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Agricultural Landscape Features and Farmers' Traditional Classification of Their Agricultural Soils in KedidaGamela, Kachabira and Damboya Woredas (Administrative Districts) in Southern Ethiopia

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Abstract

Ethiopia has extremely varied topography and agro-ecology which is basis for variability of soil properties even in smaller administrative units. The objective of this research was to characterize the agricultural landscape features of Kedida Gamela, kecha Bira and Damboya woredas by identifying landscape positions, textural classes of soil at different landscape positions and local knowledge of farmers in soil classification. Totally 463 geo referenced farm of small holder farmers was survived by using grid based survey and composite soil samples were collected from each site. The elevation and slopes were measured by ODK collectors and clinometers, respectively. The local name of the soil on each plot was identified by interviewing the owner farmers. The particle size distribution was analyzed by laser diffraction spectroscopy. The altitudes and slopes of the study area ranged between 1689 and 2637 m.a.s.l. and 0.9 and 35%, respectively. Farmers in the study area classify soil by using physical properties in to ten classes such as key, tikur, lam, marare, balaleco, shafa, darak, dora, bona and kota. The clay, silt and sand particles ranged from 20.28 to 79.33, 6.23 to 44.51 and 8.47 to 51.46%, respectively. The textural classes of the soil vary through clay, clay loam, loam and sandy loam. In order to improve the agricultural production in study area, relating farmers local knowledge of soil with scientific knowledge and site specific soil fertility management are highly recommended.

Keywords: Altitude, slope, texture and local knowledge of farmers

Introduction

Ethiopia has extremely varied topography and agro-ecology, even within smaller administrative units (FAO, 2006) which affects the productivity of agricultural landscapes. The topographic diversity of the country has resulted in the formation of a multitude of agro-ecological zones and sub zones with varied farming system which has enabled farmers to grow large number of crops and keep almost all types of livestock (Tewelde Berhan Gebre Egziabher, 1989**.** It is thus necessary to acquire site specific information about agricultural land in order to recommend relevant land management practices.

In Ethiopia, two classifications are known that include the traditional agro-ecological zones and the elaborated agro-ecological zones developed by Ministry of Agriculture and Ethiopian Institute of Agricultural Research (EIAR, 2011). The traditional zones include, *bereha* (desert, below 500 m a.s.l.), *kolla* (lowlands, 500–1,500 m a.s.l.), *weynadega* (midlands, 1,500–2,300 m a.s.l.), Dega (highlands, 2,300–3,200 m a.s.l.), *wurch* (3,200–3,700 m a.s.l.) and *Kur* (above 3,700 m a.s.l.). However, the most of agricultural lands fall into three of these (*dega*, *weynadega* and *kolla)* (MoA,2000).

Soil degradation, soil erosion and nutrient depletion in the Ethiopian highlands are prevalent at a tragic rate which has been the main problem to achieve sustainable agricultural production (Bekele and Drake, 2003; Nyssen *et al*., 2010). High population pressure relying on natural resources coupled with poor land resources management practices and poverty resulted in severe soil erosion, this in turn has been a serious threat to national and household food security. The rate of yield increase could not be as much as expected due to soil fertility problems. This makes the issue of site specific soil fertility management practices to be more imperative in order to achieve sustainable agricultural development programs (Gete *et al.*, 2010).In order to realize site specific soil fertility management, the agricultural landscape feature characterization is very vital.

Proper management of agricultural landscapes can be achieved through updated spatial data which are characterizing quality of habitats, current land use, contamination and degradation processes as well as socio-economic situation. Most of these data should be integrated in GIS for agricultural landscapes of at different levels (Stuczynski *et al.,* 2001).

The wide range of soil forming factors in different parts of Ethiopia have resulted in extreme variability of soils (MoA, 2000, Anissa *et al*., 2009). To fully understand soils, successfully predict soil patterns and anticipate soil behavior, one must comprehend the relationships among soils, landscapes, and surficial sediment" (Wisocky *et al.,* 2000). The landscape position and landscape characteristics also represent many of the vegetation, parent material, and climate and time variations of the soil-forming environment. Soil and terrain relationships have been studied intensively, but due to its complexity, it is still not fully understood.

Soil plays an important role in activities such as agriculture. Land use planning, building, erosion control system, environmental protection and nature conservation are some of the initiatives that need to be implemented to maintain good soil environment. All these activities require information about soil attributes in individual landscapes with different features. There have been several attempts to relate soil properties to landscape position for many landscapes (Norton and Smith, 1930; Dahiya*et al.,* 1984; Wysocki*et al*., 2001). This may be partly due to the realization of the role topographic position plays in influencing runoff, soil erosion and hence soil fertility (Babalola *et al*., 2007). Erosion would normally be expected to increase with increase in slope length and slope steepness, as a result of respective increase in velocity and volume of surface runoff.

The Southern Nations, Nationalities and Peoples Regional State (SNNPRS) in Ethiopia is characterized by immense ecological diversity ranging from arid and semi-arid conditions to cool temperate zones. Kambata tembaro (KT) zone is, one of zones among the region, has three agrological zones with different landscape feature such as topographic levels, farming system, crops and soil types. The zone is marked by problems of soil erosion, deforestation, and energy and water scarcity (EPA,2013)

The proper understanding of the agricultural landscape feature and their management according to their potentials and constraints is imperative for maximization of crop production to the potential limit (Numata *et al*, 2003). However, the information on landscape feature of Kedida, Gamela , Kecha Bira and Damboya woredas in relation to agricultural productivity not well documented. Therefore, the aim of this research was to characterize the agricultural landscape features of Kedida gamela, Kechaira and Damboya woredas by identifying landscape positions, local knowledge of farmers in soil classification, soil fertility management practices and the textural classes of the soils.

Material and Methods

Descriptions of Study Areas

This study was conducted in three selected woredas of Kambata and Tembaro (KT) Zone namely Damboya, Kechabira, and Kedida Gamela woredas (Fig.1). Kembat and Tembaro is one of the zones of the SNNPRS and is situated approximately 250 km south - west of Addis Ababa. The whole KT zone is situated between 500 and 3500 meters above sea level, and the topography characterized by steep slope at the foot of Anbericho, Dato and Ketta mountains. This influences the agronomic practices in the woredas, since the land degradation and soil erosion are the main problems due to its steep slope especially in high altitudes.

