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Farmers' Perception on Land Degradation and Adoption of Soil-Water Conservation Measures in Ethiopian Highlands: Review Article

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Abstract
This paper is aimed to review farmers' perception on land degradation and adoption of soil-water conservation measures in Ethiopian highlands. Because of land degradation in the form of deforestation, soil erosion, loss of biodiversity and nutrient depletion has been a serious problem of the area. Besides it has adverse impacts on costs of production and agricultural productivity, environment, food security, poverty, social and political stability. Abandonment and shortage of land, water scarcity, and fuel wood shortage, prevalence of invasive species, recurrent disasters, joblessness, migration, conflicts and poverty are the main consequences of land degradation. Land use change, overgrazing, agricultural mismanagement, inappropriate land use policy and tenure insecurity, limited access to inputs and extension services, poverty and climate change are the main causative factors. Topographic ruggedness, rainfall erosivity, soil erodibility and populous of the highland areas also considered as additional factors of land degradation. Soil and Water Conservation (SWC) has been initiated in Ethiopia since mid-1970's followed the recurrent droughts and subsequent food shortages. However, SWC practices were unsatisfactory or not successfully adopted. This is due to lack of community participation, top-down and rigid approaches; lower in personal perception and lack of knowledge; and institutional, socio-economic, bio-physical and technological characteristics. Therefore, SWC technologies must be confirmed as economically efficient and technically effective in specific agro-ecological conditions. Motivation of real community participation and equitable benefit sharing, amalgamation of scientific and indigenous knowledge, awareness creation and capacity building, appropriate research development and extensional services, accessible infrastructures and information networks, sharing experiences and scaling up of good practices are highly required. It must be in line with poverty alleviation, creating job opportunities, increasing agricultural productivity and improving food security of the country. Finally, any SWC interventions should be evaluated in terms of their technical effectiveness, environmental soundness, economic viability and social acceptability.
Keywords: Adoption, Ethiopian Highlands, Land Degradation, Perception, Soil and Water Conservation

1. INTRODUCTION

1.1. Background

Land degradation is a complex term because it has no single readily identifiable features, and it has rarely caused by a single factor. A broader definition of land degradation refers to a temporary or permanent decline in productive capacity of land, or its potential for environmental management [75] and [63]. Usually, it has described in the forms of deforestation, soil erosion, loss of biodiversity and soil nutrient depletion. Currently, Land degradation is an international agenda of the 21st Century, because it has adverse impacts on costs of production and agricultural productivity, food security, environmental, social and political stability [43]. Especially, it is a major problem facing developing countries like Ethiopia, and is projected to become more severe constraint into the future [55]. Moreover, the Ethiopian highlands (i.e. areas above 1500 m a.s.l.) have been indicated at the highest level of land degradation [37] and [38]. At once the highlands had endowed with natural resources potential like fertile soil and water resources. So that, human beings has settled or expanded all over the areas for agricultural production and other mode of life. For instance, about 95% of the cultivated land, 85% of human and 80% of cattle population is highly concentrated on the highland areas, which consists of only 43% of total area of the country [78]. It was estimated that more than 50% of the land was affected by soil erosion, 25% being seriously eroded and 4% of it has no longer production [21] and [40]. Besides, an estimated soil loss rate is ranges from 16-300 ton/ha/yr., while soil formation rate is ranges from 2-22 ton/ha/yr [46]. This implies that soil loss rate is outpaced of soil formation in the country. Subsequently, the country losses 1-2% of crop production per year, and it accounted to one billion USD [66]. Land degradation has not only on-site effects but also it has off-site effects like siltation, flooding and pollutions into the downstream areas. Many reservoirs which have established for hydroelectric power, urban water supply and irrigation schemes are highly threatened by accelerated sedimentation in the country [25] and [48]. The efforts toward soil and water conservation measures have been initiated at the mid of 1970s and 1980s following the severe food shortages in 1973/4 and the famine followed the 1983/4 drought. However, as different evidences shown that these massive soil and water conservation practices have been not achieved as expected or remained unsatisfactory, because of various interacting factors, either of the biophysical or the socio-economic paradigms.

Such as: top-down and rigid planning approach and lack of community participation; hardly to understand the nature of all the causes, processes, impacts and consequences of land degradation; and the differences in perception, views, ideas or understandings on the problem; misunderstandings to select the best SWC technologies in terms of their environmental sound, economic efficiency and technical effectiveness in specific agro-ecological conditions [7], [51], [1], [9], [12] and [53]. Moreover, farmers' perception, knowledge and capability at the local level might not be sufficiently acknowledged and emphasized to adopt SWC measures.

Thus, the main purpose of this seminar paper is to review Farmers' Perception on Land Degradation and Adoption on Soil-water Conservation Measures in Ethiopian Highlands. The main body of this seminar paper includes: the understandings and farmers' perception on land degradation; the factors influencing adoption of SWC measures, and the solutions to overcome such problems.

1.2. Objectives

The specific objectives were:

- ⇒ To assess the forms, causes, extents and consequences of land degradation
- ⇒ To analysis the indicators and determinants of perceiving land degradation
- ⇒ To identify the factors influencing adoption of SWC measures
- ⇒ To endorse the ways to combat land degradation and barriers of SWC adoption

2. RESULTS AND DISCUSSION

2.1. Understandings of Land Degradation

Land is a section of earth's surface with all the physical, chemical and biological features. It is the foundation for all life sustaining processes on the planet since it comprises soil, terrain, climate, hydrology, flora, and fauna including human activities. Whereas: Degradation is the process of detrimental changes over time in chemical, biological and physical; and reducing in quantity and quality as well as the reducing in ecosystem goods and services. Land degradation is a complex term because it has no single readily identifiable features, but it was defined contextually on how one or more of land resources have changed to worse [55] and [75]. The losses could be partial or total which caused by human induced activities. Here, a broader definition of land degradation refers to a temporary or permanent decline in productive capacity of the land, or its potential for environmental management [63]. Currently, Land degradation is an international agenda of the 21st Century, because it has adverse impacts on the environment, costs of production and agricultural productivity, food security and quality of life, social and political stability [43]. Therefore; analysing the causes and consequences, and assessing the ways to combat with land degradation is highly required.

2.1.1. Factors and Causes of Land Degradation

Land degradation is rarely caused by a single factor; rather it is caused by a combination of natural and human factors. It involves two complex interlocking factors: the biophysical and socio-economic [69]. Biophysical factors are soil property (erodibility), topography (steepness or flatness, position, length and exposure of the slope), climate variables (erosivity, e.g. rainfall intensity and distribution, wind velocity and direction), and vegetation covers. Biophysical factors are also known as inherent factors. Because of biophysical processes has accelerated land degradation through human interferences. Based on driving forces (causality), causes of land degradation are grouped into proximate/direct or underlying/indirect causes [47] and [21]. The direct causes are agricultural mismanagement, deforestation and illegal logging, land use and land cover change, overgrazing, removing crop residues and animal dungs, over cultivation and fertilization, inadequate waste disposal, industrialization, urbanization, mining and other human induced activities. Lack of appropriate land use policy; unsuitable land use and management, land tenure insecurity, population growth (human and livestock), poverty, climate change (extreme droughts and floods), limited access to inputs and extensional services, ignorance of the indigenous (local) institutions, political and social instability, etc. are among the indirect causes [59], [17], [14], [4], [69], [58], [15] and [40]. (*See below figure1: factors & causes of land degradation*).

