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Research Article

Impacts of Traditional Stone Line /Kabi Line/, Crop Types, Crop Patterns and Fertilizer Applications on Soil Properties at Ifabas /Jarra/ Community Watershed, Tullo Woreda, West Harareghe, Oromia, Ethiopia

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Abstract

This study entitled with the impacts of traditional stone lines/kabi lines/, crop types, crop patterns and fertilizer applications on soil physico-chemical properties at Ifabas / Jarra/ community watershed, Tullo Weroda west Harareghe zone Oromia Regional National State Ethiopia. The objectives of this study were to examine the effects of TSLs with fertilizers application, crop types and crop patterns on soil physico-chemical properties of CFLS with TSL in comparison to NCFLS and to observe their correlations existed between them; and to investigate the variations of C/N ratios between CFLS with TSL and \NCFLS. CRBD was purposefully used in provided an equal chances of statistical probability distribution of EUs, SPs, and OUs. The total of 54 CSSs were collected from the three sub-watersheds of Ifabas community watershed for laboratory analysis. Moreover, the total of 54 disturbed soil samples were collected in separate to determine soil BD and soil MC. Soil samples were collected at 0-15 cm soil depth by used local available and prepared auger from metal pipe. Its volume is 396.312 cm^3. Soil samples were replicated three times to approach the accuracy. Laboratory analyzed output of soil data were subjected to EXCEL2013 software and multiple ANOVA following the GLM of Multivariate procedures of SPSS version 23. The study were observed the variations of ST, SOC, TSN, ASP, and soil pH, SOM, MC and BD and C/N ratios available between CFLS and NCFLS. The results of the study in B-I had showed that, the average values of the soil BD, soil MC, silt and, sand soil, TSN, SOC, SOM and soil pH were the higher inside CFLS with TSL (0.24g/cm^3, 39.76%, 31.13%, 31.82%, 0.20%, 2.29%, 3.94% and 6.72 ratio) than NCFLS (0.16g/cm^3, 26.96%, 24.21%, 27.38%, 0.19%, 1.24%, 2.13% and 6.61 ratio). The findings of the study in B-II had revealed that, the average values of soil BD, soil MC, soil pH and clay soil were the lower under CFLS with TSL (0.12g/cm^3, 24.5%, 6.93 ratio and 32.58%) than in NCFLS (0.24g/cm^3, 30.62%, 6.72 ratio and 38.35%). The results of the study in B-III had indicated that, the average values of the soil MC, sand soil, SOC, SOM, TSN, and ASP were the higher under CFLS with TSL (30.76%, 39.40%, 1.71%, 2.95%, 0.33% and 24.56ppm) than NCFLS (19.32%, 38.19%, 1.13%, 1.95%, 0.18% and 13.57ppm), In general the study results had showed that TSL structures, CFS and CGPS have the positive effects on improving of soil physical and chemical properties as comparted to NCFLS.

Keywords

TSL/kabi Line, TRS, ASMPs, Crop Types, Crop Patterns, FL, SPCP, EUs, BLS, CSSs, SD, R and WS

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1. Introduction

Soil erosion and sedimentation in Ethiopian highlands are severely affected; the soil and land resources particularly in northern, central and eastern highlands of Ethiopia sever than other parts of Ethiopian highlands due to deforestation and over cultivation (1). These are due farmers' lack of attention to soil and land resources both were severely degraded by erosion agents.

As [39] had reported anthropogenic activities converted forested land uses into none forested land uses were resulted to sever land and soil degradation and as a results farmers/ local people/ were occupied the steep slopes and marginal lands to cultivate crops. These issues are increased erosion rate ad declined topsoil, humus, organic matters and crop yields. Due these soil and land degraded and eve if in some place nothing can be growth. [9], had revealed that, land productive capacity is heavily declined either temporarily or permanently. [27]. had reported that, land degradation is related with poverty and long drought and it is the long term decline of an ecosystem functions, services and measured in terms of net primary productivity and requires the greater inputs to recover from the situations and made it is productive. The past study done by [2], had indicated that, depletion of watershed natural resources are the major problem that is facing human being at Global scale and approximately about 1.2 billion ha of the world land was degraded by soil erosion itself which is occurred due to over cultivation, improper farming system, overgrazing, population pressures, improper irrigation system and poor land use planning and lack land use policy, continues cropping, lack of fallow system and developmental infrastructures without integrated with proper SWC measures and vast deforestation of the forest covers [2].

As [1, 2], had reported; land degradation in the central highlands of Ethiopian were affected the agricultural production sector, because of encroachment on fragile and marginal land by farmers which is rugged and steep slope to grow crops for food production without associated with SWC practices and lack of implementation of SWC measures properly, Soil erosion, sedimentation and nutrient depletion are a common issues for agricultural production and development in Ethiopia [42, 1].

Soil erosion by water and wind causes on-site and off-site effects which were resulted in land and soil degradation, decline of crop yield and depletion of watershed natural resources [38]. Soil erosion hampers agricultural productivity by deteriorating soil quality; removes the fertile topsoil, and exposed the infertile subsoil with high acidity which causes changes in soil quality [42]. Soil quality is considered as the capacity of running properly a soil to be functions which implies that the redox reactions (oxidation and reeducation reactions) that are well functioned [18]. Indicators of soil quality can be includes: physical, chemical and biological soil properties, its processes. Morphological features of plant growth can be also indicated soil quality [26]. Soil management practices of agronomic erosion control are practiced to control soil erosion in three principles interception, with canopy against raindrop, anchorage with roots and prevent soil particles detachment and transportation to downstream watershed and barriers with litters against runoff low surface water [10].

West Harareghe zone landscape feature is highly rugged and steep slope mountainous in nature and population of the zone are densely populated, while encroached on the steep slope, fragile and marginal lands and then clear out natural forests and plantation forests to grow crops for staple food and planting *Katha eidolous* as a source of income generation due to land scarcity. Therefore, this study was attempted to examine the impacts of TLS with correlation of the fertilizer application, crop types and crop patterns on the soil physicochemical properties. Agricultural production is mostly practicing by smallholder farmers in the country and largely dependent on rain-fed agriculture while soil and land resources were heavily degraded and resulted in food insecure which increase the rural poverty and in turn affects the urban development and fail under the poverty. Cultivation on sloppy land is heavily declined physical, biological and chemical soil properties [15]. Specific objectives the study include: to examine the effects of variations of TSLs in correlation with fertilizers application, crop types and crop patterns on soil chemical and physical properties of CFLS with TSL in comparison to none-treated farmlands and to observe their correlations existed between them; to investigate the variations of C/N ratios in between CFLS with TSL and \NCFLS.

The study were investigated soil texture, soil BD, soil MC, total soil N, P, S, SOC, SOM, soil pH and C/N ratio, effects of, crop types, fertilizer application and crop growing patterns on soil properties. Null hypothesis was proposed as there were not a variations of soil chemical and physical properties of CFLS with TSL in comparison to none-treated farmlands; and there were not a variations of C/N ratios in between CFLS with TSL and \NCFLS.

$$H_o = \mu_o = \mu$$

However, alternative hypothesis was proposed as there were a variations of soil chemical and physical properties of CFLS with TSL in comparison to none-treated farmlands; and there were a variations of C/N ratios in between CFLS with TSL and \NCFLS.

$$H_a = \mu \quad \neq \mu$$

The hypothesis proofed by used the significance level of $(\propto) = 0.05$. Materials and Methods

2. Materials and Methods

2.1. Study Area Descriptions

Geographically west Harareghe Zone is located in Oromia National Regional State Ethiopia. West Harareghe zone Administrative geographical boundary is approximately the laid of the land between 8°39′59.99″ N Latitude and 40°29′59.99″ E Longitude from the equator [35]. Tullo Woreda altitude is ranges from 1631 to 2800 m above sea level. Based on the agro-climatic conditions approximately about 56.67% of the Woreda falls within the midland regions that ranges from 1600 to 2300m above sea level while the remaining of 43.33% is classified as highland areas which is >2300m above sea level [32]. Thus, the study area Ifabas community watershed is laid under the highland area of altitude > 2300m above sea level. In general, bimodal rainfall pattern is a common in eastern areas of the country. According to [32] had reported Tullo Woreda and the study watershed rainfall ranges from 900mm to 950mm.

The mean maximum temperature of Ethiopia is 45℃ and it covers from April to September whereas the mean minimum temperature is 40℃ from October to March is recorded in the Qafar Depression Valley North-East Ethiopia. The annual average rainfall in Ethiopia is categorized into three groups: 1200 mm to 1600 mm in the lowland, 1600 mm to 2600 mm in the midland and > 3000 mm in the highlands [39]. Ethiopia has five agro-climatic Zones that are defined by two factors altitude and temperature [40].

FAO [21] had reported that, Ethiopian major soils have about 19 soil types; which are grouped into three types in general. These are: 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. The most common forest species remained in the west Harareghe zone includes: indigenous and exotic species. A few of the indigenous trees and shrubs species are: *Ola african, Cordia african, Podocarpus flactus, Junporuous porcera, Croton mycrostcheus, Celitus african, Acacia species, Balentus egyptica and vernonyi aamagledina whereas* a few of exotic species of trees and shrub species includes *Eucalyptus spp, Geravilla robusta and Pinous radiata, Casurina equistifolea, Pinus patula, Shenis moll, Cupressus lustinica, and Acacia selgena,,*

According to the past study did by [21, 30], had been shown that; the total land area of Ethiopia is accounted about 1221480 km^2 (122,148,000ha) and the major land use and 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%. West Harareghe Zone landscape features including the Tullo Woreda and Ifabas community watershed are highly rugged and mountainous in nature and classified the same as the classification of topography of the Ethiopian and Oromia landscape features. The classification is depending up on the slope classes. Topography in Ethiopia has classified into five classes; 0-10% which held lowlands (703000km^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 Zone, study Woreda and Ifabas community watershed. The study did in the past by [19, 28], had been shown that; the common staple food crops that are growing in the study area grains and cereals such as maize, sorghum, barely, teff, pea, haricot, bean and wheat. Oil crops are sesame, and pluses. Coffee species (*Coffee libericea, Coffee arbica and Coffee robusta*) and *Khateaedulisous* are the major perennial cash crops including *Prunusamerican, mangiferaindica banana/ mussa species*, orange, Zeithun (*Pesduasium gawave* and apple species. Root crops are red and white onion, potato carrot, and sugar bite is the most common practices in the study watershed, zone and district.

2.2. Research Methodology and Sampling Techniques

Ifabas community watershed was selected as a representative of the study for the rest community watersheds of the Tullo Woreda and west Harareghe zone which have similar with agro-climatic conditions, soil types, farming system, and topography. Ifabas community watershed was selected from Tullo District; systematically based on the field observation and secondary evidences. The proposed objectives and hypotheses were achieved through the collection of soil samples, analyzed and testified with the defined statistical model. The representative soil samples are play a crucial role to established soil properties and used to evaluate variations in top soil, subsoil, soil profile and horizon both in spatial and temporal variations [22]. Evaluations of soil properties were to provide an alternative recommendations for the study problems.

It looks about the effects of TSL in association to soil management practices of agronomic erosion controls in comparison to control farmlands on soil physical and chemical properties. The study was observed the variations of independent and dependent variables. Complete randomized block design (CRBD) method was used purposefully to answer the proposed objectives, questionnaires and the hypotheses of the study. This study was depending upon the provision of an equal chance of probability distribution to study both the treatments and observation units. The basic principle of experimental design is to reduce the experimental error [24].

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 soil and water conservation practices properly, to understand the scarcity of and to made profitable of the soil management practices that were fit within the agro-climatic condition, topographic features and soil types of the watersheds, and the intervention of new soil and water conservation practices or to improve the existed SWC practices based on the outcome of the study.

