Agro-Ecology Based Evaluation of Some Structural Soil and Water Conservation Measures Implemented in Aleta Wendo District, Sidama Zone, SNNPR, Ethiopia

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Abstract
This study was conducted in Aletawendo district which is one of the 19 districts of Sidama zone found under SNNPR of Ethiopia. Lots of soil and water conservation (SWC) measures have being employed in Aletawendo district. Nonetheless, there is a gap in the choice of SWCs in the district in that SWCs are being chosen not based on the agro-ecologies of the district. They are not being selected and implemented as per the agro-climatic conditions of the area. To recognize this, data were collected from 372 farm households and 25 natural resources management (NRM) experts found in the district. The data collected was analyzed using descriptive statistics with the help of SPSS software. The result indicated that some structural SWCs being implemented in the district were SWCs adopted from other areas and are not compatible with the agro-ecology of the area. They are direct copies of conservation technologies being used in other areas and are being directly implemented in the study watershed regardless of the scientific justifications of various experts and without any modifications on these technologies to suit the agro-ecologies of the district. Such a practice may lead to failure in the application and sustainability of SWC structures and even may lead to disaster such as floods and landslide as per various studies.
Keywords: Agro-ecology, SWCs, Kolla. Dega, Weyandega

1. Introduction

It is proven by most studies that specific types of soil and water conservation technologies should be applied in a particular area based on the agro-ecology of the area. For instance Genene & Abiy (2014), stated that in some parts of the country, the problem of environmental degradations have being beyond all limits of reversal and is expanding very fast because the attempt made to alleviate the problem was not fully based on the agro-ecological, socio-economic and topographic variability considerations. Wild, (1988) also mentioned that although the principles that underlie soil management are the same throughout the world, their successful application must take in to account the local circumstances, including various economic, social, political and environmental conditions. Therefore, analysis of the agro-ecological aspects of a given area is crucial in the choice and application of soil and water conservation technologies and approaches.

Agro-ecology possesses all climatic, biotic and abiotic parameters of a given area that are pertinent for and determine the successful application of soil and water conservation technologies (Mesfine, 1998; Dalgaard et al., 2002). These specific environmental parameters should be taken into consideration while we opt for a specific type of soil and water conservation activity, in the perspective of sustainable land management. Most of soil and water conservation practices being implemented in southern region of Ethiopia are not following proper survey and standard design. There is low or no consideration of socio-economic profile of the area, less attention to the orientation and slope of the land, improper placement of SWC treatments, wrong combination and application of designs (Genene & Abiy, 2014).

This study focuses on structural soil and water conservation technologies being implemented in Aleta Wendo district and aimed in identifying whether these technologies are implemented based on the agro-ecology of the district.

2. Major Agro-Ecologies of Ethiopia and Types of SWCs

2.1. Major Agro-ecologies of Ethiopia

Mesfine, (1998) defined agro-ecology as a natural region characterized by a fairly homogeneous climate, physiographic, relief, slope, soils, vegetation, animal species that typify an area. Dalgaard et al., (2002) have also defined agro-ecology as the interactions between plants, animals, humans and the environment within agricultural systems. According to Hurni, (1998), agro-ecological zone is a spatial classification of the landscape into area units with similar agricultural and ecological characteristics. According to him, there are attributes of such units which determine similarities, such as: (a) comparable agro climatic conditions for annual cropping, perennial crops, or agro-forestry, (b) similar conditions for livestock raising, (c) comparable land resource conditions such as soil, water or vegetative parameters, or (d) similar land management conditions such as raggedness of agricultural land, slope steepness, or topography in general. As per the above definitions, agro-ecology possesses all climatic, biotic and abiotic parameters of a given area that are pertinent for and determine the successful implementation of technologies such as soil and water conservation technologies.

