Research Article

Effects of Land Use/Land Cover Changes on Selected Soil Physical and Chemical Properties in Shenkolla Watershed, South Central Ethiopia

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Land use change from natural ecosystems to managed agroecosystems is one of the main causes of soil fertility decline. Severe soil erosion caused by agricultural expansion and poor management worsened soil nutrient depletion in cultivated outfields (crop lands). This study was conducted to examine the effects of land use and land cover changes (LU/LC) on selected soil physicochemical properties in the Shenkolla watershed. A total of 40 top soil samples at 0–20 cm depth were collected from four land use/land cover types (forest land, grazing land, cultivated outfield, and cultivated homestead garden fields). The analysis of variance (ANOVA) was applied to determine differences in soil parameters among land use types. Treatment means comparison was determined using the least significant difference (LSD) at 0.05 level of significances. The result indicated that there were significant ($P < 0.05$) differences among the four LU/LC types for soil characteristics. For most parameters evaluated, the most favorable soil properties were observed in the forest land, followed by homestead garden fields, while the least favorable soil properties were found in intensively cultivated outfields. Increase in the extent of cultivated land at the expense of forest cover associated with poor management has promoted significant loss of soil quality in intensively cultivated outfields. Reducing the land cover conversion and adopting proper management practices of the soil commonly used in homestead garden fields are very crucial in order to improve soil fertility in intensively cultivated outfields.

1. Introduction

Soil degradation caused by unsuitable use of land and weak management is a problem of the entire world that has drawn attraction towards sustainable agricultural production [1]. Inappropriate agricultural practices and land cover changes may rapidly decline soil quality by deteriorating its physicochemical properties and biological activity [2, 3]. Land use changes, such as the conversion of forest and grazing lands to intensively cultivated cropland, reduce the SOM content and cause soil bulk density to increase and aggregate stability and saturated hydraulic conductivity to decline [4].

Agriculture is the backbone of the Ethiopian economy, accounting for more than 41% of gross domestic product, 84% of export, and 80% of total employment [5].

However, soil nutrient removal, organic matter depletion, and soil erosion are seriously threatening the sustainability of agricultural production in Ethiopia [6, 7]. The shortage of land in densely populated areas of the country, to meet the demand for food production, led to conversion of vast tracts of forestlands into cultivated crop lands [8].

Deforestation, overgrazing, and continuous cultivation have triggered soil erosion losses at the rate of 130 tones/ha for cultivated fields and 35 tons/ha average for all land use classes in the highland areas of the country, which was estimated to be one of the highest in Africa [6]. Therefore, evaluating soil physicochemical properties in different land use types is crucial to provide important information for planners and policy makers to devise development interventions that ensure sustainable land management and food

security in the study area and elsewhere in the highlands of Ethiopia. To this end, the study was conducted to examine the effects of land use/land cover change on selected soil physical and chemical properties in the Shenkolla watershed, south central Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area. The study was undertaken in the Shenkolla watershed, covering 1457 ha lying, in the eastern part of the Soro district in the Hadiya zone of Southern Nations Nationalities and Peoples' Regional State. The geographical location of the area falls within the coordinates of 7°24'30"–7°27'0" N latitude and 37°43'30"–37°46'30" E longitude (Figure 1). The altitude ranges from 2200 to 2830 m which is characterized by gentle sloping to high-relief hills which ranges from 5 to 45%.

Geological formation is dominated by the quaternary volcanic composed of acidic parent materials (rhyolites, trachytes, and ignimbrites), while basaltic formations are of minor importance [9]. Nitisols are the most dominant soil types found in all land uses (forest land, grazing land, homestead garden fields, and cultivated outfields) of the watershed. Nitisols have good physical properties, with high water-holding capacity and good drainage, having high potential for agricultural uses, on which subsistent farmers of the watershed depend to grow a variety of crops and graze livestock. [9]. The most common geomorphic environment for Nitisols in the watershed is dissected side slopes (5–10%). Luvisols are also found in all land use classes on strongly sloping gradients (10–15%). The area coverage of Vertisols is limited to a very small area of the grazing land at poorly drained bottom slope position, Cambisols are found in the forest land on high relief, and Planosols cover a small area of cultivated outfields on the upper side of Vertisols [9].