Using simple random sampling technique of CRBD should be distributed soil sampling spots per EU. This experimental research design was contains three sub-watersheds based on slope classes of the land. These were lower slope (downstream), middle slope (Transfer zone of the watershed) and upper slope (header water or upstream watershed). The observation unit (OU) for this study is the representative spots where soil samples were collected in composite samples [25]. The three sub watershed land uses were under similar situations of history; past erosion, cultivation, management and deforestation. Soil samples were collected for the determination of field and laboratory analyses of soil BD and soil MC, SOC, SOM, total soil nitrogen, soil pH, soil texture and available soil P. Replication of the experiments has played a crucial role on the final results of the study to approach accuracy and it was replicated three times. 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 soil samples but not made composite soil samples for soil BD and soil MC analysis. Soil samples collection volume is equivalent to core sampler size that was prepared from locally available/metal pipe having 5.8 cm diameter and 15 cm height with 5 cm extra height. The volume is 396.11cm^3. The total of 54 composite soil samples were collected to analyzed the selected soil properties in the laboratory and in the field. Also the total of 54 soil samples were collected for the determination of soil BD and MC separately without made composite soil samples.

2.3. Source of Data

Both secondary and primary sources are the sources of data. Secondary data was obtained from the Tullo Woreda of natural resource management office and the primary source of data were collected from the collections field soil samples, observation in the field during collection of soil data and crops collections from Ifabas community watershed.

2.4. Data Collection Methods

Soil data was collected from 18 treatments; six from each sub-watersheds for laboratory and air seasoning method of soil BD and MC analyses. The requested data were collected from the farmlands situated adjacent to each other either up and down or beside each other or the selected treatments were aligned vertical or horizontal within the block or sub-watersheds to understand the property of variations existed between two treatments and blocks or sub-watersheds where deposition of soil was occurred.

2.5. Soil Laboratory Analysis

Before conducted for laboratory analyses soil data were dried under shade at room temperature by using air seasoning. The impurities should be separate during and after soil samples collected and dried were includes crop residues, tree leaves and twigs; stones, weeds, grasses, broken roots, leave, and bark before grinded. Large soil clouds crushed with Ferro metal used as soil hammer; pestle and mortar was used to mix soil samples very thoroughly and to increase soil samples quality and homogeneity of soil data that were analyzed. Using field beam balance it was weighted in the field the wet weight of soil data and filled into plastic bag and labeled. Dried well using air seasoning method and again weighed the dry weight for the determination of soil BD and soil MC.

It was grinded very well and passed through 2mm diameter sieve and then mixed thoroughly to produce homogeneity of soil samples. The grinded and sieved soil data divided into two or quarter part. After that the half or quarter part of the grinded soil sample data should be taken for laboratory analyses. The soil samples were analyzed at Ethiopian agricultural research center DabreZeith agricultural research center of soil laboratory and then, collected from there for the statistical data analyses.

Soil texture was determined using hydrometer method or international pipette method by dispersion of the soil in a mixer-dissolving agent [13, 43].

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 air dried weight of air seasoning for four weeks and divided by the volume of the core sampler [43].

$\text{SBD} = \frac{\text{wet weight of soil} - \text{Blank} - \text{dry weight of soil}}{\text{volume of core sampler}}$ Volume (V) = Height of core sampler*Area of circle = $\text{H} * \frac{\pi \text{D}^2}{4})$ [5, 31].

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, 43].

Volume based $\text{MC\%} = \frac{\text{MC in dry mass}}{\text{water density}} *$ soil bulk density [43].

Soil pH was determined with a combination of electrode in a 1:2.5 soil: water suspension [33, 42]. Soil organic carbon was determined by using the Walkley and Black of the wet digestion method which refer to the Titration Method [11, 34, 43].

$$\%SOC = (B - S) \times N \times 0.003 \times \frac{100}{\text{oven dry wt.of soil}}$$

Where, B = ml of std. 0.5 N ferrous ammonium sulphate required for blank, S = ml of std. 0.5, N ferrous ammonium sulphate required for soil sample and N = Normality of std. ferrous ammonium sulphate (0.5N). Soil organic matter was calculated by this formula using the results of soil organic carbon: $\%SOM = \text{soil organic carbon} \times 1.274$. SOM contains 58% of SOC. Hence

$$\%SOM, = SOC \times \frac{100}{58} = SOC \times 1.274.$$

Where, SOM is soil organic matter and SOC is soil organic carbon, 1.274 and 58% are constant factors. Total soil Nitrogen was determined by using Kjeldahl Method [10].

$$N\% = (\text{sample} - \text{blank of msl}) \times \text{N of HCl} \times 100 \times \frac{0.014\text{g N/meq}}{3\text{g sample}}.$$

Extractable soil phosphorus was determined by using Oslen's method cited in [4].

$$P(\text{ppm}) = \frac{GR \times 50 \times 5}{\text{corrected Wt.of soil}}$$ and P (kg/ha) = P (ppm) x 2.24

2.6. Soil Data Analysis

The aim of soil data analysis is to justify the investigated effects of TSL in correlation to fertilizer application, crop types and crop patrons for treated farmland uses and none treated farmland uses on soil physical and chemical properties. Since, the choice of the appropriate soil management practices either the indigenous or the modern SWC measures were depend on the analysis of soil samples and the provision of an alternative recommendations.

The soil data produced through laboratory analyses were subjected to multiple-way of Analysis of Variance (Multiple ANOVA) and EXCEL software 13 to observe the least significance variations existed between conserved farmland uses with TSL and soil management practices.

The data were subjected to statistical analysis at $P < 0.05$ significance level by following the General Linear Model (GLM) of multivariate procedures of SPSS software version 23.0. The results of the study was compared the relationships of average values and overall average values using Microsoft Excel analyses The results were displayed with tables and bar diagram. The study was used F-test method to observed the variations between dependent and independent variables,

3. Results

3.1. Interpretations of Results

Antony Jiju et al [8] had explained that, statistical analysis involves understanding of the nature of data and performing of the statistical analysis of data collected from the field and interpretations is refers about the understand of the results of the analysis of data of the experimental design of the study. This study had proceed the steps of the interpretation of statistical analyzed data or output in provision of separate heading, next to that present own discussion in separate heading and supported with similar studies did in the pasts. But another method of writing report of final data results are the admixture scientific writing.

Table 1. *Mean values of soil bulk density and soil moisture contents analyzed by EXCEL software 13. B-I at 0-15cm soil depth.*

EUs	CTS	CGPS	FAP/NFAP	TRS	BD (g/cm^3)	%MC	%CL	%SL	%SND
1	Maize and pea	REC	NFAP	TSLTR	0.27	44.14	32.93	35.47	31.60
2	Maize	RC	FAP	TSLTR	0.21	27.56	37.60	34.13	28.27
3	Maize and sorghum	MCP	NFAP	TSLTR	0.25	47.57	31.60	32.80	35.60
					0.24	39.76	34.04	34.13	31.82
4	Maize	Row	FAP	NTR	0.07	15.23	48.27	24.13	27.60
5	Maize based sorghum	MCP	NFAP	NTR	0.21	34.48	39.60	34.80	25.60
6	Sorghum based maize land	MCP	NFAP	NTR	0.19	31.18	40.27	30.80	28.93
					0.16	26.96	42.71	29.91	27.38

Table 2. Mean values of total soil N, SOC, SOM, ASP and soil pH analyzed by used EXCEL software 13 at 0-15 cm soil depth in B-I.

EUS	CTS	CGPS	FAP/NFAP	TRS	%Total soil N	%SOC	%SOM	P (ppm)	pH (1:2.5 ratio)
1	Maize and pea	REC	NFAP	TSLTR	0.24	2.62	4.51	15.57	6.77
2	Maize	RC	FAP	TSLTR	0.17	2.24	3.86	12.44	6.72
3	Maize and sorghum	MCP	NFAP	TSLTR	0.20	2.00	3.45	9.86	6.67
					0.20	2.29	3.94	12.62	6.72
4	Maize	RC	FAP	NTR	0.12	1.60	2.76	12.18	6.52
5	Maize based sorghum	MCP	NFAP	NTR	0.23	1.20	2.07	19.23	6.74
6	Sorghum based maize	MCP	NFAP	NTR	0.22	0.91	1.57	21.08	6.56
					0.19	1.24	2.13	17.50	6.61

Table 3. Mean values of soil BD, soil MC, and soil texture analyzed by used EXCEL software 13 at 0-15 cm soil depth of B-II.

EUs	CTS	CGPS	FAP/NFAP	TRS	BD (g/cm^3)	%MC	%CL	%SL	%SND
1	Teff, Maize and sorghum	BC plot 1, MC plot 2	FAP	TSLTR	0.14	16.76	34.13	33.60	32.27
2	Maize	BC	FAP	TSLTR	0.24	33.22	32.80	34.27	32.93
3	Maize and sorghum	MCP	FAP	TSLTR	0.16	23.61	30.80	31.60	37.60
					0.18	24.53	32.58	33.16	34.27
4	Maize	RC	FAP	NTR	0.22	30.39	34.13	26.93	38.93
5	Sorghum	BC	FAP	NTR	0.33	40.86	36.13	28.93	34.93
6	Maize and pea	REC	FAP	NTR	0.18	20.62	44.80	26.27	28.93
					0.24	30.62	38.35	27.38	34.26

Table 4. Mean values of total soil N, SOC, SOM, ASP and soil pH analyzed by used EXCEL software 13 at 0-15 cm soil depth in B-II.

EUs	CTS	CGPS	FAP/NFAP	TRS	%Total N	%SOC	%SOM	P (ppm)	pH (1:2.5 ratio)
1	Teff, Maize and sorghum	BC plot 1 MC plot 2 and 3	FAP	TSLTR	0.22	1.13	1.95	23.48	6.74
2	Maize	BC	FAP	TSLTR	0.23	1.35	2.33	22.30	6.84
3	Maize and sorghum	MCP	FAP	TSLTR	0.22	1.40	2.41	23.62	6.59
					0.22	1.29	2.23	23.13	6.72
4	Maize	RC	FAP	NTR	0.22	1.62	2.79	15.35	7.03
5	Sorghum	BC	FAP	NTR	0.23	1.03	1.77	14.81	6.57
6	Maize and pea	REC	FAP	NTR	0.14	1.24	2.13	10.16	7.19
					0.20	1.30	2.23	13.44	6.93

Table 5. *Mean values of soil BD, soil MC and soil texture analyzed by used EXCEL software 13 at 0-15 cm soil depth B-III.*

EUs	CTS	CGPS	FAP/NFAP	TRS	BD (g/cm^3)	%MC	%CL	%SL	%SND
1	Bean	BC	NFAP	TSLTR	0.11	16.49	26.67	33.73	39.60
2	Maize	BC	FAP	TSLTR	0.13	20.01	29.33	33.73	36.93
3	Maize	BC	FAP	TSLTR	0.16	21.46	28.00	29.73	42.27
					0.13	19.32	28.00	32.40	39.60
4	Maize	RC	FAP	NTR	0.25	42.94	36.00	33.07	30.93
5	Maize	RC	FAP	NTR	0.22	23.92	36.67	37.73	25.60
6	Maize	BC	NFAP	NTR	0.18	25.42	27.33	37.73	34.93
					0.22	30.76	33.33	36.18	30.49

Table 6. *Mean values of total soil N, SOC, SOM, ASP and soil pH analyzed by used EXCEL software 13 at 0-15 cm soil depth in B-III.*

EUs	CTS	CGPS	FAP/NFAP	TRS	%total soil N	%SOC	%SOM	P (ppm)	pH (1:2.5 ratio)
1	Bean	BC	NFAP	TSLTR	0.30	1.67	2.87	23.36	6.66
2	Maize	BC	FAP	TSLTR	0.34	1.70	2.94	24.57	6.60
3	Maize	BC	FAP	TSLTR	0.35	1.76	3.04	25.76	6.64
					0.33	1.71	2.95	24.56	6.62
4	Maize	RC	FAP	NTR	0.25	1.38	2.37	9.50	6.51
5	Maize	RC	FAP	NTR	0.15	0.89	1.53	11.08	6.74
6	Maize	BC	NFAP	NTR	0.14	1.13	1.94	20.14	6.85
					0.18	1.13	1.95	13.57	6.70

3.2. Bottom Sub - Watershed

3.2.1. Soil Bulk Density

The average value of soil BD was the higher in FL one (0.27g/cm^3) than FLS two and three (0.21 and 0.25g/cm^3) treated with kabi lines/TSL. In contrast to that, soil BD in NCFL four was extremely lower (0.07g/cm^3) than NCFLS five and six (0.21 and 0.19g/cm^3, respectively. The overall average value of soil BD was the higher under CFLS with TSL (0.24g/cm^3) than NCFLS (0.16g/cm^3) Table 1 B-I (appendixes III, Figure 4).