According to Mengistu, (2006), in Ethiopia, the multitudes of agro-ecological zones (AEZs) are traditionally classified into five categories with traditional names assigned to each zone, based on altitude and temperature. These are *Bereha, kola, weyinadega, dega and wurch*". In general, the highland zones (*Dega* and *Weyinadega* zones) contain most of the agricultural areas, while the semi-arid and arid lowlands zones (*Kolla* and *Behera*) are dominated by livestock in agro-pastoral and pastoral production systems (Daniel, 1997 & Hurni, 1995 cited in Mesfine, 1998). The traditional and currently accepted agro ecological belts of Ethiopia are described below (Mesfine, 1998, Bamlaku et al., 2005, Mengistu, 2006)

I. ***Wurch** (Cold highlands)*: Areas above 3000 meters and annual rainfall is above 2200mm. Barley is the dominate crop and light frost often forms at night.

II. ***Dega** (Cool, humid, highlands)*: Areas from 2500-3000 meters where annual rainfall ranges from 1200 to 2200mm. Barley and wheat are the dominant crops.

III. ***Weina Dega** (Temperate, cool sub-humid, highlands)*: Areas between 1500 to 2500 meters, where annual rainfall ranges from 800-1200mm. This is where most of the population lives and all regional types of crops are grown, especially *teff*.

IV. ***Kolla** (Warm, semi-arid lowlands):* Areas below 1500 meters with annual rainfall ranges from 200-800 mm. Sorghum and corn are grown, with *teff* grown in the better areas. The *kolla* is warm year round and temperatures range from 27 to 50 degrees Celsius.

V. ***Bereha** (Hot and hyper-arid):* General term that refers to the extreme form of *kolla*, where annual rainfall is less than 200-mm. The *Bereha* has desert type vegetation where pastoralism is the main economic activity. This area encompasses the Denakil Depression, the Eritrean lowlands, the eastern Ogaden, the deep tropical valleys of the Blue Nile and Tekezé rivers, and the peripheral areas along the Sudanese and Kenyan borders. The following table verifies the above idea

Table 1: Traditional Classification of Agro-ecological Zones in Ethiopia

Agro-ecological Zones	Altitude (masl)	Rainfall (mm/year)	Average Annual temperature (^{0}C)
Wurch (cold and moist)	> 3200	> 2200	<11.5
Dega (cool and humid)	2300 - 3200	1200 - 2200	11.5 - 17.5
Weynadega (cool sub-humid)	1500 - 2300	800 - 1200	17.5 - 20.0
Kola (warm semi-arid)	500 - 1500	200 - 800	20 - 27.5
Berha (hot arid)	< 500	< 200	>27.5

Source: Bamlaku et al., (2005)

2.2. Types of Soil and Water Conservation Technologies

Soil and water conservation refers to a set of management strategies for prevention of soil and water being damaged or becoming chemically altered by overuse, acidification, Stalinization or other chemical contaminations (Biswas & Mukherjee, 1994).

Various studies identified various types of soil and water conservation technologies and classified these technologies in to different categories. For instance, Troeh, et al, (1999) categorized soil and water conservation technologies in to two as *vegetative* (such as dense vegetation cover, reducing the intensity of land use, crop rotation, grassed water ways, stripe cropping and wind breaks) and *Mechanical* (such as contour tillage, terraces, dams, bunds). The same SWC technologies are categorized as *Biological* (fertilizer application, mulching, strip cropping, crop rotation, countering, mixed cropping) and *Mechanical* (terracing, bunding, water ways) by Tripathi & Singh, (2001).

Wild, (1993) classified soil and water conservation technologies in to three as *Biological methods* (such as crop covers, stripe cropping, mulching, etc..), *cultivation methods* (includes Contour plough, Fallowing, Conservation tillage, etc) and *Mechanical methods* (diversions, Bench/level terrace, Irrigation terrace, etc).

