia. It is 256 km away from Addis Ababa. It has a longitude and latitude of 9°08′N and 37°03′E, respectively with an elevation of 1743 meters above sea level (masl) (CSA, 2007). It is bounded by the Jimma Rare and Jimma Geneti in the North, Ilu Gelan district in the East and Gobu Sayo and Gudeya Bila district in the West and Boneya-Boshe district in the south (BARDO,2016) (Fig.1).

Land use pattern

The entire area is believed to have been covered by natural forest. But today almost all of them have been disappeared due to rapid increase of population and high deforestation to obtain more land for cultivation, grazing, timber, charcoal, and settlement. The total area of the Bako Tibe District is 63,988.17 ha of land, out of the total area 42,916.28 ha (67.07%) cultivable land, 980.2 ha (1.53%) grazing land, 5207.97 ha (8.14%) forest land, 9581.04 ha (14.97%) bush and shrubs land, 3410.83 ha (5.33%) Wet land (EGII*,* 2020*)* (Fig.3)

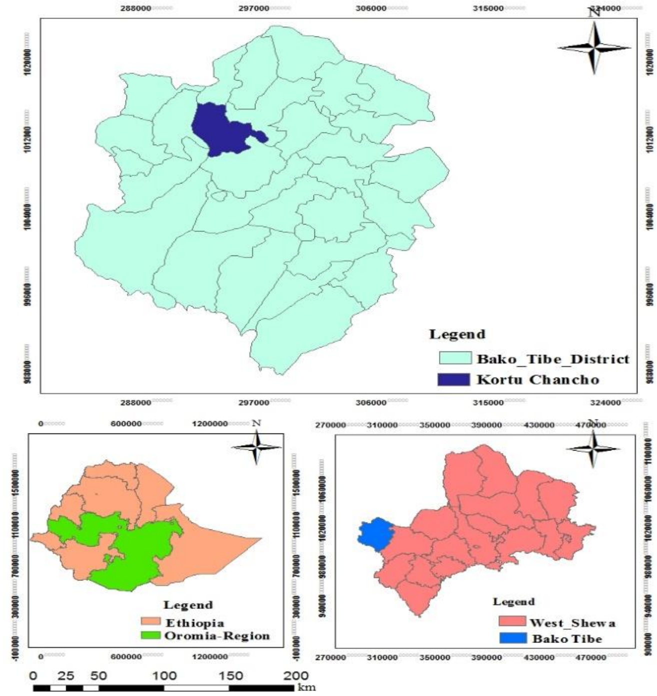

Figure 1. Location Map of the Study Area

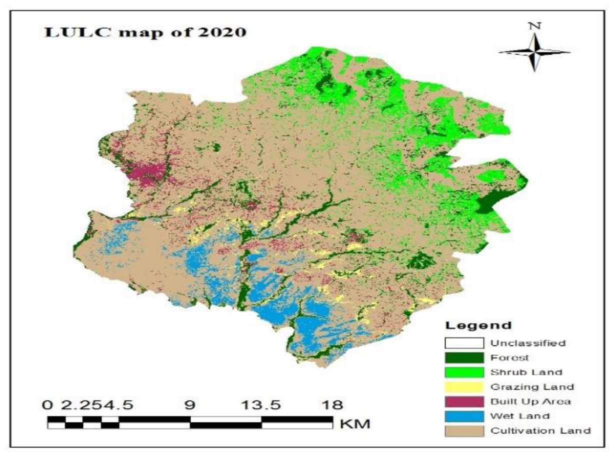

Figure 2. Land use land cover map of the study area (EGII*,* 2020)

The climatic condition of the study area (Rainfall and Temperature)

The major Agroecological zone of the study area was semi-arid (Gammoojjii Giddugaleessaa), sub-humid (Badda daree), and humid (Baddaa) with unimodal rain fall characteristics. The area received an average annual rainfall of 1257.98 mm and the temperature (^{0}C) ranges from 13.42^{0}C to 28. 73^{0}C.The rainy season extends from May to September and maximum rain is received from June to August (BARCMS, 2019).

