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Effects of Different Land Uses (Forest, Grazing and Cultivated) on the Fertility Status of Acidic Soils of Dano District, West Shoa Zone, Oromia Region, Ethiopia

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Abstract: Soil acidity is one of the chemical soil degradation problems affects productivity of the soil in high land in Ethiopia. Assessing land use induced changes in soil properties are essential for addressing the issues of agroecosystem transformation and sustainable land productivity. The study was therefore conducted on the effects of different land uses *viz.,* forest, grazing and cultivated on the fertility status of acidic soils of Dano District, West Shoa Zone, Oromia Region, Ethiopia. A total of 18 representative top soil samples (0-20 cm depth) from two areas (Kelecha and Kekero) were collected and analyzed for selected soil physicochemical properties. One way ANOVA was employed to compare the soil parameters. The concentration of essential macro and micro-nutrients (like K, Ca, Mg, Na, Fe, Cu, Zn and Mn) in soil samples were determined using flame photometer for K and Na and atomic absorption spectrometry for the rest of metals. The results indicated that cultivated land and grazing land were strongly acidic ($pH<5.5$), where as natural forest land uses were moderately acidic (5.6-6.0) soils. The increased soil acidity in cultivated grazing land may be due to intensive cultivation without fallow for extended period of time, removal of crop residue and inappropriate use of chemical fertilizers in this area. Significantly higher ($p<0.01$) soil pH, ECEC, Ca and Mg and significantly lower ($p<0.05$) exchangeable acidity were recorded in natural forest when compared to other land uses in both kebeles. The highest average mean values of 10.4±0.1, 8.3±0.1 and 29.4±6.5 cmol(+)/kg) exchangeable Ca, Mg and CEC were observed under forest land and lowest values (3.3±0.1,2.4±0.1and 22.9±0.8cmol(+)/kg), respectively in the cultivated land. To address soil acidity problems, use of lime, manure and compost should be encouraged in the study area in cultivated lands. Reducing overgrazing by improving land management options is necessary to rehabilitate acidic soils in grazing land.

Key words: Dano District · Land uses · Soil acidity · Soil properties and Soil quality indicator

INTRODUCTION

Soil acidity is one of the chemical degradation of soils. Soil acidification can either be accelerated by certain plants and human activities or slowed down by careful management practices. The acidifications of soil pose several problems for successful crop production. Soil acidity limits plant growth not only because of the deficiency of major nutrients like P, Ca and Mg but also due to toxicity of aluminium (Al^{3+}), manganese (Mn^{2+}), iron (Fe^{3+}) and hydrogen ($H^{+)}$ ions. These are vital factors limiting the yield of acid sensitive crops including barley and wheat [1, 2].

Acid soils are common in humid regions. Where ever rainfall is substantial, bases and salts are leached from the soil profile, leaving behind more stable materials rich in Fe^{3+} and Al^{3+} oxides, resulting in soils that are acidic and generally devoid of plant nutrients. In other words, soil acidity is a result of natural weathering processes that are accelerated in wet regions [3]. The rate of soil quality degradation depends on land use systems, soil types, topography and climatic conditions. Land use changes have significant influences on soil quality indicators, particularly at the surface horizon. Soil forms of exchangeable bases and available micronutrients were affected due to intensive cultivation and use of acid

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forming inorganic fertilizers for the past three decades in western Ethiopia. Study by [2 and 4] have examined the impacts of different land uses on soil qualities and the study indicated, the rate of soil quality degradation depends on land use systems [5, 6].

Knowledge about an up-to-date status of soil physical and chemical properties of different land use systems plays a vital role in enhancing production and productivity of the agricultural sectors on sustainable basis. However, practically oriented basic information on the status and management of soil physicochemical properties as well as their effect on soil quality to give recommendations for optimal and sustainable utilizations of land resources remains poorly understood. Therefore, this study was mainly conducted with specific objectives to assess and explore the effects of different land use on soil fertility status of acidic soils of Dano District, West Shoa Zone, Oromia Region, Ethiopia. The results of this study are expected to add value to the up-to-date scientific documentation of the status of soil fertility and soil quality of different land uses of the study area and other similar agro-ecological environments in the country.