3.2.2. Soil Moisture Contents

The average value of soil MC was the higher in FL three (47.57%) as compared to FLS one and two (44.14 and 27.56%) conserved with TSL/kabi lines. However, the average value of soil MC in NCFL FL five was the higher (34.48%) than NCFLS four and six (15.23 and 31.18%), respectively. The overall average value of soil MC was the higher (39.76%) inside CFLS with TSL than NFLS (26.96%) Table 1 B-I (appendixes III, Figure 4).

3.2.3. Soil Texture

The results of the study had showed that, the average value of clay soil was the higher under TSL/kabi lines CFL two (37.60%) than CFLS one and three (32.93 and 31.60%). But, the results had indicated that NCFLS clay soil was the higher in farmland four (48.27%) than farmlands five and six (39.60 and 40.27%). Overall average value of clay soil was the lower under TSL CFLS (31.04%) as compared to NCFLS (42.71%). The average value of silt soil was the higher (35.47%) on farmland one than farmlands two and three (34.13 and 32.80%) conserved with TSL while, NCFL five was the higher average value of silt soil (34.80%) than NCFLS four and six (24.13 and 30.80%). Overall average value of silt soil was the lower (27.91%) on NCFLS than CFLS with TSL/kabi lines (31.13%). The average value of sand soil was the higher in FL one (31.60%) than FLS two and three conserved with TSL (28.27 and 35.60%), respectively. However, the findings had revealed that, NCFL six was the higher sand soil (28.93%) than NCFLS four and five (27.60 and 25.60%) respectively. Overall average value of sand soil was the lower inside NCFLS (27.38%) than CFLS with TSL (31.82%) Table 1 B-I (appendixes III, Figure 5).

3.2.4. Total Soil N

The findings of the study had been shown that, the average value of total soil N was the higher as observed under FL one (0.24%) than FLS two and three (0.17 and 0.20%) conserved with kabi lines. But, in NCFL five total soil N was the higher average value (0.23%) as compared to NCFLS four and six (0.12 and 0.22%). However, as the results had disclosed, overall average value of total soil N was the higher (0.20%) under CFLS with TSL than NCFLS (0.19%) Table 2 B-I (appendixes III, Figure 6).

3.2.5. Soil Organic Carbon

The results of the EXCEL analyzed was revealed that, the average value of SOC was the higher in FL one (2.62%) than FLS two and three (2.62 and 3.86%). However, the average value of SOC in NCFL four was the higher (2.00%) than NCFLS five and six (1.20 and 2.07%). Overall average value of SOC was the higher inside CFLS with TSL (2.29%) than NCFLS (1.24%) Table 2 B-I (appendix III, Figure 7).

3.2.6. Soil Organic Matter

The average value of SOM was the higher (4.51%) for FL one than FLS two and three (2.00 and 3.45%) conserved with TSL. whereas NCFL four the average value of SOM was the higher (2.76%) than NCFLS five and six (0.91 and 1.57%), respectively. The overall average value of SOM inside CFLS with TSL (3.94%) was the higher as compared to NCFLS (2.13%) Table 2 B-I (appendix III, Figure 7).

3.2.7. Available Soil P

The average value of available soil P inside TSL CFL one was the higher (15.57ppm) than CFLS two and three (12.44 and 9.86ppm) respectively. The result of the study had showed that, the average value of NCFL six was the higher available soil P (21.08ppm) than NCFLS four and five (12.18 and 19.23ppm), respectively. Overall average value of available soil P was the higher in NCFLS (17.50ppm) than CFLS with TSL (12.62ppm) Table 2 B-I (appendixes III, Figure 8).

3.2.8. Soil pH

The average value of soil pH was the higher (6.77) under FL one conserved with TSL than under CFLS two and three (6.72 and 6.67 ratios) with TSL. The average value of soil pH value of NCFL five was higher (6.74) than NCFLS four and six (6.52 and 6.56 ratios). The overall average value of soil pH was the higher (6.72) under CFLS with TSL than NCFLS (6.61) Table 2 B-I (appendix III, Figure 8).

3.3. Middle Sub- Watershed

3.3.1. Soil Bulk Density

The average value of soil BD was the higher in CFL two ($0.24g/cm^3$) than CFLS one and three with kabi lines (0.14 and $0.16g/cm^3$) whereas the higher value was observed in NCFL five ($0.33g/cm^3$) than NCFLS four and six (0.22 and $0.18g/cm^3$). Overall average value of soil BD was higher in NCFLS ($0.24g/cm^3$) than CFLS with TSL ($0.12g/cm^3$) Table 3 B-II (appendix III, Figure 9).

3.3.2. Soil Moisture Contents

The average value of soil MC was the higher under CFL two (33.22%) than CFLS one and two (16.76 and 2361%) with TSL. However, the results of the study had showed that, the average value of soil MC on NCFL five was the higher (40.86%) than NCFLS four and six (30.39 and 20.62%). Overall average value of soil MC was the lower under TSL CFLS (24.13%) than NCFLS (30.62%) Table 3 B-II (appendix III, Figure 9).

3.3.3. Soil Texture

The average value of clay soil was the higher inside CFL one (34.13%) than CFLS two and three (32.80 and 30.80%) with TSL, while the results of the study had showed that, NCFL six was the higher clay soil (44.80%) than NCFLS four and five (26.93 and 28.93). The overall average value of clay soil was the lower under CFLS with TSL (32.58%) than NCFLS (38.35%). The higher average value of silt soil was observed inside CFL two with TSL (34.27%) as compared to CFLS one and three with TSL (33.60 and 31.60%) but the results of none conserved farmland five had showed that there was the higher silt soil (28.93%) than none conserved farmlands four and six (26.93 and 26.27%). The overall average value of silt soil was the higher under TSL CFLS (33.16%) as compared to NCFLS (27.38%). The average value of sand soil was the higher (37.60%) under CFL three with TSL than CFLS one and two (32.27 and 32.93%) whereas the results of NCFL four had showed that, the higher value of sand soil (38.93%) as compared to NCFLS five and six (34.93 and 28.93%). The overall average value of sand soil was the higher (34.27%) under CFLS with TSL than NCFLS (34.26%) Table 3 B-II (Appendix III, Figure 10).

3.3.4. Total Soil N

The study result had revealed that, the average value of total soil N was the higher (0.23%) under CFL two than CFLS one and three (0.22 and 0.22%) with TSL. In contrast to that, the higher average value of total soil N was investigated on NCFL five (0.23%) than NCFLS four and six (0.22 and 0.14%). Overall average value of total soil N was the higher (0.22%) inside CFLS with TSL than NCFLS (0.20%) Table 4 B-II (appendix III, Figure 12).

3.3.5. Soil Organic Carbon

The findings of the study had showed that, the average value of SOC was observed in CFL three (1.40%) was the higher as compared to CFLS one and two (1.13 and 1.35%) that were conserved with TSL. In despite to that on NCFL four the higher SOC (1.62%) than NCFLS five and six (1.03 and 1.77). Overall average value of SOC under CFLS with TSL was the lower (1.29%) than NCFLS (1.30) Table 4 B-II (appendix III, Figure 11).

3.3.6. Soil Organic Matter

The average values of SOM was the higher under CFL three (2.41%) as compared to CFLS one and two (1.95 and 2.33%) that were conserved with TSL. In despite to that on NCFL four was the higher SOM (1.62 and 2.79%) than NCFLS five and six (1.24 and 2.13%). Overall average value of SOC under CFLS with TSL was the lower (1.29%) than NCFLS (1.30%) whereas no differences was observed for overall average value of SOM both for conserved with TSL and NCFLS (2.23 and 2.23%) Table 4 B-II (appendix III, Figure 11).

3.3.7. Available Soil P

The result of the study had showed that, the average value of available soil P was the higher (23.62ppm) under CFL three than CFLS one and two (23.48 and 22.30ppm) that were conserved with TSL. Although the higher average value of available soil P was observed on NCFL four (15.35ppm) than NCFLS five and six (14.81 and 10.16ppm). The overall average value of available soil P was the lower inside NCFLS (13.44ppm) as compared to CFLS with TSL structures (23.13ppm) Table 4 B-II (appendix III, Figure 13).

3.3.8. Soil pH

The average value of soil pH was the higher (6.84 ratios) inside CFL two than CFLS one and three (6.74 and 6.59 ratios) that were conserved with TSL. However, the results was indicated that, NCFL six was the higher average value of soil pH (7.19 ratio) than NCFLS four and five (7.03 and 6.57 ratio). Overall average value of soil pH was the higher (6.93) in NCFLS than CFLS with TSL (6.72) Table 4 B-II (appendix III, Figure 13).

3.4. Upper Sub -Watershed

3.4.1. Soil Bulk Density

The average value of soil BD inside CFL three was the higher (0.16g/cm^3) than the CFLS one and two that were conserved with TSL (0.11 and 0.13g/cm^3) while inside NCFL four it was observed the higher soil BD (0.25g/cm^3) than NCFL five and six that were not conserved with TSL (0.22 and 0.18g/cm^3). The overall average value of soil BD was the lower inside TSL CFLS (0.13 g/cm^3) as compared to NCFL (0.22g/cm^3) Table 5 B-III (appendix III, Figure 14).

3.4.2. Soil Moisture Contents

The higher average value of soil MC was observed within CFL three (21.46%) than CFLS one and two (16.49 and 20.01%) that were conserved with TSL whereas it was observed the higher value of soil MC within NCFL four (42.94%) as compared to NCFLS five and six (23.92 and 25.42%). However, overall average value of soil MC was the lower under TSL CFLS (19.32%) than NCFLS (30.76%) Table 5 B-III (appendix III, Figure 14).

3.4.3. Soil Texture

The study results had been shown that, the average value of clay soil was the higher (29.33%) inside CFL two than CFLS one and three conserved with TSL (26.67 and 28.00%). In despite to that, the higher clay soil was observed inside NCFL five (36.67%) than NCFLS four and six that were not conserved with TSL Overall average value of clay and silt soil were the lower (28% and 32.4%) under TSL CFLS than NCFLS (33.33 and 36.18%), respectively. The average value of silt soil was the lower (29.73%) within the CFL three than CFLS one and two (33.73 and 33.73%) that were conserved with TSL But, the lower value was observed inside NCFL four (33.07%) as compared to NCFLS five and six (37.73 and 37.73%) that were not conserved with TSL. The higher average value of sand soil was observed inside CFL three (42.27%) than CFLS one and two (39.60 and 36.93%) that were conserved with TSL. However, the higher result was observed within the NCFL six (34.93%) as compared to NCFLS four and five (30.93 and 25.60%) that were not conserved with TSL. Overall average value of sand soil was t indicated he lower result (38.19%) inside NCFLS than CFLS with TSL (39.40%) Table 5, B-III (Appendix III, Figure 15).

3.4.4. Soil Organic Carbon

The higher average value of SOC was observed inside CFL three (1.76%) than CFLS one and two (1.67 and 2.87%) that were conserved with TSL, whereas the higher value was observed for NCFL four (1.38%) than NCFLS five and six (0.89 and 1.153%). Overall average value of SOC was investigated under TSL CFLS (1.71%) than NCFLS (1.13%) Table 6 B-III (appendix III, Figure 16).

3.4.5. Soil Organic Matter

The study result had showed that, the higher average value of SOM was observed inside CFL three (3.04%) than CFLS one and two (1.70 and 2.94%) that were conserved with TSL whereas the higher value was observed for NCFL four (2.37%) than NCFLS five and six (1.13 and 1.94%). Overall average value of SOM was investigated under TSL CFLS (2.95%) than NCFLS (1.95%) Table 6 B-III (appendix III, Figure 16).

3.4.6. Total Soil N

The results of the study had disclosed that, the higher average value of total soil N under CFL three with TSL (0.35%) than CFLS one and two (0.30 and .34%) that were conserved with TSL. In despite to that, for NCFL four it was observed the higher total soil N (0.25%) than NCFLS five and six (0.15 and 0.14%). Overall average value of total soil N was showed that, the higher (0.33%) beneath of CFLS with TSL than NCFLS (0.18%) Table 6 B-III (appendix III, Figure 17).