The climate is characterized generally as tepid submoist midhighland with a long-term average rainfall of about 1107 mm with the bimodal pattern having (Belg) light rainy season (March to May) and (Meher) the heavy rainy season from June to September. The annual average temperature of the study area is 17.2°C (Figure 2). The long-maturing crops such as maize and sorghum are planted during the Belg rains and extend their growth period into the main rainy season when wheat and teff are planted. Under normal climatic condition, the cultivation of crops is possible during both Belg (light rainy season) and Meher (heavy rainy season).

2.2. Land Use Types and Pattern of Management. Mixed crop-livestock system is the major source of livelihood for the community in the study area. The system is noted for its high population densities (200–350 persons per sq.km) and severe land shortage (average holdings of 0.5 ha for a family of 8 persons) along with intensive cultivation. Forest and grazing lands are communally owned and managed, while the arable lands are individually owned.

Livestock husbandry is based on free grazing on communal grazing lands. Free grazing is an age-old traditional system which allows owners to indiscriminately graze their

livestock on the communal land. Especially during the cropping season, all livestock are confined to the scarce grazing lands which for 5–6 months of the year are subject to immense grazing pressure. Large herd size on small grazing lands and poor pasture management increased the pressure on the grazing land of the study area [9]. As a result, the animals cannot get enough fodder to stay healthy and in good condition; similarly, the natural vegetation has no chance to recover at any time of the year. There is no reseeding effect, the most palatable grasses and legumes have disappeared, and bare patches have developed, giving room for accelerated soil erosion and severe dissection by rills and gullies.

In the study area, agricultural cultivation (cultivated outfields and homestead garden fields) was started approximately forty years ago. Arable lands are composed of the intensively cultivated outfields (crop lands) and well-managed homestead garden fields. Homestead garden fields are covered with staple food crops such as enset (*Ensete ventricosum*) and trees such as avocado (*Persea americana*), *Croton macrostachyus*, and *Erythrina* spp with the undergrowth of some vegetables and spices forming a multistory home garden [10]. The distant cultivated outfields are planted with cereals, wheat (*Triticum aestivum*), maize (*Zea mays*), barley (*Hordeum vulgare*), sorghum (*Sorghum bicolor*), and teff (*Eragrostis tef*) that form the costaples with enset (*Ensete ventricosum*).

Soil fertility management is clearly differentiated between the cultivated outfields and homestead garden fields. Hoeing and incorporation of the farmyard manure in homestead garden fields is distinctly different from the plough-based complex system in the intensively cultivated outfields [9]. The homestead garden fields receive the application of a wide range of organic fertilizers (farmyard manure, household refuse, compost, and leaf litter). Soil fertility of the homestead garden fields is maintained through the application of approximately 9 tons per hectare per year of farmyard manure on average, while the crop cultivated outfields are treated with a dose of less than prescribed amounts of mineral fertilizers with an average rate of 50 kg urea and 65 kg/ha DAP (diammonium phosphate: 18% N and 46% P₂O₅) [11]. Crop residue removal is another problem that causes soil fertility decline in cultivated outfields. As a result, cultivated outfields are largely depleted of soil fertility but homestead garden fields are enriched.

The differences in land use and management practices indicated that there was a difference in the extent of water erosion in the study area. Field observation indicated the presence of slight water erosion in the forest land and homestead garden fields and accelerated water erosion in the grazing land and cultivated outfields at the study site. This shows the susceptibility of the soils of cultivated outfields and the grazing land to water erosion.

2.3. Soil Sampling and Analysis. From each of the four land use types (i.e., forest land, grazing land, cultivated outfields, and cultivated homestead garden fields), ten replicates of

FIGURE 1: Map of the study area within the southern region of Ethiopia.