WOCAT, (2003) cited in Herweg & Liniger (nd) also classified SWC technologies in to four as *Management measures* (such as land use change, area closure, rotational grazing, etc.), *Vegetative measures* (such as hedge barriers, windbreaks, etc), Agronomic *measures* (such as grass strips, mixed cropping, contour cultivation, mulching, etc.), and *Structural measures* (such as terraces, banks, bunds, constructions, palisades, etc.).

However, all the classifications are not contradicting with one another, rather, they are explaining the same notions in a varying method. Nevertheless, their application would vary as per the local soil properties, climate and cropping systems as per Wild, (1988). Therefore, SWCs in Aletawendo district are categorized as Agronomic, Vegetative, management and Structural methods following WOCAT, (2003) classification for this particular study.

2.3. Agro-Ecology as Criterion for Choices and Implementation of SWC Technologies

According to Pratley (2003), the choice of soil and water conservation should be based on the agro-ecological approaches because it is new technological and development approach which is needed to provide the agricultural needs of present and future generations without depleting our natural resource base and is more sensitive to the complexities of local agriculture, and has a broad performance criterion which includes properties of ecological sustainability, food security, economic viability, resource conservation and social equity, as well as increased production. Hence, there is an increasing requirement for farmers to have a sound understanding of the sources of rainfall variability, their degree of predictability, and objective tools to asses management options in agronomic, economic and environmental terms/contexts, and have to devise management options that can produce long-term sustainable profits in such a variable environment (Pratley, 2003). Mitiku et al., (2006) also argue that the selection of appropriate SWC measures must consider all three dimensions of sustainability, social, economic and ecological. As per Wild (1988), although the principles that underlie soil management are the same throughout the world, their successful application must take in to account of the local soil properties, climate and cropping systems. Numerous failures and even disasters have occurred when soil management methods have been transferred in to a new region without taking in to account those local conditions, and this requires prior investigation.

Therefore, the choice of appropriate methods for soil conservation must depend on local circumstances including various economical, social, political and ecological conditions (Wild, 1993).

For instance, in high rainfall areas (annual RF more than 80cm) and on land with clay soils, graded bunding or channel terracing is done (Biswas & Mukherjee, 1994). Plants need some light, minerals, nutrients and water to grow properly. Desert soil is rich in minerals and some nutrients. There is more than enough sun light. The only thing needed to grow crops is water. However many desert areas are being used as farmland. These desert areas use irrigation. Irrigation is the watering of land by artificial ways (Bernstein et al., 1998).

The contemporary challenges of agriculture have evolved from the merely technical to also include social, cultural, economic and particularly environmental concerns. Agricultural production issues cannot be considered separately from environmental issues (Pratley, 2003).

Therefore, the issue of agro-ecology has been a serious and paramount issue not to be excluded from being considered as a basic and determinant factor for the choice and successful implementation of SWC technologies in a particular area.

2.4. Recommended Soil and Water Conservation Practices in Major Agro-Ecologies.

According to FAO (2006), the slope of farmlands was classified as the area with Flat to gently sloping (0%-5%), from slopping to strongly sloping (5%-15%), moderately steep (15%-30%) and Steep to extremely steep (>30%). Various SWC technologies have been recommended in these agro-ecologies based on gradient variations classified by FAO, (2006).

WOCAT (2002) cited in Herweg & Liniger, (nd), FAO (1987), SCRP (2000), SCRP (1986), Hurni (1998), Troeh, et al. (1999), Genene & Abiy (2014) and Tripathi & Singh (2001) recommend the following types of SWC technologies for varying agro-ecologies on different slope categories.

2.4.1. High Rainfall Agro-Ecologies (humid/*Dega* and cold sub-humid/*Weynadega)*

Accordingly, for areas with slopes up to 7%, the above experts and literatures recommend that these areas need to be supported with agronomic and management practices like contour cultivation, strip cropping, crop rotation, mulching, land use change, residue management, and mixed cropping. As per the above literatures and experts, these SWC technologies satisfy the overall conservation requirements in these slope categories and agro-ecological divisions.