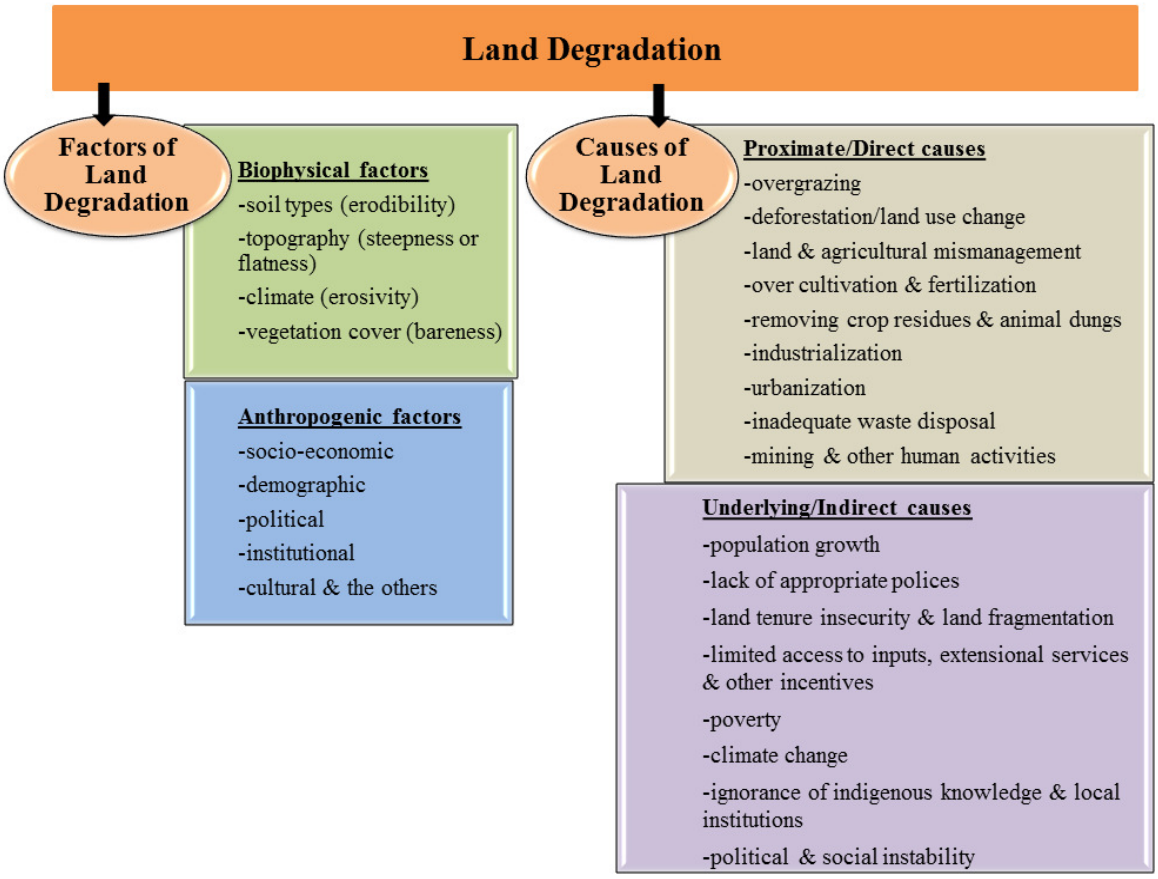


Figure 1 : Factors and causes of land degradation (Source: combined by the author from different sources)

Various studies have indicated the typical causes of land degradation in Ethiopian highlands. The following are among the others:

(i) Extensive deforestation and forest degradation: this is due to agricultural expansion, illegal extractions and collection of forest products, forest fire, unplanned human resettlements, expansion of investments and other developmental activities. In the past, high forests were remained victims of war and conflict. They have intended to set fire into dense forest in order to easier battlefields and to destroy strategic hiding grounds of the enemy soldiers. Harvesting of forest honey, charcoal making, hunting and pastoral activities are also the major causes of fire in the forest. As few evidences informing that railway construction has used huge amount of acacia sp. charcoal from woodlands of the central rift valley. For instance: the natural forest cover in Central Rift Valley of Huluka Watershed about 22% in 1973 was declined into 1.5% in 2009 [42]; in Northwestern highlands of Gojam-Dembecha area about 27% in 1957 was declined into 0.3% in 1995 [38]; in Benshangul-Gumuz of Mandura district about 5.17% in 1957 was became almost non-existent in 2006 [68]. The total land covered with major staple crops (cereals, pulses, and oil seeds) was expanded from 9.80million ha in 2004/05 into 13.45 million ha in 2011/12 [27]. Cash crops (coffee, chat, oil seeds and vegetables) also play a significant role in forest degradation because of their superior in economic return and their suitability to cultivate inside the forest frontier. For example, chat contributed to the loss of 30% of the forest cover in chat producing sites, and the rate of coffee production area per holder was increased by 25% on average [17]. (*See figures2: deforestation & land use change*).

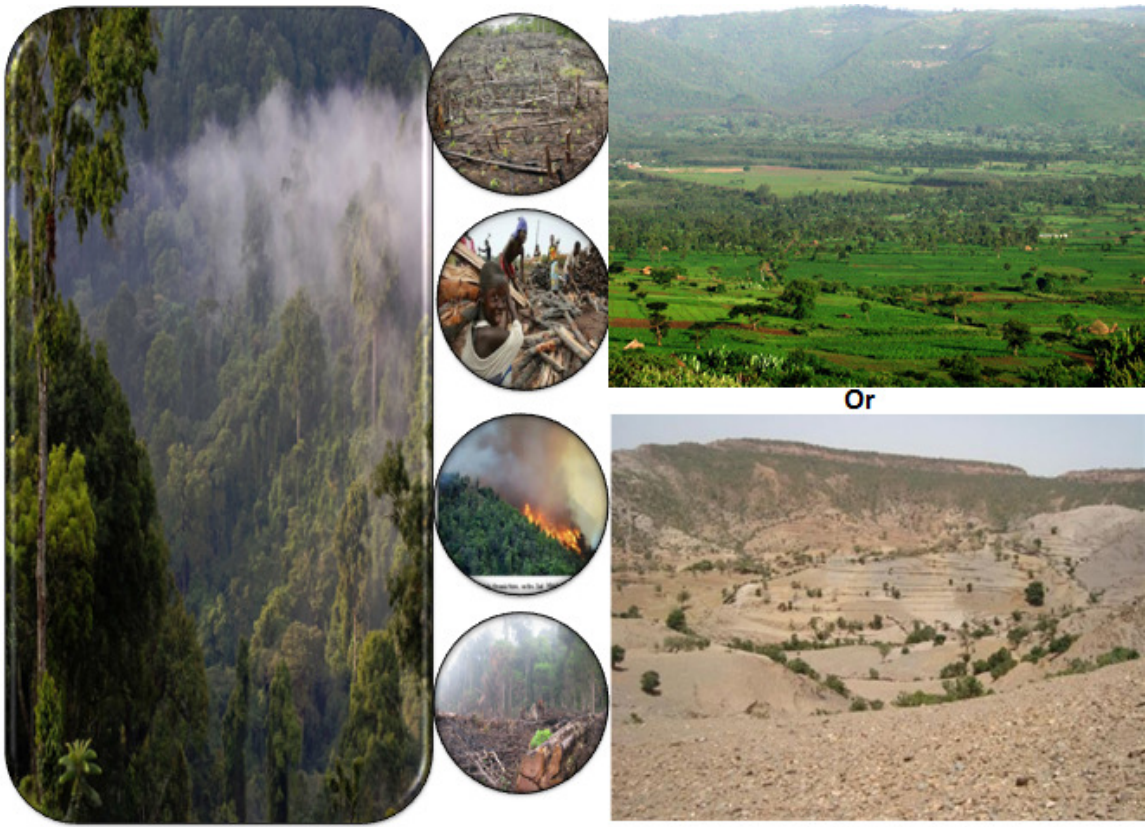


Figure 2: Deforestation and land use change (Source: combined by the author from different sources)

(ii) Inappropriate land use and cropping systems: overgrazing and marginal lands cultivation, declining fallowing periods and limiting in crop rotation system, burning of animal dungs and crop residues, and unwise use of irrigation water. (*See figures3: inappropriate farming practices & land degradation*).

Figure 3: Inappropriate farming practices and land degradation (Source: combined by the author from different sources)

(iii) Natural conditions and settlement patterns: rugged topography, deep gorges, incised valleys, rolling plains, erodible soil types, intensive temperature and rainfall events, and agro-ecological parameters can be considered as additional factors. Mode of life has highly concentrated on the highland areas of the country to found its abundant natural resources like water resources and fertile soil.