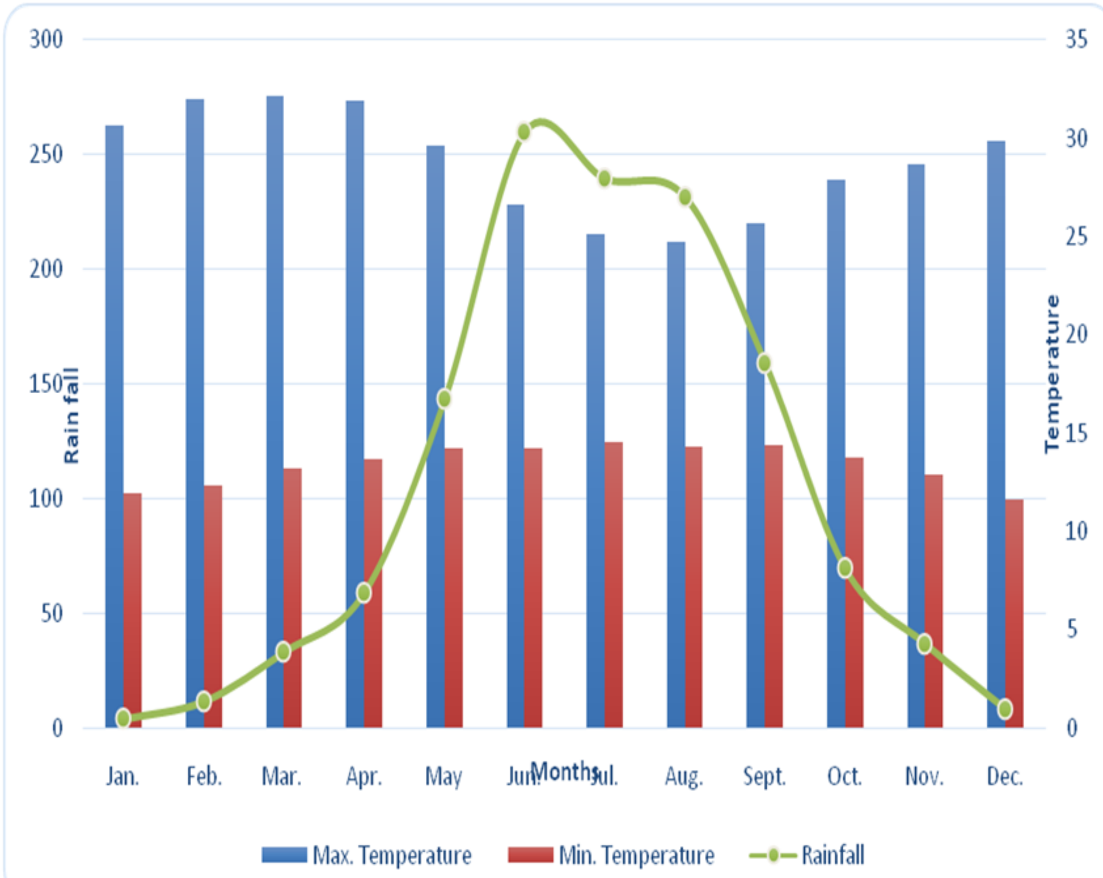

Figure 3. Mean annual rainfall and temperature for fifteen years (2005-2019), (BARCMS, 2019)

Major soil type and vegetation

Agriculture is the dominant livelihood in the study area. The study area has relatively good agricultural potential, which is reflected in the diversity of crops and animal resources. The major soil types of the area are red soil (*BiyyooDiimaa)* 55%, black cotton Soil Vertisols (*BiyyooGurraacha*) 15%, and brown soil (*BiyyooMagaala*) 25%. The most dominant soil in the area is reddish - brown nitisols. The textural class of soil of the study area is dominated by clay and loam in texture (BARC, 2014). The area is endowed with diverse vegetation species ranging from little dense and old natural forests in pocket areas at the tips of both up and down stream sides, to the patch of sparse shrub-grass complex in various areas. Dominant tree species in the area include *cordia africana (Waddeessa), Ficus Vista (Qilxuu), Croton mycrostachyus* (*Bakkanniisa*) *and the exotic tree species eucalyptus camalduleses* (*BaargamooDiimaa*) (BARDO, 2019).