FIGURE 2: Mean monthly rainfall and temperature of the study area.

disturbed and undisturbed soil samples were collected, following line transects which were laid along the contour of the sampled area. To avoid the border effect, the line transect was located at a distance of 5 m from the edges. On each line transect, ten sampling points were located at a distance of 25 meters apart at a depth of 0–20 cm. Soil samples were collected during December 2017 to January 2017 after the crop harvest. The approximate length and width of sampled area were 280 m × 30 m, 260 m × 20 m, 285 m × 30 m, and 270 m × 25 m for the forest land, grazing land, cultivated outfields, and cultivated homestead garden fields, respectively. Undisturbed soil samples were taken by a steel core

sampler of 100 cm³ in volume from each land use in ten replications for bulk density and water retention capacity determination. Disturbed soil samples were collected using an auger from each land use in ten replications. A total of 40 (4 treatment × 10 replications) disturbed soil samples and 40 (4 treatment × 10 replications) undisturbed core samples were collected. Disturbed soil samples placed in polythene bags and undisturbed soil samples in a steel core sampler were well labeled as described by the Soil Survey Field and Laboratory Method Manual [12] and then taken for the subsequent laboratory test.

Analyses of the soil samples for field capacity (FC), permanent wilting point (PWP), water-holding capacity (WHC), aggregate stability, and texture were conducted at the Ethiopian Water Works Construction Design and Supervision Enterprise soil fertility lab following laboratory procedures. Analyses of the soil samples for bulk density (BD), particle density (PD), total porosity (TP), soil pH, organic carbon (OC), total nitrogen, available phosphorus (AP), cation exchange capacity (CEC), exchangeable bases, and some micronutrients were conducted at the South Nations Nationalities and People's Region Agricultural Bureau, soil fertility laboratory. These soil laboratories are with examination standards of ES ISO 10390:2014 and ES ISO 11263:2015.

Undisturbed soil samples were air-dried, ground, and passed through 2 mm sieve and analyzed for physical and chemical parameters. The hydrometer method outlined in [13] was used to determine soil particle size distribution. The soil textural names were determined based on the USDA textural triangle as described in [14]. The bulk density (BD)

of the soil was estimated from undisturbed soil samples collected using a steel core sampler, and the procedures outlined in [15] was used to determine both BD and particle density (PD). Total porosity (TP) was estimated from the bulk density (BD) and particle density (PD) as outlined in [16]. The water-holding capacity of the soil (w/w, %) at field capacity (FC) and permanent wilting point (PWP) were measured at 1/3 and 15 bars of soil water potential, using the pressure plate apparatus [17]. Plant available water-holding capacity (AWC) was obtained by subtracting PWP from FC [18]. The soil aggregate stability test was carried out by the wet sieving method as outlined in [19]. It involves abrupt submergence of air-dry aggregates in water (soil aggregates were subjected to two pretreatments prior to wet sieving: (1) immersed immediately in water (soaked) or (2) capillary rewetted at 4°C overnight followed by wet sieving using a 0.5 mm sieve. The reported figures are the percentage of aggregates retained after wet sieving [6]. Soil pH was measured in water (pH-H₂O) using a pH meter in a 1:2.5 soil: water ratio [20].

The content of organic carbon (OC) (%) was decided by the method in [21]. The total nitrogen (TN) (%) was determined using the Kjeldahl methods for digestion [22], and available phosphorus (AP) (mg/kg) was determined by extraction from the soil using sodium carbonate at a pH equal to 8.5 [23]. The cation exchange capacity (CEC) (cmol+/kg) of the soils was determined at a soil pH 7 after displacement by using the 1 N ammonium acetate method in which it was, thereafter, estimated titrimetrically by distillation of ammonium that was displaced by sodium [24]. Exchangeable bases (Ca²⁺, Mg²⁺, Na⁺, and K⁺) were determined after leaching the soils with ammonium acetate [25]. Amounts of Ca²⁺ and Mg²⁺ in the leachate were analyzed by an (AAS) atomic absorption spectrophotometer, and K⁺ and Na⁺ were analyzed by a flame photometer. Extractable micronutrients (Fe, Cu, Zn, and Mn) were extracted by diethylenetriaminepentaacetic acid (DTPA) as described in [26]. The amounts of all these micronutrients were measured by an atomic absorption spectrophotometer at their respective wavelengths.