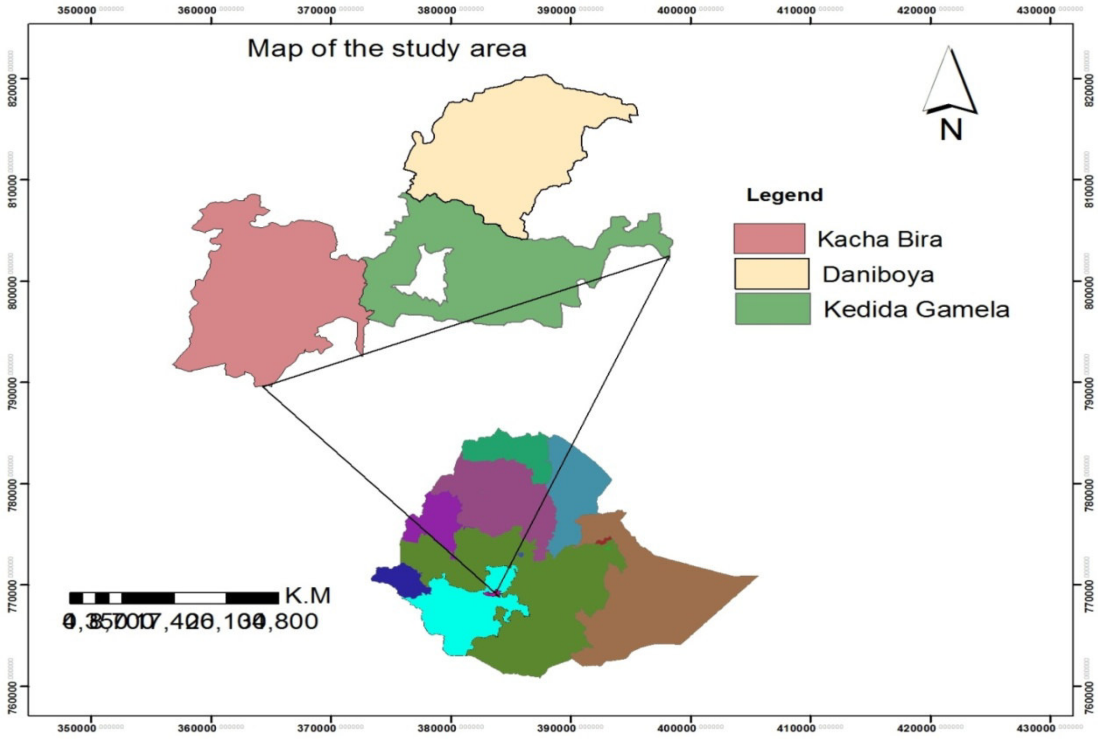

Fig.1. Map of the study area

Methods of sampling site selection

The land-use/land cover of the three woredas was pre-assessed by using Google Earth remote sensing pictures.

The central point of each sampling point (equilateral grids) was labeled with 750m grid to create sampling numbers within generated data points in the study area. Then, the land –use /land cover were classified according to the following criteria adopted by (Ethiosis, 2014).

After the classification of the sampling positions was made, data points that are not going to be sampled and eventual data points that are difficult to access were removed. Then, the number of sampling points was obtained. The number of sampling sites varied from one Peasant Associations (PA) to another depending on the agricultural land size and other features. From all PAs in three weredas, a total of 463 sampling sites were selected by grid sampling method. The Arc GIS tools were used to convert data in appropriate form.

Field studies were conducted from March to October, 2014.Topographic map, which is obtained from Ethiopian Mapping Authority (EMA), of the area was used to collect physiographic and landscape data. Samsung tablets equipped with GPS receivers were used to reach to the pre-defined geo-referenced sampling places. Site information such as altitude, longitude and elevation were recorded by ODK collector software loaded on the Samsung tablets. Slopes were measured by clinometers. Site topography, dominant crops on plot and soil colours were recorded through direct observation of sampling plots during survey and informal discussion with the sampling plot owner farmers. Data on fertilizer type application, rate and last date of application, the yield of crop per ha with and without fertilizer, the local name of the site and soil at the site, management practices such as crop rotation and residue management and farming system were recorded on site description sheets by interviewing the owner farmers. The altitude was divided into three positions: High altitude (2200-2637 m a.s.l), medium altitude (2000-2200 m.as.l) and low altitude (1689-2000 m a.s.l) for the sake of comparison of different crop type and average yield.

Soil Sample Collection and preparation

Soil samples were collected through composite sampling technique where sampling points were determined by setting pre-defined sampling points according to EthioSIS (Ethiosis, 2014). Samples were taken from locations having similar soil types, topography and similar land use history or land utilization type (LUT).

Based on the topography and soil variability, 156, 149 and155 composite soil samples were collected from the agricultural soils of Kedida Gamela , Kecha Bira and Damboya woredas, respectively. The soil sampling depth was 0-20 cm for annual crops and 0-50 cm for perennial crops.

For all soil types 10 subsamples were collected within 15 meters distance between and among each sub-sampling points in a circle method and composited. For each main sampling point, around 1 kg of representative composite soil sample was collected and put into properly labeled plastic bag. The collected soil samples were air-dried, grounded and passed through 0.5 mm diameter sieve for particle size analysis.

Particle size distribution was analyzed by laser diffraction in with HORIBA-Partica (LA-950V2). The analysis of soil samples was run in a wet mode using 1% sodium hexametaphosphate (Calgon) solution as dispersing agent. After soil samples were inserted into the equipment by spoon, consecutive four readings were recorded in the form of (ngb) file format for each soil sample from the computer which was connected to the equipment. The (ngb) file format data were converted to flat file using the file list utility and export package of the LA-950 software version 7.01 for Windows. The flat file was then converted to sand, silt and clay%, and using the appropriate script on the R language. Finally, average readings were taken for silt; clay and sand proportion from excel data to determine the textural class of each soil sample (Agrawal *et al.*, 1991). After composition percentages of sand, clay and silt were identified, textural classes were determined using the USDA triangular guideline for classifying soil textures.