(iv) Socio-political-economic factors: rapid population growth (human and livestock), poverty, land tenure insecurity, constraints in institutional capacity and setup, limited access to inputs and credit services, lack of awareness creation and resisting to accept introduced technologies. As a result, the highland areas have been highly exposed to land degradation and susceptible to climate change.

In addition, the previous and the current political economy of the country have a lion share to the causes of land degradation [35] and [17]. The country has been experienced with the three distinctive socio-political-economic systems: viz. Feudalism (pre-1974), Socialism (1974-1991), and Federalism (since 1991). Even if each regime has its ideological advantageous, the changes from one regime to the other were destructive to the previous systems. During the Feudal, the desires were to control the conquered territories and securing tax collection from meant of free access resources. At that time, millions of hectares of land were owned by absentee landlords whilst millions of people including indigenous peasants turned into tenants; and then arbitrary peasant evictions, great inequality, lack of relevant institutions, tenure insecurity and high rate of tenancy, severe drought and famine were the reasons to fallen down of the regime. Fortunately, during the Dergue regime land tenure system has radically changed from absolute private property rights to the communal; and it tried to accommodate the needs of new claimants through land redistribution and collectivisation strategies. Likewise, a number of restrictions to use rural land have limited the peasants to invest on long-term SWC measures. Even if the regime was known to massive plantation and SWC activities, the efforts were remained unsatisfactory because of its top-down and rigid planning approach, and lack of community participation. Due to the fact, during the governmental change in the 1991, a large forest areas and SWC structures were removed and destroyed by local farmers and land grabbers. The present government has more appreciated on environmental and land resources related policies, programs and strategies. It has taken lessons from the past shortcomings and then it has been resulted positive achievements to restore severely degraded land, as well as SWC measures becoming as sources of income for the local communities. According to recent data, about 11.5 million ha of Ethiopian land area is covered by forest, from which the plantation has been increased by 47.6% from 509,422 ha in 2000 into 972,000 ha in 2015 [31]. But, the current government has also various constraints and problems regarding to SWC practices that will be solved in the future. For example, grabbing of lands due to large scale investments, unplanned settlement programme and other development activities; less integration of SWC measures; less working quality on structural design and tree planting, equitable and faire benefit sharing among upstream-downstream community must be paid attention.

2.1.2. Forms and Extents of Land Degradation

Land degradation has different forms and processes. The principal processes are: Vegetation Degradation: deforestation, losses in biodiversity and organic matter, and reduces in ecosystem goods and services; Soil Degradation: declining in soil biodiversity; water erosion; soil compaction, sealing, crusting, hard-setting; waterlogging; nutrient depletion; salinization and acidification; Water Degradation: shortage of water, drying of water sources, siltation, eutrophication and water pollution; Air Pollution: contaminations of atmospheric air and the surroundings; and Desertification: formation of deserts, land degradation in dry lands [50], [24] and [54]. (*See figure4: forms & processes of land degradation*).

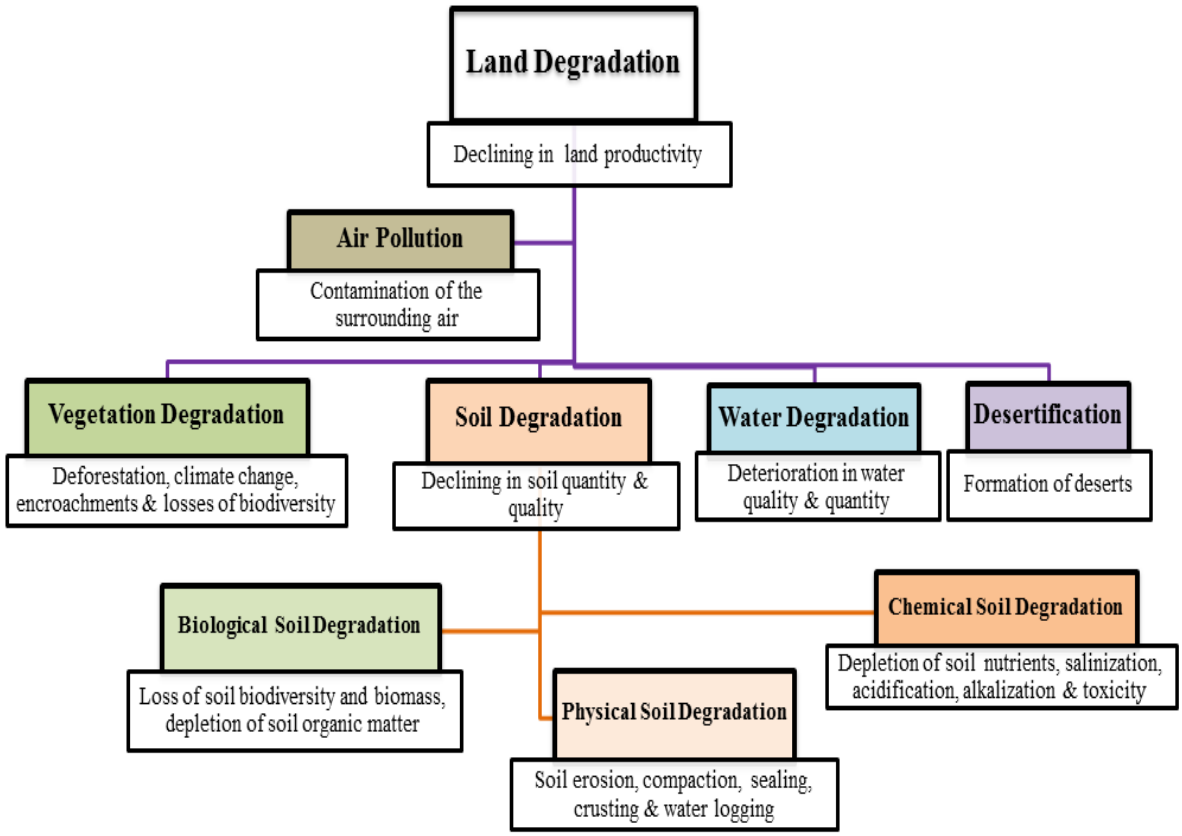
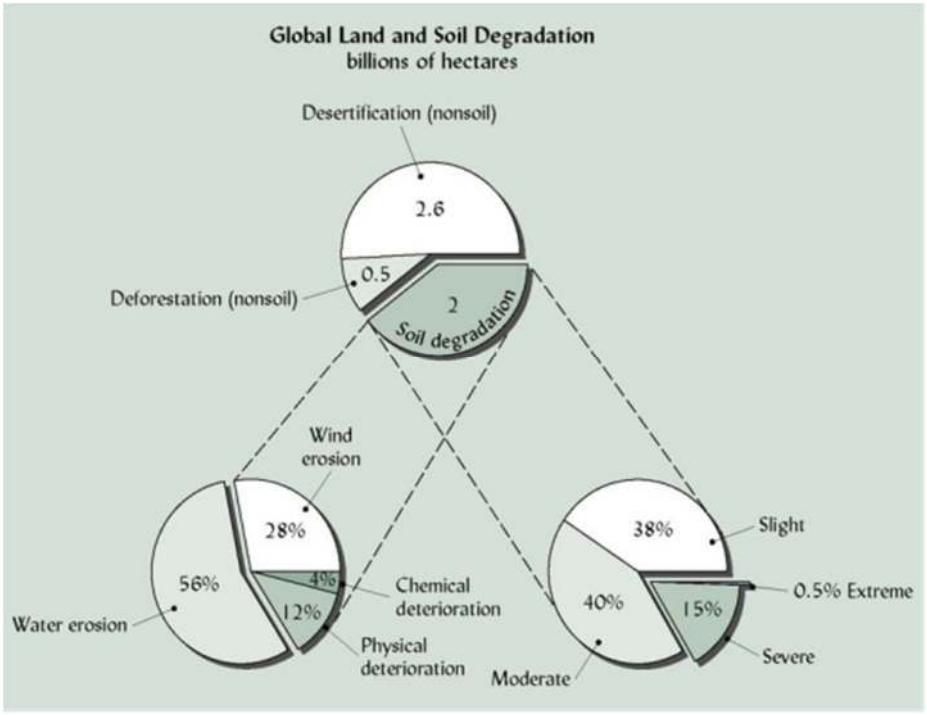