MATERIALS AND METHODS

Description of the Study Area: According to the local and the Ethiopian agro-climatic zonation [7] the study area belongs to the humid (*Baddaa)* and sub-humid (*Badda Darree*) climatic zones. Geographically, the study area is located at Kelecha and Kekero kebeles in Dano District in West Shoa Zone of Oromia Regional State. Dano District is located at 08° 45' 960 latitude and 037° 15'622 longitudes. Dano is one of districts in the Oromia Region of Ethiopia. The Zonal Capital Town, Ambo (West Shoa Zone), approximately 109 km away from the Zonal Capital Town, Ambo Regional and National Capital City, Addis Ababa. The District is bordered from North Ilu Galan and Gedo and from the East by Nono, on the South by Jibat and on the West by Jimma Zone and the study sites had almost similar topography. The administrative center of this District is Seyo (Fig. 1). The topography of the study site is mountainous and sloping landscape. According to the [8] classification legend, the main soil group of most of the West Shoa Zone areas is vertisol. Similar to most parts of the country, the economic activities of the local community of the study area are primarily mixed farming system that involves crop production and animal husbandry. The major crops grown in the area are coffee (*Coffee arabica* L.*)*, teff *(Eragrostis tef),* barley *(Hordeum vulgare* L.*)*, maize (*Zea mays* L.) and potato *(Solanum tubersoum* L.*)* hot pepper (*Capsicum frutescence*) and are usually produced once in a year under rainfed conditions. Rapid human growth and livestock populations at the study area has resulted in a substantial change in land use system whereby food crops production took precedence over grazing lands, while most natural forest has been cleared for crop production and local fuel. These environmentally unfriendly farming practices and the high rainfall amounts have exposed the soils of the study area to severe erosion resulting in nutrient loss, soil acidity and overall land and natural resource degradation.

Soil Sampling and Analysis: The study was carried out during February, 2013 and three major representative land uses (natural forest, grazing and cultivated lands) were selected based on their history and occurrence. The natural vegetation of the study area is characterized by indigenous natural forest and canopies, where as rainfed crop cultivation bounded by scattered settlements in the cultivated land and communal and private grazing lands were the characteristic features of the land use types. The soil sampling points were taken in a zigzag fashion using a 20cm × 20 cm × 25cm pit from two Kebeles. The composite top soil (0-20 cm) samples from representative site of each land use in three replicates were collected, air dried, ground and passed through a 2 mm sieve for analysis. Analysis of soil samples were carried out at Chemistry laboratory of Ambo University and Holleta Soil Research Laboratory Center based on their standard laboratory procedure.

Particle size distribution and bulk density were determined by the hydrometer and the core sample methods respectively. The pH of the soil was measured potentiometrically with a digital pH meter in the supernatant suspension of 1:2.5, soil: liquid ratio [9]. Organic carbon (OC) content was determined by the oxidation method [10]. Total N was determined using the micro-Kjeldahl digestion, distillation and titration procedure as described by [11]. Total P was determined using perchloric acid digestion method as described by [12]. Available P was analyzed using both Olsen method as described by Bray-II method colorimetrically using vanadomolybedate acid as an indicator and its concentration was measured using spectrophotometer at a wave length of 880 nm. Extractable Fe^{3+} and Mn^{2+} were extracted using diethylenetriamine pentaacetic acid (DTPA) as described by [13] and their contents were determined using atomic absorption spectrophotometer