Mapping of landscape positions

Spatial prediction model was used to estimate the quantitative values of the landscape position (elevation and slope) at the unvisited locations. Ordinary kriging was used to predict unknown values of site elevation and slope for non-sampled areas based on the nearby measured data. After kriging was carried out for landscape position, classes were defined from the map based on the relative rating values.

Statistical analysis

A descriptive `statistical method was employed to analyze and summarize the data and to calculate percentages, means and other measures of central tendencies. Analysis of variance (one-way ANOVA) was used to determine statistical significance. Differences at the 0.05 level were reported as significant. Simple linear correlation analysis was carried out between elevation and particle sizes to show how particle size varies through different altitude zones.

Results and Discussion

Landscape positions

The elevation of the three woredas was found to range between 1689 and 2637 m a.s.l (Table 1). According to traditional agro-ecological classification (MoA, 2010), all the agricultural lands of the three woedas were classified as *woina dega* and *dega*. Out of 463 sites, the two agro ecological zones cover, 367 (79.3%) and 96 sites (20.7%), respectively.

Table: 1 The descriptive statistics of elevation (in m. a.s.l) of the study area

Woreda name	**Minimum**	**Maximum**	**Average**	**Range**	**SD**	**N**	**CV(%)**
Kedida Gamela	1690	2637	2051.72	947	218.49	156	10.65
Kacha Bira	1689	2595	2184.09	906	235.95	149	10.81
Damboya	1783	2503	2108.59	720	142.75	158	6.77

Fig. 2. shows that 30.24 % of surveyed plots were found in altitude < 2000 m.a.s.l (relatively low altitude zone) whereas 36.72% and 33.04% were found between 2000 and 2200ml (relatively medium altitude) and > 2200 m.a.s.l (high altitude), respectively. Also, Figure 2 showed the elevation through all study area which is predicted from the sample points by using ordinary kiringing.

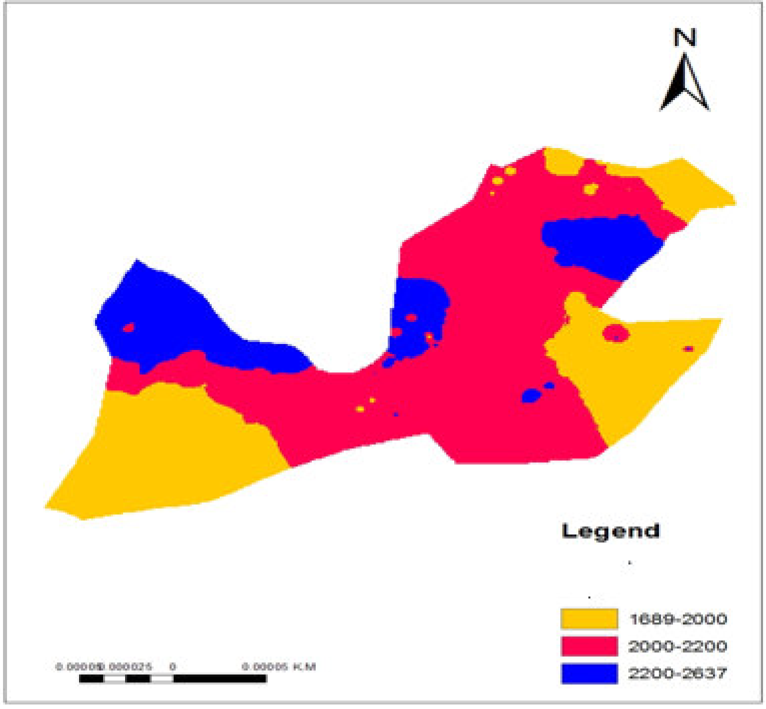

Fig.2 The elevation (in m. a.s.l)) map of the study area

The slope of the three woredas was found to range between 0.9 and 35% (Table 2). According to this result, the topography of the study area is widely variable from flat plain to hilly slopes. Among the observed 463 sites, 4 (0.86%), 48 (10.37%), 88 (19.01%), 243 (52.48%) and 80 site (17.28%) were found to be in the slope range 0-2%, 2-5%, 5-10%, 10-20% and 20-40%, respectively. Also, Fig. 3 showes the slop of unobserved sites that were predicted from measured sites by using ordinary kringing.

Table: 2 Descriptive statistics of the study area in %

Woreda	Minimum	Maximum	Average	Range	SD	N
Kedida Gamela	0.90	25.0	12.18	24.10	6.16	156
Kacha Bira	4.0	35.0	16.74	31.0	6.27	149
Damboya	2.0	35.0	15.91	33.0	6.99	158

