Farm Households' decision to invest in Soil and Water Conservation in Ethiopia: Review

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Abstract – Land degradation in the form of soil erosion and nutrient depletion presents a threat to food security and undermining land productivity in the highlands of Ethiopia. Governments and development agencies have invested substantial resources to promote soil conservation investment practices as part of an effort to improve environmental conditions and reduce poverty. However, few rigorous empirical studies have produced mixed results on factors influencing farmers' decisions to invest in soil conservation investment practices. This review is aimed on farm household's decision to invest in soil conservation and the factors influencing farm household's decision to invest in soil conservation and the intensity of investment in Ethiopia. The review result suggest that farmer's decisions to adopt soil conservation investment practices and intensity of investment appear to be explained by different process. Therefore, this implies that the major change in soil conservation investments will require attention of all of these factors, because no single factor is controlling enough to be used single handily as a major policy leverage investment.

Keywords: Land degradation, Soil erosion, Soil conservation investment

1. INTRODUCTION

In most of the developing countries land is a primary means of production as it generates a livelihood for large proportion of the population. Economists point out that increasing agricultural productivity is an essential component of such a successful rural development strategy for several reasons. Firstly, food production increase helps to feed an inevitably increasing population. Secondly, excess production can be sold in rural and urban income-generating markets and thus enable to stimulate domestic demand and other well-being metrics. Finally, increasing the foods availability has beneficial effects on poor urban populations. Policymakers consider agricultural improvements as being essential to reducing poverty and a prerequisite for economic growth, especially in sub-Saharan African (World Bank, 2001).

The productivity of agricultural economy, which is the back bone of the country economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing lands **(**Leonard, 2003**).** Although other factors like shortage of rainfall and poor land management are the principal contributing factor to the low and declining agricultural productivity in Ethiopia, which is explained by the loss of soil fertility (Bayramin *et.al*, 2002).

Land degradation has been a major global issue since the last century because of its adverse impacts on an agronomic productivity, the environment and its effect on food security and the quality of life (Eswaran *et al.,* 2001). In Ethiopia, land (which includes soil, water and vegetation) is a vital resource, since agriculture is the most important economic sector .However, research has shown that this critical resource is in a state of serious degradation.

Almost all studies on land management issues in the Ethiopian highlands suggest that land degradation is critical factor contributing to declining agricultural productivity and extreme poverty (Mahmud and Pender, 2005). The causes of land degradation in the Ethiopian can be grouped into proximate and underlying factors. The proximate causes of land degradation include cultivation of steep slopes and erodible soils, low vegetation cover of the soil, burning of dung and crop residues, declining fallow periods, and limited application of organic and inorganic fertilizers. The underlying causes of land degradation include such factors as population pressure; high costs or limited access of farmers to fertilizers, fuel and animal feed; insecure land tenure; limited farmers' knowledge of improved soil conservation measures. The proximate causes of land degradation are the symptoms of inappropriate land management practices as conditioned by underlying factors (Berhanu, 2004).

The average annual rate of soil loss in Ethiopia is estimated to be 12 tons/hectare/year, and it can be even higher on steep slopes with soil loss rates greater than 300 tons/hectare/year, where vegetation cover is scant (USAID,

2000). Sonneveld (2002) also estimated that the loss of agricultural value due to land degradation between 2000 and 2010 would be $USD 7 billion; a huge sum in relation to current investments in sustainable land management. The poor soil management and land use practices are the causes of the high soil erosion rate (Nigussie and Fekadu, 2003).

The magnitude of land degradation (and deforestation) by far exceeds land conservation investment activities being carried out (Berhanu and Swinton, 2003). Indeed, it is only recently that public intervention in the soil conservation investment has become an important priority in Ethiopia. Land degradation was largely neglected by policymakers until the 1970s and national conservation program introduced since then have been guided by little prior research (Bekele and Holden, 1999). Policies and programs were adopted based on incorrect assumptions and little understanding of the incentives and constraints related to soil conservation investment which could be misleading and may even exacerbated the degradation.