Farming System

The area is known for the mixed crop-livestock farming system in which cultivation of maize (*Zea mays L*), noug (*GuizotiaabyssinicaL.*), potato *(SolanumtuberosumL*.), sweet potato (*Ipomoea batatas L.*), hot pepper (*Capsicum frutescence L.*) and mango (*MangiferaindicaL.*), banana (*Musa spp.*), sugar cane (*SaccharumofficinarumL.*), teff (*Eragrostistef* (zucc.) and haricot bean (*Phaseolus vulgaris L.*) are the major crops of the study area. Maize and pepper are the dominant crops grown in the area (BARDO,2016). Mixed farming is the major economic activity which involves crop and livestock production systems. Livestock production is an essential part of the farming system as nearly most of land preparation is done with ox-drawn ploughs. The major rivers in the study area are Gibe, Sama, Jima, kela, Robi, Mara, Leku and Habuko (BARDO, 2019).

Site selection and land use types

Purposive sampling was conducted to select the kebele based on three land use types (forest, cultivated and grazing land). Dominantly Kortu Chanco kebele in the specified district was selected. To take purposive sampling, the land use types were systematically selected based on similarity in soil color by visual observation and similar slope and altitude to reduce altitude, slope as well as soil type difference impacts on the different land use types. The three land use types were cultivated, grazing and forest lands.

Clinometers and Global positioning systems (GPS) were used to indicate the slopes of sampling and geographical locations of the study sites for selected land use types, respectively. The cultivated land pieces have been under intensive cultivation with oxen tillage for more than 30 years according to the farmers'response.Rapid human growth at the study area is resulted in a substantial change in land use systems and most natural forest is cleared for crop production and local fuel. The Kortu Chanco kebele covers 1255.26 ha out of the total district area.

Grazing land is the land with lowest disturbance and naturally dense grasses. It is virgin land characterized by logging and overgrazing for an extended period of time without ploughing it for more than 30 years. It is virgin land.

Cultivated land is the land covered with diverse crops grown for subsistence farming. Farmland (cultivated land) in this area are maize crop, as well as the widespread practice of burning the residues (straw) is dominated in this area. Cultivated land of diverse characteristics, comprising few trees, plots of cultivated land for subsistence agriculture, and a high percentage of bare ground, uncovered land, affected by human tillage practices like mineral soil fertilizers.

Forest Land is covered with tall and dense trees forming a closed or nearly closed canopy (60–100 %) and without apparent or reported human impacts. This unit also includes under-canopy macrofauna and soil microflora under canopy trees mixed with low bushes and open areas. Dominant tree species in this group include *Celtis africana*, *Calpurinasubdecandra*, and *Croton mycrostachyus*. In addition, leaf fall, macro fauna (worms, large insects) soil micro flora (bacteria, fungi and algae) and microbial activities are common in this land use.

Soil sample collection and sampling design

Both undisturbed and disturbed soil samples were taken from two soil depths and five sampling points based on the heterogeneity of land unit in a zigzag manner. The whole factors were situated on the similar slope, geologic and topography. About one hectare for each land use types of cultivated, grazing and forest lands was used for taking the soil samples. Under each land use type, the soil samples were taken in three replications. These samples were taken during the dry season. Soil samples were collected from different land uses at soil depth of 0 – 20 and 20-40 cm.

Undisturbed soil samples were collected from each types of land use with a core sampler for the determination of soil bulk density. Disturbed samples of soil were collected by auger from land use types and soil depths for the determination of some selected soil physicochemical properties. The data were collected using quantitative methods for soil sample fertility analysis of the study area.

Soil samples were collected in the dry season, approximately one kilogram of soil samples was collected from each site at a depth of 0-20 and 20-40 cm. when the soil samples were collected, eroded knolls, fence lines, old roadway, water channel, field edge and compost pits were excluded. This was used to minimize differences which may arise because of the dilution of SOM due to mixing through cultivation and other factors. All 18 (3 land use types * 3 replications * 2depths) samples from different land uses were prepared and packed in a plastic bag and transported to Bako agricultural research institute for the analysis of soil fertility parameters using standard procedures.

Soil sample preparation

All collected samples were air dried ground well with mortar and pestle, mixed well and passed through 0.5 mm for OC, TN determination and 2 mm sieve mesh for other soil physicochemical properties and stored in polythene bags to prevent contamination and minimize soil moisture loss, to obtain fine air- dried soil.

Laboratory analysis

Soil particle size was analyzed using the Bouyoucous hydrometer method in the presence of dispersing and disintegrating reagents (Bouyoucous, 1962). After the particle size distributions were determined in percent. Then, textural class of the soil indicated using USDA soil textural triangle classification system (USDA, 2008).