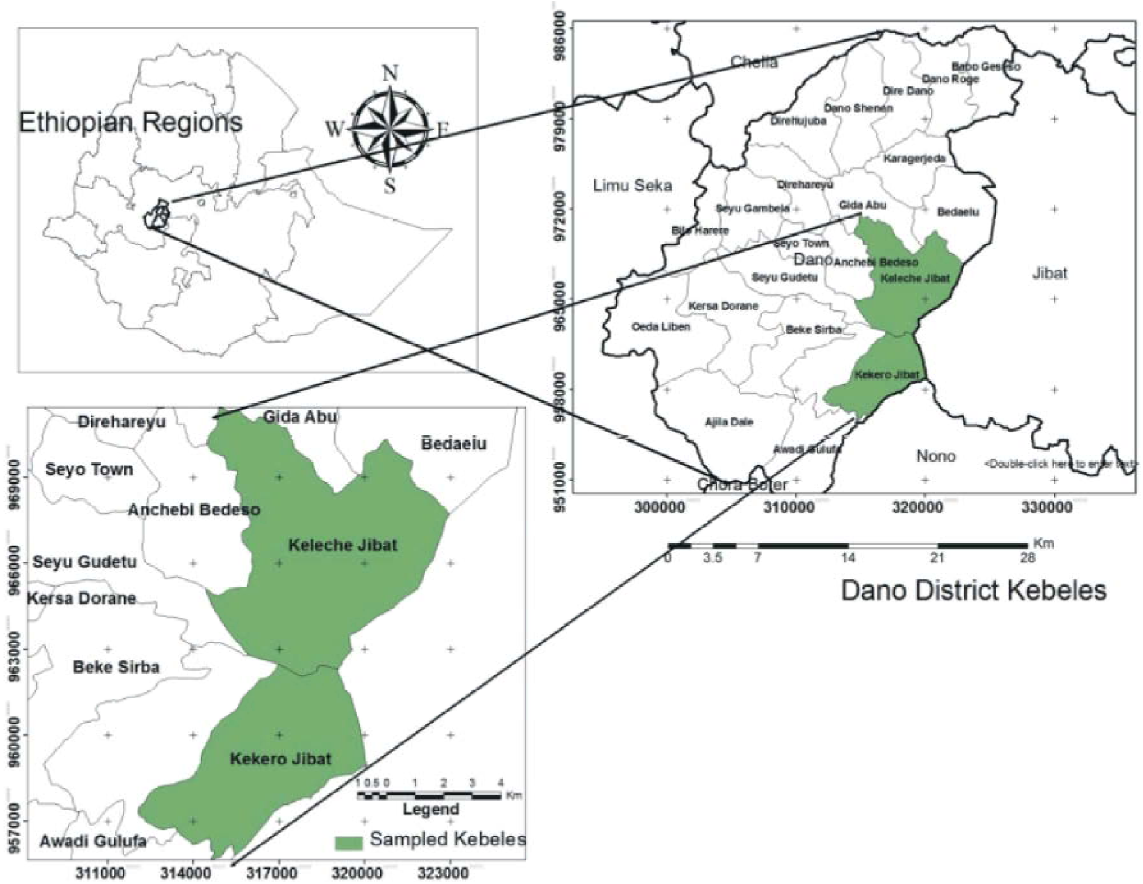

Fig. 1: Location map of the study area

Exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were extracted with 1 M NH_4OAc at pH 7. The extracts of Ca^{2+} and Mg^{2+} were analyzed using AAS while K^+ and Na^+ were determined by flame photometer. To determine the cation exchange capacity (CEC), the soil samples were first leached with 1M ammonium acetate (NH_4OAc), washed with ethanol and the adsorbed ammonium was replaced by Na^+ [14]. Then, the CEC was measured titrimetrically by distillation of ammonia that was displaced by Na^+. Total exchangeable acidity was determined by saturating the soil samples with 1M KCl solution and titrated with 0.02 M HCl as described by [15]. From the same extract, exchangeable Al in the soil samples was titrated with a standard solution of 0.02 M HCl. The effective CEC (ECEC) is calculated as the sum of exchangeable bases and exchangeable acidity, the percent acid saturation was calculated as the ratio of the exchangeable acid and as percentage of CEC. The percent base saturation (PBS) of the soil samples was calculated from sum of the exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) as percentage of CEC.