3.4.7. Available Soil P

The results had showed that, the average value of available soil P was the higher (25.76ppm) under CFL three than CFLS one and two conserved with TSL (23.36 and 24.57ppm), but the results of the study had showed that inside NCFLS four and five were the lower values (9.50 and 11.08ppm) of available soil P than NCFL six (20.14ppm) which did not conserved with TSL. The overall average value of available soil P was indicated the higher inside CFLS with TSL (24.56ppm) than NCFLS (13.57ppm) Table 6, B-III (appendix III, Figure 18).

3.4.8. Soil pH

The results of the study had revealed that, the average value of soil pH was the higher (6.66) und CFL one than CFLS two and three (6.60 and 6.64 ratios) that were conserved with TSL. But, the results of the study had revealed that, soil pH of NCFL six was the higher value (6.85) as compared to the NCFLS four and five that were not conserved with TSL. Overall average value of soil pH under TSL CFLS was the lower (6.62) than NCFLS (6.70) Table 6, B-III (appendix III, Figure 19).

3.5. C/N Ratios

The finding of the study had been shown that, C/N ratio in B-I treatment to treatment observation was ranges from 9.54 to 14.25 inside TSL conserved farmlands while it was ranges from 3.23 to 19.00 as observed for none conserved farmlands. In B-II as observed the results had indicated that, between treatment to treatment for conserved farmlands the C/N ratios was ranges 3.40 to 7.43 beneath to TSL conserved farmlands whereas it ranges from 3.58 to 9.88 as examined for none conserved farmlands. The C/N ratios were ranges in B-III as observed from treatment to treatment from 4.13 to 6.29 and it ranges from 4.14 to 10.92 for none conserved farmlands. Average value of C/N ratio was the higher in B-I (11.61) than B-II and B-III (5.78 and 5.22), respectively. In similar to that the average value of C/N ratio was the higher in B-I none conserved farmlands (7.37) than in B-II and B-III (7.12 and 6.45).

4. Discussions

Kabi lines which was vastly implemented and constructed in Ethiopia by farmers were to conserve soil, runoff water and sediment in all of agro ecological zones of the country including where the study was carried out; the Ifabas community watershed, Tullo Woreda, west Harareghe zone Oromia National Regional State Ethiopia [41]. TSL for SWC has been constructed for the purpose of the maintenance of soil properties and soil fertility, to optimize agricultural yield, and retention of runoff, while they provides the ultimate goal of watershed recharge and maintenance of climate change. *In support to this study in Niger stone lines (Haussa term: Gandari) have been laid out mainly by the people living on the plateaus to conserve water and trap windblown sand* [33].

4.1. Bottom Sub-watershed

4.1.1. Soil Bulk Density

Soil BD under broadcasting of pea and maize crops on CFL one was the higher than the soil BD, observed on CFLS two and three under row cropping of maize and mixed cropping of sorghum and maize that were conserved with TSL. Even though it was conserved with TSL; it might be observed newly constructed structures on the CFL one whereas the older TSL structures were observed on the CFLS two and three. These variations were occurred because of CTS, CGPS and TSL have a positive impacts on improving of soil BD; that is in reduction of soil BD as a results of addition of crops residues and accumulation o soil colloidal and organic matters, respectively.

Fertilizer application might be lowered soil BD on CFL two that was conserved with TSL. The lower soil BD of NCFL four might be resulted from the application of inorganic fertilizer, but not observed the differences between them because of crop types and crop growing patterns. The overall average value of soil BD was showed that, the higher under CFLS with TSL than NCFLS. The differences were happened as a result of crop types and crop growing patterns, but not only due to soil erosion, sedimentation and runoff surface controls practices, that were constructed by farmers. For conserved farmlands crop types and growing patterns were influences the soil properties more as observed on the field than CTS and CGPS. Under the TSL and maize with pea growing in relay cropping, maize and sorghum in mixed cropping, and maize in row cropping patterns while for none conserved farmlands crop types and their growing patterns of maize in row cropping, maize based sorghum and sorghum based maize in mixed cropping were the common practices as observed in the field during data collection. These variations were caused the differences in soil BD between the conserved and none conserved farmlands. It was not observed the differences because of fertilizer applications so much (Table 1, appendix III, Figure 4). This study was in parallel to the study done by [12], who had reported that, the higher soil BD under structural soil conservation might be due to past erosion and management practices, continues and intensive monocropping cultivation. This study also in parallel with the study done by [16], who had reported that, on the middle landscape position (15-30%)

the higher soil BD under the land conserved with soil bund and desho grasses, fanayjuu terraces with desho grasses as compared to none conserved farmlands (0.94 ± 0.09, 0.90 ± 0.12 and 1.06 ± 0.06), respectively. Moreover, the study results was related with the age of the structures which was resulted to less or high deposition of organic materials (old vs. new TSL). It was another factor that was caused the variations of soil BD is due to collection of crop residues for fuel energy and animal feed. These were the common practices in the Ifabas community watershed while the higher soil BD under farmlands conserved with TSL were due to past erosion and removal of SOC and SOM that were till not restored back as a result of construction of kabi lines. The lower soil BD of farmland three than farmland one resulted from the higher soil MC Table 1 appendix III, Figure 4.

4.1.2. Soil Moisture Contents

As the results had indicted soil MC was the higher inside CFL with TSL. These variations was caused as a result of the age of TSL structures which was resulted in higher deposition of soil colloidal (fine soil particles) and sediments, organic matters than farmlands one and two. Also these differences had resulted from the alignment of TSL along the contour lines. These were caused accumulation of soil colloidal and soil organic matters. These in turn caused the differences of soil MC from EUs to EUs. Likewise both crop growing patterns and crop types were caused variations in soil MC. According to the results of the study had showed (Table 1) soil MC was the higher under FL three of mixed cropping than relay cropping and row cropping. The results had indicated that the lower soil MC in NCFL four under row cropping of maize, while the higher soil MC was observed NCFL five than NCFL four and six which were grown of mixed cropping of maize and sorghum (appendix III, Figure 4). However, these variations were not related with soil colloidal and soil BD [29]. Also these variations were due to the used of inorganic fertilizer, Table 1. Soil MC was the higher under CFLS than CFLS according to the study results of Ifabas community watershed. Because, kabi lines/TSL serves as barriers and interception of runoff surface, soil loss and sediments. The reason is that due to somewhat higher accumulation of organic materials and soil colloidal than none conserved farmlands [12].

4.1.3. Soil Texture

The study results had indicated that, clay soil was the higher on FL two than FLS one and three conserved with kabi lines. These differences caused due to the capacity to store soil colloidal or fine soil particles (clay soil) in the basin and basin capacity differences rather than resulted from variations in crop growing patterns, crop types and might be fertilizer applications. Except these differences had showed on FL two conserved with TSL and FL four NCFL Table 1. Overall average value variations of clay soil between CFLS and NFLS were resulted from soil management practices, intensive and continues cultivation and clean weeding of weeds under none grassy crops. The study had showed that, clay soil was the higher on NCFL four than farmlands five and six. These variations might be resulted from crop growing patterns and crop types. Because, farmland four had mono-cropping and grow in row pattern while FLS five and six were mixed cropping.

The higher clay soil might be from the past good management practices even though TSL structure were not constructed to tackle soil erosion and runoff surface Table 1, appendix III, Figure 5. However, for both treated and none treated farmlands soil samples were collected from 0-15cm of soil depth and both of them were mollaic and umbraic soil types because of soil organic carbon was ≥0.06% [16]. Overall average value of clay soil was the lower as examined under farmlands conserved with TSL than none conserved farmlands. The reason is that sand soil is largely the mineral quartz and quartz has no plant nutrients and so sand cannot hold nutrients because of easily leached out with rainfall [36]. Rainfall of the study watershed has ranges from 900 to 950 mm the potential to eroded silt and clay soils and leave sand soils [32].

The results had revealed that, the higher silt soil was obtained under TSL farmland one than CFLS two and three. These differences were related with crop types, and crop growing patterns, but not fertilizer application. Moreover it might be related with structural age that was deposited soil colloidal ad organic matter in the basin. For farmland one crop type was maize and pea and relay cropping pattern of growth, for farmland two and three maize in row cropping and maize and sorghum in mixed cropping were crop types and growing patterns, respectively.

The higher value of silt soil found under none conserved farmland five was due to the differences in crop growing pattern that was maize based sorghum grow in mixed cropping, maize grow in row cropping and sorghum based maize grow in mixed cropping but not as a result of fertilizer differences. Mostly it could related with past soil management such as weeding and mulching differences which was the better for farmland five than four and six.

The higher sand soil was obtained under TSL conserved farmland three than farmlands one and two conserved with TSL. This was as a result of crop types and crop growing patterns but not due to fertilizer applications. In despite to that the most differences were due to structural ages differences that were deposited different amount of the soil particles in the basin. The other reasons they were related to the differences with past soil management practices such as soil amendment, and tillage intensity. Moreover, stone size and its arrangement differences were resulted for these sand soil percent differences. The results of the study had been shown that the higher sand soil for none conserved farmland four than none conserved farmlands five and six. These variations were resulted from crop types and crop growing patterns but not from fertilizer applications. The others were due to soil management differences during the crops growing period. In additions to that these variations were due to crop residue accumulation variations that held this coarser soil material on sites.

Overall average value of silt soil was showed that, the higher under TSL conserved farmlands than none conserved farmlands. This study was supported with the study done on the landscape of middle slope (15-30%) by [16], silt soil were showed that the higher under soil bund with desho grass, fayynajuu terraces with desho grasses than none conserved farmlands (36.00 ± 2.00 35.33 ± 1.15 30.67 ± 3.05) respectively. Overall average value of sand soil was indicated that, the lower on farmlands conserved with TSL than none conserved farmlands. This variation was happened due to structural erosion controls constructed on farmlands. This study was in line with the study done by [16], who had reported that under soil bund with desho grass, fayynajuu terraces with desho grass observed the lower sand soil than none conserved farmlands (21.33 ± 2.3, 21.33 ± 1.15, 34.00 ± 2.00). The results of this study had showed that, conserved farmlands with kabi lines was clayloam soil class while none conserved farmlands was showed that clay soil.

4.1.4. Total Soil N

The study result was showed that, total soil N was the higher inside the TSL on farmland one due to pea corps growing in mixture with maize crops whereas farmlands two and three were grown none nitrogen fixation crops whereas none nitrogen fixation were grown on FLS two and three (maize in row cropping and maize with sorghum in mixture). As the study results had revealed, crop growing patterns were the series factors that was determined the total soil N differences. In addition to that structural deposition of organic materials accumulation was improves the available of decomposers that decomposes the organic materials and release the essential nutrients into the soils. But, these variations were not dependent on the fertilizer applications because of applied for farmland two while it was observed the lower value of total soil N Table 2 (appendix III, Figure 6). Slope differences has also the major factors for these variations [16]. The higher value of total soil N was investigated on none conserved farmland five which was maize based sorghum grown in mixed cropping patterns rather than sorghum based maize grown in mixed cropping on FL six and maize in row cropping patterns grown on FL four which were resulted in lower total soil N. This was implies that crop types and CGPS had caused variations in total soil N. this might be due to organic matters accumulation varies. The study had revealed overall average value of total soil N was the higher under farmlands conserved with TSL than none conserved farmlands. The most variations were due to implementation of TSL to control erosion and sedimentation which improves soil MC where decomposers seeks to live. This study was in line with the study done by [20], who had reported that, the decomposition of soil organic materials which was the primary sources of essential soil nutrients such as soil N.

4.1.5. Soil Organic Carbon and Soil Organic Matter

The higher value of SOC and SOM were observed according to the study results in farmland one conserved with TSL than farmlands two and three. These variations were related with crop types and crop growing patterns rather than fertilizer applications. as the results indicated both SOC and SOM on none conserved farmland four was the higher than farmlands five and six which were correlated positively with crop types and crop growing patterns but not with fertilizer applications. Overall average value of both SOC and SOM were the higher for farmlands conserved with TSL as compared to none conserved farmlands. This study was in parallel with the past study done by [39], top soil has high SOM and the most fertile soils, while less SOC and SOM observed under none conserved farmlands might be resulted from excessive past erosion, intensive and continues cultivation of crops such as the today practices of Fagge cropping/ monocropping system Table 2 (appendix III, Figure 7). So that yet not restored back the basic cations that were lost from the topsoil which form swarm to soil colloidal by the processes of leaching to the deepest of soil depth and somewhere else. Soil organic carbon and soil organic matters were varies with slope differences [16].

