

Research Article

The Impacts of Traditional Stone Lines /Kabi-lines /and Soil Management Practices of Agronomic Erosion Controls on Soil Textures, Soil Bulk Density and Soil Moisture Content at IFABAS / Jarra /Community Watershed West Harareghe Zone Oromia National Regional State Ethiopia

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Abstract

This study was entitled with: The impacts of traditional stone lines /kabi-lines /and soil management practices of agronomic erosion controls on soil textures, soil bulk density and soil moisture content at Ifabas / Jarra /Community Watershed West Harareghe Zone Oromia National Regional State Ethiopia. This study had been carried out to observe soil texture using field testing methods and to examine soil moisture contents and soil bulk density under treated and non-treated farmlands in relation to soil management practices of agronomic erosion controls. This study was intentionally used complete random block design (CRBD) which was preferred to observe the variations between dependent and independent variables. The total soil samples were 54 composite soil samples which were collected from three blocks or sub-watershed of Ifabas community watershed to test soil texture using forefinger and thumb rule and mortar and pestle or Ferro and 2lt highland crushed method of field testing. The total of 54 soil samples were collected without made composite soil samples to determine soil bulk density and soil moisture content. Moreover, the soil samples of the total 18 composite soil samples were collected to test soil texture by using local un-graduated cylinder and 30cm ruler ratio method. Soil samples were replicated three times to approach accuracy and reduce biasness. The soil data were subjected to EXCEL and multiple-way of Analysis of Variance (multiple-ANOVA) following the General Linear Model (GLM) of Multivariate multiple procedures of SPSS window version 23 computer based software to observe the variations existed between dependent and independent variables. The analysis was carried out for soil texture, soil BD and soil MC. The results of the study were observed the variations at significant level of $P \leq 0.05$. The results of un-graduated cylinder and 30 cm ruler ratio reading method had showed that insignificant variations between blocks (BS) and blocks with treatments (BS*TRS) interaction effects of sand, silt and clay soil textural fractions at ($P=0.703$, $P=0.175$, $P=0.388$, $P=0.267$, $P=0.811$ and $P=0.199$), respectively whereas between treatments interaction effects of sand and clay soil textural fractions had showed that, the significant variations at ($P=0.002$ and $P=0.023$) but silt soil textural fraction had showed that, the insignificant variations at ($P=0.091$). It needs ties at intervals, maintenance and burying of the larger stones under the soil surface.

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Keywords

TSL, Treatments, Farmland, Soil Texture, Experimental Units, Blocks, Composite Soil Samples, Soil Properties, Soil Depth, Replication and Watershed

1. Introduction

Back Ground and Justification

Due farmers' lack of attention to soil and land resources both were severely degraded by erosion agents and Land productive capacity is heavily declined either temporarily or permanently [7]. Land degradation is related to poverty and long drought [28] and about 2.6 billion people are affected in more than 100 countries before 23 years ago due to land degradation [28]. The major factors of land degradation include overgrazing, improper irrigation system and poor land use planning and lack of land use policy, lack of fallow system and deforestation. The global assessment of land degradation was indicated that about 15% of surface land was degraded, while the current assessment identified and indicated that about 24% of the land surface was degraded. The symptoms of land degradation includes: soil erosion, nutrient depletion, salinity, water scarcity, pollution, disruption of biological cycles, and loss of biodiversity, whereas about one-fifth of land degradation was occupied on cultivated land and accounted about 20% of all cultivated areas, 20% occurred in broad leave forests, 19% in needle leave forests, and 20 to 25% on rangelands [28]

Soil erosion hampers agricultural productivity by deteriorating soil quality; removes the fertile topsoil, and exposed the infertile subsoil with high acidity. The traditional Kabi lines/TSL were constructed to controls erosion (Afaan Oromo term: stone lines), to maintain the losses of soil and runoff water on-sites. It is prerequisites for climate changes, and water resource depletion [9, 29, 31, 33]. The study done in Africa by [35], had stated that, the gandari (stone line) structure is used to rehabilitate mainly bare surface of the degraded areas of the land which is covered with very hard crust and impermeable to allow runoff water (Hausa term: *fako*); *fakos* need sandy-clayey soils. It was wait four to six years to cultivate crops till sand was deposited well.

TSL is not move much areas of the land out of cultivation. It protect crops from failure at the end of rainy seasons where rainfall and soil moisture where deficit such as west Harareghe middle land and highland areas. Provides an opportunity for farmers to overpass the problems of soil moisture scarcity, maintain climate changes by increasing carbon dioxide sink into the soil and to combat desertification. In East Africa, traditional stone lines are commonly practiced in areas where receiving 200-750mm of annual rainfall, and usually spaced about 15-30m apart (VI), and spacing narrower on steep slopes. In Kenya, stone lines were used as a

traditional soil conservation method; in Baringo and Embu Districts in the 1930s. In Wolloita, southern Ethiopia stone lines, are known very well locally as "Kella", and laid along the contour lines and across the slope at regular intervals to stop soil erosion and runoff water. In Tanzania in the Pare Mountains, particularly in Dodoma and Arusha regions stone lines were widely used to control erosion, overland flow and create structures like terraces and retain irrigation water. The past study did by [9], [31] had revealed that TSLs constructed using stone only, mixture of soil, stone and fragmented rocks or soil only along the contour lines and across the slope to control runoff water, and topsoil losses, reduce its velocity, and conserve SOM. Stone lines controlled more than 60% of soil losses in Ethiopian highlands depending on the agro-climatic conditions, age of structure, soil type and topography [9].

West Harareghe zone landscape feature is highly rugged and steeply slope mountainous in nature and population of the zone are encroached on the steep slope, fragile and marginal lands to grow crops and planting *Katha eidolous* for cash crops due to their land scarcity and high population density.

This study was proposed to fill the gaps that were not examined in any previous research works about the significances of TSL treated farmlands and soil management practices of agronomic erosion controls on soil texture, soil BD and soil MC in comparison with none treated farmlands using different texture field testing methods and air seasoning of disturbed soil samples for soil BD and soil MC. This study was in parallel with the study done in Africa by [36] who had revealed that, several indigenous SWC have not been studied at all for instance no research study had been done on traditional stone lines. *Traditional stone lines in the Ader Doutchi Maggia, Niger, can be observed by anyone driving on the main road from Konni to Tahoua.* [9], had been well explained the significances of TSLs on soil properties, and crop yield; the study done by [8], had been shown that; the potential and limitations of an indigenous structural SWC technology at Wello, Ethiopia. The study was looks the impacts of independent and dependent factors of TSLs on field testing of soil texture, soil BD and soil MC [26]. The specific objective of the study had include to observe soil texture using different field testing methods and to investigate the determination of soil MC and soil BD. Research hypotheses were consists null hypothesis and alternative hypothesis that were a significant variation of soil texture using field testing

methods and determination of soil MC and soil BD. for treated and none treated farmlands $H_0: \mu_o = \mu_x$ and the alternative hypothesis there were not a significant variation of soil texture using field testing methods and determination of soil BD and soil MC for treated and none treated farmlands $H_a: \mu_o \neq \mu_x$

2. Materials and Methods

2.1. Description of the Study Area

West Harareghe Zone geographical boundary is approximately the laid of the land between $8^{\circ}39'59.99''$ N Latitude and $40^{\circ}29'59.99''$ E Longitude from the equator and situated in eastern Ethiopia Oromia regional national state [37]. Tullo Woreda altitude is ranges from 1631 to 2800 m above sea level. But based on the agro-climatic conditions approximately about 56. 67% of the Woreda falls within the mid-land region that ranges from 1600 to 2300m above sea level while the remaining of 43. 33% is classified as highland which is >2300 m above sea level [35]. Thus, the study area Ifabas community watershed is laid under the highland area of altitude > 2300 m above sea level. The mean maximum temperature of Ethiopia is 45°C and it covers from April to September whereas the mean minimum temperature is 40°C and covers from October to March. According to [35], the Tullo Woreda where the study watershed is situated has received about 1000mm annual average rainfall.