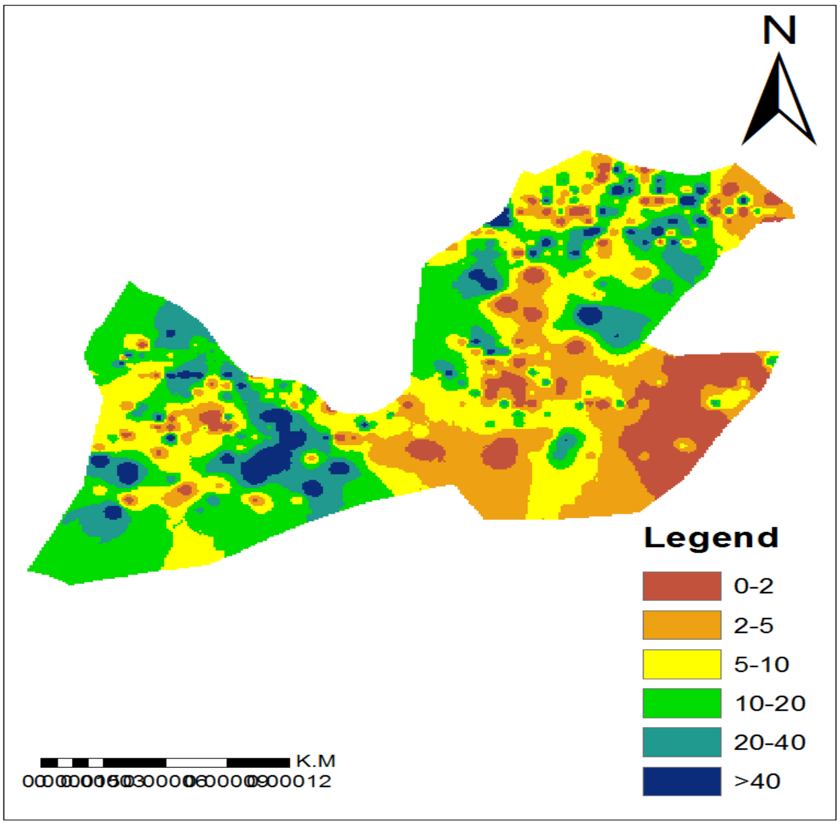

Fig.3 The slope (in %) map of the study area

From this study, it was found that, the yield of tef, maize and wheat was significantly affected by slope position ($P<0.05$) with negative Pearson correlation coefficients. This indicates the grain yield decreased with increasing (steep) slope. This may be due to strongly sloping plain and hilly slope areas are relatively vulnerable to severe top soil erosion. Rezaei and Gilkes (2005) showed that landscape attributes including slope aspect and elevation affected plant growth through indirect influences involving soil properties. As result increasing state of erosion due to slope effect can further deteriorate soil properties. The control of such damaging effects would require soil conservation strategies such as proper land leveling, afforestation, terracing and inclusion of restorative crops in cropping systems on these lands (Farmanullah Khan,2013). In addition to this, many authors reported that water content, total porosity, sand content, clay content, bulk density, soil pH, organic matter and total nitrogen are influenced by slope position (Ofori *et al.,*2013).

The clay particles were affected significantly and positively by slope position ($P<0.01$) whereas the sand particles were affected significantly and negatively by slope position ($P<0.01$). This might be due to the low erodibility of clay rich soils with a low shrink-swell capacity and the capacity of these clay particles to form large aggregate that resist detachment and transport (Green and Schwankl, 2005). But the effect of slope position on silt particles was not significant ($P>0.01$).Disagreeing with this result, Mohammed *et al.* (2005) reported that the soil textural class varied with positions of soils in the landscape where coarser materials were found in the upper slope positions and the finer materials in the lower part of the slope position.

Farmers' knowledge of soil classification

During field survey, farmers indicated that they have developed a local system of soil classification based on their experience of the potential and constraints of their soils which help them to differentiate between soil types in their area and to give local names for different soil types. They use the system to determine how they will manage soil fertility. Farmers in the region distinguished up to ten different soil types, mainly on the basis of soil color, texture, status of their soil fertility and moisture holding capacity (Table 3). The ten types are *key* (red, sticky, clayey soil), *tikur* (black, medium-textured soil), *lam* (brown, medium-texture, highly fertile soil) and *marare* (black-coloured clay soil with high water holding capacity), *balalecho* (red, strongly acidic soil), *shafa* (coarse textured sandy soil), *darak* (gray colour, infertile soil), *dora* (red clayey, less workable soil), *bona* (white colored, highly saline soil), *kota* (gray colored soil) were identified by farmers during the field survey as described in Table 3. According to Raji (2011), for sustainable development and to improve communication between the scientists, the extension agents and the farmers, it is suggested that local soil name be integrated into the soil map legend.

Table 3: The local soil names and its abundance in Kedida Gamela, Kach Bira and Damiboya woredas

Local name of the soil at the site	**Equivalent soils modern soil taxsonomy**	**The % of different soil type each three woredas**			
		KedidaGamela	**Kachabira**	**Damiboya**	**Average**
Key	Nitisols	33.36	59.13	24.71	39.07
Tikur	Vertisols	26.29	28.86	27.23	27.46
Lam	Alifsols	10.9	4.03	10.25	8.39
Marare	Andosols	16.67	0.67	27.58	14.97
Balalecho	Ferasols	1.93	4.7	0.63	2.42
Shafa	-	7.69	-	6.33	7.01
Darak	-	-	1.27	2.01	1.64
Dora	-	1.29	1.34	-	1.32
Bona	-	1.23	-	0.63	0.93
Kota	-	0.64	-	0.63	0.64
Total		**100**	**100**	**100**	**100**