4.1.6. Available Soil Prosperous

The results had showed that, available soil P was the higher inside conserved farmland one than farmlands two and three that were due to the differences with crop types and crop growing patterns while not observed as that much due to inorganic fertilizer differences. The higher value of available soil P was observed for none conserved farmland six than farmlands four and five. The lower available soil P was observed for none conserved farmlands due to leaching of the basic cations that were different under different crop types and crop growing patterns Table 2 (appendix III, Figure 8) [29]. These variations were resulted from the differences of crop types and crops growing patterns. Overall average value of available soil P was the higher as investigated inside TSL conserved farmlands than none conserved farmlands. These were due to differences in soil management practices by crop types and crop growing patterns.

4.1.7. Soil pH

The higher average value of soil pH was investigated inside farmland one that was conserved with TSL. This variations might be due to the growth of pea crop by mixed with maize crop which is nitrogen fixing crops as a relay cropping Table 2 (appendix III, Figure 8). The application of inorganic fertilizer increase the soil phosphorous as a result of this the leaching of the basic cations are increases but it was lowered the soil pH-values for farmlands two and three [17]. The result of this study had showed that the average value of soil pH on none conserved farmland five was the higher than none conserved farmlands four and six. This might be as a result of more deposition of fine soil particles on a flat plain than the others farmlands. In addition to that because of none application of inorganic fertilizers it was decreased the available soil phosphorous while increases the value of soil pH [17]. Moreover, this study was in line with the study done by [20], who had indicated that soil reaction limited soil respiration or functions and soil respiration limited available and decomposition of organic substrates that increases the soil acidity. Under TSL structures constructed by farmers to control erosion and runoff water it was observed that the higher average value of soil pH for farmland three than farmlands one and two. This higher value was observed on farmland one than the farmlands five and six none conserved with kabi lines. The difference was resulted on farmland six that had applied both inorganic and organic fertilizers while growing pattern was mixed cropping of maize and sorghum crops. These differences might be resulted from bean crops grown in mixed cropping.

The overall average value of soil pH was the higher under farmlands conserved with TSL than none conserved farmlands. These variations were happened as a result of the differences with crop types, crop growing patterns but not observed that much due to fertilizer applications differences Moreover, they were observed as a result of past soil management practices, past soil erosion and soil amendment [20].

4.2. Middle Sub-Watershed

4.2.1. Soil Bulk Density

The results of the study was indicated that, the higher value of soil BD inside the farmland two conserved with TSL than farmlands one and three. These variations might be due to the narrow space between stone lines, because of this; the movement of soil particles between stone lines are very less and hence high deposition of soil colloidal were occurred. This implies that, these variations did not due to TSL solely, but also resulted from the differences of crop types, crop growing patterns and fertilizer applications. In despite to that, the study had showed the higher soil BD inside none conserved farmland five than none conserved farmlands four and six. These variations were resulted from the differences in crop types and CGPS which grown sorghum in broadcast patterns Table 3 appendix III, Figure 9. The lower soil BD in farmland one might be resulted from the past deposition of fragmented stones and alluvial soil deposing by floods and sedimentations before five decades ago. For farmland three the lower soil BD was even if a new structures it was resulted from compacted arrangement of stone lines and high deposition of organic materials and soil colloidal. More variations of soil BD for farmlands one, two and three conserved with TSL were resulted from crop types and crop growing patterns but not due to the differences with fertilizer applications [12].

The overall average value of soil BD in none conserved farmlands were the higher than conserved farmlands with TSL. This was as a result of kabi lines intercept to runoff and soil losses in between successive stone lines and deposited behind the structures. This study was parallel with the study done by [16], who had reported that, on the middle landscape position of (15-30%) the lower soil BD under the land conserved soil bund with desho grass, fanayjuu terraces with desho grasses than none conserved farmlands (0.94 ± 0.09, 0.90 ± 0.12 and 1.06 ± 0.06), respectively. The higher soil BD in NCFLS was due to soil erosion and runoff surface water which removes soil organic carbon and soil organic matters from top soil surface. The study has indicate as land slope positions increases soil BD was decreases as a result of the lower SOC on the upper plains of the watershed [16].

4.2.2. Soil Moisture Contents

The study results had revealed that, the higher soil MC under TSL conserved farmland two than farmlands one and three. This variations might be as a result of the application of organic materials such residues and animal wastes/farmyard manure that were enhances SOM and SOC which were serve as spongy and increases soil moisture holding capacity of the soil. This study was in line with the study done by [33], who had reported that, the application of organic manure improves soil MC or soil and water conservation in-suit and then prevent soil degradation. In addition to that these variations had caused as a result of crop types and crop growing patterns but not due to fertilizer application differences alone. In contrast to that the higher soil MC was investigated for none conserved farmland five than none conserved farmlands four and six as a result of crop types and crop growing patterns but it might not be due to fertilizer application differences so much.

Overall average value of soil MC had showed that, the higher for none conserved farmlands than conserved farmlands with TSL. These variations were resulted from the locations of the farmlands; because none conserved farmlands where located in the area of wetlands that have spring water occurred during rainy seasons, while the conserved farmlands have high drainage capacity and located out of such conditions or wetland areas. Because wetlands has the capacity to conserved and stored much amount of soil MC or rainfall runoff surface water Table 3 (appendix III, Figure 9).

4.2.3. Soil Texture

The study results had showed that, the higher clay and silt soils that were investigated under TSL conserved farmland one which was resulted from the crop types and crops growing patterns but not observed as a result of inorganic fertilizer applications. Moreover in addition to TSL it was resulted from the surface settled stones on surface and sub-surface of the soils that were protecting the fine soil colloidal movement to downslope and increase rainfall infiltration rate. But, the higher value of none conserved farmland six was resulted from the cultivation differences as observed including the crop types and its growing patterns. The higher silt soil was examined inside the deposition area of the farmland two due to fill of the traditional basin and overtopping of the clay soils but not influenced by other factors. The higher sand soil that was observed under conserved farmland three was resulted from the newly constructed age of the structures rather than the others factors. Overall average value of clay soil was the lower under TSL conserved farmlands as compared to none conserved farmlands but sand soil was the higher inside TS CFLS Table 3 (appendix III, Figure 10) than none conserved farmlands. These are due to stone lines arrangement and its wider space that was passed the fine soil colloidal and held coarser materials of the soil. This study was not parallel with the past study done by [16], who had reported that, sand soil under soil bund with desho grasses, fayynajuu terraces with desho grasses conserved FLS were the lower than none conserved farmlands (21.33 ± 2.3, 21.33 ± 1.15, 34.00 ± 2.00), respectively.

The overall average value of silt soil was the higher inside TSL conserved farmlands than none conserved farmlands. These variations might be as results of crop types, stone size arrangement, crop growing patterns, past erosion, structural maintenance and management systems by farmers as observed during field data collections. This study was supported with study done on the landscape of middle slope (15-30%) by [16], who had reported that, silt soil were showed that the higher under soil bund with desho grasses, fayynajuu terraes with desho grasses conserved FLS than none conserved farmlands (36.00 ± 2.00 35.33 ± 1.15 30.67 ± 3.05) respectively.

Overall average value of sand soil was showed that, the lower on farmlands conserved with TSL than none conserved farmlands. This study was in line with the past study done by [16], who had reported that, overall average value of sand soil on middle landscape position (15-30%) were the lower under soil bund with desho grasses, faynajuu with desho grasses conserved FLS than none conserved farmlands (25.11 ± 8.5, 24.66 ±8.25 and 33.56 ±11.08), respectively. In general sand soil was increases whereas clay and silt soil were decreases as the slope of the landscape increases. This variations were due to transportation and translocation of fine and medium soil textural classes that are selectively removed by erosion agents to down the slope and deposited in the hillsides and leaving the coarser materials on the upper slope of the land position.

4.2.4. Soil Organic Carbon and Soil Organic Matter

The results f this study had revealed that, both SOC and SOM on farmland three were the higher than farmlands one and two conserved with TSL which were established to reduce runoff and soil erosion through interception of runoff surface water and soil losses down the slopes. These meaningful differences were examined due to crop types and crop growing patterns but not as a result of fertilizer applications so much Table 2 (appendix III, Figure 11). Also these variations had caused due to past and current soil management practices and stone lines arrangement and its wider spaces that were deposited the different soil colloidal and organic materials. This study was parallel with the study done by [16], who had revealed that, on the middle landscape position (15-30%) SOC was positively correlated with CEC, total soil N, clay soil, and available soil P, while negatively correlated with sand and silt soil, soil BD, and soil pH. This study also indicated that SOC under farmlands conserved with soil bund with desho grasses, faynajuu terraces with desho grasses were the higher than none conserved farmlands (2.42 ±0.31, 1.82 ± 0.21 and 1.58 ± 0.19), respectively. Hence, teff in broadcast, maize and sorghum in mixed cropping on farmland one; maize and sorghum in mixed cropping on farmland three and maize in broadcast on farmland two were the crop types and crop growing patterns that were brought these variations of SOM and SOC. As observed the results of none conserved farmland four was showed the higher SOC and SOM than none conserved farmlands five and six. The significant differences were observed due to variations of crop types and crop growing patterns. So that, these differences were investigated as a result of the maize grown in row cropping on farmland four but maize and pea on relay cropping in farmland six and sorghum in broadcast on farmland five. But not observed the significant differences due to inorganic fertilizer applications and soil management practices.

The result of the study had showed that SOC inside TSL was the higher than none conserved farmlands, whereas not observed the significant variations of SOM between conserved and none conserved farmlands. These differences might be resulted from crop types, structural conservation practices and crop growing patterns. This study was in line with the study done by [39], who had revealed that, crop types and crop management practices were improves soil properties which reflects the soil fertility. The variations might be dependent on the slope differences because it was observed the higher on very flat plain of none conserved farmlands than somewhat gentle slopes of the conserved farmlands with TSL. This study was supported with the past study done by [16], who had reported on the middle landscape position (15-30%) had showed that, the overall average value of SOC were indicated the higher under farmlands conserved with soil bund with desho grasses, faynajuu terraces with desho grasses than none conserved farmlands (2.20 ±0.65, 1.76 ±0.47 and 1.44 ± 0.45), respectively. The results of this study had showed that the higher SOC and SOM were observed at the lower slope of landscape features than on the middle and upper slope of landscape features. In line with this study, the study done by [37] was showed that, soil management needs to vary with slope of the land and soil types which improve soil fertility and properties in varies.

4.2.5. Total Soil N

The result of this study had showed that, the higher total soil N under TSL conserved farmland two than farmlands one and three. This variations might be resulted from the current decomposed crop residues and crop growing patterns and age of TSL structural differences but did not due to crop types and fertilizer application differences Table 4 (appendix III, Figure

12). In contrast to that the higher result was observed on none conserved farmland five than none conserved farmlands four and six that were resulted from crop growing patterns and crop types but did not as a result of inorganic fertilizer application differences. Similarly, the past study done by [16], had disclosed that on the middle landscape position (15-30%) total soil N were higher under farmlands conserved with soil bund with desho grasses and fayynajuu terraces with desho grasses than none conserved farmlands (0.32 ± 0.0, 0.30 ± 0.00 and 0.17 ± 0.01), respectively. Physical SWC measures improves total soil N [7], through deposition of soil colloidal that are enhance organic matters and humus which improves total soil N by decomposition of organic materials and release the nutrients which held in dead organic materials through nitrification of nitrobacteria of decomposition processes [14].

The results had revealed that, the higher overall average value of total soil N under farmlands conserved with TSL than none conserved farmlands. This study was similar with the study done by [16], who had revealed that, the higher total soil N under soil bund with desho grasses and faynajju terraces with desho grasses conserved FLS (2.20 ± 0.65 and 1.76 ± 0.47) than none conserved farmlands (1.44 ± 0.45). The higher total soil N that was investigated under the farmlands conserved with Kabi line was resulted from the application of FYM rather than the crop types and crop growing patterns solely. Adding manure as amendment might be improves soil fertility while they were enhanced the status of total soil N [4]. In despite to that the higher total soil N was dependent on the application of inorganic fertilizer instead of crop types and crop growing patterns solely.