Data Analysis: The obtained data were treated using one-way ANOVA and using t-test at 95% and 99% confidence level to reveal the magnitudes and directions of relationship between different parameters of soil properties within and among land use types [16].

RESULTS AND DISCUSSION

Effect of Land Use Types on Soil Physical Properties: Changes in land uses and practices often modify most soil physical and chemical properties to the extent reflected in agricultural productivity. Different land use systems have significant influence on most important soil quality indicators. All the land use types was loam soil (Table 1) indicating the similarity in parent material. However, loam content in the surface layer (0-20cm) of the soils varied significantly ($P<0.05$) among the land use types. Its content was significantly lower in cultivated land as compared to the forest and grazing lands. The soil texture analysis, based on hydrometer method, indicated that, in most of the soils, the proportion of sand fraction was high

Table 1: The Soil texture in Different Land Use System (n=5, mean ± SD)

Kelecha Kebele						
	Land Use Types					
Soil Parameters	CL	GL	FL	Class	LSD	CV
SD	44.66±0.05[a]	43.76±0.25[b]	40.63±0.03[c]	Loam soil	2.95	3.36
ST	34.22±0.02[a]	33.88±0.15[b]	32.57±0.26[c]		0.02	0.03
PD	2.62±0.02[c]	2.51±0.98[b]	2.21±0.03[a]		0.07	0.14
BD	1.62±0.08[c]	1.32±0.01[b]	1.23±0.07[a]		0.02	0.48
TP	38.16±3.34[c]	47.41±0.98[a]	44.34±1.33[b]		2.32	2.39
	Kekero Kebele				LSD	CV
SD	43.97±0.08[b]	45.64±0.02[a]	41.85±0.03[c]		0.05	0.02
ST	34.92±0.25[c]	34.53±2.56[b]	33.66±0.09[c]		0.04	0.06
PD	2.61±0.02[c]	2.49±0.06[b]	2.41±0.03[a]		0.01	0.13
BD	1.34±0.01[c]	1.32±0.04[a]	1.24±0.07[c]		0.02	0.04
TP	48.65±2.5[b]	46.98±0.3[a]	48.54±0.66[c]		1.02	0.98

BD= Bulck density, PD particle density, TP= Total porosity, CL=cultivated land, GL=grazing land, FL=forest land, CV=coefficient variance, LSD=least significant different and mean values with different superscript letters in columns indicate significant differences at α=0.05; α= 0.01.

Table 2: The Values of pH (KCl) and pH (H_2O) (mean ±SE)

	Kelecha Kebele			Kekero Kebele		
	Soil pH(1:2:5)					
Land Uses	KCl	H_2O	ΔpH	KCl	H_2O	ΔPH
CL	4.24±0.27[c]	5.10±0.03[b]	0.86	3.81±0.05[c]	5.53±0.13[a]	1.72
GL	4.48±0.04[b]	5.54±0.63[a]	0.56	4.65±0.02[b]	5.11±0.02[c]	0.46
FL	5.42±0.13[a]	5.56±0.02[a]	0.16	4.9±0.06[a]	5.73±0.31[a]	0.83
LSD	0.36	0.60	0.24	0.12	0.06	
CV	3.3	0.07	3.23	1.19	0.54	

CL=cultivated land, GL=grazing land, FL=forest land, CV=coefficient variance, LSD=least significant different and mean values with different superscript letters in columns indicate significant differences at α=0.05; α= 0.01