Sustainable land management and the adoption of soil conservation technologies can be a pivotal tool for enhancing food security for smallholder farmers in Sub-Saharan Africa. Its role can be particularly relevant in the context of rain fed agricultural systems, characterized by notorious weather variability. Not with standing their importance in both food security and reducing weather variability, and despite number of national and international initiatives to encourage farmers to invest in them (Kassie *et al.*, 2012), however, the adoption of agricultural technologies in developing countries is still low (Somda *et al.* 2002; Tenge *et al.* 2004; Jansen *et al.* 2006; Wollni *et al.*2010). Given this state of conditions, review of the issue of what specifically determines the decision taken by farmers to invest in soil conservation investment technologies is very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation investment technologies. The objective of this review is to identify farmers' socio-economic, physical and institutional factors influencing household's decision to invest in soil conservation measures.

2. METHODOLOGY

Data were obtained from document analysis. It was undertaken using in-depth review of related literature from the internet and up to-date soil conservation investment reports of Ethiopian government. Both Published and unpublished materials such as articles and books, reports from government and non-government organizations, archives of stakeholders' organizations and some media reports both print and electronic were also explored.

3. DISCUSSIONS

3.1. Concepts of land degradation

Natural resources degradation in general and land degradation in particular has a great effect on the economies of developing countries (Ayalneh, 2002). It is one of the most critical environmental issues facing many countries today (Haw *et al.,* 2000). Land degradation and soil degradation often used interchangeably; however land degradation has a broader concept and refers to degradation of soils, water, climate, and fauna and flora (Alemeneh *et al.*, 1997). Land degradation refers to change in the qualities of soil, water and other characteristics that reduce the ability of land to produce goods and services that are valued by humans (Wiebe, 2002).

Land degradation is one of the major challenges in agricultural production in many parts of the world, especially in developing nations like Ethiopia. According to Blaikie (1989) land degradation is the reduction in the capacity of the land to produce benefits from a particular land use under a specified form of land management. On the other hand, according to Douglas (1994) and Hurni (1993) the unhindered degradation of soil can completely ruin its productivity capacity for human purposes and may be further reduced until steps are taken to stop further degradation and restore productivity.

Also, Land degradation is a complex phenomenon influenced by natural and socio economic factors. Most cost estimates of land degradation do not distinguish between soil erosion, soil degradation and land degradation in their analysis (Mahmud *et al.,* 2005). Broadly defined, land degradation is a reduction or loss of the biological or economic productivity and complexity of rain feed cropland, irrigation cropland or range, pasture, forest, and woodlands resulting from processes such as (i) soil erosion caused by wind and/or water;(ii) deterioration of the physical, biological or economic properties of the soil; and (iii) long-term losses of natural vegetation" (Pagiola, 1999).

Soil erosion is a particular physical process that causes land and soil degradation, and refers to wearing away of the land surface by water and/or wind as well as to the reduction in soil productivity due to physical loses of top soil,

reduction in rooting depth, removal of plant nutrients, and loss of water. Other forms of soil degradation includes other types of physical degradation such as compaction, surface sealing and crusting, water logging and aridification; chemical degradation, including depletion of soil nutrients ,acidification, salinization, and pollution; and biological degradation, including loss of soil organic matter, flora and fauna populations or specious in the soil (Scherr, 2000). In Ethiopia, among others, removal of top soil through water erosion, nutrient depletion through the removal of dung and crop residuals, off-site costs through sedimentation of water storages and lakes are believed to be major land degradation problems (Gete *et al.,* 2006).

3.2. Causes and Consequences of Land Degradation

Over the past 10 years the occurrence of agricultural and environmental crises in Sub Saharan Africa (SSA) has become increasing, soil erosion, soil fertility loss are considered to be undermining the productive capacity of agricultural systems. These problems have been ascribed to many different causes, including social, economic, institutional, biological and physical factors (Benine *et al.,* 2002). Land degradation is believed to be the direct causes of population pressure, poverty, limited access to agricultural inputs, information and credits, low productivity of agricultural production practices, fragmented and insecure land holdings (Tesfaye, 2003).

Land degradation is caused by multiple forces including extreme weather conditions particularly drought, and human activities that pollute or degrade the quality of soils and land utility negatively affecting food production, livelihoods, and the production and provision of other ecosystem goods and services (WHO, 2015).

The direct and indirect causes of land degradation are linked by chain of causes and effect called vicious cycle/causal nexus. Limited land resources and increase in rural population are the two external or deriving forces for poverty. Land shortage and poverty, taken together, lead to non-sustainable land management practices which are the direct cause of land degradation. Theoretically, there are two types of views about population according to FAO (1986): neo-Malthusian argue that population pressure has resulted in land scarcity, fragmentation of and holdings, reduction of fallow periods, shifting crop patterns, accelerated conflicts and completion over land use, and environmental land degradation. On the other hand, some argued population growth as a stimulus for agricultural intensification and environmental recovery. According to (Boserup, 1961) land becomes increasingly scarce, farmers adopt cultivation practices and input in order to preserve and improve their land. Increasing labor-land ratios determines the path of technical change, leading to the mix of technology and new inputs associated with improved land management.