Figure 4: Forms and processes of land degradation (Source combined by the author from different sources)

The extents of land degradation are varying in many parts of the world and their severity has increased at alarming rate. Even though it is difficult to assess actual extent of LD; the estimated degraded land area of the globe is varying from one to more than six billion ha [39]. Four approaches have been used to assess degraded lands. Such as: expert's opinion, satellite observation/remote sensing, biophysical models and taking inventory of abandoned agricultural lands. For instance, based on remotely sensed, [16] study revealed that about 3.5billion ha (24%) of the global land area was degraded from 1981 to 2003. Global Assessment of Human-induced Soil Degradation (GLASOD) also indicated that 2billion ha (15%) of global land area is severely degraded due to soil degradation, especially by water erosion. The highest proportions were reported for Asia and Africa (*See figure5: the extents & severity of land-soil degradation in the world*).



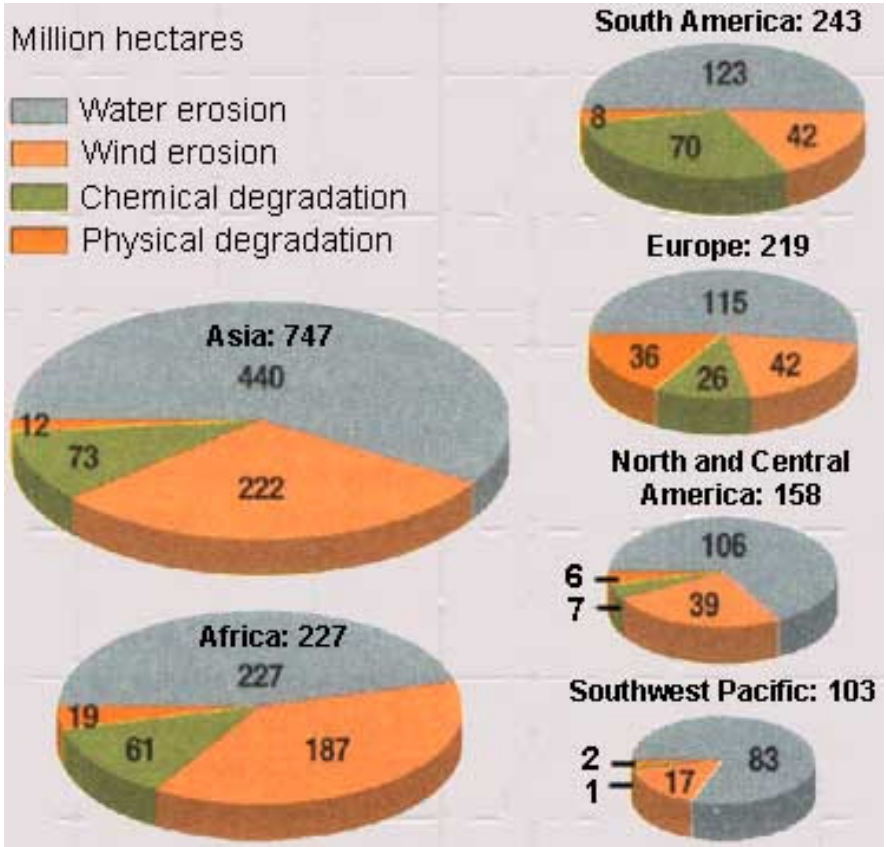


Figure 5: The extents and severity of land and soil degradation in the World (Adopted from [60])

In Ethiopia about 27 million ha (50%) of the highland area was significantly eroded, 14 million ha (25%) seriously eroded and over 2 million ha (4%) beyond reclamation and it has no longer productive [21] and [40]. (*See figure6: the extent and intensity of soil degradation in Ethiopia).*

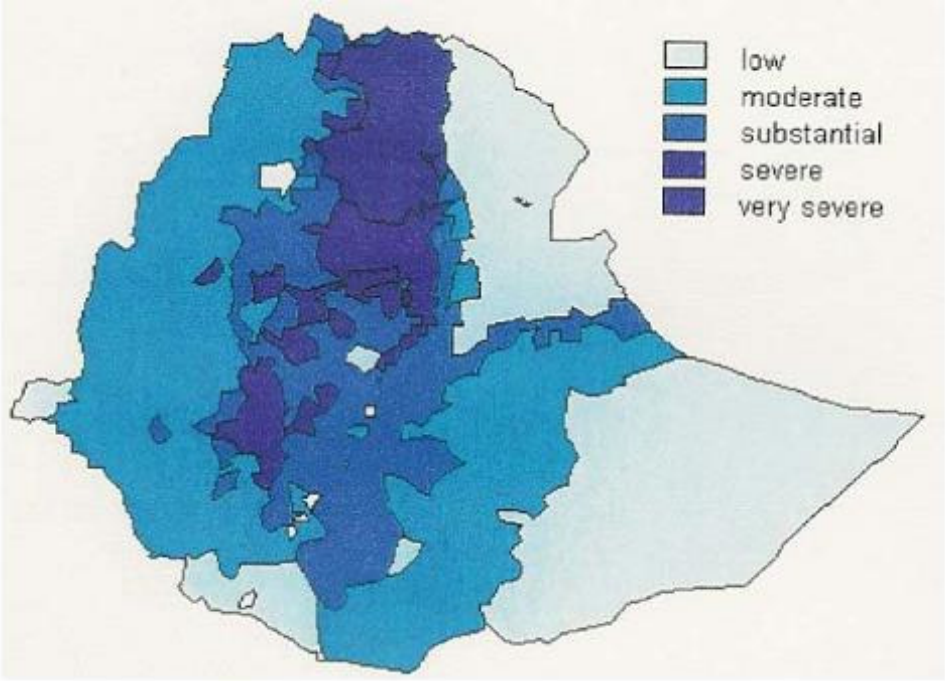


Figure 6: The extents and intensity of soil degradation in Ethiopia (*Adopted from [44])*

Moreover, Ethiopia has indicated at the highest level of land degradation in the world. Historically, the progressive of deforestation and forest degradation in the country was dated back to 3,000 years old [15]. Currently, the natural forest coverage in the country was declined to less than 3.34 million ha (2.9%), and the average annual deforestation rate was became greater than 0.25% in 2005 [30]. An estimated soil loss rate in the country ranges from 16-300 ton/ha/yr., while soil formation rate ranges from 2-22 ton/ha/yr [46]; and the average annual soil loss for cropland in the highlands was estimated about 42 ton/ha/yr. Besides, various studies made in different parts of Ethiopia have also reported that the annual soil loss show spatial (land use type and agro-ecology) and temporal (seasonal) variations and the results have exceeded the indicated average value (*See table1: the estimated soil losses*).

Table 1: Estimated soil losses in different parts of the country (ton/ha/year)

T. No	Estimated average soil loss in ton/ha/yr	Area of Study in Ethiopia	References
1	98	Douga Tembien district	[76]
2	93	Chemoga watershed	[22]
3	84.5	Ethiopian highlands	[21]
4	72	Fincha'a watershed	[23]
5	71.8	Guder watershed	[52]
6	65.9	Northeast Wollega	[3]
7	50	Koga watershed	[67]
8	45	Chaleleka Wetland catchment	[49]

2.1.3. Consequences of Land Degradation

Land degradation has negative connotations on food security and quality of life, especially in developing countries like Ethiopia. It has adverse impacts on agricultural production, environment and social welfare. It has negative consequences on individuals, community and nations as a whole. It has affected not only the performance of the land for food and fibre production but also have grave consequences for the environment. For example, formation of an inch top soil may need more than thousands of years, so it should not be allowed to degraded. As various studies have indicated that majority of the respondents have perceived and mentioned the consequences of land degradation in different angles. For instance, according to [79] study results at West Harerghe Zone, Oromiya region showed that about 89.4% of the households suggested that land degradation bring productivity decline, 10.61% reported it decreases the soil depth, colour and changed the type of crops grown, 16.06% claimed it exposed stone rocks, deteriorate water holding capacity and made land preparation difficult, and for 44.55% of them, it results gully and sandy soil formation which reduced farm size. In addition, according to [69] study revealed that about 68.9% and 63.3% of the respondents argued as soil erosion has consequences of migration and poverty respectively. (*See figure 7: the consequences & impacts of land degradation*).