(40.63±0.03 to 44.65 ±0.05) % followed the silt fraction (32.57±0.26 to 34.22 ±0.02) % and the clay fraction (21.13 ±0.07 to 26.79±0.55) % in land use types at Kelecha keble whereas, in Kekero kebele, the proportion of particle size ranged from (41.85±0.03 to 45.64 ±0.02) % for sand, (33.66±0.09 to 34.92 ±0.25) % for silt and (19.83±0.03) to 24.49±0.06) % for clay. Sand and clay were positively (r = 0.43, r = 0.95) and significantly correlated with CEC and negatively(r = -0.96, r = -0.99) with exchangeable acidity of soils. Despite the fact that texture is an inherent soil property, management practices may contributed indirectly to the changes in particle size distribution particularly in the surface layers as result of removal of soil by sheet and rill erosions and mixing up of the surface and the subsurface layers during continuous tillage activities [17]. The bulk density showed numerically narrow variation among land use types (Table 1). The reason might be due to the recent conversion of the forest land into grazing and cultivated lands in the study area. However, previous findings have reported higher bulk density in grazing and cultivated lands as compared to forest land. Soils in pasture land were found to be significantly more compacted than other land uses [18]. Bulk density value was not significantly ($P \geq 0.05$) affected by land uses. However, numerically the highest mean (1.62 ±0.08 g/cm^3) value of bulk density was recorded on the cultivated and the lowest mean (1.23 ± 0.07g/cm^3) value under the forest land of kelecha kebele and the highest mean(1.34 ±0.07g/ cm^3) value of bulk density was recorded on cultivated and the lowest mean (1.24±0.01 g/cm^3) value under forest land of Kekero kebele (Table 1). The lower and higher bulk density of soil forest and cultivated land may be attributed to the high, SOM, porosity and less disturbance of land under forest land [19].

Soil bulk density was positively and significantly (r = 0.81) correlated with the silt and negatively (r = -0.803**) with clay of soils. Soil particle density varied with the land use type and recording the highest and lowest in the soils of cultivated and forest land, respectively. In this study, the mean value of soil particle density in cultivated land 2.62±0.02 and 2.21±0.03 forest land. The lower particle density of the forest land as compared to grazing and cultivated lands is due to trapped air and higher contents SOM in forest land. These higher particle density values on the surface soil layers of the cultivated land may be due to the presence of heavy minerals of Fe and Mn in the surface soil as indicated by the higher Fe and Mn contents in the surface layer which is in agreement with past reports by [1, 20].

Effects of Land Use Types on Soil Chemical Properties: The soil pH values measured in water were higher almost by about 1.0 to 1.5 units than their respective values measured in KCl solution under different land uses of the topsoil (0-20 cm) depth at both sites (Table 2). There is a strong relationship between soil acidity and other soil properties from soils of different land uses. The correlation analysis indicated that soil pH (H_2O and KCl) is highly significantly ($p<0.01$) and positively correlated with total exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) (r = 0.88; r = 0.0.69) and CEC (r= 0.65; r = 0.78), but negatively correlated with exchangeable acidity (r=-0.79; r=-0.93) and acid saturation (r = - 0.74; r = - 0.80) for pH (H_2O and KCl respectively (Table 4 and 5). These results are in agreement with the findings of (Yihenew, 2002) who observed that pH is highly significantly ($p<0.01$) and positively correlated with Ca^{2+} (r = 0.50) and Mg^{2+} (r = 0.41) where as highly significantly and negatively correlated with exchangeable acidity (r=- 0.61) [21, 22].

Soil Organic Matter, Total Nitrogen and Carbon to Nitrogen Ratio: Most cultivated soils of Ethiopia are poor in their OM content due to low amount of organic materials applied to the soil and complete removal of the biomass from the field [22]. The OM content of cultivated land was significantly ($P < 0.01$) lower than forest and grazing while non significant ($P > 0.05$) difference was observed between forest and grazing land (Table 3). Additionally, complete removal of crop residues in the cultivated land might have resulted in declining soil OM. Generally, the contents of soil OC were ranged from (4.57±0.03 to 4.77±0.44) in cultivated land (4.75 ±0.04 to 5.02±0.35) in grazing and (5.31±0.42 to 5.57 ±0.07) in forest land for both locations (Table 3). In most case the C: N ratio ranges from 20 to 30 considered as normal soil. However, the C:N ratio registered at both sites ranges about (7.72 ±0.88 to 10.56 ±0.12) which are below the normal (Table 3). This indicates the existence of enough N to meet microbial needs. [23] reported that soils with C: N ratios in the range of 10 to 12 provide N in excess of microbial needs. Whereas soils with C: N ratios above 35 not likely to contain enough N to meet microbial needs. Therefore OM and TN content have direct relation to soil acidity. This implies that intensive cultivation; removal of crop residues significantly depletes OM and TN that leads soil acidity problems in the present study area. Periodic tillage operation with insufficient soil management in the cultivated and grazing land may be responsible for the significant low organic matter and total nitrogen content that may aggravate soil acidity. Tillage looses the soil, improves its aeration, which hastens microbial break down of soil organic matter through respiration, decomposing of organic matter may hasten soil acidity.