From the undisturbed soil samples the soil's bulk density (BD) was obtained by drying at 105 °C in an oven (Black, 1965). Soils pH was measured in water (H_2O) suspension in a 1:2.5 (soil: liquid) by pH meter, (Van Reeuwijk, 1995).

To determine OM, OC was primarily determined by the wet digestion as described by Walkley and Black (1934) method in which carbon was oxidized under standard conditions with potassium dichromate ($K_2Cr_2O_7$) in sulfuric acid solution and then multiplying by the factor 1.724 (assuming 100/58). The TN content in soils was determined using the Kjeldahl digestion, distillation and titration method, which involves oxidizing the OM in concentrated sulfuric acid solution (0.1N H_2SO_4) as described by (Black,1965).

Available P was extracted by the Bray-II method calorimetrically by using vanadomolybedate acid as an indicator. Its concentration was measured using a spectrophotometer at a wave length of 882 nm (Bray & Kurt, 1945).

The basic cations (K^+, Mg^{2+}, and Ca^{2+}) of the soil samples were determined using ammonium acetate (1N NH_4OAc) extraction at pH 7.0. Exchangeable K was determined from flame photometer reading. Exchangeable Ca and Mg were analyzed using atomic absorption spectrophotometer (AAS) as described by Rowell (1994). The soil CEC was obtained titrimetrically by distillation of ammonium that could be displaced by sodium from NaCl solution (Chapman, 1965).

Statistical Analysis

Analysis of variance (ANOVA) was used to analyze soil physicochemical properties at different land use types and soil depths using SAS software version 9.3 (SAS, 2013). Means were separated by the least significant difference (LSD) The same software also conducted correlation analyses among soil physicochemical properties.

RESULTS AND DISCUSSION

Soil Texture

Silt and clay fractions showed variations at ($P \leq 0.05$) of interaction effects (Table 1). However, analysis of variances revealed that there are no significant differences in the main effect of land use type and soil depth of sand particles (Table 2).The maximum sand percentage (54.6%) was conducted at the surface layer (0-20 cm) of cultivated land and the minimum mean of sand (40%) was observed on subsurface (20-40 cm) of forest land. The maximum (18.4%) means of silt was conducted at sub-surface layer of cultivated land, (15%) was observed on sub-surface (20 – 40 cm) of forest land and the minimum (9%) on the surface (0 – 20 cm) and sub-surface (20 – 40 cm) layer of grazing land were observed (Table 1). This high sand in cultivated land and high silt contents could be related to lower impact of erosion on both soil particles by surface and sub-surface runoff under the cultivated land.

Although the overall maximum clay content of the study area was (45%) the mean was recorded in the subsurface (20 – 40 cm) layer of forest land while the minimum (33.6%) on the subsurface (20 – 40 cm) layer of cultivated land (Table 1), which could be because of the downward movement clay particles to the subsurface soil through the process of clay migration. These results agree with the findings of Kiflu and Beyene (2013), who stated that clay particles increase from the surface layer to subsurface layer. Similarly, Abreha (2013) reported that textural differentiation in soil profiles is the precipitation of clay particles due to downward movement. Conversely, Eyayu et al. (2009) reported that overall mean soil depth showed higher sand and lower clay contents depth wise downward.

Table 1. Interaction effects of land use types and soil depths on selected soil physical properties of Kortu Chancho kebele

Land type	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	TC	BD (gcm^{-3})
Grazing	0-20	53.4^{a}	9^{b}	37.6^{ac}	Sandy clay	1.14^{a}
	20-40	52^{a}	9^{b}	39^{ac}	Sandy clay	1.18^{a}
Forest	0-20	51.3^{a}	10.4^{b}	38.3^{ac}	Sandy clay loam	1.03^{ab}
	20-40	40^{b}	15^{a}	$45b^{a}$	Clay	1.08^{b}
Cultivated	0-20	54.6^{a}	11^{b}	34.4^{c}	Sandy clay loam	1.12^{a}
	20-40	48^{ab}	18.4^{c}	33.6^{c}	Sandy clay loam	1.15^{a}
LSD (0.05)		**9.61**	**3.31**	**7.47**		**0.09**
CV (%)		**14.79**	**21.24**	**15.26**		**2.09**

*Interaction effect means within a column followed by the different letter(s) are significantly different from each other at P ≤ 0.05; Coefficients of variation=CV%; LSD= Least significance difference.