Ethiopia has five agro-climatic Zones that are defined by two factors altitude and temperature. West Harareghe Zone of land lied under the warm to cool semi-arid zones of the country which it covers the highland temperature of the altitude which ranges from 1500m to 2500m a. s. l. [40]. The Ethiopian major soils have about 19 soil types that are grouped into three types [21]; Lithosols which covers about 163, 185 km^2 (14.7%), Fuvisols (soil deposits of parent materials laid down by Rivers and streams) accounted to 882, 61.5 km^2 (7.9%) and Aluvisols which covers about 640, 63.5 km^2 (5.8%) areas. Ifabas community watershed is grouped under these three major groups of soil types.

The most common forest species remained in the west Harareghe zone includes: indigenous trees and shrubs species such as: *Ola african*, *Cordia african*, *Podocarpus flactus*, *Junporuous porcera*, *Croton mycrostcheus*, *Celitus african*, *Acacia* species, and *Vernonyia amagledina* whereas exotic trees and shrubs species includes *Euclaptus spp*, *Geravilla robusta* and *Gervilla radiata*, *Casurina equistifolea*, *Pinus patula*, *Shenis moll*, *Cupressus lustinica*, *Acacia selgena*, *Jacaranda sp* and *Delinxus regia*.

The past studies did by [19, 32] had reported that; the total land area of Ethiopia is accounted about 1221480 km^2 (122,148,000ha) and the major land useand land covers encompasses: 1115000 km^2 (111,500,000ha) among this total land area of the country: cultivation land is covers about

14.7%, grazing and browsing land are accounted about 56.9%, forestland is covers about 11.7% and bush land is covers about 18.7%. Ethiopian topography has classified into five classes; 0-10% which held lowlands (703000 km^2) area of the country (less than 15000m a. s. l.) without the exception of the flat plain, highland plateau and the valley bottoms. The rest classes are group into the Ethiopian highlands of 11-25%, 26-35%, 36-50% and $>50\%$, which occupies the large areas of the country, respectively. Mixed farming systems are the most common farming systems in the west Harareghe Zone, the study Woreda and community watershed.

2.2. Research Methodology

This experimental design was observed the impacts of treated farmlands with TSL and soil management practices of agronomic erosion controls on soil properties in comparison to control farmland uses. It was depend on the representative soil samples to investigate the relationship between dependent and independent variables. It is playing a crucial role to established soil properties and used to evaluate variations in top soil, subsoil, soil profile and soil horizon both in spatial and temporal variations [20].

Sampling Techniques

Complete randomized block design (CRBD) method was used purposefully to answer the proposed objectives and the hypotheses. This study was depending upon the provision of an equal chance of probability distribution. The basic principle of experimental design is to reduce the experimental error; [27]. The needs to surveying soil properties to help the land use planners and land use policy makers, teaching and learning processes, agricultural extensions', farmers and researchers' to implement proper soil and water conservation practices, to understand the scarcity of and to made profitable the soil management practices that were fit within the agro-climatic condition, topographic features and soil types of the watershed [38].

Using simple random sampling technique of CRBD should be distributed soil sampling spots per EU. The study community watershed was divided into three sub-watersheds based on the slope; lower slope (downstream), middle slope (Transfer zone of the watershed) and upper slope (header water or upstream watershed). This experimental designed study was includes two experimental designs: 1) control treatment land uses and 2) TSL treated farm land uses and soil management practices of agronomic erosion controls which is refers to experimental unit (EU), each sampled strip considered as sample plots. The observation unit (OU) is the representative spots where soil samples were collected in composite samples [27]. The three sub watershed land uses were under similar situations of history; past erosion, cultivation, soil management practices and deforestation.

Soil samples were collected from three Ifabas community sub-watersheds for the determination of field analyses of soil texture, soil moisture contents and soil bulk density. This

experimental design was replicated three times in order to approach accuracy. Soil samples were collected from 0-15cm layers of soil depth, three sample plots per treatment, three observation units per sample plot and made the composite samples while they did not made composite soil samples for soil MC and soil BD. Soil sample collection volume is equivalent to the core sampler size; having 5.8 cm diameter and 15 cm height with 5 cm extra height or the hammered part. The volume is 396.11cm^3 . Each EU is divided into three sample plot randomly. Samples were collected from two end and middle of the sample plot and made the composite samples and three composite soil samples were collected per EU. Accordingly, the total of 54 separate soil samples for determination of soil MC and BD while also the total of 54 composite soil samples were collected ($\text{TCS} = 3\text{B} \times 3\text{R} \times 2\text{TR} \times 3\text{SP} = 54$) to analyses soil textures in the field. Moreover to investigate soil texture the total of 18 soil samples in composite were collected i. e. from upper, middle and bottom EU.

2.3. Data and Source of Data

Secondary data was obtained from the Tullo Woreda natural resource management office and the primary source of data is the field data and field observation of Ifabas community watershed.

Soil data was collected from 18 treatments six from each block of sub-watershed for field texture, soil BD and soil MC analyses. The requested data were collected from the farmlands situated adjacent to each other either up and down or beside each other to understand the property variations existed between two treatments, blocks and blocks with treatments interaction effects where deposition of soil was occurred during erosion, floods and sedimentations.

2.4. Soil field Analysis

The analyses of soil data were dried under shade at room temperature by air seasoning. Impurities separated during and after soil samples collected were includes crop residues, tree leaves and twigs; large stones, weeds, grasses, broken roots, leave, and bark.

Soil textured was determined by forefinger and thumb rule of feel method, dried, pestle and mortar crushed method, un-graduated local cylinder and 30 cm ruler ratio reading method of field soil texture testing [41]. For un-graduated cylinder and ruler method uncrushed soil clods after cleaned from impurities, filled into cylinder about 4cm, 5cm and 6cm, fill with pipe water, string very well, left and wait for 1: 30 hours and then that after 1: 30 hours it was observed these layers from upper to bottom un-decomposed materials, water, clay, silt and sand soil textural fractions. Therefore, read the height of the three separates with the help of 30cm ruler but the height of the filled did not affected the analysis on the separates.

Soil Bulk density was determined using core sampler method having diameter of 5.8cm and height of 15cm and 5cm extra height. Soil bulk density was calculated by using the differences between wet weight and dry weight of air seasoning for four weeks and divided by the volume of the core sampler [41].

$$BD = \frac{\text{wet weight of soil} - \text{Blank} - \text{dry weight of soil}}{\text{Volume of core sampler}}$$

Volume (V) = Height of core sampler * Area of circle = $H * \frac{\pi D^2}{4}$ [4], [34]. Soil moisture content was determined by Gravimetric method which is refers to direct method. It was expressed in two methods mass based and volume based: methods.

Mass based $\text{MC}\% = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} * 100$ and follow the method described by [23, 41].

Volume based $\text{MC}\% = \frac{\text{MC in dry mass}}{\text{water density}} * \text{soil bulk density}$ [41].

2.5. Data Analysis

The aim of data analysis was to justify the investigated effects of TSL and agronomic erosion controls of soil management practices on soil textures, soil BD and soil MC in comparison to none treated farmlands. The soil data produced through field analyses were subjected to multiple-way of Analysis of Variance (Multiple ANOVA) and Excel software to observe the least significance variations existed between conserved farmlands with TSL and none conserved farmlands for the proposed soil physical properties in relation to agronomic erosion controls of soil management practices. The data were subjected to statistical analysis at $P \leq 0.05$ significance level by following the General Linear Model (GLM) of multivariate multiple procedures of SPSS computer software version 23.0. The results were displayed with table and bar diagram. The study was used F-test method to observed the variations between dependent and independent variables.

3. Results

3.1. Field Results of Interpretations

Interpretations of results are consists two methods of scientifically proofed. The first method of interpretation of the statistical analysis experimental outputs are followed this step first interpreted results, discuss its own discussion of the factors to be studied or interpretation results and support with past similar studies and the second method of interpretation are present the output interpretations of the results separately and its own discussion and supported with the evidences from the past similar studies separately [25]. Therefore, this study

was preferable the second method of report wrote.