Exchangeable Acidity and Acid Saturation: There was a great variation on exchangeable acidity and acid saturation of the soils under the different land use types in both sites at the soil depth of (0-20 cm) topsoil. The highest exchangeable acidity value obtained from soils of cultivated soils (4.68± 0.82 to 7.86±0.01 cmol (+) /kg) and followed by grazing lands (3.95± to 6.89 0.03±cmol (+)/kg). However, the lowest exchangeable acidities were registered on forest land (0.73± to 0.80 ±0.04 cmol (+)/kg) at Kelecha and Kekero kebeles respectively (Table 4).

The soil of forest land had highly significantly ($p<0.01$) exchangeable acidity than soils under the other two land use types. Similar trends were observed in acid saturation percentage. It is significantly lower ($p<0.01$) on soils of forest fields than other land use types. Relatively, the highest acid saturation were recorded in cultivated fields (44.23±1.22 to 58.61±0.37) and followed other two land use types where as the lowest was on soils of forest land fields (3.5±0.14 to 3.72±0.23) on the former and later kebele (Table 4). The significant difference in acid saturation between forest and cultivated soils were probably due to the difference in agronomic management practice and application of farm yard manure. On the other hand, the relatively higher acidity on grazing land entails that pasture species such as grasses and legumes aggravate soil acidity development by taking more basic cations during harvest and livestock feed. The reason could be less return of grass/legume biomass to the soil except the underground plant parts. Moreover, the development of soil acidity also attributed poor livestock distribution on grazing lands due to exposure of sheet and rill erosion.

Available Phosphorous and Available Potassium: The highest concentrations of available P (5.07± 0.55 to5.45 ± 0.65mg/kg) by the Bray II method were registered on the forest land at Kelecha and Kekero, respectively. However, lowest values were recorded cultivated land

Table 3: Value of organic matter, total nitrogen and C: N ratio of soils in different land use

Kelecha Kebele					
	Land Use Types				
Parameters	CL	GL	FL	LSD	CV
OC (%)	4.57±0.03[c]	4.75±0.04[b]	5.31±0.42[a]	0.17	1.58
TN (%)	0.44±0.25[c]	0.45±0.07[b]	0.71±0.91[a]	0.07	6.24
C:N	10.39±0.12[b]	10.56±0.57[a]	7.48±0.46[c]	0.74	3.38
	Kekero Kebele				
OC (%)	4.77±0.44[c]	5.02±0.35[b]	5.57±0.04[a]	0.06	0.09
TN (%)	0.46±0.1[c]	0.65±0.40[b]	0.73±0.02[a]	0.07	0.59
C:N	10.36±4.4[a]	7.72±0.88[b]	7.63±2.0[c]	0.54	2.73

CL= cultivated land, GL= grazing land, FL= forest land OC= organic carbon TN= Total nitrogen C:N=carbon nitrogen ratio and mean values with different superscript letters in columns indicate significant difference α=0.05; α= 0.01, Where *p<0.05, **P<0.01

Table 4: Acidity indicators parameters of soil of different land uses (n=5, mean ±SD).