Many of Sub-Saharan countries are among the poorest in the world and the farming populations constitute both the majority and the poorest segments of these societies. Poverty may lead to inability to invest in soil conservation and the survival strategies may be detrimental to the natural resource bases (ILRI, 2000). The combination of low economic growth, rapid population growth and environmental degradation impose a self-reinforcing vicious circle which worsens poverty and environmental deterioration unless to deal effectively with the problem of land degradation.

Poverty is very likely to contribute to land degradation for many reasons. When people lack access to alternative source of likelihood, there is a tendency to exert more pressure on a few resources that is available to them. Bekele and Holden (1998).

The joint effect of wide spread poverty, land degradation, population pressure, and institutional failures etc. in Ethiopia has in recent times begun to manifest itself in deteriorating food security even in years of good weather condition for agriculture. In this respect (Hurni, 1993) reported that in Ethiopia areas that suffer from frequent famines are also those exhibiting highest annual rates of soil erosion.

3.3. Empirical Studies on Soil Conservation Decisions

Agricultural production in Ethiopia is highly influenced by a decline in productivity due a decline in soil fertility. Soil erosion is a great threat to the nation's future food security and development prospective. On top of this, farm households' land use and conservation decisions are likely to be influenced by a number of factors. Due to this, numerous empirical technology adoption studies have been conducted for the last many years by different researchers with in and out of the country. The results of these studies, however, are inconsistent. In this section attempts will be made to illustrate the findings that have been drawn from these studies. Lynne *et al.* (1988) on their study on attitudes and farmers conservation behavior stated that, factors such as income and nature of

terrain were found to affect conservation behavior. Farmer's attitude influences the amount of effort exerted in conservation. The authors also suggested other factors including attitude towards investment risk, extension education and percentage of cultivated land affect conservation decision.

A study conducted by Laper and Pandy (1999) showed that the high cost of establishment, maintenance and the loss of land to hedgerows are considered to be the major constraints to adoption by non-adopters. The economies of the contour hedgerow system are found to improve substantially if crop intensification or cash cropping is possible. In the marginal environments on site benefits alone may not be sufficient to justify investment in soil conservation.

A study made by Baidu-Ferson (1999) indicated that higher percentage of degraded farm land, extension education, lower risk aversion, and the availability of short term profits are important for increasing the adoption and intensity of use of improved technologies. A study conducted by Wagayehu (2003) on soil and water conservation decision behavior of subsistence farmers in the Eastern high lands of Ethiopia, showed that, plot area and slope, access to information, and project assistance have positive and significant influence on conservation decisions. Whereas, family size and the land holding per economically active persons in the family was found to have a negative influence on decision.

A study conducted by Tesfaye (2003), On SWC use in Konso, Wolita and Wello, Ethiopia; indicated that land size, livestock ownership, family size, risk perception, land tenure on non- arable lands, labour organization, characteristics of technology, indigenous institution and physical factors are significant determinants of SWC. He pointed out that farmers' SWC decision are affected by the interplay of social economic and institutional factors. Bekele and Holden (1998), found that peasants' decisions to retain conservation structures are positively and significantly related to soil erosion perceptions, attitudes towards new technologies, exposure to new practices, per capita availability of cultivable land, parcel area and slope, and productivity of technology.

A study conducted by Yitayal (2004) showed that, slope and distance of the farm plots significantly influenced the use of both traditional and improved soil conservation measures. Area of cultivated land increased the probability of using improved soil conservation measures especially, improved soil bund and cutoff drain. Farmer's age decreased the use of improved soil conservation structures while education level of head of households has positive impact on soil conservation. Extension education had a substantial contribution to motivate the use of improved soil conservation measures but, it had no effect on the use of traditional soil conservations practices. Land to labor ratio affected the use of both traditional and improved soil conservation practices.