Bulk density

The ANOVA showed that there was a significant (P ≤ 0.05) difference in BD among the main effects of land use types, soil depth and interaction effects at (P $\leq$0.05) (Table 1 and Table 2). The highest (1.18 gcm^{-3}) mean value of BD was recorded under the subsurface layer (20–40 cm) of grazing land followed by the subsurface (20–40 cm) layer of cultivated land (1.15 gcm^{-3}) While, the lowest mean value (1.03 gcm^{-3}) of BD was obtained under the surface layer (0–20 cm) of forest land followed by subsurface layer (20–40 cm) of forest land (1.08 gcm^{-3}) (Table 1). Soil BD of the area was lowest under the forest land might be due to the higher clay content under forest land, and high OM content and more pores. This finding is in agreement with Tufa et al. (2018), who said that soil in grazing land might be due to the practice of overgrazing, which tends to lower the quantity of OM.

As Jones, (1983) stated, the critical values of BD for growth plant at sandy loam are (1.8gcm^{-3}), fine sandy loam (1.7gcm^{-3}), loam and clay loam (1.6gcm^{-3}) and clay (1.4gcm^{-3}). The BD (1.1 gcm^{-3}) of this finding was relatively related to clay textural class, which was under the precarious values for the growth plant

Table 2. The land use types and soil depth main effects on selected physical properties of soil at Kortu Chanco kebele

Land use types	Sand (%)	Silt (%)	Clay (%)	BD (gcm^{-3})
Grazing land	52.67^{a}	9.00^{b}	38.33^{ab}	1.16^{a}
Forest land	45.68^{b}	12.66^{a}	41.66^{a}	1.02^{b}
Cultivated land	51.33^{a}	14.66^{a}	34.00^{b}	1.14^{a}
LSD (0.05)	9.07	3.02	7.21	0.03
		Soil Depth		
0-20cm	50.80	12.60	36.60	1.08^{b}
20-40cm	48.89	11.66	39.45	1.11^{a}
LSD (0.05)	7.40	2.46	5.89	0.02
CV (%)	14.45	19.84	15.09	2.25

*Main effect means within a column followed by the different letter(s) are significantly different from each other at P ≤ 0.05; CV = Coefficient of variation; LSD= Least significance difference.

Soil pH

The analysis of variances showed there is a significant (P $\leq$ 0.05) variations of pH among land use types and their interaction effects (Table 3 and Table 4). The soil pH of the study site showed variations under the different land use types (Table 4). Relatively higher pH (6.4) was detected at the sub-surface of forest land and lower pH (5.13) on the subsurface of cultivated followed by pH (5.18) of grazing lands were obtained (Table 3). This difference in pH could be due to high OM at the surface and sub-surface layer of forest land, and continuous removal of basic cations by harvested crops and animal grazing on the surface layers of cultivated and grazing lands, respectively. Similar research results reported by Cardelli *et al*, (2012) cited in Habtamu, (2018) due to the application of NH_4^+ sourced fertilizers to cultivated lands that nitrifies NH_4^+ and the uptake of basic cations by crops. Soil pH Values were significantly lower on the surface layer of cultivated soil when compared to non-cultivated soils. These results also agree with the findings of Bore and Bedadi (2015) who reported that the lower pH was obtained under cultivated land compared to the other adjacent land use types.

Based on the ratings by As Tekalign, (1991) stated the ratings, pH value (< 4.5) is rated very strongly acid, (4.5-5.25) strongly acid, (5.3 - 5.9) moderately acid, (6.0 - 6.6) slightly acid and (6.7 - 7.3) neutral. This indicated that, the pH of the study area is ranging from slightly acidic under forest land to relatively strongly acidic under cultivated and grazing lands.

Total nitrogen

The analysis of variances revealed that there is a significant (P$\leq$0.05) difference in TN among land use types and soil depth (Table 3). Considering the interaction effects, the TN content ranged from 0.12% to 0.28% with a mean value of 0.20% (Table 3).

The maximum TN (0.27%) was recorded under forest land while the minimum TN values were recorded on grazing lands (0.23%) and cultivated lands (0.15%) (Table 4).This could be due to low OM content under cultivated and grazing lands and high OM content under forest land. In agreement to this findings Nigussie and Kissi, (2012); Ufot *et al*. (2016) and Chemeda *et al*. (2017) indicated that TN was higher under forest land compared to grazing and cultivated lands.