3.2. Un-graduated Cylinder Texture Testing Method

This is one of the filed texture testing method and the most accurate one as compare to others field testing methods.

Materials requested: Water, 30cm or 50cm ruler, Un-graduated cylinder or bottle, Counter time, Note book, pen and pencil, Metal or thin wood stick like, No need any chemical to test texture in the field

3.3. Procedures

Followed these procedures: separate soil clods and impurities; washed and clean un-graduated cylinder and then, that dried very thoroughly; add soil clods which separated from impurities and it should be filled up to 3cm, 4cm, 5cm and 6cm or 7cm depend on the sample size or amount of the soil that were collected from the field; fill very well with pure municipal water or clean pipe water; used wood or metal stick and string very thoroughly al-together (water and soil clods); then, after that leave for 1:30 hours; after 1:30 hours read the layers soil separates so that: un-decomposed materials or organic materials occupied the top of the layers, clean water occupied the layer of the next to undecomposed organic materials, coarser or sand soils settled to the bottom and occupied the bottom layer because of the Stake Law had stated that, the larger and heavier objects fall first than the lighter or smaller objects, medium size or silt soil particles occupied above the coarser soil particles, fine soil/clay soil or colloidal soil particles occupied the layer above silt layer i.e. between the silt and water soil.

However, the height from the bottom to the top of soil layers (i.e. below the clean water layer) is not the same or equal to the height that was filled with the soil clods originally. Thus, it should be taken the final height that is measured using the ruler and recorded on your note book but not the height filled with soil clods originally before filled with water and string together. Because, the height is taller than the height filled with soil clods alone. Example originally you could fill 4cm height but your current height might be 8cm (i.e., the height of the three soil separates- sand, silt and clay soil particles) figure 7.

3.4. Field Soil Samples Collection

There are different methods and procedures are available in order to collect the guanine soil sample data. The following photos are clarifying the procedures of soil sample collections.



Figure 1. After cleaned and placed at sample placed the auger.



Figure 2. After immersed into soil the augur 0-15cm of soil depth.



Figure 3. Photo field sampling after immersed into the sampling depth.

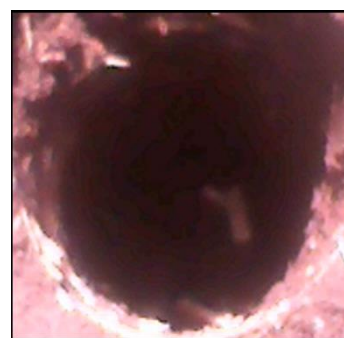


Figure 4. After the soil sample has taken (hole of observation unit).



Figure 5. Photo after inserted 15cm soil depth the augur and 5cm leave above ground surface (hammered part).



Figure 6. Top view of soil sampler (Augur) after inserted 0-15cm soil depth.

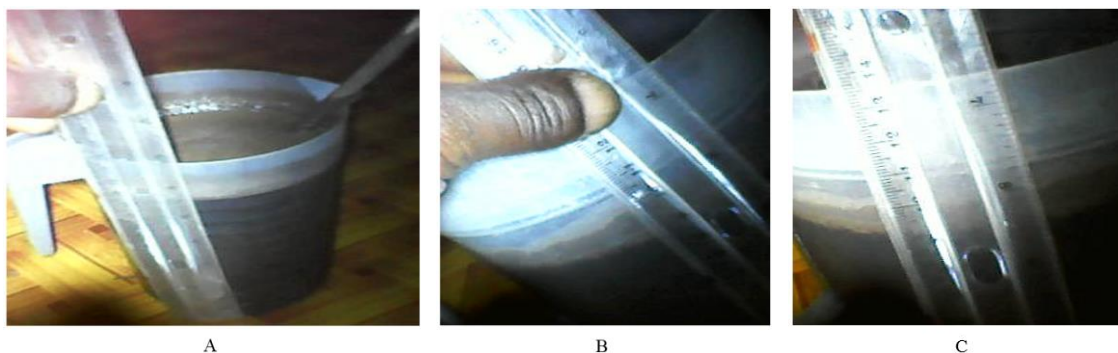


Figure 7. (a to c) show how to measure soil texture by used field test method of un-graduated cylinder and 30cm ruler ratio.

3.5.2. Mortar-Pestle-Ferro Metal and Highland

The results of the study were revealed that B-I totally (100%) siltyclay soil for farmland one; and medium resistant to crushed; totally (100%) clay soils for farmland two and three which were conserved with TSL and high resistant to crushed. Farmland four none conserved was totally (100%) clay soils, and high resistant to crushed whereas under farmland five it was examined that two of third (2/3) or 66.67% had showed that siltyclay soils and medium resistant to crushed and one of third (1/3) or 33.33% had clay soils and high resistant to crushed while farmland six as examined two

3.5. Field Texture Testing Methods

3.5.1. Fore-finger and Thumb Rule Method

The results of the soil textural fractions were tested using forefinger and thumb rule method after dried and crushed the large size clods had showed that, the conserved farmlands with TSL (block-I) had been shown that totally clay soils and high resistant to crushed; whereas for none conserved farmlands had been shown that 77.78% clay soils and 22.22% siltyclay soils which were high and medium resistant to crushed, respectively. The results of study (block-II) had showed that 77.78% siltyclay soil; and medium resistant to crushed and 22.22% clay soil; and high resistant to crushed under farmlands treated with TSL while for none conserved farmlands were showed that, soil textural fractions were totally clay soils and high resistant to crushed. The results of the study (block-III) had indicated that soil textural fractions were totally siltyclay soils and medium resistant to crushed for farmlands treated with TSL whereas for none conserved farmlands had been shown that 55.55% clay soils, and high resistant to crushed and 44.44% siltyclay soils; and medium resistant to crushed (Table 5).

of third (2/3) or 66.67% had showed that siltyclay soils and medium resistant to crushed and one of third (1/3) or 33.33% had showed that clay soils and high resistant to crushed. The results of the study were showed that, B-II for farmland one, two and three (TR1, TR2 and TR3) conserved with TSL totally (100%) siltyclay soils and medium resistant to crushed whereas for farmland four, five and six (TR4, TR5 and TR6) totally (100%) the results were showed that clay soils and high resistant to crushed. The results of the study were showed that, B-III conserved with kabi lines for farmland one, two and three (TR1, TR2 and TR3) had indicated that, 2/3 of (66.67%) siltyclay soils and 1/3 of (33.33%) clay soils which were medium and high resistant to crushed, respectively. However

for non-conserved farmland four, five and six (TR4, TR5 and TR6) the results were revealed that 1/3 of (33.33%), clay soils, and 2/3 (66.67%) siltyclay soils which were high and medium resistant to crushed, respectively (table 6).

3.5.3. Ruler and Un-graduated Local Cylinder Method



Figure 8. Photo showed that the ruler and un-graduated cylinder field texture testing method.

The final results had indicated that between TRS IES both sand and clay soil were showed significant variations at ($P=0.002$ and $P=0.023$), but between BLS and BLS*TRS IES had showed that insignificant variations at ($P=0.703$, $P=0.267$, $P=0.388$ and $P=0.199$), respectively. Between BLS, TRS and BLS*TRS IES silt soil had showed that insignificant variations at ($P=0.175$, $P=0.691$ and $P=0.841$) table 1. The statistical analysis of the final results had revealed that, BLS*TRS IES were showed that sand soil was the lower under TSL CFLS in B-I, B-II and B-III (23.21 ± 2.65 ,