According to study of Biruk (2012), distance of the plot and off-farm income were found to be statistically significant in influencing the probability of investing on improved conservation measures, total farm size, plot area, participating in training, and availability of labor force were found to be statistically significant in influencing the extent of investment on improved soil conservation practices. The result also showed that farmers located far away from their farm plots, knowledge of the existence of conservation technologies, perceived security of tenure, access to extension service had lower probabilities of investing in conservation activities and made lower investment than other farmers. Also Nonfarm income of the respondents was an important determinant of farmers' investment decisions. Finally the result of the double hurdle model showed that livestock holding was also important determinant of farmers; decision to invest on soil conservation.

A study conducted by Stefania (2013), showed that, the relationship between tenure insecurity and land-related investment has been widely studied in the literature. The sources of tenure security considered range from lack of land titles (Bezabih *et al.*, 2012), short-term tenancy contracts (Bandiera, 2007), lack of transferability (Besley, 1995) and risk of expropriation (Deininger and Jin, 2006). Fewer studies have considered the relationship between tenure insecurity and investments in soil conservation (Gebremedhin and Swinton, 2003). Similarly, Stein T. *et al.* (2009) show that the Ethiopian low-cost land certification programme had a positive impact on investment and maintenance of soil conservation structures.

Lack of secure rights on land decreases farmers' incentives to invest in land improvement (Besley, 1995). Moreover soil conservation investment is constrained and influenced by credit facilities, extension service, infrastructure availability, household endowment and household and farm characteristics. A study conduct by Senait (2005) showed that land owner ship type, distance of farm plot from home stead, resource availability and

contact with extension agents were found to be the most important factors affecting choice of land management practices such as use of commercial fertilizer, manure, stone/soil bund or a combination of them.

A study conducted by Mulugeta (1999) showed that land security, size of cultivated land, technology specific characteristics, formal schooling, wealth status of the household, availability of off-farm income and assistance from different sources were important determinants of adoption of physical soil conservation practices. A similar study by Adebabay (2003) reported that participation in conservation programs, land security, perception of soil erosion problem, the available land labour ratio and educational level of a household head were found to be important and significant factors for adoption of improved soil conservation technologies.

A study of Berhanu and Swinton (2003) found that land tenure security was a major factor that significantly conditions the conservation technology adoption. A farm household's expenditure on land conservation practices and input uses can consume a significant share of its overall expenditure. Land conservation and input uses, thus, imply that the household foregoes other consumption and/or investment opportunities, at least temporarily.

Sustainable land management and the adoption of soil conservation technologies can be a pivotal tool for enhancing food security for smallholder farmers in Sub-Saharan Africa. Its role can be particularly relevant in the context of rain fed agricultural systems, characterized by notorious weather variability. Notwithstanding their importance in both food security and reducing weather variability, and despite a number of national and international initiatives to encourage farmers to invest in them (Kassie *et al.,* 2012), however, the adoption of agricultural technologies in developing countries is still low (Wollni *et al.* 2010). While several factors has been identified as barriers to soil conservation investment in Africa, short term planning horizons resulting from poverty and market imperfections are argued to be strong contributors to making investment in soil conservation unattractive (Pender,1996). Poverty and environmental degradation in developing countries form a nexus in which resource degradation, caused by heavy dependence on natural resources and agricultural stagnation, leads to deepening poverty further dependence on ecologically fragile environments (Dasgupta and Maler, 1994). These effective links between poverty and environmental degradation are formed by the absence of good access to credit and poor cash liquidity (both facets of notorious market imperfections), which lead to significant consumption-smoothing problems and, thereby, high subjective discount rates (Pender 1996). In this respect, individual RTPs can be indicators of the level of poverty and immediate consumption smoothing problems of people living in rural areas in developing countries where credit and other markets are poorly developed (Holden *et al.,* 1998).

3.4. Concept of soil conservation investment

The conventional western approach to soil conservation is a recent phenomenon in Ethiopia, through farmers do use traditional measures. Since the 1960s, various soil conservation strategies have been introduced to enhance agricultural development and rural livelihoods (Keeley and Scoones, 2000). The 1970s and 1980s, the period when large scale conservation project got underway, were remarkable in the history of soil conservation in the country. Huge sums of money poured in form of international donors for the execution of the projects. Although the achievements were remarkable in quantitative terms, the impacts of these efforts were far below expectations and land degradation continued to be a serious problem. In an effort to combat degradation and rehabilitate resources, soil conservation and forestry activities have been ongoing and have progressed substantially.