4.2.6. Available Soil P

The available soil P under TSL conserved farmland three was showed that, the higher than farmlands one and two. These variations were associated with SOM and SOC percentages and fertilizer application differences and also it was dependent on the crop types and their growing patterns. This study was in line with the study done by [16], who had reported that, available soil P was positively correlated with clay soil and negatively correlated with silt soil but nil correlation was observed with sand soil. However, the higher available soil P was observed on none conserved farmland four than none conserved farmlands five and six that were resulted from crop growing patterns and crop types but did not due to fertilizer application that was observed the variations. The quantity of available soil P is crop specific dependent and also time specific because their amounts of available soil P that will be come into the soil solutions different from crop to crop and from time to time [7]. However according to this literature review less available soil P was recorded inside farmlands conserved with structural SWC measures. Because, available soil P was depend on the crop harvesting systems, and crop growing patterns such as monoculture which was degraded soil and land serially in the long run if repeated in continues uses Table 4 (appendix III, Figure 13).

As the result of the study had indicated the overall average value of available soil P was the higher inside farmlands conserved with TSL than none conserved farmlands. This study was similar with the study done by [16], who had reported that, overall average value of available soil P were showed the higher under soil bund with desho grasses and fayynajuu terraces with desho grasses conserved farmlands than none conserved farmlands (12.95 ±5.27, 12.4 ±5.76 and 7.94 ±2.63), respectively for landscape position of the middle slope (15-30%).

4.2.7. Soil pH

The study results had showed that, the higher soil pH value was observed under TSL conserved farmland two than conserved farmlands one and three. These variations were resulted from animal manure application whereas also resulted from crop types and their growing patterns but did not resulted from fertilizer application observed the differences that much The higher soil pH value was observed for farmland six none conserved than none conserved farmlands four and five that were due to variations with crop types and their growing patterns but did not observed due to fertilizer application differences that much. This study was in line with the pervious study done by [16], who had disclosed that soil pH were the higher under farmlands conserved with soil bund with desho grasses and fayynajuu terraces with desho grasses on the middle landscape position (15-30%) than none conserved farmlands (6.27 ±0.75, 6.41 ±0.32 and 6.06 ±0.09), respectively. Physical soil and water conservation structures such as TSL has improves soil pH but less soil pH was reported under farmlands conserved with structural SWC [7]. The nearby huge mountainous locations and alluvial soil deposition were resulted from the past flood plains that was another factor of soil pH variations. The overall average value of soil pH was the lower under farmlands conserved with TSL than none conserved farmlands. These variations might be resulted from the past erosion and soil management practices Table 4 (appendix III, Figure 13).

4.3. Upper Sub-watershed

4.3.1. Soil Bulk Density

The results of the study had revealed that, the higher soil BD on farmland three than farmlands one and two conserved with TSL. These variations were happened as a result of the differences in crop types and crop growing patterns but did not observed as a result of fertilizer applications as much except might be the variations caused due to fertilizer application on soil of FLS one conserved with TSL and NCFLS.

Moreover the variations in bulk density might be from the locations EUs and the size of stone lines arranged. The higher value was observed for none conserved farmland four than none conserved farmlands five and six were resulted from crop growing patterns, and crop types Table 5, appendix III,

Figure 14. This might be the result of past erosion, continues and intensive monocropping and past soil management differences. Overall average value of soil BD was the lower under TSL of farmlands than none conserved farmlands. This study was supported by the study done [16], who had reported that, overall mean of soil BD was the lower under conserved farmlands with soil bund, fayynajuu terraces and desho grasses than none conserved farmlands (0.94 ± 0.09, 0.90 ± 0.12 and 1.06 ± 0.06), respectively. The higher soil BD on none conserved farmlands were due to past erosion and runoff surface water that was removes SOC from topsoil layer of 0-15cm. As the slope of the landscape increases soil BD is increases which was associated with low SOC.

4.3.2. Soil Moisture Contents

The finding of this study had revealed that, the higher soil MC inside conserved farmland three than conserved farmlands one and two with TSL. This variations was due to the differences in location/ topography, crop types, crop growing patterns, fertilizer applications, and soil texture variations Table 5. The runoff, sediment and fine soil particles retention capacity with stone lines and their size are affects the soil MC retention capacity of a soil. In despite to that the higher soil MC was examined under none conserved farmland four than none conserved farmlands five and six. These variations were because of the differences in crop growing patterns and crop types that was conserved the soil surface from the raindrop impacts and wind below. In addition to that, fertilizer application differences, might be caused the variations in soil moisture capacity.

Overall average value of soil MC was the lower inside the farmlands conserved with TSL than none conserved farmlands. These variations were due to the size and arrangement of stone lines that were passed runoff and fine soil colloidal by leaving high sand soil behind on-sites. As a result of past erosion that was removes SOC and SOM which serve as a spongy to retain much runoff water till not restored back from accumulation of organic materials and their decomposition soil colloidal. However, the higher overall average value of soil MC inside none conserved farmlands were due to sampled farmlands were located within the wetland areas (appendix III, Figure 14).

As landscape of the slope increase; soil MC inside kabi lines were decrease because of water or moisture were drain from the higher position to the lower position of the landscape. But, for none conserved farmlands the lower soil MC was observed at the bottom sub-watershed than the middle and upper sub-watersheds because of the latter two watersheds sample farmlands were located within the swampy areas.

4.3.3. Soil Texture

The result of the study had showed that clay soil inside TSL CFL two was the higher than CFLS one and three that were treated with kabi lines Table 5. These variations might be resulted from the variations of crop types, crop growing patterns, fertilizer applications in addition to TSL structural erosion control. This study was in line with the study done by [10], who had revealed that depending on the age, soil types, slope and climate stone lines reduce more than 60% of net soil losses. In contrast to that, clay soil was the higher on none conserved farmland five than farmlands four and six that were not treated with TSL. These variations were resulted from crop growing patterns, crop types and fertilizer applications Table 5 (appendix III, Figure 15). This study was parallel with the past study done by [16], who had reported that, on the upper landscape position (slope>30%) farmlands conserved with soil bund and fayynajuu terraces with desho grasses have the higher clay soil (36.00 ±3.46 and 36.00 ±3.46) than none conserved farmlands (30.00 ± 2.00). The overall average value of clay soil was the lower under farmlands treated with TSL than the farmlands that were not treated with kabi lines. As [29], had reported, stone lines period of instability represented by colluvial sediments often up to 5m thick in layer. The variations were resulted from the past erosion and past soil management differences which removes SOC, SOM and fine soil colloidal, whereas till not restored back after implemented TSL on the farmlands to increase crop yields. Similarly this study was supported with the past study done by [16], who had pointed out that, on the upper landscape position; overall average value of clay soil was the higher inside farmlands conserved with soil bund and fayynajuu terraces with desho grasses (41.33 ±4.8 and 41.56 ±4.94) than none conserved farmlands (34.66 ±4.58).

Silt soil was the higher under conserved farmland one than conserved farmlands two and three treated with TSL to control erosion. These variations were resulted from, crop growing patterns and fertilizer application differences while not observed the variations due to crop types except FL one Table 5. Moreover, the variations might be resulted from the locations/topography of the farmlands and stone lines capacity to retain runoff and fine soil particles. The lower silt soil that was observed inside none conserved farmland four was due to variations with fertilizer applications and crop growing patterns that were covers the soil surfaces from raindrop impacts. This study was in line with the past study done by [16], who had reported that the upper landscape position of (slope>30%) farmlands conserved with soil bund and fayynajuu terraces with desho grasses have the higher silt soil (28.00 ±1.1 and 28.67 ±2.31) than none conserved farmlands (24.00 ±1.15).

Overall average value of silt soil was the higher under conserved farmlands with kabi lines than none conserved farmlands. As [16], who had reported that the upper landscape position of overall mean value of silt soil were the higher inside farmlands conserved with soil bund and fayynajuu terraces with desho grasses (33.56 ± 4.3 and 33.78 ± 4.17) than none conserved farmlands (31.78 ±7.51).

The study results had been shown that, the higher sand soil inside conserved farmland three than farmlands one and two conserved with TSL. These differences were arisen from the differences of the age of the kabi lines, crop growing patterns and fertilizer applications while not observed that much as a result of crop types might be except on farmland one conserved which was grown bean crop in broadcasting pattern. Moreover, the variations were arisen from the size of the stone lines and its capacity to retain runoff water and soil losses. The higher sand soil was observed on none conserved farmland six than the farmlands four and five. These variations might be resulted from crop growing patterns, and fertilizer application differences. Moreover, as a result of farmland locations/topography that was influenced with wetlands. This study was in line with the past study done by [15], who had reported that the upper landscape position (slope>30%) farmlands conserved with soil bund and fayynajuu terraces with desho grasses have the higher sand soil (36.00 ± 3.4 and 35.33 ± 1.15) than none conserved farmlands (46.00 ± 0.00). Overall average value of sand soil was the higher on farmlands conserved with kabi lines than none conserved farmlands. [15], had revealed that the upper landscape position of overall mean value of sand soil were the higher inside farmlands conserved with soil bund and fayynajuu terraces with desho grasses (25.11 ± 8.5 and 24.66 ± 8.25) than none conserved farmlands (33.56 ± 11.08).

4.3.4. Organic Carbon and Organic Matter

As the study results had revealed, SOC and SOM were the higher inside TSL conserved farmland three than conserved farmlands one and two. Except for farmland one that was bean crop growing in broadcasting patterns, the rest farmlands were maize crop types whereas the growing patterns were differences. These variations were due to crop growing patterns and inorganic fertilizer applications varies. In addition to that the variations had happened as a result of stone lines arrangement and stone size used to construct the kabi lines. Another factor was location of the farmlands that is influences the differences in SOM and SOC. Both SOC and SOM on none conserved farmland four was the higher than farmlands five and six Table 6 (appendix III, Figure 16). These differences were caused because of crop growing patterns and fertilizer applications differences whereas not due to crop types. This study was in line with the past study done by [15], who had reported that, SOC on the upper landscape position (>30%) were the higher under soil bund and fayynajjuu terraces with desho grasses conserved farmlands (1.39 ±0.05 and 1.25 ±0.16) than none conserved farmlands (0.92 ± 0.16). Similarly overall mean value of SOC were the higher under soil bund and fayyanjjuu terraces with desho grasses conserved farmlands (1.220 ±0.65 and 1.76 ± 0.47) than none conserved farmlands (1.44 ± 0.45). This study had showed that SOC was the lower under no soil management practices and clear weeding of weeds under none grassy crops.

The results of this study had been shown that, the higher SOC was observed at the bottom of sub-watershed than the middle and upper sub-watersheds. Slope and SOC should be an inverse relationships because as the slope increase SOM accumulation decreases. This was due to the removal of SOM from upper sub-watershed and deposited on the bottom and middle sub-watersheds by eroding agents. Overall mean values of SOC and SOM were the higher under TSL structural erosion controls than none conserves farmlands. These variations were resulted from the deposition of fine soil colloidal and organic materials accumulated on the surface of topsoil [14].

Land that was treated with soil management practices provides physical barriers to surface runoff and reduced the losses of soil colloidal, SOC and organic materials because of clay soil have large exchangeable surface areas to absorb and stabilize SOC in the soils. Accordingly kabi lines have the potential to add SOM to the soils through biomass deposition besides soil erosion control. These variations were indicated that stone lines solely was not improves significantly SOC and SOM, but the ways to be built the structure was another factor which reduce soil losses, and enhances SOC, SOM, and soil MC retention which in turn influences the available soil P and soil pH. This implies that conservational practices are not perfect and cannot any longer ago with dynamics of the environment, while they needs to modernization rather than dependent on the backward local practices [39]. However it needs selection of good practices from local practices.