Areas with Slopes between 7% and 15% need to be treated with construction of graded soil bund or graded *Fanyaa-juu*, with assumption of removing excess water from the field and also should be supported by biological stabilizers. There should be also agronomic practices in between bunds. Contour grass strips can be used for preventing erosion of less slope lands around 7-10%.

Areas with slopes between 15% and 30% are unsuitable for cultivation of seasonal crops which require frequent tillage unless supported by mechanical soil and water conservation technologies. This is becauese high rainfall in the area with frequent tillage (3-5 times) can aggravate soil erosion. Structural measures like terraces, bunds (graded bunds and graded *Fanyaa-juus*), dams, cut-off drains are recommended strategies to control runoff, wind velocity and erosion.

Slopes more than 30% should not be used for cultivation as per the recommendations of these experts and literatures. It should be used for fruit production, agro-forestry, forestry, coffee plantation, forage production. If cultivation is needed, bench terrace with strong riser which can prevent land sliding should be constructed. Since the horizontal interval may vary from 3 to 5m, farmers may not be capable of crop cultivation so that they use it for orchard or agro-forestry. Land use change, area closure, rotational grazing, reducing the intensity of land use, cut and carry system, orchard planting supported by water harvesting are best management measures recommended for such areas.

2.4.2. Low and Erratic rainfall Agro-Ecologies (*Kolla* and *Bereha*)

SWC technologies recommended for these areas are not the same with SWC technologies recommended for *Dega* and *Weynadega* agro-ecologies. For these (*Kolla* and *Bereha*) agro-ecologies, in slopes up to 7%, agronomic practices can satisfy the conservation requirements according to literatures and experts above.

As per the arguments of the above experts, for slopes between 7-15%, level soil bund or level *fanya juu* or stone bunds are recommended with assumption of collecting rain water from the channel. According to them, these structures should be supported by biological stabilizers on the structures. There should be agronomic practices in b/n bunds. Contour grass strips, hedge barriers, wind breaks, can be used also for preventing erosion on less slope lands around 6-10%.

Land having slope 15-30% is unsuitable for cultivation of seasonal cash crops unless supported by physical soil and water conservation structures. Most of the areas under this slope category in the region are affected by gully erosion due to the slacken property of rift valley soils. Level soil bund, level *fanya juu*, and scattered or alternate tranches are important physical structures to be applied in this area. It is highly recommended to support the structure with biological stabilizers. Land with slop more than 30% and degraded mountainous areas should not be used for cultivation. Area closure, cut and carry of grasses followed by fruit production, agro-forestry, forestry, coffee plantation and forage production can suit for these areas.

In densely populated areas, where there is gentle slope up to 10%, farmers should use agronomic conservation practices to enhance soil fertility, to conserve soil moisture and then to reduce runoff. The main agronomic conservation measures include traditional conservation practices like contour cultivation; strip cropping, tree planting, manure application, mulching, and choice of appropriate cropping system like intercropping and crop rotation. The agronomic conservation measures should be applied either alone as a best alternative or complementary to be used together with physical soil and water conservation measures based on slop profiles and farming practices of the area.

2.4.3. Pits, Half Moons and Trenches

These structures in soil and water conservation activities are structures which are aimed to conserve water and recommended to be applied in low land areas where the dominant agro-ecology is *Kolla* (where there is low average annual rainfall) (Daniel & Chris, 2003). Pits are mainly applied in semi-arid areas on sandy/loamy plains, often covered with a hard pan, and with slopes below 5%. The overall aim of the system is to capture and hold rainfall and runoff, and thereby improve water infiltration, while increasing nutrient availability (WOCAT, 2007). Traditionally, planting pits are termed as '*zaï*' and used on a small scale to rehabilitate rock hard, barren land in Burkina Faso in which rainfall could no longer infiltrate (Daniel & Chris, 2003).