2.4. Statistical Analysis. The analysis of variance (ANOVA) was applied to determine variations in soil parameters among land use types. Treatment means comparison was determined using the least significant difference (LSD) at 0.05 level of significances [27]. For the analysis of data, the SPSS software (version 16.0 for Windows) was used.

3. Results and Discussion

3.1. Soil Texture, Bulk Density, and Porosity. The mean values of particle size of soils in noncultivated lands (forest and grazing land) were compared with the mean values of nonforested lands (cultivated outfields, homestead garden fields, and grazing land). The mean value of sand in the nonforested land (39.3%) was higher than the mean value of sand in the noncultivated land (35%), while the mean value of clay in the noncultivated land (22.5%) was higher than the

mean value of clay in the nonforested land (17.6%). This indicated the positive influence of the noncultivated land on soil quality. But, there was no difference between the mean values of silt in the noncultivated land and the nonforested land (Table 1).

Moreover, analysis of particle size of soils indicated that there was a significant difference among land use types (Table 2). Relatively higher sand content (46%) was recorded in soils of cultivated outfields followed by that of the grazing land. However, the highest value of clay (26%) was recorded in forest soils. This implies that intensive cultivation of the soils increases sand (course particles) as fine particles are washed away by water and wind erosion, while the forest lands are protected from such losses. This indicates that soil inherent properties such as particle distribution can be affected by long-term intensive tillage of the soils. However, the current finding disagrees with the report in [28] in which it was found that land use systems had no effect on soil particles. This finding is in agreement with the works [6, 29], in which intensive land uses and soil depths significantly affected particle size distribution creating more sandy texture.

The bulk density and total porosity (TP) were significantly ($P \leq 0.01$) affected by land use/land cover change. The most favorable properties (low BD and high TP) were recorded for the forest land and homestead garden fields, while cultivated outfields had the highest BD (1.62 g/cm³) and the lowest TP (0.32%), indicating soil compaction and wettability problems under intensively cultivated outfields. Wettability problem of soils of cultivated outfields could be minimized by integrating regular tillage with proper soil fertility management. High bulk density is an indicator of low soil porosity which may cause poor movement of air and water through the soil. As bulk density increases, both TP and soil wettability decreases. Increased compaction may result in disrupting both infiltration and redistribution of water in the soils including reduced soil wettability and porosity [9]. The cause of reduced soil wettability (soil water repellency) is compaction that results in high bulk density and the soil particles with a hydrophobic surface coating. This is influenced by the surface area of the soil, which varies considerably with the soil texture.

3.2. Soil Water-Holding Capacity and Water-Stable Aggregates. Water-holding capacity at PWP and AWC of the soil was significantly affected ($P < 0.05$) by the land use type, but no significant difference was observed in the soil water content at FC (Table 3). Forest soil had the highest AWC (15.32 mm/m), while homestead garden fields had the highest water-holding capacity at PWP (25.49). The highest value of water retention capacity at PWP in the homestead garden fields can be attributed to the high percentage of the organic matter content from farm yard manure application. Soil fertility of the homestead garden fields is maintained through the application of approximately 9 tons per hectare per year of farmyard manure on average besides tree leaf litters. The highest soil water retention at FC under the forest land use means

TABLE 1: Mean values of particle size of soils as affected by the noncultivated and nonforested parts of the experimental area.

Particle size distribution (%)	Noncultivated land			Nonforested land			
	Forest land	Grazing land	Mean	Cultivated outfield	Homestead garden field	Grazing land	Mean
Sand	34.0	36.0	35.0	46.0	36.0	36.0	39.3
Silt	41.0	45.0	43.0	43.0	41.0	45.0	43.0
Clay	26.0	19.0	22.5	11.0	23.0	19.0	17.6

TABLE 2: Mean values of selected physical properties of soils as affected by different land uses.