22.92 ± 2.65 and 17.27 ± 2.65) than NCFLS (29.64 ± 2.65 , 28.55 ± 2.65 and 31.16 ± 2.65), respectively. Overall TRS-Mean IES of sand soil was indicated that the lower inside TSL CFLS (21.13 ± 1.53) than NCFLS (29.78 ± 1.53) Table 2. Between BLS*TRS-Means) IES of silt soil had indicated that the higher in B-II and B-III under TSL CFLS (35.42 ± 3.81 and 38.58 ± 3.81) than inside NCFLS (31.62 ± 3.81 and 38.00 ± 3.81), respectively. However, in B-I the results had disclosed that the opposite which was observed the higher silt soil inside NCFLS (30.97 ± 3.81) than CFLS with TSL (30.41 ± 3.81) Table 2. Between TRS mean IES of silt soil was the higher (34.80 ± 2.20) beneath to CFLS with TSL than NCFLS (33.53 ± 2.20). Between BLS-means value of IES of silt soil was showed the higher in B-III (38.28 ± 2.70) than in B-I and B-II (30.69 ± 2.70 and 33.52 ± 2.70), respectively Table 2. Between BLS*TRS means IES had been shown that clay soil was the higher under TSL CFLS in B-I, B-II and B-III (44.12 ± 3.11 , 41.67 ± 3.11 and 44.16 ± 3.11) than NCFLS (39.38 ± 3.11 , 39.83 ± 3.11 and 30.83 ± 3.11), respectively Table 2. Overall TRS-Means IES of clay soil was indicated that the higher under TSL CFLS (43.32 ± 1.79) than NCFLS (36.68 ± 1.79) Table 2. Overall blocks mean value of IES of clay and sand soils were the higher in B-I (41.75 ± 2.20 and 26.42 ± 1.87) than in B-II and B-III (40.75 ± 2.20 , 40.75 ± 2.20 ; 25.73 ± 1.87 and 24.22 ± 1.87), respectively. Soil textural class between BLS*TRS IES was clayloam soils under none conserved farmlands, while under conserved farmlands with TSL was clay soils. Between TRS IES soil textural class was clayloam soil inside CFLS with TSL, but under NCFLS clay soil. Between BLS IES soil textural class were clay soil in B-I and B-II while it was clayloam soil in B-II.

Table 1. Soil texture of (Mean $\pm$ SE) clay, sand and silt analyzed by used GLM multivariate multiple of ANOVA at 0-15 cm soil depth ($n=18$).

SVs	Df	Sand			Clay			Silt		
		MS	FV	PV	MS	FV	PV	MS	FV	PV
CM	5	82.83	3.94	0.024	72.97	2.52	0.088	39.84	0.913	0.505
IPt	1	11665.26	554.83	<0.001	28797.60	995.41	<0.001	21009.77	481.419	<0.001
B	2	7.64	0.36	0.703	29.70	1.03	0.388	88.33	2.024	0.175
TR	1	336.70	16.01	0.002	198.07	6.85	0.023	7.22	0.165	0.691
B*TR	2	31.09	1.48	0.267	53.69	1.86	0.199	7.67	0.176	0.841
Error	12	21.03			28.93			43.64		
Total	18									
CT	17									

a.. R Squared = 0.621 (Adjusted R Squared = 0.464), b. R Squared = 0.512 (Adjusted R Squared = 0.309), c. R Squared = 0.276 (Adjusted R Squared = -0.026) and d. Computed using alpha = 0.05, and SE- Standard error

Table 2. Determination of soil BD and soil MC analyzed by used GLM multivariate (multiple ANOVA) at 0-15cm layers (n=54).

SVs	df	MC			BD		
		MS	FV	PV	MS	FV	PV
CM	5	429.387	2.061	0.087	0.019	2.716	0.031
IPt	1	44352.496	212.885	<0.001	2.069	293.357	<0.001
B	2	666.902	3.201	0.050	0.044	6.204	0.004
TR	1	166.813	0.801	0.375	0.000	0.044	0.834
B*TR	2	323.159	1.551	0.222	.004	.564	0.573
Error	48	208.340			0.007		
Total	54						
CT	53						

Parameters followed by different letters across the columns (a, b, and c) for B-Means showed significantly different at $P \leq 0.05$

Table 3. Determination of (Mean $\pm$ SE) of soil BD and soil MC on soil properties intra-blocks at 0-15cm soil depth (n=54).

Blocks	Treatments	Intracation effects	MC	BD	n
B -I	NTRL	(B*TR-Mean)	30.62 $\pm$ 4.61 ^{ax}	0.24 $\pm$ 0.02 ^{ax}	9
	TR W TSL	(B*TR-Mean)	39.9556 $\pm$ 4.82 ^{ax}	0.15 $\pm$ 0.03 ^{ax}	9
	Total	(B-Mean)	32.00 $\pm$ 36 $\pm$ 3.39 ^a	0.21 $\pm$ 0.02 ^b	18
B-II	NTRL	(B*TR-Mean)	24.53 $\pm$ 3.79 ^{by}	0.24 $\pm$ 0.03 ^{by}	9
	TR W TSL	(B*TR-Mean)	30.62 $\pm$ 4.02 ^{by}	0.18 $\pm$ 0.02 ^{by}	9
	Total	(B-Mean)	33.49 $\pm$ 1.88 ^b	0.20 $\pm$ 0.02 ^b	18
B-III	NTRL	(B*TR-Mean)	19.32 $\pm$ 2.78 ^{cz}	0.2189 $\pm$ 0.028 ^{cz}	9
	TR W TSL	(B*TR-Mean)	30.49 $\pm$ 1.83 ^{cz}	0.181 $\pm$ 0.29 ^{cz}	9
	Total	(B-Mean)	32.38 $\pm$ 1.60 ^c	0.18 $\pm$ 0.02 ^c	18
Overall Mean	NTR	(TR Mean)	26.90 $\pm$ 2.78 ^{ax}	0.1981 $\pm$ 0.016 ^{by}	27
	TRW TSL	(TR-Mean)	30.42 $\pm$ 2.78 ^{ax}	0.1933 $\pm$ 0.016 ^{by}	27
	Total	(Grand Mean)	32.97 $\pm$ 0.88	0.196 $\pm$ 0.01	54

Parameters followed by different letters across the columns (a, b, and c) for B-Means showed significantly different at $P \leq 0.05$

Table 4. Field soil texture of (Mean $\pm$ SE) by used 30 cm ruler ratio-and un-cylinder method at 0-15cm soil depth (n=18).

Blocks	Treatments	Interaction effects	Sand	Silt	Clay	Soil textural class	n
I	NTRL	B-I *TR Mean	29.64 $\pm$ 2.65 ^{ax}	30.97 $\pm$ 3.81 ^{by}	39.38 $\pm$ 3.11 ^{cz}	Clayloam soil	3
II		B-II*TR Mean	28.55 $\pm$ 2.65 ^{ax}	31.62 $\pm$ 3.81 ^{by}	39.83 $\pm$ 3.11 ^{cz}	Clayloam soil	3
III		B-III*TR Mean	31.16 $\pm$ 2.65 ^{ax}	38.00 $\pm$ 3.81 ^{by}	30.83 $\pm$ 3.11 ^{cz}	Clayloam soil	3
		Total TR Mean	29.78 $\pm$ 1.53 ^a	33.53 $\pm$ 2.20 ^a	36.68 $\pm$ 1.79 ^a	Clayloam soil	9
I	TRL w TSL	B-I *TR Mean	23.21 $\pm$ 2.65 ^{cz}	30.41 $\pm$ 3.81 ^{by}	44.12 $\pm$ 3.11 ^{ax}	Clay soil	3

Blocks	Treatments	Interaction effects	Sand	Silt	Clay	Soil textural class	n
II		B-II*TR Mean	22.92 ±2.65 ^{cz}	35.42 ±3.8 ^{by}	41.67 ±3.11 ^{ax}	Clay soil	3
III		B-III *TR Mean	17.27 ±2.65 ^{cz}	38.56 ±3.81 ^{by}	44.16 ±3.11 ^{ax}	Clay soil	3
		Total-TR Mean	21.13 ±1.53 ^b	34.80 ±2.20 ^a	43.32 ±1.79 ^b	Clay soil	9
I	TBWSD	I(B-I Mean)	26.42 ±1.87 ^{ax}	30.69 ±2.70 ^{by}	41.75 ±2.20 ^{cz}	Clay soil	6
II		II(B- II Mean)	25.73 ±1.87 ^{ax}	33.52 ±2.70 ^{by}	40.75 ±2.20 ^{cz}	Clay soil	6
III		III(B- III Mean)	24.22 ±1.87 ^{ax}	38.28 ±2.70 ^{by}	37.50 ±2.20 ^{cz}	Clayloam soil	6
		Total(Grand Mean)	25.46 ±1.08	34.16 ±1.56	40.00 ±1.27	Clay/clayloam soil	18