Table 3 Interaction effects of land use types and soil depth on pH, TN, Ava. P, OC of soil properties at 0 – 20 cm and 20 – 40 cm depth under different land use systems.

Land use	Depth (cm)	pH (H_2O)	TN (%)	Av. P ($mgkg^{-1}$)	OM (%)	C:N
Grazing	0-20	5.18^a	0.20	5.32^a	3.93^a	8.76^a
	20-40	5.42^a	0.19	6.01^a	4.56^a	13.94^b
Forest	0-20	6.2^b	0.28	8.02^b	6.05^b	12.53^c
	20-40	6.4^b	0.26	5.99^c	5.55^b	12.38^{dc}
Cultivated	0-20	5.30^a	0.17	5.20^d	3.48^c	11.88^{dce}
	20-40	5.13^a	0.12	5.62^d	3.22^c	15.58^f
LSD (5%)		**0.37**	**0.30**	**0.82**	**0.70**	**1.36**
CV (%)		**5.18**	**15.8**	**10.57**	**21.65**	**0.79**

*Interaction effect means within a column followed by the different letter(s) were significantly different from each other at P ≤ 0.05; Coefficients of variation=CV%; LSD= least significance difference; TN= Total nitrogen; AV.P= Available phosphorus; OM= Organic matter, C: N = Carbon to nitrogen ratio.

Available soil phosphorus

The ANOVA results revealed that av. P was significantly ($P \leq 0.05$) affected by different land use types (Table 3). The av. P was higher in the surface soil layer of forest land (8.02 $mgkg^{-1}$) and followed by the subsurface soil layer of grazing land (6.01 $mgkg^{-1}$) and (5.99 $mgkg^{-1}$) in sub surface of forest land (Table 3).The main factor of land use types the maximum av. P (7.00 $mgkg^{-1}$) was obtained in forest land and the minimum av. P (5.41 $mgkg^{-1}$) was obtained under cultivated land.

The land use types and soil depth interaction resulted the highest av. P (8.02 $mgkg^{-1}$) and the lowest av. P (5.20 $mgkg^{-1}$) contents were recorded at the surface soil layer of the forest and surface soil layer of the cultivated lands, respectively (Table 3). In line with this the findings of Aytenew and Kibret, (2016) and Chemeda *et al*. (2017) who recorded highest av. P under forest land. This finding is also similar with Abad *et al,* (2014) who found soil av. P was high under forest land.

Table 4 Main effect of selected soil chemical properties of soil at Kortu Chancho Kebele

Land use type	pH	TN (%)	Avail. P ($mgkg^{-1}$)	OM (%)	C:N ratio
Grazing land	5.3^b	0.23^a	5.66^b	4.24^a	10.69
Forest land	6.33^a	0.27^b	7.00^a	5.79^b	12.44
Cultivated land	5.21^b	0.15^c	5.41^b	3.34^c	12.93
LSD (0.05)	0.34	0.04	0.75	0.65	9.5
Soil Depth					
0-20cm	5.50	0.24^a	6.32	4.39	10.62
20-40cm	5.73	0.19^b	5.73	4.53	13.84
LSD (0.05)	0.27	0.04	0.61	0.53	7.75
CV (%)	4.94	17.83	9.94	20.46	0.66

*Main effect means within a column followed by the different letter(s) are significantly different from each other at P ≤ 0.05; Coefficients of variation=CV%; LSD, Least significance difference; TN= Total nitrogen; AV.P= Available phosphorus; OM= Organic matter, C: N= Carbon to nitrogen ratio.

Organic matter

The ANOVA revealed that the finding showed that the OM of soils was significantly ($P \leq 0.05$) affected by different land use types (Tables 4). The highest (6.05%) of OM was observed under forest land surface layer, and the minimum OM (3.22%) was observed at subsurface under cultivated land (Table 5). This could be due to the high plant residues in forest land and the low application of organic manures and matter in cultivated land. The highest percentage of OM at surface stratum of forest land was due to the disproportionate amount of plant residues and biomass on surface land. This implies that OM of the soil was sufficient on the surface soil layer due to presence of both animal and plant residues to accommodate many diversity organisms found in the soil.