Land use	Particle size distribution (%)						
	Sand	Silt	Clay	Si/Cl	Textural class	BD (g/cm ³)	TP (%)
Forest	34 ^d	41b ^c	26 ^a	1.57 ^c	Clay loam	1.21 ^d	0.53 ^a
Grazing land	36b ^c	45 ^a	19 ^c	2.42 ^b	Clay loam	1.5 ^b	0.44 ^b
Cultivated outfields	46 ^a	4 3 ^{ab}	11 ^d	3.9 ^a	Sandy loam	1.62 ^a	0.32 ^d
Homestead	36 ^b	41 ^{bc}	23 ^a	1.8 ^c		1.41 ^c	0.43 ^c
Mean	38.01	42.37	19.71	2.42		1.45	0.43
SE (±)	0.39	0.54	0.47	0.28	Clay loam	0.05	0.01
F	69.24	4.69	61.13	46.14		24.86	16.09
Sig	***	*	***	***		***	***

For each column, means having common letters are not significantly different at $P \leq 0.05$; BD = bulk density, TP = total porosity, and SE = standard error of the mean; *** $P < 0.001$ and * $P < 0.05$.

TABLE 3: Mean values of some selected physical properties of soils as affected by land uses.

Land use	Water-holding capacity			Water-stable aggregates
	FC (1/3 bar)	PWP (15 bar)	AWC (mm/m)	
Forest	35.16	19.84 ^{ab}	15.32 ^a	84.65 ^a
Grazing land	28.44	13.5 ^b	14.94 ^a	75.51 ^a
Cultivated outfields	28.38	15.9 ^b	12.48 ^a	63.49 ^a
Homestead	34.31	25.49 ^a	8.81 ^d	82.13 ^a
Mean	31.37	18.58	12.79	76.84
SE (±)	1.27	0.84	0.57	1.6
F	1.68	8.47	5.9	9.3
Sig	ns	**	*	**

For each column, means having common letters are not significantly different at $P \leq 0.05$; FC = field capacity, PWP = permanent wilting point, AWC = available water-holding capacity, SE = standard error of mean, and ns = nonsignificant; ** $P < 0.01$ and * $P < 0.05$.

the natural vegetation shows no signs of wilting after field crops have long wilted. Landon [30] explained that SOC, texture, mineralogy, and morphology of soil affect the content of the available water content. In the same way, the highest water-stable aggregates were found in forest soils (84.65%) and homestead garden fields (82.13%), reflecting high organic matter content that served as aggregating agents making the soils less susceptible to erosion (Table 3). Intensive cultivation degrades the soil structural aggregation which is reflected by a diminished aggregate stability under intensively cultivated outfields. After long-term continuous cultivation, the amount of the water-stable aggregate was significantly reduced from 86.22% in the forest soil to 63.5% in the cultivated outfield soil. This result is in agreement with the research

report in [4]. Loss of organic matter is likely to have soil aggregates easily detach from each other, and finally the finer particles are transported by water erosion.

3.3. Soil Reaction (pH), OC, TN, and AP. The pH (H₂O) value of the soils was significantly ($P \leq 0.01$) affected by land use types. The highest mean value (7.20) and the lowest (5.80) soil pH (H₂O) values were recorded under the forestland and the cultivated outfields, respectively (Table 4). According to the rating proposed in [30], the soil pH is moderately acidic in cultivated outfields but neutral under forestlands, suggesting that intensive land use including the application of the mineral fertilizer in cultivated outfields leads to acidification. This finding is in agreement with the reports in [9, 31].

TABLE 4: Mean values of the selected chemical properties of soils as affected by land uses.