Parameters followed by the similar letters across the columns (ax, by and cz) for B-Means and B*TR Means are not shows that significantly different at $P \leq 0.05$

3.6. Soil Moisture Contents

It was observed that, the significant variations of soil MC between BLS IES at ($P=0.050$) while it was not observed the significance variations between TRs IES at ($P=0.375$). Soil MC had showed that, insignificant variations between BLS*TRS IES at ($P=0.222$) Table 4. The statistical analysis of GLM multivariate multiple of ANOVA had showed that, the mean value of soil MC between BLS*TRS-mean value of IES in B-I, B-II and B-III CFLS with TSL were the higher (39.7556 ± 4.818 , 30.622 ± 4.022 and 30.762 ± 7.493) than NCFLS (30.6222 ± 4.818 , 24.530 ± 3.796 and 19.3200 ± 2.78), respectively. Between BLS-mean value of IES of soil MC was the higher in B-I (33.36 ± 3.59) than in B-II and B-III (27.58 ± 2.78 and 25.04 ± 4.12), respectively. Overall TRS-mean value of IES of soil MC was the higher inside TSL CFLS (30.4167 ± 2.78) than NCFLS (26.9015 ± 2.78) table 3.

3.7. Soil Bulk Density

The mean value of soil BD had showed that there were significant variations between BLS IES at ($P=0.004$) whereas it was not observed the significant variations between TRS IES at ($P=0.834$). The results of multiple ANOVA had showed that there were insignificant variations between BLS*TRS IES at ($P=0.573$) table 4. Between BLS*TRS mean value of IES of soil BD in B-I, B-II and B-III were the lower inside TSL CFLS (0.15 ± 0.03 , 0.18 ± 0.02 and 0.181 ± 0.03) than NCFLS (0.24 ± 0.02 , 0.24 ± 0.03 and 0.22 ± 0.03), respectively. Between BLS-mean value of IES the results were showed that soil BD was the higher in B-II (0.21 ± 0.02) than B-I and B-III (0.20 ± 0.02 and 0.18 ± 0.02) respectively. Overall TRS-mean value of IES was the higher inside NCFLS (0.20 ± 0.02) whereas the lower under CFLS with TSL (0.19 ± 0.02) table 3.

4. Discussions

Soil erosion severity and appropriate soil and water con-

servation intimation economic, social, technical and adoption by users. Soil texture testing and known soil separate play a crucial role on the prevention and control of erosion. However without understand texture and other physical and chemical properties farmers attempted to arrested erosion and improve crops yield. Thus, TSL and bench terrace with Katha edulis in the Harareghe highlands are a common practices [16].

In Ethiopia soil losses had occurred by water, wind, gravity and mechanical processes but water erosion solely in average losses the top soil of highland of Ethiopia about 4mm layer of soil depth or 40 to 52t/ha/year; however, on individual cultivated farmland soil losses by overland flow water was accounted about 300t/ha/year annually which exceeds the soil formation [2]. Kabi lines was vastly implemented in Ethiopia by farmers were to conserve soil losses, runoff water and sediment in all agro ecological zone including the Ifabas community watershed. TSL is constructed for the purpose of the maintenance of soil properties and soil fertility, to optimize agricultural yield, retention of runoff, while they provides the ultimate goal of watershed recharge and maintain climate change. In support to this study the study done in Niger on stone lines (Hausa term: Gandari) have been laid out mainly by people living on the plateaus to conserve water and trap windblown sand [35]. This study was reaching on the depletion of the studied soil elements under none conserved farmlands as the final end results had been shown. But under the farmlands conserved with TSL the end results had shown that; the studied soil elements were highly improved or/and modified for instance soil texture had showed high modification because of texture is intrinsic by nature and had not change through any soil management or conservation activities. Since, it is the result of soil formation from rocks and minerals by the processes weathering and chemical actions.

4.1. Soil Moisture Content

The analyzed data were carried out using GLM multivariate multiple of ANOVA which had been revealed that,

BS*TRS-mean interaction effects of soil MC beneath to TSL CFLS were the higher in B-I, B-II and B-III than NCFLS [table 2](#). These variations were resulted from the higher soil colloidal which was negatively charged and have the highest soil porosity in terms of numbers. Moreover, crop types, and crop growing patterns had been varies in residues deposition on the surface of the soil colloidal which releases different amount of nutrients during decomposition by soil microbial. These differences were caused more variations for soil moisture retention capacity between blocks as presented [\[15\]](#). The statistical analysis of GLM multivariate multiple of ANOVA had indicated that between TRS-mean value of interaction effects of soil MC was the higher inside CFLS with TSL than NCFLS. Because of accumulation of soil colloidal in the basin which is improve soil moisture holding capacity of the soil. The others reasons due to the higher SOC and SOM inside TSL CFLS than NCFLS which serves as spongy and it was hold much soil moisture contents. This study was in line with the study done by [\[10\]](#), which had illuminated that large or much number of water molecules is associated with soil colloidal particles, SOC, SOM and some are held with internal surface of soil colloidal but others water molecules adsorbed by cations which is hydrated. This implies that TSL has a positive effect on soil moisture content improvement for agricultural practices. Soil BD of NCFLS has the higher than CFLS with TSL which attain the lower soil MC inside NCFLS due to high erosion and runoff surface water which resulted in high compaction.

The mean value of soil MC between blocks IES were the higher in B-I as compared to B-II and B-III that were conserved farmlands with kabi lines. These variations were related with the past erosion, continues cultivation and the arrangement and size of the stone used to build the stone lines [\[3\]](#). This study was in line with the study done by [\[9\]](#) had stated that, stone lines have a potential to improve soil colloidal by controlling soil erosion and sedimentation. Then, that the increased soil MC depend on soil types, slopes, climate and age of the structures. Removal of residues of crops are the most common in the study watershed for fuel energy and animal feed which had observed the lower soil MC under NCFLS. None treated farmlands are located within the wetland areas which caused a variation of soil moisture contents. The arrangement of stone lines has larger in size, no ties, improper basin and space between successive stone lines as a result of these soil moisture was passed through these large opened spaces. [\[11\]](#), had reported that, stone lines has the potential to improve soil MC while it needs an improvement because of farmers use larger size stones that freely drain moisture through their spaces. [\[1\]](#), had reported that, stone lines are increase water stored in the soil, water harvesting, infiltration rate and it increases natural regeneration of trees, and crop yields (see photo below).



Figure 9. Large sized stones arranged along the contour line in B-III.

Because of the structures were built very well with fine sized stones and arranged on the counter lines. This study was in line with the study done by [\[6\]](#) who had justified that, soil MC was the higher under conserved farmlands with stone bund than none conserved farmlands due to the storage of high SOM and reduction of the flow velocity, and kinetic energy and soil erosion by stone bund structures that increases the infiltration rate. [\[3\]](#), had reported that, a physical soil conservation structure improves soil moisture contents. A management practices that affect soil crusting and compaction, vegetative cover, and soil porosity will increases or decreases the rate of water infiltration [\[17\]](#).

4.2. Soil Bulk Density

The GLM multivariate multiple of ANOVA had been shown that; the mean value between blocks with treatments IES of soil BD were the lower under CFLS with TSL than NCFLS [table 2](#). It was not observed the significance variations between B*TR-means of IES. This study was in line with the study done by [\[3\]](#), who had pointed out that, soil BD was the lower under conserved farmlands as compared to none conserved farmlands. TSL structural soil and water conservation measures were reduce runoff velocity, soil loss, removal of organic matters, soil organic carbon, clay soils, sedimentation and increases soil infiltration rate which in turn reduced soil BD. This study was parallel with the study done by [\[2\]](#) stone lines improve soil structures/the arrangement of soil horizons and ground covers which in turn improves soil compaction and soil bulk density.