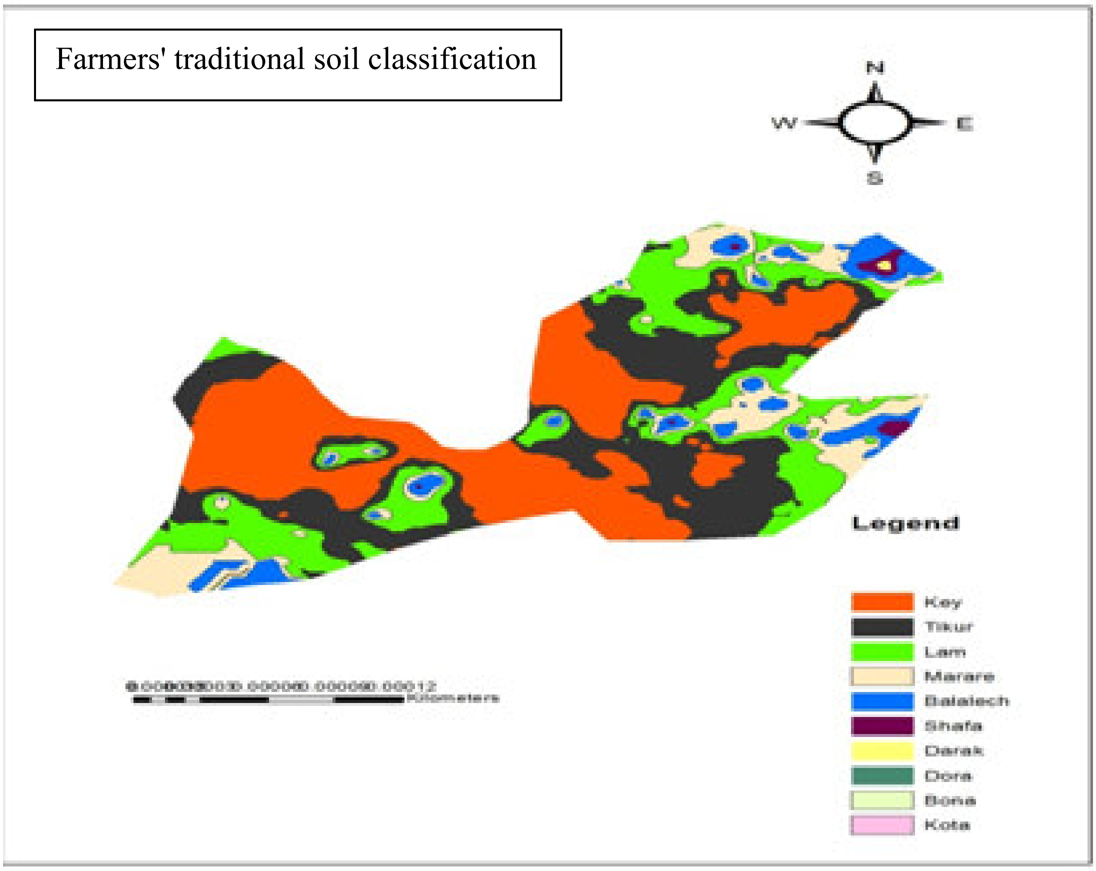

Figure 4: The spatial distribution of local soil classes in the study area

As showed in Table 3 and Figure 4, *key soil* is the most dominant in the study area by covering 33.36%, 59.13% and 24.71 % in Kedida Gamela, Kacha Bira and Damiboya woreda, respectively. *Tikur* soil is the second dominant next to key by covering 26.29%, 28.86% and 27.23% in kedida gamela , kacha bira and damiboya woredas, respectively. The two soil types cover on average 66.53% of the agricultural soil of the study areas. The other all types cover only 43.47%. When asked to compare the fertility of different soils, farmers ranked as *lam* > *Tikur* > *marare* > *key*> *shafa* > *darak*. Also, they responded that the other types of soils such as *balalecho*, *dora*, *bona* and *kot*a are highly infertile and the worst types of soil with respect to soil fertility. Karltun *et al* (2013) and Saïdou (2004) reported that there is good agreement between farmers' knowledge and scientific indicators of soil fertility. Also, Saïdou (2004) reported that soil texture and hydrological quality; soil workability and Soil fauna, especially earthworm are indicators used by farmers to identify either their soils are fertile or not. In addition, Gebeyaw Tilahun (2015) reported similar findings. Desbiez (2003) reported that farmers' perceptions of soil fertility were more holistic than those of researchers, as they included factors they felt influenced the soils and crop growth in their fields.

When farmers were asked about the management of different type of soils, they responded that they have enough experience to manage different soil types differently. According to them, they used different types of plough for different types of soil during tillage. For instance, they use wider plough to drain tikur soils (Vertisols) than key soils. They added that they open terraces to drain Vetisols and they do not plough as rain in order to prevent compaction. In addition to this, farmers of Kacha Bira woreda responded that they were applied lime for key and balalecho soils before two years and now they are not using lime for their soils due no access for liming materials. Farmers in other woredas responded that they have never used lime for any type of soils. From this study, it can be concluded that, farmers have awareness and experience to mange different types of soils in their agricultural land but they are facing the scarcity of inputs such as liming materials.

Soil fertility management practices

When farmers are asked about their soil fertility dynamics, they responded that due to severe water erosion the fertility of their soil is declined and which forced them to adopt many physical and biological soil conservation methods. Ervin and Ervin (1982) confirmed that farmers who operate land which is inherently more susceptible to erosion problems are thought to have a greater propensity to adopt conservation practices. Thus, it is possible to conclude that the problem farmers' faced enforced them to adopt new methods of soil conservation. Perceiving the problem provides stimulus to adopt conservation practices that stop the problem (Long, 2003).

During the field survey, many physical and biological soil fertility management practices such as crop rotation, manures, terraces, use of compost, soil bund, *Fanya juu,* stone bund, cut-off drain and eyebrow basins were observed.

All most all farmers responded that they understood the concept of using crop rotation to enhance soil fertility and using different crop rotations that resulted in increasing their crop yields. They added that personal preference and economic considerations such as the price of the crop influence their choices. The major types of crop rotations practiced by frames in the study areas were maize-haricot beans-maize, Tef-haricot beans-tef, maize-sorghum-maize, wheat-haricot beans-wheat and others. However, they responded that, they are not using fallowing and cover crops as soil fertility management practices due to small farm land size and crop residue used as animal feed, construction material and fuel.

It was noticed during field survey, that many sloppy terraced farmlands existed. It seems that many people have learnt from the problems they faced in the past years. Farmers responded that after constructing soil conservation structures, their soil fertility was improved; water bodies and crop yield are increased. This finding agreed with that of Abay Ayalew (2011), who reported that the construction of soil conservation measures in the degraded highlands and stabilizing with multipurpose plant species is very important to conserve the soil and increase crops yields. Also, Benin (2006) and Pender and Gebremedhin (2006) reported similar finding. Physical structures modify terrain through changing slope length and angel, which in turn reduces runoff velocity, enhances water infiltration and traps sediments, washed down the terrain (Vancampenhout *et al*. 2006; Nyssen *et al.* 2007). Sediment accumulated behind the terrace provides suitable conditions for plants/crops through conserving nutrients and water (Dercon et al. 2003; Gebremichael *et al.* 2005;Vancampenhout *et al.,* 2006). Also, it was observed that, the physical soil water conservation (SWC) structures were stabilized by biological SWC measures by planting elephant grass and banana. This result line with Waga Mazengia and Jermias Mowo (2013).