Carbon to nitrogen ratio (C: N)

The ANOVA indicated that the C: N ratio has a significant variation among interaction impacts of different land uses and soil depth (Table 4). Relative to forest land, soils of the grazing and cultivated land recorded a narrow C: N ratio. Aeration during tillage and increased temperature that enhance mineralization rates of OC rather than organic N could probably be the causes of the lower level of C: N ratio in cultivated land. This supported by Abbasi *et al*. (2007) who concluded higher microbial activity and more CO_2 evolution and its loss to the atmosphere in the top (0-20 cm) soil layer resulted to the narrow C: N ratio.

Cation exchange capacity

The ANOVA provided that soil CEC was significantly ($P \leq 0.05$) affected by different land use types. The higher (17.34 $cmolckg^{-1}$) and lower (8.02 $cmolckg^{-1}$) CEC was conducted under forest and cultivated land, respectively. This could be because of the presence high SOM under forest land and high reduction of SOM under cultivated land. In line with that, CEC of soil was higher under forest land than adjacent grazing and cultivated lands (Yitbarek *et al*., 2013).

The effects of land use types with the soil depth significantly ($P \leq 0.05$) affected the CEC of the soil under the study area (Table 5). The highest CEC (19.17cmolckg^{-1}) was conducted under the subsurface (20 – 40 cm) layer of forest land, whereas the lowest CEC (6.63cmolckg^{-1}) was recorded at the surface soil layer of cultivated land. The higher CEC value was found in the subsurface (20-40 cm) layer (Table 5). This is supported by similar findings by Kiflu and Beyene (2013) who found the soil CEC was not significantly affected by soil depth under cultivated land.

Table 5. Effects of soil depth and land use types on CEC, Ex Ca, Ex..Mg and Ex. K of Kortu Chancho kebele

Land use	Depth (in cm)	CEC	Ex. Ca	Ex. Mg	Ex. K
			cmolckg^{-1}		
Grazing land	0-20	11.81^{ad}	4.67^{a}	2.00^{a}	0.93^{a}
	20-40	10.10^{ac}	6.0^{ab}	2.83^{a}	0.98^{a}
Forest land	0-20	15.52^{b}	7.5^{bc}	3.00^{ab}	1.006^{a}
	20-40	19.17^{b}	6.53^{bc}	4.17^{bc}	1.39^{b}
Cultivated land	0-20	6.63^{c}	4.6^{b}	2.53^{ab}	1.27^{b}
	20-40	9.42^{cd}	7.33^{c}	3.0^{ac}	1.40^{b}
LSD (0.05)		**4.31**	**2.67**	**1.67**	**0.26**
CV (%)		**15.06**	**11.4**	**16.4**	**30.93**

*Interaction effect within a column followed by the different letter(s) are significantly different from each other at $P \leq 0.05$; CV=Coefficient of variation; LSD, Least significance difference; CEC= Cation exchange capacity; Ex. Ca= Exchangeable calcium; Ex. Mg= Exchangeable magnesium; Ex. K= Exchangeable potassium

Exchangeable basic cations

The analysis of variance revealed that there is no significance difference between the main effects of land use types and soil depth (Table 5 and Table 6). The highest exchangeable Ca (7.5cmolckg^{-1}) was observed on the surface layer of forest land, whereas the lowest (4.60 cmolc kg^{-1}) on the surface layer of cultivated land. This might be due to high OM content with colloidal surface and storehouse of basic cations. Exchangeable Ca increased as the soil depth increased (Table 5) which might be due to the high leaching. Similarly, Adesodun (2007) reported that leaching of exchangeable cations is common especially in acidic soils of tropics.

The highest (4.17 cmolckg^{-1}) exchangeable Mg was observed in the subsurface layer of forest land and the lowest (2 cmolckg^{-1}) exchangeable Mg on the surface layer of grazing land (Table 5). This might be due to low OM content, high plant uptake and leaching of exchangeable Mg from grazing land due to over grazing. Exchangeable Mg had increased with increasing soil depth in all land use systems (Table 5) which could be due to the effect of its leaching down the profile. According to FAO, (2006) rating, soils of the study area was rated medium in cultivated (2.76 cmolckg^{-1}) and grazing land (2.57cmolckg^{-1}) and high in forest land (3.58 cmolckg^{-1}) in its exchangeable Mg content.