4.3.5. Total Soil N

Total soil N was showed that, the higher under TSL conserved farmland three than conserved farmlands one and two. These variations were resulted from the differences crop growing patterns and fertilizers applications but not resulted from crop types. However, total soil N was the higher on none conserved farmland four than none conserved farmlands five and six. These differences were arisen from crop growing patterns and fertilizer applications but not arose from crop types. Moreover, the differences were resulted from the accumulation of SOM, and the size of the stone lines arranged along the contour line. From *Soil and water conservation point of view agronomic practices provide a protective role* [6], and improvement of total soil N. Different crop types and their growing patterns have a different potential to improve the status of total soil N. because of different crop types are different in reduction to raindrop impacts and erosion control [29]. In parallel to this study the past study done by [6], had showed that there is 4.73 times more runoff under maize grown as a mono-cropping than under maize grown as inter-cropping with cow-peas.

Overall average value of total soil N was the higher under TSL conserved farmlands than none conserved farmlands. Under the kabi lines the total soil N was the higher due to an increases of SOC and SOM and reduction of soil erosion. Improvement of soil MC was reduced overland flow and soil losses were contributed an increase of SOC and total soil N. As a result of an increasing of crop residues and SOM, then that, the total soil N increases because of SOM is the major source of total soil N as a result of conservation practices that is increases the biomass production, litter quantity and decomposition of SOM [37] As the study results had showed that total soil N increases as the slope of the land increases. In general crop types, crop growing patterns, fertilizer application, soil management practices such as TSL and crop harvesting systems were affects the total soil nitrogen [6]. Moreover, total soil N was influenced with the addition of fertilizers [36]. According to the report of [15], had stated, overall average of total soil N was showed that, the higher inside soil bund and fayynajuu terraces with desho grasses under the conservation farmlands (0.35 ± 0.07 and 0.31 ± 0.09) than none conserved farmlands (0.19 ± 0.06).

Taddeo R et al[37] had reported that, good soil management practices is play a crucial role on improving soil properties and soil fertility whose support health crops and their yield. Because the practices improve soil colloidal and organic matters by interception and addition of recsioudes.

4.3.6. Available Soil P

Available soil P was showed that, the higher inside TSL conserved farmland three than conserved farmlands one and two. These variations were investigated as a result of crop growing patterns and inorganic fertilizer applications differences but not resulted from crop types. Besides that, it would be arisen from construction of stone lines and stone size differences. Similar to TSL structural erosion control and soil management practices of agronomic erosion controls such as crop rotation should present these variations. On the other hand the higher available soil P was observed on none conserved farmland six than none conserved farmlands four and five. These variations were arisen from the differences of crop growing patterns; and the application of inorganic fertilizers, whereas not arisen from crop types. Furthermore it was resulted from the wetlands and location /slope of topography differences which were different with generation erosion rates. In general as investigated from the study results the overall average value of available soil P was showed the lower on none conserved farmlands than conserved farmlands with TSL structures Table 6 (appendix III, Figure 18). The study result had been shown that, the available soil P was the higher on upper sub-watershed as compared to the middle and bottom sub-watersheds. This was due to the upper sub-watershed was located above the long mountainous and below the short mountainous on the plain of the flat areas. As [15], had reported that, overall mean value of available soil P was showed that, the higher under farmlands conserved with soil bund and fayynajuu terraces with desho grasses (12.95 ±5.37 and 12.4±5.76) than none conserved farmlands (7.94 ± 2.63). Similarly the study had indicated that, on the upper landscape position (slope > 30%) the available soil P was the higher (6.64 ± 0.13, and 6.62 ± 0.45) inside conserved farmlands with soil bund and fayynajuu terraces with desho grasses than none conserved farmlands (5.54 ± 1.45). Both soil management practices and slope positions have a major effects on available soil P variations because crop types and crop growing patterns added the varies organic matters and crop residues beside the intensity of weathering of rocks and reduction of soil erosion that was increases the available soil P fixation, however on none conserved farmlands continues cultivation and high erosion rate were decreased the available soil P. Crop biomass, weeding under crops and crop harvesting systems also caused the variations of the available soil P. the study was parallel with the past study done by [37] had been shown that, crops management system are improves soil fertility and their production and productivity.

4.3.7. Soil pH

The study results had revealed that, the average value of soil pH was the higher inside TSL conserved farmland one than conserved farmlands three and two. These variations were resulted from the variations of the crop growing patterns and inorganic fertilizer application differences. But it might be crop type grown on farmland one conserved with TSL which grown Bean crops In addition to that it was resulted from the locations/ slope of topography, stone lines arrangement along the couture lines and their sizes.

Soil pH was indicated that, the lower on none conserved farmland four than farmlands five and six. These variations were as a result of crop growing patterns and fertilizer applications, but not due to crop types. Moreover, past erosion, crop harvesting systems and soil management practices such as weeding practices were caused these differences. The overall average value of soil pH was the higher inside none conserved farmlands as compared to conserved farmlands with TSL. The lower soil pH value inside TSL conserved farmlands might be due to intensive and continues cultivation, past erosion and biomass of harvesting system and weeding under crops. However, the higher soil pH value on none conserved farmlands were related with landscape positions, soil management practices and soil amendment addition and location within the wetland areas Table 6 (appendix III, Figure 19). Under the conserved farmlands the lower soil pH was due to removal of organic matters and fine soil colloidal that were not still resorted back as a result of TSL construction. As [16], had reported that the lower soil pH on none conserved farmlands due to low base saturation percentage and low sediment organic carbon content. Based on this study this study the results was showed that soil pH was the lower on the upper sub-watershed as compared to the middle and bottom sub-watersheds. Because as the slope increase (>30%) the effect of soil erosion and leaching of soluble base cations which inform increase soil concentration of H^+ ions and reduced soil pH value.

Variations of soil pH across landscape features were the associations with the distribution of soil organic carbon, cations exchange capacity and clay soil. [16], who had revealed that soil pH value on the upper landscape feature was the higher under soil bund and fayynajjuu terraces with desho grasses conserved FLS (5.36 ± 0.06 and 6.35 ±0.11) than none conserved farmlands (5.30 ±0.10). Overall mean value of soil pH was showed that, the higher inside soil bund and fay-yanjuu terraces with desho grasses conserved FLS (8.48 ±0.26 and 6.5 ±0.32) than none conserved farmlands (5.90 ±0.48). In addition to that, it was due to alluvial soil deposition from the mountainous that is located above.

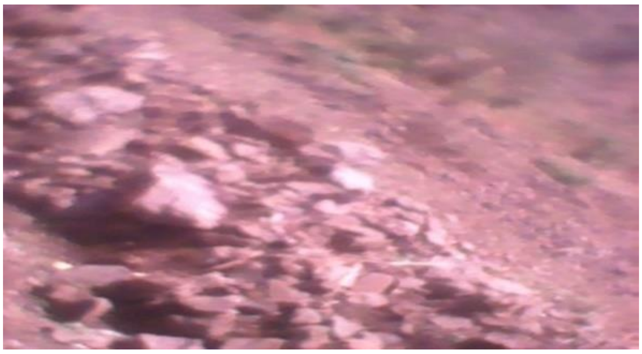

Figure 1. *Large sized stones arranged along the contour line in B-III.*

4.4. C/N Ratio

The C/N ratio in B-I treatment to treatment had ranges from 9.54 to 14.25 inside TSL conserved farmlands while it ranges from 3.23 to 19.00 as observed for none conserved farmlands. In B-II as observed between treatment to treatment both on conserved and none conserved farmlands the C/N ratios were ranges from 3.40 to 7.43 beneath to TSL conserved farmlands whereas it ranges from 3.58 to 9.88 as examined on none conserved farmlands. The C/N ratios were ranges in B-III as observed from treatment to treatment ranges from 4.13 to 6.29 and it ranges from 4.14 to 10.92 on none conserved farmlands. Average mean value of C/N ratio was the higher under B-I (11.61) than B-II and B-III (5.78 and 5.22), respectively. In similar to that the average mean value of C/N ratio was the higher under B-I none conserved farmlands (7.37) than B-II and B-III (7.12 and 6.45), respectively. The C/N ratios were decreased as the slope of the land increases while in general the ratios are the lower on the topsoil (0-15 cm soil depth layer). This study was supported with the study done by [3], who had reported that, the C/N ratios of the topsoil was somewhat the lower. The ratio of C/N determines the decomposing of organic materials. Thus organic materials having low C/N ratio such as manure, and leguminous cover crops are easily decomposed [20]. So that amendment of these materials added into the soils will improves soil respiration. According to those authors: described *Materials with high C:N ratios (e.g., compost, sawdust) decomposes more slowly but provides a more stable, long term supply of organic materials than legumes, biosolids, and manures*.

5. Conclusion and Recommendations

5.1. Conclusion

This experimental designed research was focused on the identification of the comparisons of non-treated farmlands versus to treated farmlands with TSL structural soil and water conservation measures. This study was reaching on the depletion of the studied soil elements under none conserved farmlands as the final results had been shown. But under the farmlands conserved with TSL structural SWC the end results had been shown that; the studied soil elements or soil properties were improved or/and modified for instance soil texture had showed high modification because texture is intrinsic by nature and had not changed through any soil management practices or conservation activates. Since, it is the result of soil formation from rocks and minerals by the processes of weathering and chemical actions.

As the study results were revealed soil pH, ASP, TSN, SOC, SOM and soil MC were showed that, an increases under TSL conserved farmlands than none conserved farmlands. Soil BD was also showed reduction under TSL conserved farmlands than none conserved farmlands. Crop types, crop growing patterns and inorganic fertilizer application were caused high variations of soil properties including the kabi lines between the treated and none treated farmlands. Moreover landscape position or topography and the locations either in wetlands or not have caused high variation o the studied soil properties.

5.2. Recommendations

1) Based on the findings of this study the following recommendations should be recommended:
2) 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 burying under the surface of the soil and then building somewhat the highest height are the better to achieve the expectation from TSL structural; lack of ties at certain intervals might be resulted to medium soil moisture contents and even if resulted to be below the standard that was conventional for the obtained soil textural classes. so that, it needs ties at certain intervals and maintenance regularly and burying of larger stones under the soil surface;
3) It must be provide an immediate training for the farmers of the study community watershed, kebele agricultural extensionist and the whole study Woreda and zone having similar characteristics of soil types, agro-climatic condition and topographic features;
4) It should be highly recommended if the stone lines or kabi lines combined with rainwater harvesting structures such as chololllo pits, tassa pits, kushkaba, small pits or true planting pits, semicircular pits between successive lines and 5 by 9 pits on cultivation lands;
5) The TSL structures should be integrating with nitrogen fixation species particularly which are serves as source

of fodder and forage for animal feeds during dry seasons in particular;

6) It should be need to opening basin behind the structure to enhance water harvesting and retention if the rainfall distribution uneven pattern, and soil moisture deficit areas and smallholders must be highly encouraged on the implementation, construction and maintenance of stone lines.

Abbreviations

ASMPs	Agronomic Soil Management Practices
FA	Fertilizer Application
CTS	Crop Types
CPS	Crop Patterns
AVSPP	Average Values of Soil Physical Properties
AVSCP	Average Values of Soil Chemical Properties
ANOVA	Analysis of Variance
a.s.l.	Above Sea Level
ASP	Available Soil Phosphorous
BC	Broadcast Cropping
BD	Bulk Density
B-I,	II, III Block One, Two, Three
CFLS	Conserved Farmlands
Cl	Clay Soil
Cm	Centimeter
Cm^3	Cubic Centimeter
C/N	Carbon to Nitrogen Ratio
CSSs	Composite Soil Samples
DOSRWM	Department of Soil Resource and Watershed Management
TSN	Total Soil Nitrogen
TSLTR	Traditional Stone Line Treated
V	Volume
ΠD^2	Pi and Square Diameter
°C	Degree Centigrade
NTR	None Treated
OBU	Oda Bultum University
OU	Observation Unit
pH	Soil Reaction
PPm	Part Per Million
R	Replication
RC	Row Cropping
REC	Relay Cropping
SMPAECs	Soil Management Practices of Agronomic Erosion Controls
CRBD	Complete Randomized Block Design
CGPS	Crop Growing Patterns
CTS	Crop Types
E	East
EU	EUs Experimental Unit or Experimental Units
Etal	Extra
FAP	Fertilizer Applied
FYM	Farm Yard Manure
GLM	General Linear Model
Ha	Hectare
G/cm^3	Gram per Cubic Centimeter
Km^2	Square Kilometer
MCP	Mixed Cropping
MC%	Moisture Content Percent
N	North
NFAP	None Fertilizer Applied
NCFLS	None Conserved Farmlands
M	Meter
Mm	Millimeter
MC	Moisture Content
SOM	Soil Organic Matter
SL	Silt Soil
SND	Sand Soil
SPCP	Soil Physico-chemical Properties
ST	Soil Texture
SWC	Soil and Water Conservation
TSLs/TSL	Traditional soil Lines or Traditional Soil Line
USDA	United Nation Department of Agriculture
WS	Watershed
WRDDIRD	Water Resources Department Directorate of Irrigation Research and Development
O ‘ ‘’	Degree-Minute-Second
<	Less than
>	Greater than
%	Percent
SOC	Soil Organic Carbon

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Author Contributions

Mussa Abdula Ibro is the sole author. The author read and approved the final manuscript.