When BD of soil samples was less than 1gm per cubic centimeter; experimental indicators was not easy to measures soil BD [\[12\]](#) It was reduce soil BD and soil compactness. Since, kabi lines has a positive effect on reduction of soil BD. The study was parallel with the study done by [\[24\]](#) who had revealed that, soil bulk density was significantly affects soil health while influenced by several factors such as soil mineral types, soil porosity, organic matter contents, soil texture, and soil structure and soil moisture contents. Changes in soil bulk density influences agricultural productions. This study was in line with the study done by [\[17\]](#), who had revealed that, soil BD has provides a key role to assess the potential of leaching of soil nutrients, severity of erosion and crop productivity.

According to this author unacceptable soil BD can be causes high runoff and erosion that are losses soil and nutrients. So that, runoff surface water restricted to move through soil particles. Between blocks IES, soil BD had showed that the higher in B-II than B-I and B-III. In despite to that, they were observed the significant variations between blocks IES (at $P \leq 0.05$). These variations were resulted from the differences in crop types, and crop growing patterns which were deposited different crop residues. Soil nutrients were leached during soil erosion which was detached and transported to the downslope. Runoff increase soil loss and nutrients which caused excessive soil BD. Addition of organic amendment inside TSL and none conserved farmlands such as crop residues; compost, FYM and mulch were decreased soil BD. But, clear weeding under none grassy crops in Ifabas community watershed was the common practices and increases soil BD in NCFLS than CFLS. However, as the slope positions increases soil BD decreases [table 2](#).

The mean of soil BD between treatments IES had showed that, the lower under CFLS with TSL than NCFLS. The findings of the study had revealed that soil BD inside B-I, B-II and B-III were the lower values. In support to this study the study done by [\[22\]](#) had reported that, soil BD less than 1 or 1.3g per cm^3 ; since, soil samples were collected when highly wetted or saturated. Moreover, [\[22\]](#) had revealed that soils have many pores when moist materials very well it is drop easily out of the augur, materials with granular vesicular pores, mineral soils with andic properties of soil BD is less than 0.9 kg per m^3 or 0.0009gm per cubic centimeter. The lower; soil BD was resulted because of the effect of SOM contents in the study watershed that was greater than 2% as the findings of the study indicated in all blocks, blocks with treatments and treatments IES. This study was parallel with the study done by [\[22\]](#) if organic matter content is $> 2\%$, soil bulk density has to be reduced by 0.03 kg/m^3 for each 1% increment of organic matter content. In general soil textural class of the Ifabas community watershed is clayloam soil such soil if the soil BD less than 1.40g per cm^3 it is restricted or affected plant root growth [\[17\]](#). In addition to that this author had reported that, deposition of crop residues, soil MC, organic materials and soil colloidal should be decline soil BD and compactness inside kabi lines.

4.3. Soil Texture

4.3.1. Forefinger and Thumb Method

The most common method used to recognize soil separates in the field. It is very easy and simple method. In B-I inside TSL CFLS soil separate had showed that hundred percent clay soils, but in NCFLS showed that siltyclay was the higher (77.78%), while clay soil was the lower ([table 2](#)). Clay soil was the highest inside CFLS with TSL than inside NCFLS due to retention and deposition of fine soil particles behind the basin. It was recognized that the soil separates by using this role of forefinger and thumb feel method is important, in the

feel method, to know the characteristic of "feel" of each separate [\[5\]](#). In B-II inside CFLS with TSL it was observed hundred percent clay soils, whereas in NCFLS had recognized about 77.78% siltyclay and 22.22% clay soils [table 2](#). Under kabi lines much clay soils observed than NCFLS. In B-III beneath to kabi lines it was recognized that hundred percent siltyclay soils, but in NCFLS it was observed about 55.55% of clay soils and about 44.44% of siltyclay soils. Block with block IES were indicated that inside TSL about 59.26% and 40.74% were siltyclay and clay soils, respectively. However, inside NCFLS about 77.78% and 22.22% were observed clay and siltyclay soils, respectively. These variations had been observed in B-I, B-II and B-III were resulted from slope differences, crop types, crop residues and crop growing patterns. The findings of the study had disclosed that TSL was a positive effect on retention of colloidal by interception of runoff and soil losses downslope by erosion agents. The study was in line with the study done by [\[14\]](#), who had recognized that, soil separates based on the feel of soil rubbed between forefinger and thumb method.

In B-II clay soil textural fractions was the lower under TSL than none-treated farmlands. It might be losses much clay soils and deposited on none treated farmlands which is located on a flat plain [\[9\]](#) In B-III soil textural fractions were totally siltyclay and higher for the farmlands treated with TSL than none treated farm farmlands. This is due to the location of none treated farmlands where the vast areas covers with swampy wetlands. Alluvial soil depositions where occurred as a result of sedimentation and flooding from the catchments located above particularly for farmlands treated with TSL. The study was supported with the study done by [\[39\]](#) who had reported that, soil structure and texture determine pore spaces, erosion resistant, looseness, easy of tillage and root penetration.

4.3.2. Mortar and Pestle/Ferro Metal and Highland Method

In B-I the results of the soil texture had showed that conserved FL one with kabi lines were 100% siltyclay soil and medium resistant to crushed, while in FLS two and three were hundred percent clay soils and high resistant to crushed [table 6](#). The variations were occurred due to soil management practices of agronomic erosion control differences, past erosion; continue cultivation and whole crops harvesting systems in Ifabas community watershed.

In NCFLS for FL four had disclosed that hundred percent clay soil and high resistant to crushed, however in FL five and six about two of third and one of third were siltyclay and clay soils, respectively which were medium and high resistant to crushed. These differences were happened as results of wetlands and soil management practices of agronomic erosion controls and TSL. In B-II farmlands one, two and three under CFLS with TSL had showed that hundred percent siltyclay soils and medium resistant to crushed. But inside NCFLS of FL 4, 5 and 6 hundred percent were clay soils and high re-

sistant to crushed. Due to wetland areas that are held high soil colloidal materials in nature. In B-III of FL 1, 2 and 3 about two of third and one of third were siltyclay and clay soils which were medium and high resistant to be crushed, respectively. But, in NCFLS of FL 4, 5 and 6 about one of third and two of third were clay soil and siltyclay soil which were high and medium resistant to crushed, respectively. These were resulted from crop types, crop growing patterns, crop residues accumulated and soil management practices, continuous growing of monocropping, past erosion and clean weeding habit and whole crop harvesting of the Ifabas community watershed.

4.3.3. Un-graduated Cylinder and 30 cm Ruler Ratio Method

The statistical analysis of the GLM multivariate multiple of ANOVA had been shown that the average value of sand soil between blocks with treatments IES were the higher inside NCFLS than CFLS with TSL. This implies that, kabi line has a positive effect on improving soil colloidal in interception with runoff and soil losses down the slope. The average value of sand soil between treatments IES had indicated that the lower under TSL CFLS than NCFLS. The findings of the study had showed that between blocks IES the average value of sand soil was the higher in B-I than B-II and B-III. Because of erosion by water and wind during onset of rainy seasons were removed and transport down the slope both silt and clay soil textural fractions, while leave the coarser soil fractions on the surface of the land for none conserved farmlands [13]. The results of the study had showed that, sand soil was decreased as the slope positions were increased. This study was in line with the study done by [13] who had reported that as landscape position increases from (5-10%), 10-15% to 15-30% sand soil was decreased due to transportation and translocation from the higher slope to the lower slope. According to the stalk law's the larger size of the soil particles settled first and can be seen a line between zone in which the individual particles are visible through the naked eye [9]. The result of this study was match with the study results reported by [10], so that after one and half hours the boundaries between sand, silt, clay, water and un-decomposed humus can be seen easily a line between zones in which the individual particles are visible through the naked eye.