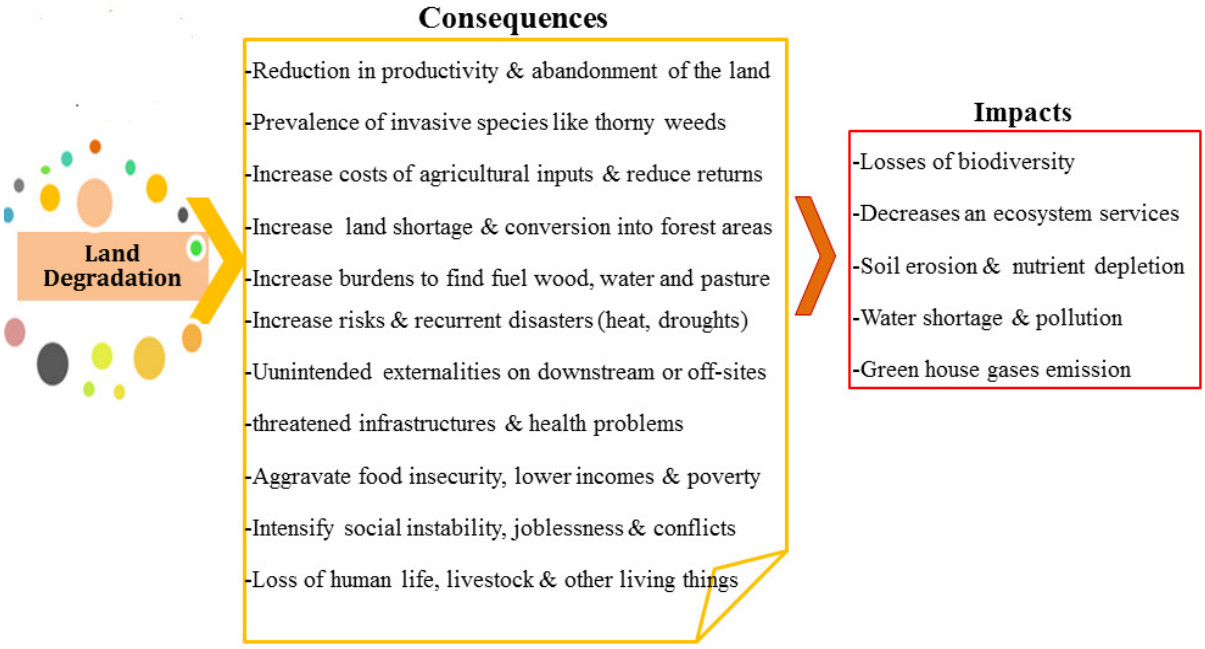


Figure 7: The consequences and impacts of land degradation (Source: combined by the author from different sources)

Consequences of land degradation can be assessed through economically quantified (monetary) or none economic values. For example: losses or dried out of water sources; walking long distance to find firewood, crop residues, animal dungs, water and pastures; unemployment and conflicts among human beings on natural resources utilization are among economically none quantifiable consequences of land degradation [4]. The direct costs of soil nutrient losses due to unsustainable land management could be economically estimated. For instance, in Ethiopia about 3% of agricultural GDP (106 million USD) was lost in 1994, and more than 7 billion USD between 2000 and 2010 [21]. Land degradation has not only on-site impacts, such as soil degradation, declining soil fertility, and desertification, reduce infiltration and water storage capacity; but also it has off-site impacts which include eutrophication of water courses and lakes, destruction of wildlife habitats, siltation of dams, reservoirs, rivers, and probably damage to infrastructure caused by muddy floods [44]. Many reservoirs which have been constructed for hydroelectric power, urban water supply and irrigation schemes have been threatened by accelerated sedimentation in Ethiopian highlands. According to [48] the siltation deposited into Gilgel Gibe-I hydropower dam is 1.2 to 1.3 ton/m^3/year and it was reduced the expected life span of the dam from 50 to 20 years. Consequently, these have been caused water supply shortages, increased costs of maintenance and removing sediment, declined in water quality, loss of aquatic resources and recreational opportunities. In general, in addition to climate change (droughts and floods), land degradation has been portrayed the country as a food deficit with its people and animals. Therefore, it also highly required to analysis the indicators and determinants to perceive the impacts of land degradation.

2.2. Farmers' Perception on Land Degradation

2.2.1. Indicators of Perceiving Land Degradation

The previous was not present at the place. Nature is in its dynamics for a long period of time. But, human interferences or anthropologic activities accelerated and/or disrupted the natural processes and functions. It is not easy to understand all of the causes, processes, impacts and consequences of land degradation. Because it is not only for the complexity of natural phenomena but also the differences in our perception, views, ideas or understandings on the problem. Here, perception is someone's ability to notice and understand things through our senses; it is a form of knowledge that has usually a strong weight in our decisions, as human beings tend to give more importance to information directly acquired from the subject we observed than to information indirectly provided by a tier person or a device [18]. At the local level, perception occurs in two dimensions: the internal, basically that of farmers, and the external, basically that of technical and government officials. Farmers can be perceived and expressed the causes and status of land degradation whether occurring on their farm lands or not. Besides, farmers' perception is strongly based upon traditional knowledge, and locally derived site specific indicators as per of their long-term observations [47]. Perception is one of the factors that determine the state of acceptance and implementation of various land management practices. If the farmers perceive land degradation problems (severity, impacts and dynamics), they decide to use the traditional or externally introduced SWC measures. Otherwise, if the farmers cannot perceive the outcomes of the problem, they do not accept and

implement SWC practices. The majority of local farmers were easily perceived the indicators of soil erosion on their farm lands. Various studies revealed that as a number of farmers very familiar or aware of LD hazards, and they have considered the erosion problem from their trends of change (*See table2: majority of the respondents perceived land degradation/soil erosion as the main problem*).

Table 2: Majority of farmers have perceived land degradation/soil erosion as the main problem

T. No	Respondents (%)	References	Area of studied in Ethiopia
1	84.9	[64]	Northwestern, Wyebla watershed
2	93.5	[71]	Central highlands, Beressa watershed
3	69	[69]	Northwestern, Dera Woreda
4	75.4	[28]	Northwestern, Awi Zone
5	82.7	[79]	Northeastern, West Harerge
6	92.5	[11]	Southern, Alalicha watershed
7	88	[18]	Southern, Wolaita, Gununo
8	68	[29]	Southern, Gamo Gofa
9	71	[36]	Southeastern, Bilate watershed
10	58	[19]	Northern, Tigray

Some studies have also indicated that farmers perceived indicators of land degradation in the form of soil nutrient depletion, reduction in productivity, increasing costs of production and external inputs, water scarcity and drought, bush encroachment and prevalence of invasive species like weeds and pests, declining of wildlife, variability and intensity of rainfall, runoff and flooding, erosion and sedimentation, decreasing in topsoil, surface soil colour change (redness), soil surface crusting, wind erosion, change in colour of crop leaves (yellowish) and stunted crops, stoniness and rock exposure, bare land and exposure of roots, pedestals and band sand dune formation, formation of sheet, rill and gully erosion [29], [11] and [73]. And these indicators have enhanced mutual understandings among farmers, researchers and decision-makers, and they help to share their different perspectives and knowledge. In addition, *see figure8: the indicators to perceive the prevalence of land degradation/soil erosion on the ground*.