3. Methodology

3.1. Study Area

Sidama Zone is one of 14 zones found under South Nations Nationalities and Peoples Regional state of Ethiopia and *Aleta Wendo* is one of the 19 districts of Sidama zone which is located at the south-central part of Sidama zone at a distance of around 64 km from the capital city of SNNPR, Hawassa. Astronomically it is situated in the coordinates of 6^0 35′ to 6^0 40′ North latitude and 38^0 25′ to 38^0 30′ East longitudes. The total area of the district is 27823 ha and it is bordered in the south by Dara district, in the west by Chuko district, in the north by Dale district and Wensho district, in the east by Bursa district and in the southeast by Hula district. There are around 236070 people in the district who live being clustered in 29 Peasant Associations (PAs), out of which 49.2% (116099) are females and the rest 50.8% (119971) are males, as per the 2016 statistics of Sidama zone Bureau of Finance and Economic Development (BoFED, 2016). Around 88.2% (208141) of the people are living in rural areas depending on crop production and animal rearing and the rest 11.8% (27929) are dwellers in the urban part of the district. The average population density is estimated to be 651 persons per square kilometer and the average land holding size of the district is 0.5 hectare according to districts' BOARD (2016), which is below the national average (1.2 ha) (CSA, 2010 cited in Genene & Abiy, 2014). According to BOARD (2016), the agro-ecology of the district includes 85.1% *Weina Dega (*Temperate, cool sub-humid*)* and 14.9% *Dega* **(**Cool, humid*)*. It has mean annual temperature ranging from 10^oc to 23^oc, elevation ranging from 1858 to 2026 masl and average annual rainfall ranging from 1200mm to 1400mm. The district exhibits bimodal rainy seasons termed as *Belg* and *Meher* in local language. The *Belg* belongs to rainfall season of March and April, and Meher implies rainfall season of June, July and August. Out of the total area of the district, 46.4% is hilly/ mountainous, 35% is sloppy/valleys and the rest 14.6% are flat plains (BOARD, 2016). The overall land use condition of the district is shown in Table 2. As shown on Table 2, around 89% of the total land of the district is cultivated for annual and perennial crops production. 4.2% of the district is covered by forests and 0.17% is grazing land.

Table 2: Land Use Condition of Aletawendo District

Land use type	In hectare	In percent
Cultivated land	24739	88.9
Forest	1170.4	4.2
Pasture/grazing lands	48.2	0.2
Others (being considered as settlement, swampy, degraded or otherwise unusable)	1864.9	6.7
Total land	27823	100

Source: - BOARD (2014)

3.2. Data Types, Data Sources, Method of Data Collection and Analysis

Both primary and secondary data were used to conduct this study. The primary data were collected from 372 farm households who implemented different SWCs in their farmlands, and 25 NRM experts working in the district, using pre-tested semi-structured questionnaire. The sample size was determined using the formula of Yamane (1967) cited in Israel (2012). Two stage sampling method was used to select these 372 sample farm households. In the first stage, Peasant associations (PAs) have been grouped as *Dega* and *Weyinadega* PAs based on their agro-ecologies, and 5 PAs have been selected in random basis from existing 29 PAs in the district (3 from *Weynadega* PAs and 2 from *Dega* PAs). The PAs are Gidibo, Sheicha, and Habeja from Weyinadega PAs, and Bargo and Garbicho-Kila from *Dega* PAs. In the second stage, 372 farm households have been selected in a random basis from the sampled 5 PAs. Individual interview and focus group discussion were employed to collect primary data and secondary data were collected from different published and unpublished sources. The data collected were analyzed using descriptive statistics and SPSS statistical package has been employed to assist the analysis.

4. Results and Discussions

4.1. Socio-Economic and Demographic Characteristics of farm households

4.1.1. Sex and marital status of farm households

Of the total sampled farm households in the study area, 94.1% were male-headed and 5.9% were female headed households (Table 3). Regarding marital status of the sampled households, 95.4% of the household heads were married, 3.8% were widowed and the rest 0.8 percent were divorced.