Biological SWC measures such as exclosure, homestead tree plantation, reforestation and enrichment tree plantation within exclosures help to restore vegetation cover and diversity (Asefa *et al.* 2003; Fu *et al.* 2003). With vegetation cover restoration, beside soil fertility improvement through regular organic matter addition, the soil surface can also be protected from raindrop splash and scoring effects of runoff water. This reduces soil particle detachment and transportation. The vegetation intercepts the rainwater, which enhances infiltration and reduces runoff. The infiltrated water percolates into the ground (aquifer), which in turn improves the hydrology. People down-slope witnessed that spring discharges considerably increased after the exclosure, and even in some cases dried springs recovered.

From this study, it was found that, the soil conservation measures adapted well to the local conditions and protected the soil from being eroded. As a result most farmers in the study areas adopted the technology. Eleni Tesfaye (2008) also indicated that introduced soil and water conservation measures, fanya-juu and soil bunds, were widely acknowledged as being effective measures in arresting soil erosion and as having the potential to improve land productivity.

During field survey, on some farmlands steep mountains without terraces were observed. Responding to the question why some people do not construct terraces, the respondents said those farmers who plow steep mountains know that the soil can easily be washed away, but they want to grow some crops on the hilly land they were given for tree planting. They said that terraces would decrease the size of the land. They fear that the terraces may be converted to gully and reduce their farm land and crop production gives them the chance to benefit from the land. According to Million Tadesse and Kessa Belay (2004) and Addisu Damitew (2015), the major factors influence adoption of physical soil conservation measures are; farmers' perception of soil erosion problem, technology attributes, the number of economically active family members, farm size, family size and wealth status of the farmer.

Particle Size Distribution

The result indicated that the particle size distribution varied widely from both woreda to woreda and within woreda. The sand particles varied from 14.01% to 51.69 %(mean=27.56%) in Kedida Gamela, 8.47% to 32.9 %(mean=23.85) in Kecha Bira and 10.3% to 50.06% (mean=24.28) in Damboya woredas' agricultural soils (Table 4). The sand particle separate showed the highest variability in Damboya woreda followed by Kedida Gamela and Kachabira woredas' agricultural soils.

The silt particles varied from 6.23 to 44.31% (mean=31.31%) in Kedida Gamela, 7.1 to 40.01% (mean=24.32%) in Kecha Bira, 13.31 to 44.51% (mean=32.72%) in Damboya woredas agricultural soils. This separate showed the highest variability in Kedida Gamela followed by Kacha Bira and Damboya woredas agricultural soils.

The clay particles varied from 20.28 to 79.33 %(mean=41.13%) in Kedida Gamela, 35.95% to 77.13 %(mean=51.83) in Kecha Bira woreda and 21.64 to 76.09% (mean=43.00%) in Damboya woredas' agricultural soils. The clay particle separate showed the highest variability in Kedida Gamela woreda followed by Damboya and Kachabira woredas agricultural soils. Among the three soil particles, clay particles showed the highest variability and it was found to be the dominant soil particles in the study woredas (Table 4). However, the sand particles are dominated on the plain land of south east of Kedida Gamela woreda and eastern part of Damboya woreda whereas other areas, with undulating topography, were dominated by clay particles. This may be due to the high erodibility of sand rich soils (Green and Schwankl, 2005).

Due to variation in particle size distribution, differences in textural classes are also recorded in agricultural soils of the study areas. According to USDA textural class, 48.71% of Kedida Gamela, 94.63 % of Kecha Bira and 56.13% of Damboya woredas agricultural soil was found to be clay. The other, 48.08% of Kedida Gamela, 5.37% of Kecha Bira and 41.29% of Damboya woredas are clay loam. The remaining 2.57% of Kedida Gamela and 1.94 % of Damboya woredas were found to be loam. Only one sample for kedida Gamela woreda (0.64%) and for Damboya woredas were found to be sandy loam and sandy clay loam, respectively.

The major reason for the wide variability of particle size and textural classes in the study woredas may be due to the variability in parent materials, land uses, topographies, farming practices, climatic factors and runoff. Similarly, Thangasamy *et al.* (2005) reported that variation in soil texture may be caused by variation in parent material, topography, in situ weathering and translocation of clay. In agreement with this finding, Sitanggang *et al.* (2006) reported that textural variations are mainly associated with variation in parent material and topography.

The silt to clay ratio of the soil ranged from 0.19 to 1.55 for Kedida Gamel , from 0.09 to 1.11 for Kecha Bira and from0.17 to 1.70 for the Damboya woredas. This ratio is one of the indices used to assess the rate of weathering and determine the relative stage of development of a given soil. According to Young (1976), a ratio of silt to clay below 0.15 is considered as low and indicative of an advanced stage of weathering and/or soil development while greater than 0.15 indicates that the soil is young containing easily weatherable minerals. Hence, the silt to clay ratio of the soil observed in the present study is generally>0.15 except only 2% of Kacha Bira woredas' soil suggesting low degree of weathering and young soil development stage

Table 4.Descriptive statistics of particle size distribution of the soils of the study Woredas

Particle size	Woreda	N	Range	Mean	Median	SD	CV(%)
Sand (%)	KedidaGamela	156	14.01 -51.69	27.56	27.22	6.27	22.75
	KachaBIra	149	8.47-32.59	23.85	24.02	4.36	18.28
	Damboya	155	10.3-50.06	24.28	23.6	6.11	25.16
Silt (%)	KedidaGamela	156	6.23-44.31	31.31	32.99	6.66	21.27
	KachaBIra	149	7.1-40.01	24.32	24.81	6.30	25.90
	Damboya	155	13.31-44.51	32.72	33.93	7.45	22.77
Clay (%)	KedidaGamela	156	20.28-79.33	41.13	38.81	10.68	25.97
	KachaBIra	149	35.95-77.13	51.83	50.23	9.28	17.90
	Damboya	155	21.64-76.09	43.00	41.38	10.68	24.84

SD=standard deletion N=number of total soil samples per woreda

Conclusion and Recommendations

In collusion, as other parts of Ethiopia, the landscape position of the agricultural land in study area is very variable and highly requires site specific management. Farmers in the study area have sufficient knowledge to classify their soils inside their plots. In order to recognize farmers' knowledge, the correlation between farmers' knowledge of soils and the soil chemical and physical properties should be recommended which is very important to detect technical, ecological and management problems of the soils.