Land use	pH (H ₂ O)	OC%	TN (%)	C/N ratio	AP (mg/kg)
Forest	7.20 ^a	2.24 ^a	0.24 ^a	9.33	16.00 ^a
Grazing land	6.57 ^c	1.93 ^c	0.20 ^b	9.65	14.27 ^{ab}
Cultivated outfields	5.80 ^d	1.31 ^d	0.14 ^c	9.36	9.13 ^d
Homestead	6.83 ^b	1.85 ^c	0.20 ^b	9.25	12.27 ^c
Mean	6.6	1.83	0.19	9.40	12.92
SE (±)	0.08	0.1	0.01	0.36	0.51
F	17.12	13.59	57.71	0.079	10.99
Sig	***	***	***	ns	**

For each column, means having common letters are not significantly different at $P \leq 0.05$; OC = organic carbon, TN = total nitrogen, C/N = carbon to nitrogen ratio, AP = available phosphorus, SE = standard error of the mean, and ns = nonsignificant; *** $P < 0.001$ and ** $P < 0.01$.

TABLE 5: Mean values of CEC and exchangeable basic cations as affected by land uses.

Land use	CEC (Meq/100gm)	Ca (Cmol/kg)	Mg (Cmol/kg)	Na (Cmol/kg)	K (Cmol/kg)	TEB	PBS (TEB/CEC * 100)
Forest	36.63 ^a	15.40 ^a	8.69 ^a	0.19 ^a	4.07 ^a	28.35 ^a	77.40
Grazing land	33.07 ^{ab}	14.60 ^a	7.49 ^{ab}	0.16 ^b	3.74 ^a	25.99 ^a	79.00
Cultivated outfields	25.40 ^c	11.13 ^b	6.41 ^b	0.12 ^c	2.45 ^b	20.11 ^b	79.20
Homestead	29.13 ^{bc}	13.53 ^a	6.85 ^b	0.16 ^b	2.93 ^a	23.47 ^a	81.00
Mean	31.06	13.67	7.36	0.16	3.3	24.51	80.78
SE (±)	1.05	0.36	0.3	0.14	0.22	0.941	2.05
F	7.08	8.48	3.47	18.46	9.08	54.35	1.45
Sig	**	**	ns	***	**	***	ns

For each column, means having common letters are not significantly different at $P \leq 0.05$; CEC = cation exchange capacity, Ca = exchangeable calcium, Mg = exchangeable magnesium, Na = exchangeable sodium, K = exchangeable potassium, TEB = total exchangeable bases, BS = base saturation, SE = standard error of the mean, and ns = nonsignificant; *** $P < 0.001$; ** $P < 0.01$.

The soil organic carbon content was significantly ($P \leq 0.001$) affected by land use with significantly higher mean values (2.24%) under the forest land and lower mean values (1.31%) under intensively cultivated outfields (Table 4). The difference can be explained by intensive cultivation of the land that speeds up oxidation of the organic matter coupled with total removal of crop residues, as animal feed and source of household energy [9]. Based on the ratings in [32], the SOC content of the soils was rated as low under cultivated outfields and medium under the grazing land and homestead garden fields and rated as high under the forest land (Table 4). This result is in agreement with the findings in [33, 34], in which it was reported that the SOC content is lower in cultivated soils than in those soils under natural vegetation.

Total nitrogen content of soils was significantly ($P \leq 0.000$) affected by land use with the higher mean values (0.24%) under the forest land and the lowest (0.14%) under intensively cultivated outfields, while the grazing land and homestead garden fields had similar mean values (Table 4). The nitrogen content of the soils is generally in the low to medium range as one moves from cultivated outfields to the forest, homestead garden fields, and grazing areas and follows the pattern of the organic matter levels. This finding is in agreement with the results in [35, 36], in which it was reported that intensive and continuous cultivation speed up oxidation of OC and thus resulted in reduction of TN. However, the content of total nitrogen was higher in the forest land (0.24) and lower in the crop land (0.14) (Table 4). This result is in conformity with the findings in [37]. In

forests and grazing lands with good cover of natural vegetation, its return into soil is high which increases the SOM content, which in turn increases the total nitrogen content of these soils.

There was no significant difference among evaluated land use types in C/N ratios, and its mean value of 9.40 is suggesting rapid organic matter decomposition under the humid tropical conditions of the area, indicating improved availability of nitrogen to plants, and there will be possibilities to incorporate crop residues to the soil without adverse effect of nitrogen immobilization [38]. Optimum range of the C/N ratio is about 10:1 to 12:1 that provides nitrogen in excess of microbial needs [39]. Therefore, the C/N ratio of the soils of the study area was below the optimum range of microbial needs.