Table 3. Distribution of Sampled Households by Sex and Marital Status

Variable		Frequency	Percent
Sex	Male	350	94.1
	Female	22	5.9
Marital status	Married	355	95.4
	Widowed	14	3.8
	Divorced	3	0.8

Source: Own survey, 2016

4.1.2. Age, family size, educational level and landholding of household heads

Age of the respondents in the study district ranged from 32 to 80 and the mean age of the respondents was 48.75 years with standard deviation of 12.52. The family size of sampled respondents also ranged from 3 to 12 and the average family size was around 5 persons with standard deviation of 2.46 (Table 4). Regarding education, the mean grade level achieved by respondents was about grade 6. The minimum grade achieved was grade 0 (illiterate) and the maximum was grade 12. The average land holding size of the sampled households was 0.67ha with minimum, maximum and standard deviation of 0.13 ha, 3 ha and 1.17 respectively.

Table 4: Distribution of Sampled Households by Age, Family size, Education and Landholding

Variables	Mean	Sd. Deviation	Minimum	Maximum
Age	48.75	12.52	32	80
Family size	4.85	2.46	3	12
Education	5.94	2.86	0	12
Landholding	.67	1.17	.13	3

Source: Own survey, 2016

4.1.3. Types of soil and water conservation technologies implemented in Aletawendo district

All sampled farmer households implement various types of soil and water conservation (SWC) practices in their farmlands in Aletawendo district. Of all sampled farmers, 24.7% implement only structural SWCs, 20.2% implement only vegetative SWCS, 22.6% implement agronomic SWCs, 2.4% implement management measures and the rest 30.1% implement combinations of all type (Table 5).

Table 5: Distribution of Respondent Farmers by Types of Soil and Water Conservation Measures Implemented

SWC types	Frequency	Percent
Structural	92	24.7
Vegetative	75	20.2
Agronomic	84	22.6
Management	9	2.4
Combination	112	30.1
Total	337	100

Source: Own survey, 2016 based on WACT, (2003) classification

4.2. Application of Soil and Water Conservation Measures in Aletawendo District

According to the survey result, all farm households in the study district implement soil and water conservation technologies of various types on their farmlands. Table 6 below shows different types of structural, vegetative, agronomic and management soil and water conservation technologies being implemented in Aletawendo district.

Table 6: Types of Soil and Water Conservation Activities being Practiced in Aletawendo District

Structural	Vegetative	Agronomic	Management
Level soil bunds	Hedge barriers	Mixed cropping	Crop rotations
Level funnya juu	Wind breaks	Crop cover	
Trench	Dispersed trees in farmlands	Mulching	
Half moon		Applying fertilizers	
Planting pit			

Source: Own survey, 2016 based on WACT, (2003) classification.

As shown in table 6 above, the structural SWC technologies being practiced in the watershed are level soil bunds stabilized by grasses (especially elephant grass) with tied ditches on the upper side of the slope to retain water; level *Fanyaa-juus* with the soil embankments thrown up-ward to the upper slopes and water retention basins in the lower slopes which is the counter opposite of level soil bunds; Half moons and Trenches with water retention basins and planting pits in the middle. According to the observations made, the major structural soil and water conservation activity being practiced in the study watershed is level soil bund. Level *Fanyaa-juu* is not common and observed in some farmlands. Trenches, pits and Half moon structures are also constructed in some farmlands and farmers training centers (FTCs). Level soil bund is dominantly constructed in the district.

Dispersed trees in farmlands are the dominant vegetative conservation measures and intercropping followed by fertilizer application and mulching are out of agronomic conservation measures frequently seen in farmlands of households in the study watershed.

Management measures are not common in the study area. The only management SWC measure being observed in the study watershed is 'crop rotation'. No management SWCs such as fallowing, area closures and land use changes are observed in the study area.