Figure 8 : The indicators to perceive the prevalence of land degradation/soil erosion (Source: combined by the author from different sources)

In fact, farmers' perception on land degradation is highly depend or crucially affected by multiple factors and determinants which tried to described in the following.

2.2.2. Determinants to Perceive Land Degradation

Farmers' perception on land degradation varies from place to place depending on natural, social, economic, cultural and political conditions of the area [28] and [81]. Land holding size and tenure security, method of land preparation and cropping systems, farm plot distance from home, individual experiences and age, gender, education and agricultural extension, positions in social and wealth status of the farmer are among the determinants to perceive land degradation [8], [36] and [18]. For instance, farmers with bigger farm size perceive soil erosion better than the smaller ones, and they used to practice traditional fallow and allocate large portion of their land for none food crop uses, rather for grazing, wood lot and other land uses practices. These practices can help to mitigate or control soil erosion and soil fertility depletion [19]. Higher soil erosion is observed on fields where improper farming practices are common. Educated and wealthy farmers have a strong perception of land degradation to adopt and make use of soil conservation technologies so they help to mitigate soil erosion and nutrient depletion. Farm plots around homestead have always supplemented with farm yard manure and better in soil fertility status than fields away from homestead. Land tenure arrangement is a very important factor that influences farmer's decision to invest on their farmland. For example rental land is more likely to be degraded than owned land. In addition, farmer's age, farming experience, farm training and numbers of economically active household members are positively responsible to soil erosion [74]. Soil is a non-renewable resource because erosion occurs at rates that outpace of soil formation. Artificially soil formation is impractical, but we must promote land, soil and water conservation to tackle with land degradation and to improve agricultural productivity. Different types and technologies of SWC were described as the following.

2.3. Types and Technologies of Soil and Water Conservation

The term conservation broadly used as prolonging the useful life of resources, promotion of optimum use of land according to its capability and suitability, halting degradation (reduce erosion or control loss of nutrients), and restoring productivity. So that, soil and water conservation is aiming to reduce soil erosion from raindrop, runoff and wind, to improve soil conditions (infiltration, soil organic matter content, ions exchange capacity), and to maintain soil fertility and productive capacity of the soil. Types of SWC measures can be categorized into the Physical (mechanical/ engineering/structural), Biological (vegetative), and Agronomic (soil and crop management). The physical measures are aimed to reduce velocity of surface runoff, to minimize soil erosion and retain water, as needed safely to dispose excess runoff. Usually, it was recommended that if physical measures were combined with the biological and/or agronomic measures (*See figure9: the types and technologies of SWC measures and practices*).

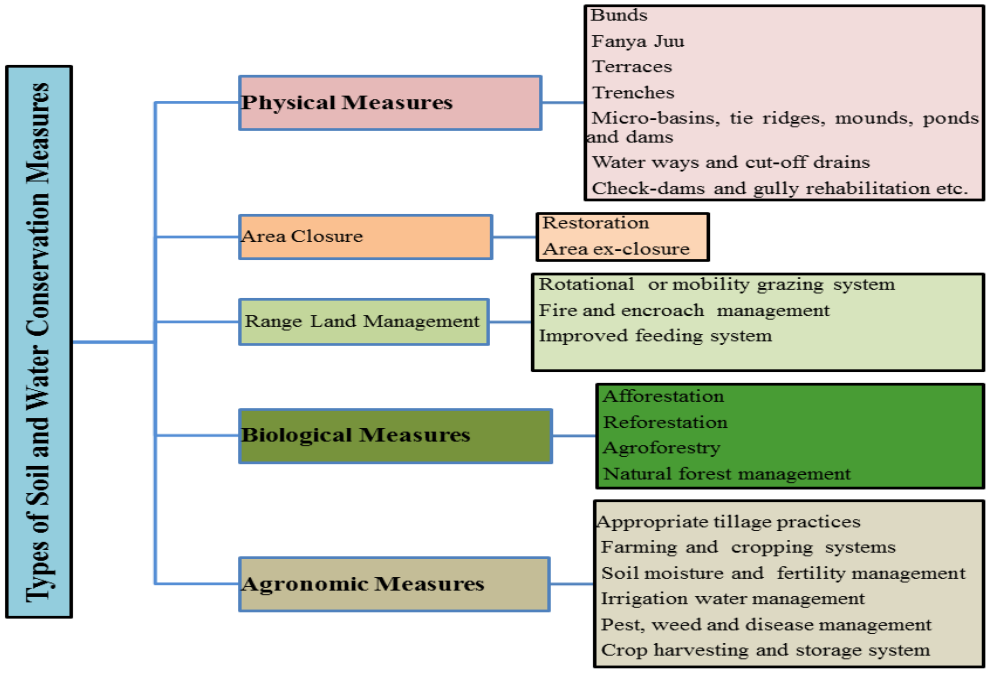


Figure 9: Types and technologies of Soil and Water Conservation Practices (Source: combined by the author from different sources)

2.4. Factors Influencing Adoption of *Soil and Water Conservation* Measures

Adoption is a decision to make full use of innovations like a new technology, idea, practice and objects as the best course of available action [65]. It is the mental process in which an individual passes from first knowledge of an

innovation to a decision, either to adopt or reject, and later to confirm the decision. [62] has described the following five stages of adoption processes. These are:

i. **Awareness**: At this stage an individual first hears about the innovation. This means that individual is exposed to an idea but lacking detailed information about it. This is somewhat like seeing something without attaching meaning to it.
ii. **Interest**: At this stage an individual is motivated to find out more information about the new idea. An individual wants to know what it is, how it works and what its potential.
iii. **Evaluation**: At this stage mental trial of new idea takes place. An individual considers the relative advantage of the new idea over other practices or alternatives.
iv. **Trial**: At this stage an individual tests the innovation on a small scale for himself. An individual seeks information about technique and method of applying the new idea.
v. **Adoption**: If satisfied with trial an individual will decide to continued use the innovation on large scale prefer to old methods.

In addition, the same author has suggested the following typical set of adopter categories:

a) ***Innovators:*** they are also known as 'venturesome'. They are very eager to try new idea. They have more cosmopolite social relationship. They have ability to understand and apply complex technical knowledge. They have ability to cope with high degree of uncertainty about an innovation. They play gate keeping role in the social system.
b) ***Early Adopters:*** Early adopters are also known as 'respectable'. They are localities and have opinion leadership. Members of the social system consider them as "the individual to check with" before using a new idea. Change agents consider them as "local missionary". They hold "central position" in the communication structure of the system and are respected by peers.
c) ***Early Majority:*** Early majority are also known as 'deliberate'. They adopt new ideas just before the average member of a social system. They seldom hold leadership position. They provide "interconnectedness" in network system. Motto of early majority is "be not the first by which the new is tried, nor the last to lay the old aside".
d) ***Late Majority:*** Late majority is also known as 'sceptical'. They adopt new ideas just after the average member of a social system, and they adopt an innovation when they feel that it is safe to adopt.
e) ***Laggards:*** Laggards are also known as 'traditional'. They are the last in a social system to adopt an innovation. They are the most localities and isolates. They possess almost no opinion leadership. The point of reference for the laggards is the past. They interact with people having traditional values. They are suspicious of innovations and change agents. (*See figure10: the typical categories of adopters in a social system*).