Acknowledgements

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References

Abay Ayalew.2011. Construction of Soil Conservation Structures for improvement of crops and soil productivity in the Southern Ethiopia. Journal of Environment and Earth Science 1:2224-3216.

Addisu Damtew , Husen Maru and Demeku Mesfin. 2015. Determinants of adopting techniques of soil and water conservation in *Goromti* Watershed, Western Ethiopia, journal of Soil Science and Environmental Management 6(6):168-177.

Agrawal Y.C., I.N. Mc Cave and J.B. Riley, 1991. Laser diffraction size analysis. In principles, methods, and application of particle size analysis, Cambridge University Press. 119-128p

Arnaud Desbiez, Robin Matthews, Bhaba Tripathi , Jim Ellis Jones.2003. Perceptions and assessment of soil fertility by farmers in the mid-hills of Nepal, Agriculture. Ecosystems and Environment 103:191–206.

Anissa Gara , Sawahiko Shimada , Hiromichi Toyoda , Hiromu Okazawa Shinji SuuzukiI , and Ahmed Ghrabi. 2009. Relationship between vegetation and topography for an erosion management in Ethiopia Journal of Arid Land Studies 19(1): 257- 260

A. Saïdou, T.W. Kuyper, D.K. Kossou, R. Tossou and P. Richards.2004.Sustainable soil fertility management in Benin: learning from farmers. national journal of agricultural science 4:349-369.

Asefa DT, Oba G, Weladji RB, Colman JE. 2003). An assessment of restoration of biodiversity in degraded high mountain grazing lands in northern Ethiopia. Land Degradation and Development, 14(1):25-38.

Asmare Yallew, Alemu Hailiye, Alemayehu Assefa, Melkamu Ayalew, Tessema Zewudu, Berihane Assayegn and Halima Hassen. 1998. Barley production practices in Gojam and Gondar. In: Chilot Yirga, Fekadu Alemayehu and Woldeyesus Sinebo (eds.).*Barley based farming system in the high lands of Ethiopia.* Ethiopian Agricultural Research Organisation. Addis Ababa,Ethiopia. Pp.67-89.

ATA Rezaei, S. and Gilkes, R. J. 2005. The effects of landscape attributes and plant community on soil chemical properties in rangelands. Geoderma, 125**:** 167-176.

Babalola TS, Fasina AS, Tunku P .2007. Between soil properties and slope position in a humid forest of South Western Nigeria. Medwell Online Agricultural Journal 2(3):370-374.

Bekele, W., Drake, L. 2003. Soil and water conservation discussion behavior of subsistence farmers in the eastern highlands of Ethiopia: A case study of the Hunde Lafto area. Addis Ababa, Ethiopia.Pp32.

Benin, S. 2006. Policies and Programs Affecting Land Management Practices, Input Use, and Productivity in the Highlands of Amhara Region, Ethiopia. In *Strategies for Sustainable Land Management in the East African Highlands*, edited by J. Pender, F. Place, and S.Ehui. Washington, DC: IFPRI. Coulthard TJ (2001) Landscape evolution models: a software Review. Hydrological Process 15: 165–173.

Dahiya, S, Richter, J, and R,S.Malik. 1984. Spatial variability. A Review. International Journal of Tropical Agriculture. 11:1-102.

Dercon G, Deckers J, Govers G, Poesen J, Sánchez H, Vanegas R, Ram´rez M, Loaiza G .2003. Spatial variability in soil properties on slow-forming terraces in the Andes region of Ecuador. Soil and Tillage Research, 72(1):31-41

EIAR (Ethiopian Institute of Agricultural Research). 2011. Coordination of National Agricultural Research System, Ethiopia. English and Amharic Version. EIAR, Addis Ababa. Pp 137.

Eleni Tesfaye (2008), "Continued Use of Soil and Water Conservation Practices: a Case study in Tulla District, Ethiopia", MSc Thesis, Wageningen University, The Netherlands.

EPA (Environmental Protection Authority). 2003a. *State of environment report for Ethiopia*. Addis Ababa: Berhanena Selam publication. Pp 152.

E. Ouedrago, A. Mando and N.P. Zombre. 2001. Use of compost to improve properties and crop productivity under low input agricultural system in West Africa. Agriculture ecosystem and environment 84:259-266.

Ervin CA, Ervin DE .1982. Factors affecting the use of soil conservation practices: hypotheses, evidence, and policy implications. Land Econ. 58:277-292.

Farmanullah Khan, Zubair Haya, Waqar Ahmad , Muhammad Ramzan, Muhammad Sharif, Ishaq Ahmad Mian and Muhammad Hanif. 2013. Effect of slope position on physico-chemical properties of eroded soil. Soil Science Society of Pakistan, 32(1): 22-28

FAO (Food and Agriculture Organization). 2006. Plant nutrition for food security: A guide for integrated nutrient management. *Fertilizer and Plant Nutrition Bulletin* 16. FAO, Rome.

Fu B, Liu S, Chen L, Lu Yi, Qiu J .2003. Soil quality regime in relation to land cover and slope position across a highly modified slope landscape. Ecological Research, 19(1):111-118.

Gebermichael D, Nyssen J, Poesen J, Deckers J, Haile M, Govers G, Moeyersons J .2005. Effectiveness of stone bunds in controlling soil erosion on cropland in the Tigray highlands, northern Ethiopia. Soil Use and Management, 21(3):287-297.

Gebeyaw Tilahun 2015. Assessment of farmers' perceptions about soil fertility with different management practices in small holder farms of *Abuhoy Gara* Catchemnt, Gidan District, North Wollo. American Journal of Environmental Protection. 3(4): 137-144.

Green ,.AT., and L.J. Schwankl.2005. understanding soil erosion in irrigated agriculture :OKkland: University of California division agriculture and natural resource. Publication 8196.

Gete Zelleke, Geta.chew Agegnehu, Dejene Abera and S. Rashid, 2010. Fertilizer and Soil Fertility Potential in Ethiopia: Constraints and Opportunities for Enhancing the System. International Food Policy Research Institute (IFPRI), Washington, DC, USA.(http://www.ifpri.org/publication/fertilizer-and-soil-fertility-potential Ethiopia) (Accessed on May 17, 2013).