The average value of silt soils between blocks with treatments IES were the higher inside TSL CFLS for B-II and B-III than NCFLS. The average value of treatments IES of silt soil under TSL CFLS were the higher than NCFLS. These variations were resulted from soil management practices with TSL and agronomic erosion controls. The average value of silt soils between blocks IES was the higher in B-III than in B-I and B-II. The results had implied that silt soils were increase as the slope of the land increases. It was not in line with the study done by [13] who had reported that as landscape positions increases the percentage of silt soils were decreases. The average value of clay soils between blocks with treatments

IES had indicated that the higher under TSL CFLS than NCFLS. Average value of clay soils between treatments IES were the higher inside TSL CFLS than NCFLS. The average value of clay soil was the higher in B-I than in B-II and B-III. As the slope of the land increases clay soils were decreases due to transportation and translocation to downstream hillside and deposition on flat slope. The study was parallel with the study done by [13] who had accounted that as the landscape position increases clay soils were declined. Moreover it was supported with study done by [33] who had reported that stone lines retain soil and water on the sites which is mainly used to rehabilitation of the barren degraded lands with impermeable crust. On the other hand; for farmlands conserved with TSL the fine soil particles were deposited in the traditional basin; behind the stone lines arranged along the contour lines. Based on the findings of the study overall mean of sand soil fractions were significantly lower inside conserved farmlands than none conserved farmlands. But silt and clay soil fractions were significantly higher under the conserved farmlands than none conserved farmlands. In support to this result the study done by [13] had accounted that the accumulation of the fine soil textures behind the implemented structure for SWC measures are common. [30] also had revealed that, because of stone lines arranged along the contour lines act as barriers against runoff and losses of fine soil particles, trap sediment, increase infiltration rate and reduce the extent of soil erosion. Stone lines is built to minimize water and soil movement down the slope and, over time, enable the building of a terrace from the accumulation of soil on the upper side of the barriers. This fact was supported by several past studies [9, 18, 31] that were reported sand soil has a coarser materials that is not eroded by runoff water and wind even if gravitational forces is not move down along the slope easily; that is the main logic under none treated farmlands as observed the higher sand soil textural fractional. Soil variations were observed between treatments and between blocks due to erosion processes detachment, transportation and deposition by erosion agents. This study was supported with the study done by [16] who had revealed that, the *soil variability is rather complex due to land sliding and intense erosion and deposition processes*. The result of the study was showed that the soil textural class of the Ifabas community watershed was clayloam soil.

5. Conclusion

Soil Texture tested using field test method of un-graduated cylinder and 30 cm ruler ratio; the final results of statistical analyzed of GLM multivariate multiple of ANOVA had indicated that, the association existed between dependent and independent variables were positively correlated. Thus, that insignificant variation were observed for intra-blocks means of interaction impacts of sand, clay and silt soil textural fractions at ($P=0.703$, $P=0.388$ and $P=0.175$) while included silt soil textural fraction at ($P=0.691$); intra-treatments means of interaction effects of sand and clay soil textural fractions had

been shown that, the significant variations at ($P=0.002$ and $P=0.023$).

The interaction effects between blocks and treatments means had showed that the insignificance differences of sand, clay and silt soil textural fractions at ($P=0.267$, $P=0.199$ and $P=0.841$). Both intra-blocks with intra-treatments means of interaction effects of sand soil was the lower while silt soil was the higher (in B-I) and the lower results were observed (in B-II and B-III), whereas clay soil textural fractions was the higher under the farmlands treated with TSL than none treated farmlands in B-I, B-II and B-III, because of the retention of organic matters, fine and medium soil textures with interception of soil losses and runoff downslope and deposited in the basins. Between treatments means of inter-blocks interaction effects of sand soil was indicated, the lower results but silt and clay soils were the higher under TSL treated farmlands as compared to none treated farmlands. Between blocks means of interaction effects of sand soil was the higher in B-I as compared with B-II and B-III, however silt soil was the higher in B-III than in B-I and B-II whereas clay soil was the higher in B-I than in B-II and B-III. The finding of this study had showed that as the slope positions increases the sand soil decreases.

Soil texture tested by using the method of forefinger and thumb rubbed of full of hand palm of dried soil clods had showed that in B-I totally the texture was clay soil in conserved farmlands, but in none conserved farmlands the results had indicated that 77.78% siltyclay soil and 22.22% clay soils. In B-II about 77.78% was siltyclay soil and about 22.22% was clay soils under TSL treated farmlands, while totally clay soil was observed in none treated farmlands. In B-III inside TSL conserved farmlands siltyclay soils was observed but in none conserved farmlands 55.55% was clay soils and 44.44% was siltyclay soils was observed.

Mortar and pestle with Ferro metal and highland texture tested method in B-I the result had showed that under treated farmlands with TSL siltyclay soil in farmland one and medium resistant to crushed, while in farmland two and three had revealed that in total clay soils and high resistant to crushed. In total clay soil was observed in farmland four in none treated farmlands which is high resistant to crushed. It was observed in none treated farmland five two of third (2/3) siltyclay soil while one of third was clay soils was observed and medium and high resistant to crushed, respectively. For farmland six two of third was siltyclay soils and one of third was clay soils which are medium and high resistant to crushed, respectively. In B-II farmland one, two and three that were treated with kabi lines had showed that in total siltyclay soils and medium resistant to crushed, whereas in none treated farmland four, five and six the results of the study had revealed that in total clay soils and high resistant to crushed. In B-III conserved farmland one, two and three with TSL had been shown that two of third was siltyclay soils and one of third was clay soils which are medium and high resistant to crushed respectively. However, in none treated farmland four, five and six the re-

sults had disclosed that one of third was clay soils and two of third was siltyclay soils which are high and medium resistant to crushed respectively.

The findings were indicated that the average values of soil BD was he significant variations between blocks IES at ($P=0.004$) whereas also observed the significant variations of average values of soil MC at ($P=0.050$). Between treatments and blocks with treatments IES of average values of soil BD and MC had not revealed that the significant variations at ($P=0.834$ and $P=0.573$ | $P=0.375$, and $P=0.222$).

Between blocks and treatments interaction effects the average values of soil MC were the higher under TSL CFLS than inside NCFLS whereas the average values of soil BD were the higher on NCFLS than under the TSL CFLS. Overall treatments interaction effects of the average values of soil MC had showed the higher under TSL CFLS than on NCFLS, however the soil BD had indicated that the higher for NCFLS than under TSL CFLS. Between blocks interaction effects the average values of soil MC had revealed that the higher in B-II than in B-I and B-III but the higher value was observed for B-III than B-I. Between blocks interaction effects the average values of the soil BD was the higher in B-I than in B-II and B-III whereas the higher value was observed for B-II than B-III.

6. Recommendations

Must be maintain yearly and up scaling the performance of the kabi lines instead of arrangement of the stones on the surface of the soil burning under the surface of the soil and then building somewhat the highest height are the better to achieve the expectation from TSL implementation. Because of not removed the land out of use or cultivation it needs encouraging of the TSL structures built by farmers or land users.

It must be provide an immediate training for the farmers of the study community watershed, and the whole study Weroda and Zone having similar characteristics of soil types, agro-climatic condition and topographic features. Provisions of trainees as the trainer of the trainees for zones, zonal and kebeles experts and agricultural extensionists.

It should be highly recommended if the stone lines or kabi lines combined with rainwater harvesting structures such as cholollo pits, tassa pits, Kushkaba, small pits or true planting pits, semicircular pits between successive lines and 5 by 9 pits to cultivation cereal crops.

Soil management practices of agronomic erosion controls should be integrated with TSL very well through the given of trainees to local people or farmers. The TSL structures should be integrating with nitrogen fixation species that are serves as source of fodder to feed animals during dry seasons. Small-holders must be highly encouraged on the implementation, construction and maintenance of stone lines.

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Author Contributions

As much as possible the work has the author’s work. All the work is, read, revised and review by himself alone (the author-principal investigator r) without any support except support of strengthen. This manuscript has the scholarship types and its contribution is one of the universal resource location for both present and coming scientific generation.

Data Availability

The data used to create or prepared this manuscript are available upon the request from the author of this manuscript only but no elsewhere.

Conflict of Interest

The authors declare no conflicts of interest about this manuscript. Every things was done with me alone.