Data Availability Statement

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

Conflicts of Interest

No conflict of the interest declare about this manuscript.

Appendix

Appendix I: Field Photo NCFL

Figure 2. None conserved farmlands.

Appendix II: Field Photo CFL

Figure 3. Conserved farmlands.

Appendix III: Bottom Sub-watershed

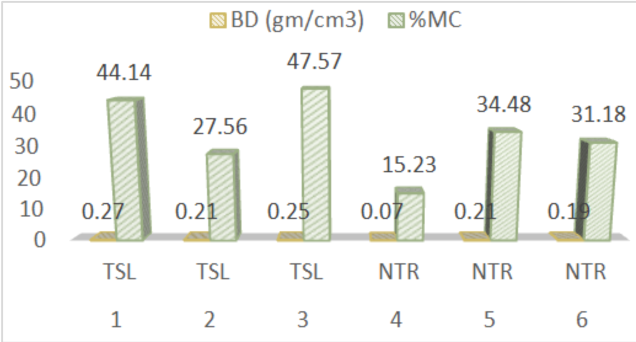

Figure 4. Average value of soil BD g/cm^3 and soil MC (%) of FLS treated with TSL and none treated (NTR).

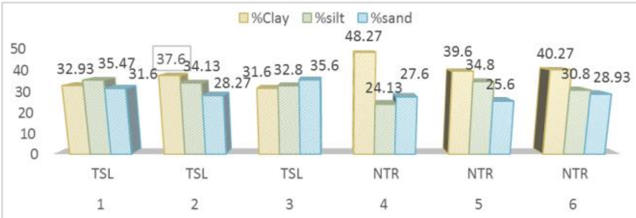

Figure 5. Average values clay, silt and sand soil textures (%) under treated farmlands and none treated farmlands.

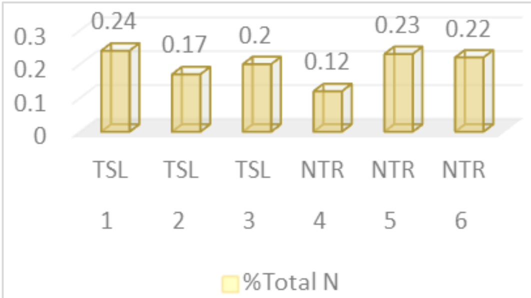

Figure 6. Average values of total soil N (%) both under Treated farmlands and none treated farmlands.

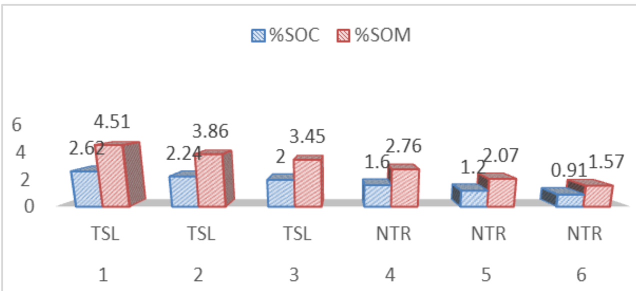

Figure 7. Average values of soil SOC and SOM (%) both under Treated farmlands and none treated farmlands.

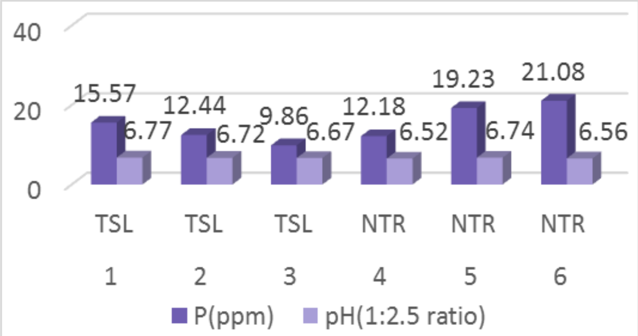

Figure 8. Average values of available soil P and soil pH under treated and none treated FLS.

Appendix IV: Middle Sub-watershed

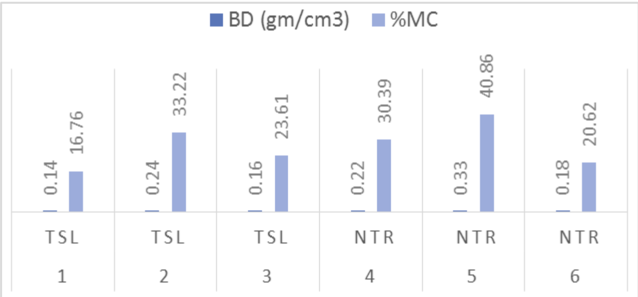

Figure 9. Average values of soil BD and soil MC under treated and none treated FLS.

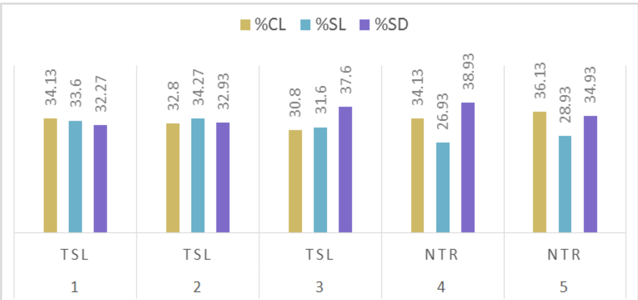

Figure 10. Average values of Soil texture under treated and none treated FLS.

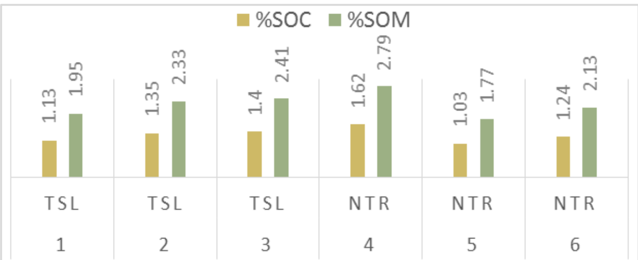

Figure 11. Average values of SOM and SOC under treated and none treated FLS.

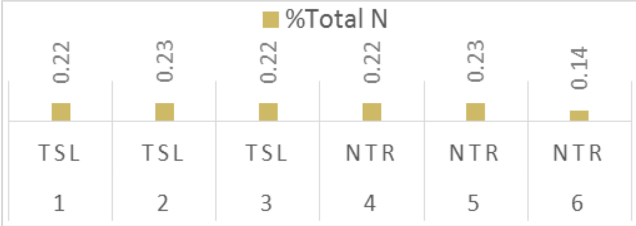

Figure 12. Average values of total soil N under treated and none treated FLS.

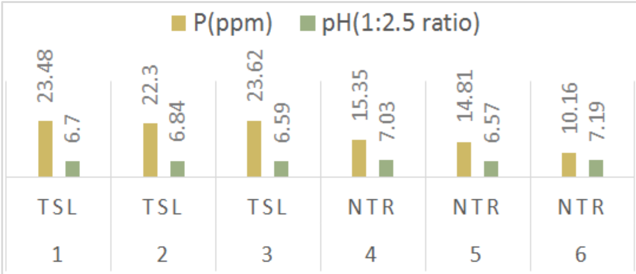

Figure 13. Average values of soil pH and Available soil P under treated and none treated FLS.

Appendix V: Upper Sub-watershed

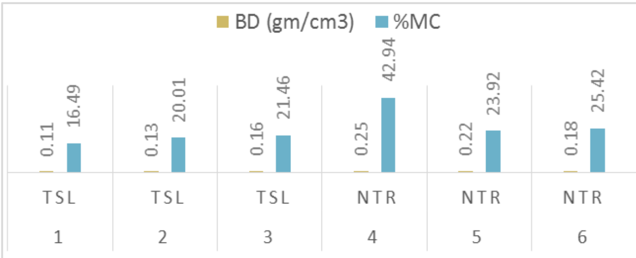

Figure 14. Average values of soil BD and soil MC under treated and treated FLS.

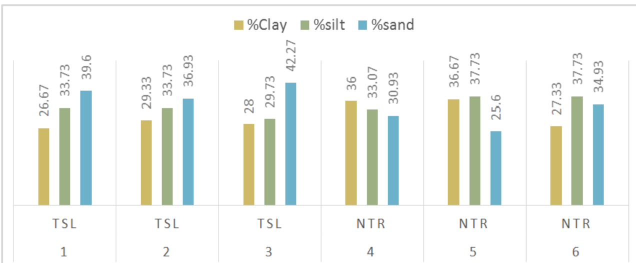

Figure 15. Average values of soil texture under treated and none treated FLS.

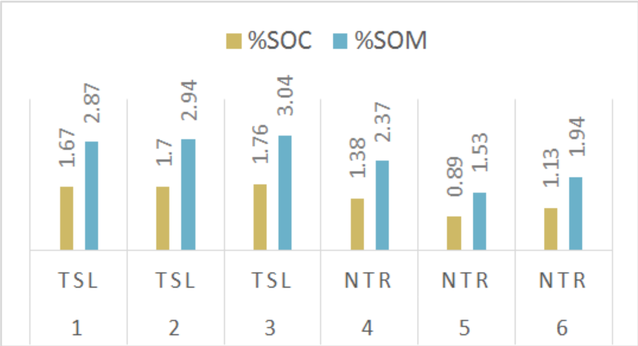

Figure 16*. Average values of SOC and SOM under treated and none treated FLS.*

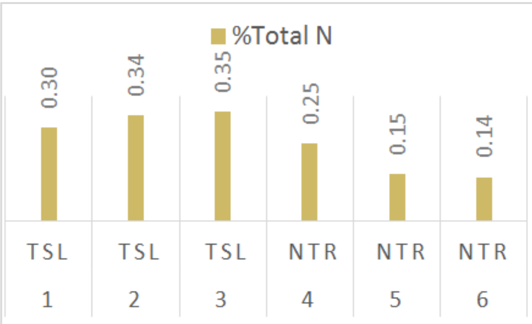

Figure 17*. Average values of total soil N% under treated and none treated FLS.*

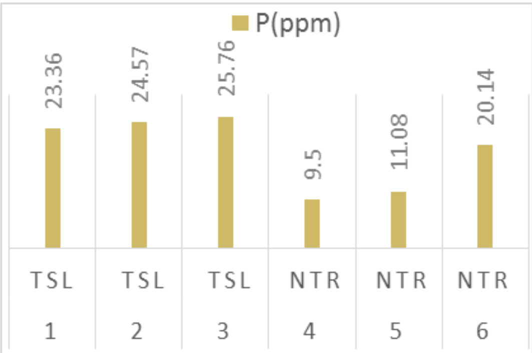

Figure 18*. Average values of available soil P (PPM) under treated and none treated FLS.*

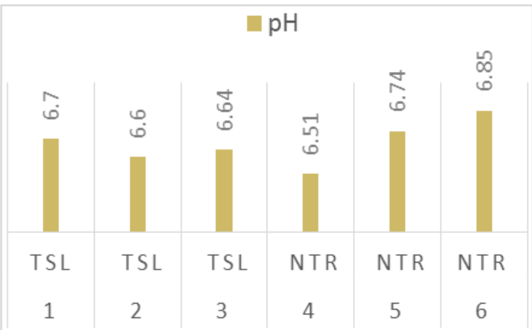

Figure 19*. Average values of soil pH under treated and none treated FLS.*

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