The analysis of Variances shows that there is a significant difference at interaction effect (Table 5) and there was no significant effect among soil depth of exchangeable potassium (Table 5). The highest (1.39cmolckg^{-1}) exchangeable K was recorded on the surface layer of forest land while the lowest (0.93cmolckg^{-1}) exchangeable K in the surface layer of grazing land, which could be due to low plant uptake on the forest land and relatively high compaction in grazing land that restricts its downward movement as well as its uptake by freshly growing grasses. This result is in agreement with that of Wakene, (2001) who reported that lower exchangeable K contents in cultivated and grazing lands than forest land.

Table 6. Pearson's correlation matrix for selected soil physiochemical properties of kortu chanco kebele

	pH	OM	TN	C:N	P	Ca	Mg	K	CEC	Sand	Silt	Clay	BD
PH	1.00												
OM	0.75	1.00											
TN	0.47	0.61	1.00										
C:N	0.69	0.49	0.53	1.00									
P	0.52	0.71	0.36	0.20	1.00								
Ca	0.39	0.53	-0.03	0.52	0.54	1.00							
Mg	0.50	0.63	0.16	0.38	0.67	0.53	1.00						
K	0.53	0.22	-0.12	0.32	0.30	0.41	0.34	1.00					
CEC	0.77	0.74	0.53	0.62	0.29	0.28	0.38	0.21	1.00				
Sand	-0.25	-0.28	-0.15	0.23	-0.24	-0.38	0.05	-0.29	-0.25	1.00			
Silt	0.02	-0.20	-0.20	0.48	-0.10	-0.08	-0.20	0.52	-0.04	-0.64	1.00		
Clay	0.31	0.50	0.32	0.42	0.37	0.54	0.07	0.03	0.34	-0.86	0.15	1.00	
BD	-0.75	-0.70	-0.72	-0.45	-0.67	-0.31	-0.52	-0.38	-0.57	0.28	-0.09	-0.30	1.00

*TN= Total Nitrogen, CEC= Cation Exchange capacity, EX. Ca=Exchangeable Calcium. Av. P=Available phosphorus, OM= Organic matter, OM= Organic matter, Ex.Mg=Exchangeable Magnesium, BD= Bulk density, Ex

CONCLUSION

This study found forest land was low in BD and better in OM and Av. P, TN, CEC, and exchangeable bases contents. Cultivated and grazing lands were poorer in soil physiochemical properties, which has constrained crop production and productivity. Land use influences several biological and physiological processes of soil. Poor land use decisions can lead to land degradation and affect soil physical and chemical properties. In Bako Tibe Kortu Chancho kebele, where land use types are occurring rapidly, erosion, deforestation, poor soil nutrient management, indiscriminate chemical fertilizer use in cultivated lands and unscientific land use have affected a large population dependent upon agriculture. This study compared some of the selected physiochemical parameters of soil in three land-use systems. The variations in soil physiochemical parameters suggest the need for improvement in the soil health of traditional farmlands. Moreover, it is recommended that sustainable soil nutrient management practices with increased organic matter addition, crop rotation practices, biomass incorporation, increasing crop diversity, and maintaining soil cover in cultivated lands are needed to amend soil problems in traditional farmlands and maintain soil health in vegetable farmlands.

There should be an improvement in the soil physiochemical status of cultivated lands by applying nutrient-rich amendments such as organic matter, which are environmentally friendly, socially acceptable, and economically feasible. To increase the fertility and carrying capacity of the grazing lands, it should not be used for overgrazing but for control grazing by dividing the area into blocks by making fences that allow fallowing. Forest land should have been given special attention as it is the base for keeping soil more fertile by serving as the storehouse of nutrients. Forest lands should also be conserved in different ways, such as by closing the area, promoting legal and cultural respect, and making an area ecologically conducive. The result of this finding is helpful for helped farmers and policymakers to direct their efforts in adopting improved soil management practices and better land use system planning to make the Kortu Chancho soils environmentally sound while maintaining high production after land use change. Specifically, this research aims to study the differences in selected soil physiochemical status brought out by the land use systems. Further, the study was undertaken on one kebele and selected soil physiochemical properties due to budget and time constraints. Therefore, this work recommended further research in the study area relating to the effects of land use types on soil physiochemical properties in respect to soil fertility and its health in depth.

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Conflict of interest

There is no any conflict among the authors

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