Appendix

Table 5. Abbreviation.

a. s. l	Above Sea Level
B	Block
ANOVA	Analysis of Variance
%	Percent
B-I	Block One
B-II	Block Two
B-III	Block Three
BLS*TRS IES	Blocks with Treatments Interaction Effects
BLS IES	Blocks Interaction Effects
BD	Bulk Density
CFLS	Conserved Farmlands
Cm	Centimeter
Cm ³	Cubic Centimeter
CRBD	Complete Randomized Block Design

E	East
EU	Experimental Unit
FAO	Food and Agricultural Organization
FL	Farmland
FL1, 2 and 3	Farmland One, Two and Three
FL4, 5 and 6	Farmland Four, Five and Six
GLM	General Linear Model
g/cm ³	Gram per Cubic Centimeter
Ha	Hector
Kg/m ³	Kilogram per Cubic Meter
TCSS	Total Composite Soil Sample
TR1	Treatment One
TR2	Treatment Two
WRDDIRD	Water Resources Department, Directorate of Irrigation Research & Development
Km ²	Square Kilometer
M	Meter
MC	Moisture Content
Mm	Millimeter
N	North
N	Number of Treatment
NCFLS	None Conserved Farmlands
n. d.	No Date
OU	Observation Unit
O	Degree-minute-second
P	Significance Level
PV	Significance Value
R	Replicate
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SSDS	Soil Science Division Staff
SP	Sample Plot
SPSS	Statistical Package or Social Science
SWC	Soil and Water Conservation
t/ha/yr	Ton per Hectare per Year
TCSS	Total Composite Soil Sample
TR3	Treatment Three
TR4	Treatment Four
TR5	Treatment Five
TR6	Treatment Six
TSL	Traditional Stone Line

VI

Vertical Interval

Table 6. The way of crushing dry soil clods in between forefinger and thumb method.

Block	FL	HR	MR	EC	ST	TR	CP
II	1	H			Clay	TSL	P1+p2+p3
	2	H			Clay	TSL	P1+p2+p3
	3	H			Clay	TSL	P1+p2+p3
	4	H			Clay	NTR	P1+p2+p3
	5	H			Clay	NTR	P1+p2+p3
	6	H			Clay	NTR	P1+p2+p3
III	1		M		Siltyclay	TSL	P1+p2+p3
	2		M		siltyClay	TSL	P1+p2+p3
	3		M		siltyClay loam	TSL	P1+p2+p3
	4	H			Clay	NTR	P1+p2+p3
	5	H			Clay	NTR	P1+p2+p3
	6		M		siltyClay	NTR	P1+p2+p3
I	1	H			Clay	TSL	P1+p2+p3
	2		M		siltyClay	TSL	P1+p2+p3
	3	H			Clay	TSL	P1+p2+p3
	4	H			Clay	NTR	P1+p2+p3
	5	H			Clay	NTR	P1+p2+p3
	6	H			Clay	NTR	P1+p2+p3

P1 sample plot one, P2 sample plot two and P3 sample plot three which considered each stone line for treated farm lands with traditional stone line and each strip line for non-treated farmlands as sample plot one, two and three. HR-high resistant, MR- medium resistant, EC- easily crushed, TR - treatment, NTR= none- treatment, ST- soil texture, CP- composite and FL- farmlands

Table 7. Pestle, and mortar (highland, small Ferro metal) soil texture testing method.

Block	FLs/TRs	TR No.	HR	MR	LR	ST	TRs	SP Sequential
I	1	1		M		siltyClay soil	TSL	Bottom
		2		M		siltyClay soil	TSL	Middle
		3		M		SiltyClay soil	TSL	Top
	2	1	H			Clay soil	TSL	Top
		2	H			Clay soil	TSL	Middle
		3	H			Clay soil	TSL	Bottom
	3	1	H			Clay soil	TSL	Bottom
		2	H			Clay soil	TSL	Middle
		3	H			Clay soil	STL	Top
	4	1	H			Clay soil	NTR	Top

Block	FLs/TRs	TR No.	HR	MR	LR	ST	TRs	SP Sequential
II	5	2	H			Clay soil	NTR	Middle
		3	H			Clay soil	NTR	Bottom
		1		M		SiltyClay soil	NTR	Top
		2		M		SiltyClay soil	NTR	Middle
		3	H			Clay soil	NTR	Bottom
		6						
	6	1	H			Clay soil	NTR	Bottom
		2		M		siltyClaysoil	NTR	Middle
		3		M		siltyClay soil	NTR	Top
	1	1		M		siltyClaysoil	TSL	Bottom
		2		M		siltyClay soil	TSL	Middle
		3		M		siltyClay soil	TSL	Top
	2	1		Medium		siltyClay soil	NTR	Top
		2		Medium		siltyClay soil	NTR	Middle
		3		Medium		siltyClay soil	NTR	Bottom
	3	1		Medium		Silty clay soil	STL	Middle
		2		Medium		siltyClay soil	STL	Top
		3		Medium		siltyClaysoil	STL	Bottom
	4	1	High			Clay soil	NTR	Bottom
		2	High			Clay soil	NTR	Middle
		3	High			Clay soil	NTR	Top
	5	1	High			Clay soil	STL	Top
		2	High			Clay soil	STL	Middle
		3	High			Clay soil	STL	Bottom
	6	1	High			Clay soil	NTR	Top
		2	High			Clay soil	NTR	Middle
		3	High			Clay soil	NTR	Bottom
III	1	1		Medium		Siltysoil (alluvial)	TSL	Top
		2		Medium		Silty soil (alluvial)	TSL	Middle
		3		Medium		Silty soil (alluvial)	TSL	Bottom
	2	1		Medium		siltyClay soil	TSL	Bottom
		2		Medium		SiltyClay soil	TSL	Middle
		3		Medium		SiltyClay soil	TSL	Top
	3	1		Medium		Silty claysoil	TSL	Bottom
		2		Medium		siltyClay soil	TSL	Middle
		3		Medium		siltyClay soil	TSL	Top
	4	1	High			Clay soil	NTR	Top
		2		Medium		siltyClay soil	NTR	Middle
		3		Medium		siltyClay soil	NTR	Bottom
	5	1	High			Clay soil	NTR	Top

Block	FLs/TRs	TR No.	HR	MR	LR	ST	TRs	SP Sequential
		2	High			Clay soil	NTR	Middle
		3	High			Clay soil	NTR	Bottom
	6	1		Medium		siltyClay soil	NTR	Top
		2		Medium		siltyClay soil	NTR	Middle
		3		Medium		siltyClay soil	NTR	Bottom

Table 8. Field soil texture method using mortar and pastel method of crushed of clods and presented means in%.

BS	TSL-TR			NTR		n
B-I	SLCL	SL	CL	SLCL	CL	
TR-Mean	1/3*100=33.33%	2/3*100=66.67		4/3*1/3*100=44.44%	5/3*1/3*100=56%	3
B-II	3				3	3
TR-Mean	3/3*100=100%				3/3*100=100%	3
B_III	3	1	2	9/3	18/3	3
TR-Mean	3/3*100=100%	1/3*100=33.33%	2/3*100=66.67%	9/3*1/3*100=100%	18/3*1/3*100=200%	3

Table 9. Treatments means within each blocks.

BS	TSL-TR			NTR		No
B-I	SLCL	SL	CL	SLCL	CL	
TR-Mean	1/3*100=33.33%	2/3*100 = 66.67		4/3*1/3*100=44.44%	5/3*1/3*100=56%	3
B-II	3				3	3
TR-Mean	3/3*100=100%				3/3*100 =100%	3
B_III	3	1	2	9/3	18/3	3
TR-Mean	3/3*100=100%	1/3*100=33.33%	2/3*100=66.67%	9/3*1/3*100=100%	18/3*1/3*100=200%	3

Table 10. Overall block means.

	TSL-TR			NTR		No
	SLCL	SL	CL	SLCL	CL	18
TTS	7	2	1	10/3	17/3	
OB-M	38.89%	11.11%	5.56%	18.52%	31.89%	

TTS- total treatments and OB-M- overall total means between the blocks (TSL-TR+NTR)

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