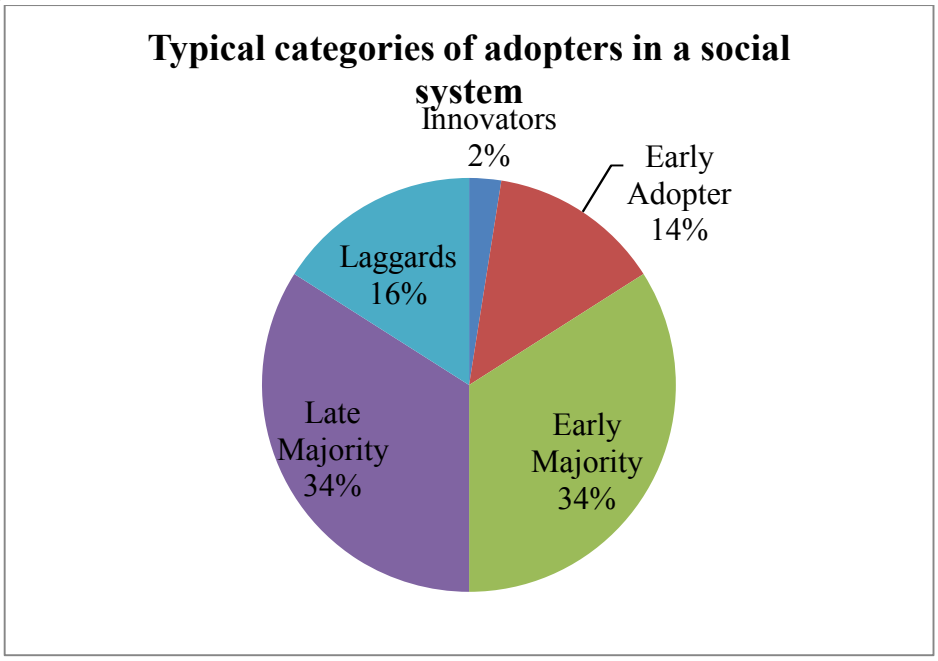


Figure 10: Typical categories of adopters in a social system (Adopted from [62])

Although soil and water conservation techniques have extensively been introduced over the past decades in Ethiopian highlands, sustained use of the measures was not as expected due to various factors. Various theoretical

and empirical studies have indicated four interactive factors that influencing adoption of SWC measures. These are the biophysical, socioeconomic, personal and institutional factors. Moreover, farmer's decision has also considered by three main paradigms. These are economic constraints (availability of assets and technologies, costs and profitability), innovation-diffusion-adoption (access to information), and individual perception (personal, physical and institutional characteristics) [56] and [61]. Therefore, policy and institutional barriers; knowledge gaps and inadequate technical support; and economic and financial constraints have described in the following:

2.4.1. Policy and Institutional Barriers

Policy and institutional issues are among the major barriers that hinder the adoption of soil and water conservation practices in Ethiopian highlands. The previous and even the current political economy of the country have a lion share. Lack of land use policy and inappropriate land tenure security; weak agricultural policies and wrong approaches; weaken environmental policy implementation; lack of institutional setup and linkages; ignorance of the indigenous knowledge and practices; political and social instability are among the major institutional factors which have been affected adoption of SWC practices. It is an obvious that land is the fundamental socio-economic asset and it has been an issue of power and governance in Ethiopia. During Feudal regime the country had a complex land tenure system. There was absolute private ownership of land and highly centralized by Monarchical rules. Millions of hectares of land were owned by absentee landlords whilst millions of people including indigenous peasants turned into tenants; there were arbitrary evictions, great inequality and lack of tenure security. Dergue regime has nationalized land as common property of the nations. During that period land was subjected to periodical redistribution/reallocation for equity and to reduce landlessness, and it has made tenure insecurity as well. Due to the fact, land tenure system in the country is considered as one of the most important obstacles on adoption of SWC practices, especially for long-term investments [41], [77] and [45]. For instance, the investment in stone terraces was positively influenced by factors associated with long-term investment perspective and land tenure security; whereas: short-term investments in soil bunds were strongly linked to insecure land tenure [19]. Tenure insecurity (expected decline of land holdings) is negatively related to soil conservation adoption [7] and [9]. Besides, farmers with smaller land holding size and that only source of income for the households has negative connotations on adoption of SWC measures because some conservation structures like stone terraces take more space, may loss farm area and declining production. In addition, land certified households were more participated on tree planting than none land certified households because land tenure security has been enhanced in the form of land registration and certification programmes [32]. Top down and rigid approach was ignored local institutions, culture and social capitals, lack of effective community participation, single medium focus and sector driven approaches have missed the integration. In addition; lack of an appropriate institutional setup and arrangements, and timely restructuring offices and high staff turnover wastes institutional capacity and discontinued SWC activities. SWC endeavours in the country have gave a greater emphasis as reactive approach, that means it takes place after the initial impacts of land degradation and droughts have occurred, for example, since the great famines in 1973. The international community and the Ethiopian government began to carry out massive conservation measures to covered extensive areas. Since then, the conservation movement has continued. Food or Cash for Work was widely used as public work programme through food aid funded by international donors like World Food Program. Farmers were provided with grain and edible oil in payment for their participation in the conservation works concentrated merely at drought prone areas, but it fails to SWC adoption or not sustainable because of top down approach or centralization in the planning and implementation processes. This means, the local farmers were virtually considered ignorant of land management and they were not allowed to comments on externally introduced conservation measures that were unfamiliar to their locality. On the other hand, farmers were dissatisfied because the conservation measures were neither addressing their needs and priorities nor fitting to their farming circumstances. Unfortunately, after food-for-work payments were discontinued, SWC structures failed to maintain by farmers and they have destroyed the structures that have constructed on their cultivated lands [70], [77] and [13].

2.4.2. Knowledge Gaps and Inadequate Technical Supports

The technical interventions of SWC practices were merely technological oriented, physical works and top-down approaches. It was not supported by dialogue or negotiation processes and it limited to participation of beneficiaries in decision making. The command and control policies have not linked to their indigenous knowledge of the farmers and social learning institutions. These wrong approaches made the people to have limited sense of responsibility over the assets created [79] and [53]. Likewise, SWC measures should be selected based on agro-ecological characteristics (e.g. topography, soil types, climatic variables, land use and farming system), designing parameters (e.g. spacing, length, width, depth, area, directions, etc.), and considering availability of labour and materials in the area. Hence, knowledge gaps and these inadequate technical supports made ineffective achievement of SWC practices. On one side, it is due to limited professional access and technical standards. On the other side, new SWC structures have externally promoted to the local as a quota system without improvement of scientific research. To achieve the quota, they have designed and implemented through non-professionals, political leaders and they take massive social mobilization. This approach has negatively affects the quality as well

as adoption of SWC measures. In addition, the interventions have been highly concentrated on mountainous or communal lands (*ex-situ/extensive conservation*), but not such practiced on private farm lands (*in-situ/intensive conservation*). This also raised the questions like who have maintaining responsibilities and who have more share benefits among the community.

2.4.3. Economic and Financial Constraints

Massive social mobilisation, food or cash-for-work and other incentives or privileges have been used for SWC measures in Ethiopia. However, poverty, lack of capitals including land, labour and infrastructures, lack of availability or accessibility of inputs (tools and materials) are highly discouraging farmers from applying and adoption of SWC measures. Even if financial incentives may appear attractive, non-financial factors must be in consideration to understand the actual and potential adoption of conservation technologies. For example, top-down extensional approaches that heavily depend on incentives rather than on training and educational processes were hardly to adopt conservation practices [73]. Direct public involvement in constructing soil conservation structures on private lands appears to undermine incentives for private conservation investments [20]. For example: lack of property rights to land creates negative incentives for natural resources management and utilisation. Unfortunately, current Constitution, land proclamations and subsequent land registration and certification program provided land tenure security and increase efficient land use and agricultural production by easing land transferring, providing collateral for agricultural loans, and increasing incentives to adopt long term SWC measures [33]. In addition, lack of available social capital (networks, informal institutions and norms) is highly influences farmers' preferences, transaction costs and information exchange. Accessibility to social networks enables farmers to overcome their economic constraints, and thus facilitate adoption of SWC technology [6] and [57]. Lack of access to market, pervasive market imperfections and high rates of time preference also create disincentives for SWC investments [12]. On the other hand, lack of access to subsidies and credits, biased extensional services, costs and unfair distribution of inputs were also highly determined the effectiveness of SWC practices. To overcome the barriers of SWC adoption, different paradigms have been used as solutions; and these have discussed in the following section. Specifically, the studies were focused on farmers' subjective beliefs, sources of information, material conditions (farm assets), and market availability and population pressure [9]. The decisive factors (explanatory variables) can influence SWC adoption practices either positively or negatively, and either to increase or decrease the continuity of adoption. For instance; educational and wealth status, farm and livestock size, access to information and extensional services, slope and erosion levels, having good perception on the impacts and technological benefits, and roles in social groups/leadership status of the farmer has positive relationships and significantly affect adoption of SWC measures. In contrary; gender, tenure insecurity, distance of plots from homestead and markets, and good soil fertility condition has negative relationships and significantly affect adoption of SWC measures. Unfortunately; farmers' age, family size, off-farm activities, farming and cropping system has either positive or negative relationships on adoption of SWC measures. For example: age and farming experience has positive connotation for traditional/indigenous conservation practices, whereas it has negative implications to accept the new technologies quickly. Larger independent family members have positive connotation for the required labour forces, whilst dependent family members have negative relationship on adoption because of requiring higher food crops. Structural design (spacing & location) and time of implementing SWC practices can be highly determined by farming and cropping systems in the agro-ecologies. (*See Table3: Factors influencing adoption of SWC measures and their relationship with adoption continuity*).