IFPRI (International Food Policy Research Institute). 2006. Atlas of the Ethiopian Rural Economy. IFPRI and the Central Statistical Agency, Ethiopia. Washington DC. ISBN10:0-89629-154-5.

I. Numata, , J.V. Soares, D.A. Roberts , F.C. Leonidas , O.A. Chadwick and, G.T. Batista.2003. Relationships among soil fertility dynamics and remotely sensed measures across pasture chronosequences in Rondonia, Brazil, Remote Sensing of Environment 87 :446–455

Karltun, E.,Mulugeta Lemenih, and Tolera, M. (2013), Comparing farmers' perception of soil fertility change with soil properties and crop performance in Beseku, Ethiopia. Land Degradation and Development 24: 228–235.

Lenka Pešková.2012. Enhacement of Quality and Extent of Extension Services of Angacha woreda, Kembata Tembaro zone**"**,Cezech Development Cooperation and implemented by the Czech University of Life Sciences Prague Pp 197

Long L .2003. Conservation Practices Adoption by Agricultural Land Owners. Phd Dissertation. Northern Illinois University. Delealb, Illinois.

Million Tadesse and Belay Kessa .2004. Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area, Journal of Agriculture and Rural Development in the Tropics and Subtropics 105: 49–62

Ministry of Agriculture (MoA). 2000. Agroecological Zonations of Ethiopia. Addis Ababa, Ethiopia

Ministry of Agriculture (MoA). 2011. Key interventions in soil fertility research and Management: a roadmap 2011-2015. Addis Ababa. Ethiopia.

Mohammed Assen, P.A.L. Le Roux, C.H. Barker and Heluf Gebrekidan, 2005. Siols of Jelo micro-catchment in the Chercher highlands of eastern Ethiopia: I. Morphological and physicochemical properties. Ethiopian Journal of Natural Resources. 7(1): 55-81.

Nkosinomusa Buthelezi, Jeffrey Hughes and Albert Modi. 2010 The use of scientific and indigenous knowledge in agricultural land evaluation and soil fertility studies of two villages in KwaZulu-Natal, South Africa , World Congress of Soil Science, Soil Solutions for a Changing World. 19:20-23.

Nyssen J, Govaerts B, Araya T, Cornelis W M, Hans B, Haile M, Sayre, K., Deckers, J. 2011. The use of the *marasha* ard plough for conservation agriculture in Northern Ethiopia. Agronnmy Sustainable Development**.** 31: 287-297

Pender, J., and B. Gebremedhin. 2006. Land Management, Crop Production, and Household Income in the Highlands of Tigray, Northern Ethiopia: An Econometric Analysis. In *Strategies for Sustainable Land Management in the East African Highlands*, edited by J.Pender, F. Place, and S. Ehui. Washington, DC: International Food Policy Research Institute

Raji, B. A., Malgwi, W. B., Berding, F. R. and Chude, V. O. 2011. Integrating indigenous knowledge and soil science approaches to detailed soil survey in Kaduna State, Nigeria. Journal of Soil Science and Environmental Management 2(3):66-73.

Robin, S.R, Russel, L.K, Nyawira, M., Andualem, T., Sara, W., Cathleen, J.W. and Woudyalew,M..2000. Land-use and land-cover dynamics in response to changes in climatic, biological and socio-political forces: the case of south western Ethiopia. Landscape Ecology 15:339-399.

Stroud A, Mekuria M. 1992. Ethiopia's agricultural sector: an overview,. In *Research with Farmers: Lessons from Ethiopia*, Franzel S, van Houten H (eds.). CABI:Wallingford (UK). pp. 9-27

Tewelde Berhan Gebre Egziabher, 1989.The rates of ecological crises in Ethiopia., Proceedings of the First

Natural Resources Conservation Conference. Addis Ababa, Ethiopia (mimeographed). Pp 103–110.

Teklu Baissa , Amnat Suwanarit, Yongyuth Osotsapar and Ed. Sarobol. 2003. Status of Cu, Zn, B and Mo in Agricultural Soils of Western Ethiopia: Laboratory Assessment. Kasetsart Journal of Natural Science. 37 : 408 – 420

Thangasamy, A., Naidu, M. V. S., Ramavatharam, N. and R. Reddy. 2005, Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. Journal of Indian Society Soil Science 53:11–21

Thierfelder C, Wall PC. 2009. Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe. Soil and Tillage Research, 105: 217–227.

Sitanggang, M., Rao, Y. S., Nayan Ahmed and Mahapatra, S. K. 2006, Characterization and classification of soils in watershed area of Shikohpur, Gurgaon district, Haryana. Journal of Indian Society Soil Science 54: 106–110.

Stuczynski T., Kukula S., , Kukla H., Jadczyszyn J., Zaliwski A., Gawrysiak L.,Federowicz-Jackowski W., Bielecka E. 2001 - System informacji o rolniczej przestrzeni produkcyjnej podstawa strategii rozwoju regionalnego. PostepyNauk rolniczych, 4:109-128.

Waga Mazengia and Jermias Mowo.2013. Role of collective actions in integrated soil and water conservation: The Case of Gununo Watershed, Southern Ethiopia ,African Journal of soil and water conservation and sustainability ,1(5):81-93

Willgoose G .2005.Mathematical modeling of whole landscape evolution. Annual Review of Earth and Planetary Sciences 33, 443-459.

Wysocki DA, Schroeneberger PJ, and Lagary AE .2000. Geomorphology of soil landscapes. In: Summer, M.E (Eds). Handbook of Soil Science. CRC Press. Boca Raton , FL, USA.

Vancampenhout K, Nyssen J, Gebremichael D, Deckers J, Poesen J, Haile M, Moeyersons J . 2006.Stone bunds for soil conservation in the northern Ethiopian highlands: Impacts on soil fertility and crop yield. Soil and Tillage Research, 90(1-2):1-15

Young A .1976.Tropical soils and soil survey. Cambridge University Press, London, UK, pp.468.