	Kelecha Kebele		Kekero Kebele	
Land Use	Ex. Acidity	AS%	Ex. Acidity	AS%
CL	4.68±0.82[a]	44.23±1.22[a]	7.86±0.10[a]	58.61±0.37[a]
GL	3.95±0.07[b]	30.64±1.02[b]	6.89±0.03[b]	53.78±0.11[b]
FL	0.73±0.03[c]	3.5±0.14[c]	0.80±0.04[c]	3.72±0.23[c]
LSD	0.05	15.96	0.69	10.09
CV	0.69	25.65	0.77	13.28

AS= Acid saturation, CL= cultivated land, GL= grazing land, FL= forest land, LSD= least significant difference and Mean values with different superscript letters in columns indicate significant difference α=0.05; α= 0.01, Where *p<0.05, **P<0.01.

Table 5: The Values of Available Phosphorus and Potassium in Different Land Use (mean± SD) in mg /kg and ppm (n=5)

	Kelecha kebele		Kekero kebele	
Land Use	Ava.(P)mg/kg	Ava.(K)ppm	Ava.(P)mg/kg	Ava.(K)ppm
CL	3.57±0.05[a]	119.58±1.04[c]	3.92±0.04[a]	128.38±0.04[c]
GL	4.84±0.02[b]	146.87±0.08[b]	4.96±0.15[b]	150.85±0.05[b]
FL	5.07±0.55[c]	240.35±0.05[a]	5.45±0.65[c]	250.95±0.05[a]
LSD	0.05	1.35	0.04	0.09
CV	0.57	0.35	0.26	0.23

CV=cofficient of variation, CL= cultivated land, GL= grazing land, FL= forest land, LSD= least significant difference and Mean values with different superscript letters in columns indicate significant difference α=0.05; α= 0.01, where *p<0.05, **P<0.01

soils (3.57±0.05 at the former and 3.92±0.04mg/kg) in later Kebeles (Table 5). However, the available P contents of the soils in the present study were below the critical level in two land uses of both kebeles. It was also calibrated available phosphorous by Bray II method as very low (<3.00ppm), low (4.00 to 8.00ppm), medium (8.00-11.00ppm) and rich (>12.00ppm). Hence, available P in cultivated field was generally low (<10ppm). It is also better to consider that the amount of P extracted by Bray II method depends on the pH of the soil, it extracts more in acid soils and the opposite is true for higher pH. The low available P content in acid soils is not only due to the inherently low available content of acid soils but also the high fixation capacity of the soil. Correspondingly, available P and K were highly significantly (p<0.01) and negatively correlated with level of acid saturation (r=-0.71** and r=-0.86**) respectively (Table 5). According to [20] under acidic condition, the presence of high levels of soluble, Al and Mn leads to the precipitation insoluble phosphate compounds. Moreover, phosphate can be fixed by hydrous oxides of Al and Fe as well as by certain silicate clays, which can also reduce its availability.

Exchangeable Bases and Cation Exchange Capacity: Depletion of bases cations by leaching aggravates extent and rate of soil acidification process. The lower 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 OM [5, 24]. The authors reported that conversion of natural forest land into shrub, grazing and cultivated lands caused losses of CEC in the magnitude of

Table 6: Exchangeable base of Kelecha and Kekero Kebeles in cmol (+)/kg (mean ± SD, n=5)