4.3. Evaluation of Soil and Water Conservation Practices Implemented in Aletawendo District

Agro-ecologies of Aletawendo district (*Dega* and *Weynadega)* exhibit high rainfall, with annual amount ranging from 1200mm-1400mm as per district BOARD, (2016) and farmlands in these agro-ecologies need to be treated with graded structures as per Biswas & Mukherjee, (1994) and according to various studies discussed above. This is because these structures (graded bunds and graded *fanyaa- juus*) have water drainage ditches that are inclined to one side to drain excess water from the farmland. Level soil bunds and level *funya-juus* are recommended to be implemented in rain deficient areas (*Kolla* agro-ecologies) because they possess water retention ditches that do not let water to get-out of the farm. If implemented in high rainfall areas, they may expose farmlands for water logging, landslide, and other disasters. Table 7 discusses the difference between level and graded soil bunds. There is great difference between these two structures in terms of the purpose they are applied, the type of agro-ecology they need to be applied and the type of ditch they encompass.

Table 7: The Difference between Level and Graded Soil Bunds.

No	Parameters	Level soil bund	Graded soil bund
1.	Purpose	To retain water	To drain water
2.	Recommended agro-ecology	For low lands/arid agro-ecologies	For high rainfall areas
3.	Soil type	Sandy soils	Clay soils
4.	Ditch	Water holding ditch	Water drainage ditch

Trenches, half moons and pits are also recommended for water stress areas for the purpose of conserving moisture since they are water harvesting schemes in rain deficient areas.

However, as per the survey result, level soil bund, level *funya-juus*, Pits, Trenches and Half moon structures are being implemented in Aletawendo district (Table 7) which is not appropriate for this district where high annual rainfall is being recorded. These structures in soil and water conservation activities are structures which are aimed to conserve water in rain deficient areas and recommended to be applied in low land areas where the dominant agro-ecology is *Kolla* (where there is low average annual rainfall) (WOCAT, 2007), in enclosures and highly degraded areas for tree planting.

The reason why SWCs in the woreda are not based on the agro-ecologies of the district is that conservation experts in the district are provided with audio-visual materials that display the different SWC technologies being implemented in different parts of the country as good experiences of soil and water conservation measures and have being ordered by their supervisors to directly implement what they have seen on audio-visual materials as per the results of focus group discussion made during the study. Due to this, most of structural soil and water conservation activities being implemented in the district are not conservation activities that suit the agro-ecologies of the area. They are direct copies of conservation technologies being used in other areas and being directly implemented in the study watershed regardless of the scientific justifications of various experts and without any modifications on these technologies to suit the agro-ecologies of the district.

Therefore, it can be concluded that the choices of structural SWCs in *Colla* watershed are not based on the major agro-ecologies of the watershed. They are direct copies of conservation technologies being used in other areas and being directly implemented without considering the agro-ecologies of the district. Various studies discussed above argue that there should not be such a blind recommendation of a single or some conservation measures to all agro-ecological, topographic and socio-economic set-ups. Such a practice may lead to failure in the application and sustainability of SWC structures and even may lead to disaster such as floods and landslide (Wild, 1998).

5. Conclusion

Most of structural soil and water conservation practices that are being implemented in *Colla* watershed of *Aleta Wondo district* are conservation practices adopted from other regions, that have varied agro-ecologies with *Colla* watershed, while conservation practices compatible with the agro-ecological belts of the watershed are supposed to be applied. This may have its own problem on the application and sustainability of the conservation technologies. As per Wild, (1988), numerous failures and even disasters have occurred when soil management methods have been transferred into a new region without taking into account those local conditions. According to Genene & Abiy (2014), in some parts of the country, the problem of environmental degradations have being beyond all limits of reversal and is expanding very fast because the attempt made to alleviate the problem was not fully based on the agro-ecological, socio-economic and topographic variability considerations.

Therefore, conservation experts and farmers in the district must understand the sources of rainfall variability, their degree of predictability and have to devise management options that can produce long-term sustainable profits in variable environment (Pratley, 2003).

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