Table 3: Factors influencing adoption of SWC and their relationship with adoption

T. No	Explanatory Variables	Expected relationship with adoption	Empirical evidences
1	Gender	negative	[7], [26], [5], [72], [1], [41], [9], [12], [2] and [19].
2	Non-ownership and tenure insecurity	negative	
3	Distance of plots from homestead and markets	negative	
4	Soil fertility condition	negative	
5	Educational status	positive	
6	Wealth status	positive	
7	Extensional services and access to information	positive	
8	Slope and erosion levels	positive	
9	Perception of land degradation as a serious problem	positive	
10	Technological attributes, benefits and profitability	positive	
11	Membership in social groups/leadership status	positive	
12	Land holding/farm size	positive	
13	Livestock size	positive	
14	Age	positive or negative	
15	Family size	positive or negative	
16	Farming and cropping systems	positive or negative	
17	Off-farm activities	positive or negative	

2.5. Solutions to Overcome Barriers of SWC

Different empirical studies were suggested various solutions to overcome the gaps and barriers of SWC adoption. The need to introduce SWC practices should be in terms of economically efficient and technically effective because farmers preferring only for their agricultural productivity and economic benefits [80]. SWC structures designing alternatives must be based on specific agro-ecological conditions like altitude, rainfall characteristics, soil properties, slope and farming system of the area [8]. Conservation and restoration of biodiversity should be considered in terms of their ecosystem interrelationships, interactions, processes and functions, so that, the targets must be in ecosystem approach for natural resources management [34]. SWC structures should be implemented according to their standards. Researchers, extensional experts and local farmers linkage must be strengthened in order to identify and disseminating appropriate technologies. Moreover; motivation of real community participation and equitable benefit sharing, amalgamation of the scientific and indigenous knowledge, enhancing diversification and intensification of production systems, appropriate research and extensional services, integration of interdisciplinary learning processes are highly required attention [65] and [73]. The government needs to improve land tenure security and promote farmers' awareness creation, capacity building, and training on land management and utilization [1] and [20]. Availability of affordable projects, fund raising and credit services, inputs and materials, infrastructures and information networks, sharing and scaling up of good experiences should be a focus of policy makers and development practitioners. In general, poverty alleviation and improvement of food security should be the main achievable goals in SWC practices. As any developmental activities, the practices should be evaluated in terms of their environmentally sound, economically viable and socially acceptable.

3. CONCLUSION

Land degradation is a temporary or permanent decline in productive capacity of the land. It is an international agenda of the 21st Century, because it has adverse impacts on costs of production and agricultural productivity, food security, environmental, social and political stability. It is a major problem facing the developing countries like Ethiopia, especially in the highland areas of the country. Because, the highlands has consisted with higher population and used as sources of the main staying of country's Economy, i.e. the traditional subsistence rain-fed agricultural production. Vegetation degradation (deforestation, losses in biodiversity and organic matter, and reduces in ecosystem goods and services); Soil degradation (declining in soil biodiversity, erosion, soil compaction, sealing, crusting, hard-setting, waterlogging, nutrient depletion, salinization and acidification); Water degradation (shortage of water, drying of water sources, siltation, eutrophication and water pollution); Air pollution (contaminations of atmospheric air and the surroundings); and Desertification (land degradation in dry lands) are the principal forms and processes of land degradation. In addition to natural factors of the area; land use change, overgrazing, land and agricultural mismanagement, inappropriate land use policy and tenure insecurity, limited access to inputs and extensional services, poverty, population growth, climate change are the main causative factors of land degradation in Ethiopian Highlands. Farmers have perceived the indicators of land degradation in the form of soil nutrient depletion; surface soil colour change (redness); soil surface crusting; stoniness and rock exposure; bare land and exposure of roots; pedestals and band sand dune formation; runoff and flooding; formation

of rill and gully erosion; change in colour of crop leaves (yellowish) and stunted crops; reduction in productivity; increasing costs of production and external inputs. The local farmers have also perceived the consequences of land degradation as water scarcity; fuel wood shortage; land abandonment and shortage; losses of biodiversity like wildlife; recurrent risks and disasters; bush encroachments and the prevalence of invasive species like weeds and pests; food insecurity; poverty; social instability; joblessness and conflicts are among the others. However, personal characteristics (sex, age, education status, family size); socio-economic paradigms (social position, wealth status, land holding size, livestock size, farming and cropping system, farm plot distance from home); bio-physical features (agro-ecological features and level of land degradation); political and institutional arrangements (tenure security, extensional and credit services, inputs, information networks, infrastructures and other incentives); and technological acceptance (effectiveness and profitable) were highly determined farmers' perception to understand the impacts of land degradation and to adopt SWC measures on their farmlands. In addition, policy and institutional barriers, knowledge gaps and inadequate technical support, economic and financial constraints are among the main challenges to adopt SWC practices. Therefore, newly introduced SWC practices should be in terms of economically efficient and technically effective as per of specific agro-ecological conditions. Motivation of real community participation and equitable benefit sharing; amalgamation of scientific and indigenous knowledge; awareness creation and capacity building; appropriate research development and extension services; accessible infrastructures and information networks; sharing experiences and scaling up of good practices are highly required to perceive causes and consequences of land degradation and to adopt soil and water conservation measures.

4. THE WAYS FORWARD

To ensure sustainable soil and water conservation measures in Ethiopian Highlands:

- ✓ Biophysical and socioeconomic characteristics of the area should be understood
- ✓ The scientific and indigenous knowledge of the community should be equally paid attention
- ✓ Upstream-downstream linkages and equitable benefit sharing must be in consideration
- ✓ The optimum balances between protection, production and development should be equally maintained in a watershed context. For example, physical structures must be combined with biological or agronomic measures
- ✓ Multi-disciplinary and multi-sectorial integration, diversification of incomes and specialization of production system should be considered approaches
- ✓ Awareness creation and capacity building, availability of incentives and real community participation at all stages must be strengthened
- ✓ The effectiveness and efficient of SWC measures must be timely monitored and evaluated, as well as it must be supported by research and educational institutions
- ✓ The national natural resource policies, proclamations, regulations and directives must be implementing effectively; otherwise, the gaps and limitations must be solved. It should be needed viable decentralization of authority over land resources and flexible into the contexts
- ✓ The government required to formulate national land use policy and strengthen modern land registration and certification to enhance tenure security and to adopt long-term SWC measures
- ✓ Poverty alleviation, creating job opportunities, increasing agricultural productivity and improving food security must be considered as the main achievable goals of SWC measures
- ✓ Further analysis will be required to understand these and other factors influencing farmers' perception on causes and consequences of land degradation and their decisions to adopt newly introduced SWC measures or to use their previous indigenous knowledge and practices
- ✓ Finally, any SWC interventions should be evaluated in terms of their technical effectiveness, environmental soundness, economic viability and social acceptability

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