The available phosphorus was significantly ($P \leq 0.01$) affected by land use/land cover change with the highest mean values (16 mg/kg) under the forest land, followed by that under the grazing land (14.27 mg/kg), and the lowest (9.13 mg/kg) under the intensively cultivated outfields (Table 4). It is interesting to note that the phosphorus level is low in the cultivated outfields in spite of decades of DAP (diammonium phosphate: 18–46% and N-P₂O₅) fertilizer application, suggesting the less availability of phosphate in the soil is perhaps due to high fixation in the clay colloids. Based on the ratings, the available phosphorus content of the soils was rated as low under cultivated outfields and rated as medium under the forest land, grazing land, and homestead garden fields [32].

TABLE 6: Mean values of selected micronutrients as affected by different land use classes.

Land use	Mg/kg			
	Fe	Mn	Zn	Cu
Forest	81.02 ^a	55.47 ^a	1.52 ^d	0.58 ^b
Grazing land	102.14 ^a	101.38 ^a	2.55 ^c	0.39 ^c
Cultivated outfields	98.60 ^a	92.65 ^a	4.82 ^b	0.54 ^b
Homestead	100.37 ^a	97.02 ^a	7.38 ^a	0.68 ^a
Mean	95.53	86.63	4.07	0.55
SE ($\pm$)	3.89	5.25	0.37	0.04
F	6.05	16.15	50.31	6.75
Sig	*	***	***	*

For each column, means having common letters are not significantly different at $P \leq 0.05$; Fe = iron, Mn = manganese, Zn = zinc, Cu = copper, and SE = standard error of the mean; *** $P < 0.001$; * $P < 0.05$.

3.4. Cation Exchange Capacity and Exchangeable Bases. The CEC and exchangeable bases of the soils (except for Mg) are highly significantly ($P < 0.01$) varied across land use types, with all parameters being higher under the forest land use and lower under the cultivated outfields (Table 5). The mean values of CEC (31 cmol (+)/kg), total exchangeable bases (24.51 Cmol/Kg), and base saturation (80%) are in the high range of the good fertility status of the soil. These results are in agreement with pervious findings in [39–41] which also reported high cation exchange capacity (CEC) values under the grassland as compared to the cultivated land.

3.5. Micronutrients. The soils are generally high in Fe and Mn but low to medium in Cu and Zn (Table 6), which is consistent with the acidic soil reaction. In acidic soils, the level of micronutrients is expected to be high except for Cu [9]. There was a highly significant ($P < 0.001$) variation in Mn and Zn levels among the land use types; however, Fe and Cu were significantly ($P \leq 0.05$) affected by land use/land cover change. Homestead and grazing lands have the highest levels of all micronutrients. This result is in agreement with the report in [41]. Relatively higher extractable Cu content was observed in homestead soils (0.68 mg/kg), followed by forest land soils (0.58 mg/kg) (Table 6). This could be due to the relation of copper with organic carbon. Based on Cu ratings developed in [42], the ratings of the Cu content of soils of the study area were rated as low (deficient) in all the land use types.

4. Conclusion

The result of the study showed that land use/land cover change significantly affects physicochemical properties of soils. The most favorable soil properties were observed under the forestland, followed by homestead garden fields and grazing areas, while the least favorable soil properties were observed in intensively cultivated outfields. Expansion of the agricultural land at the expense of forest cover and poor management have promoted significant loss of soil quality in intensively cultivated outfields (cropland). Therefore, reducing the land cover conversion and adopting proper management of the soil are very crucial in order to maintain

soil fertility and sustain agricultural production in the study area and in other similar areas of the Ethiopian highlands. Furthermore, efforts that ensure sustainable land management (application of balanced plant nutrients, farmyard manure, crop residue return, and compost) ought to be taken so as to improve the soil quality in intensively cultivated outfields.

Data Availability

The data used to support the findings of this study are available upon request from corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest.

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