	Land Use Types				
Metals	CL	GL	FL	LSD	CV
	Kelecha Kebele				
Ca	3.28±0.13[c]	4.23±0.34[b]	10.42±0.08[a]	0.04	1.81
Mg	2.38±011[c]	3.65±0.05[b]	8.34±0.06[a]	0.03	0.17
K	0.22±0.03[c]	1.03±0.01[b]	1.22±0.02[a]	0.02	1.07
Na	0.02±0.10[c]	0.03±0.01[b]	0.12±0.03[a]	0.06	0.09
TEB	5.90±0.37[c]	8.94±0.41[b]	20.10±019[a]	0.05	0.14
ECEC	10.58±1.19[c]	12.89±0.22[b]	20.83±0.29[a]	0.04	0.10
CEC	16.98±1.2[c]	18.42±0.07[b]	29.44±6.50[a]	0.06	0.10
	Kekero kebele				
Ca	3.13±0.02[c]	3.18±0.03[b]	11.85±0.07[a]	0.02	0.12
Mg	2.14±0.08[c]	2.15±0.05[b]	8.91±0.07[a]	0.03	0.01
K	0.33±0.01[c]	0.53±0.04[b]	0.54±0.06[a]	0.02	0.81
Na	0.02±0.01[c]	0.06±0.03[b]	0.13±0.03[a]	0.07	0.37
TEB	5.62±0.12[c]	5.92±0.15[b]	21.43±0.23[a]	0.09	1.08
ECEC	13.48±0.13[b]	12.81±0.02[c]	21.51±0.27[a]	0.10	0.25
CEC	16.77±4.67[c]	18.56±0.05[b]	31.52±0.02[a]	0.06	0.09

CEC= Cation exchange capacity, TEB= total exchangeable bases, CL= cultivated land, GL= grazing land, FL= forest land and Mean values with different superscript letters in columns indicate significant difference α=0.05; α= 0.01, Where p<0.05, **P<0.01

30.38 and 50%, respectively, in the surface (0-20 cm) soils. The results demonstrated that content of exchangeable bases contents were well maintained in the forest ecosystem due to nutrient recycling as compared to grazing and cultivated lands, where basic nutrients loss up on grazing and harvesting prevailed.

The present study revealed the lower exchangeable K^+ and Na^+ in the cultivated land than the remaining land uses. The lower value of exchangeable K^+ and Na^+ in cultivated soil may be related to intensive cultivation and removal of base cations during crop harvest that enhanced its depletion (Table 6). The low exchangeable basic (Na, Ca, Mg and K) cations in the cultivated land may be due to removal of basic cations (Na^+, Ca^{2+}, Mg^{2+} and K^+) by crop uptake, leaching and erosion which finally intensify the acidification processes. There was a great variation in effective cation exchange capacity (ECEC) of the soils under the different land use systems. This was evidenced with the study made by [24, 25, 26]. The highest ECEC (12.81±0.02 to12.89±0.22) cmol (+) /kg) and 20.83±0.29 to 21.51±0.27 c mol (+) /kg) were recorded in the grazing and forest land while the lowest (10.58±1.19 to13.48±0.13) cmol (+) /kg) was registered in the cultivated at two kebeles, respectively (Table 6). The cultivated soils had a statistically significantly higher ECEC, (p<0.01) in Kelecha and (p<0.05) in Kekero kebeles respectively, than soils under the other two land use types. In line with ECEC, the highest value of CEC (29.44±6.50 to 31.52 ±0.02 cmol (+)/ kg) were observed in forest land and the lowest recorded on cultivated land and grazing land (16.77±4.67 to16.98±1.2) and (18.42± 0.07 to18.56±0.05) cmol (+)/kg at both former and later kebele (Table 6).

CONCLUSIONS

The present study indicated that the difference in land use systems (forest, cultivated and grazing) has significant influence on soil physicochemical properties. From the present study, it could be concluded that the soil quality and health were maintained relatively under the forest, whereas the influence on most basic soils properties such as soil OC, available P, CEC and total N, CEC and available P was negative on soils of the cultivated land suggesting the need for intervention so as to optimize and sustain soil acidity and fertility problems in the cultivated land. From the results of the study, it is possible to conclude that, the soils collected from of the cultivated and grazing lands of both sites were very strongly acidic than forest land. Higher soil pH and lower acid saturation in forest soils indicate its suitability for crop production and have a better status of available nutrients. Whereas significantly lower soil pH and higher acid saturation in cultivated fields show that, the soil is not suitable for crop production and poor in available nutrients. Moreover, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) and available P are significantly lower and below the critical level in soils of all land uses. A strong negative correlation of acid saturation with exchangeable bases, soil pH, CEC, available P and K, imply that acidity affects major soil fertility parameters.

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