In the past, the bulk soil conservation activities were targeted to the eastern and northern parts of the country erosion and degradation have severity reduced the agricultural potential. The western parties of the country; that means the relatively high agricultural potential areas, have not attracted attention. Some people have expressed concern that this could be a mistake, since today's degraded and low-potential areas. However, low (even negative) returns to soil conservation investments in high rainfall areas (Herweg, 1993) because they reduce crop area, harbor pests and cause water logging.

The majority of planned and implemented activities within the country soil conservation program are physical measures such as construction and maintenance of soil and stone bunds, which in aggregate are known as terracing (CEDEP,1999).Construction and maintenance of check dams, waterways and cutoff drains are also undertaken, but these are less common, as they are more costly. In the high rain fall areas, proper alignment of terraces with respect to the flow of runoff is a challenge, as there is rarely any integration with drainage structures such as water-ways and cutoff drains. Similarly to soil conservation measures, trees are another form of land-related investment that can increase productivity in the future but also generate short-term profits. Growing a mix

of trees and annual crops, in fact, is generally more profitable that growing only crops (Bandiera, 2007). Understanding the complementary factors to soil conservation in the face of climate change would therefore aid in the design and implementation of sound conservation practices.

The overlap technologies those are central to the pursuit of sustainable intensification, a concept that appears frequently in recent debate. But the equivalent of the concept of Sustainable intensification can be found in Boserup (1965). She posits that, under population pressure and increasing constraints to arable land as farmers' intensity by cropping more on the same land, they can protect the land with land improvements such as terraces and bunds, and sustain soil fertility by use of fertilizer and manure. Such improvements can greatly increase yields and reduce degradation.

However, Heady and Vocke (1992), notes that poor rural households put immediate food security and income objectives first, possibly relegating environmental enhancement to second tier. Hence it is not certain that households will necessarily want to or be to take longer term measures to sustain the land; this is reflected in rapid land degradation in many rural areas and the relative rarity of spontaneous investment (outside of government or donor programs) in soil conservation. Polices (macroeconomics, sectorial, institutional, infrastructural, research, and extension) can strongly affect the desire to and capacity of households to undertake soil conservation investments (investments such as bounds and terraces) (Barbier, 1990).

Rural household considered as the primary actors responsible for agricultural growth and for soil conservation investments (Reardon and Vosti, 1995).they act within a complex institutional, socio-economic and physical environment. Also Soil conservation investments differ (in nature and determinants) from the "productivity investments" about which much has been written during the technology adoption and Green revolution debates in the1970s and 1980s (Feder *et al.,* 1982*).* Soil conservation measures can help preserve soil nutrients and prevent productivity losses in the future (productivity-enhancing mechanism), on the other hand, conservation investment could help consolidate the tenure security of land-users. Similarly, Stein T. *et al.* (2009) show that the Ethiopian low-cost land certification programme had a positive impact on investment and maintenance of soil conservation structures.

Adaptation through sustainable land management practices enable farmers and communities to adapt to climate change by increasing food production, conserving soil and water, enhancing food security and restoring productive natural resources. As a result of an increase in potential erosion rates due to climate change, agricultural productivity can be reduced by 10% to 20% (Delgado *et al.,* 2011). Understanding the complementary factors to soil conservation in the face of climate change would therefore aid in the design and implementation of sound conservation practices. Accordingly, a growing body of literature identifies a strong link between climate change and soil conservation. For instance, Kassie *et al.* (2007) indicates that the effect of mean annual rainfall on the adoption of stone terracing varies based on agro ecology type. Their findings show the significant productivity benefit of the technology in conserving moisture in drier areas compared to higher rainfall areas. In general, however, the results have been mixed, in particular for sub-Saharan Africa. Empirical studies have also found that land related investments can enhance security and therefore suggest a causal relationship that works in the opposite direction (Brasselle *et al.*, 2002).

4. CONCLUSIONS AND RECOMMANDATIONS

The review result suggest that the decisions to adopt soil conservation investment practices and intensity of investment appear to be explained by different process. Firstly they classify the causes of soil erosion, which is the main form of land degradation in developing countries in to physical and human factors. This source further explained that population growth and apparently decline in holdings (fragmentations) are the first most important perceived causes of human induced land degradation. As population increases many farming households are pushed to poor marginal agricultural lands where inadequate and unreliable rain fall, adverse soil condition, fertility and topography limit agricultural productivity and increase the risk of chronic land degradation. This suggest that in promoting SWC technologies to farmers, attention needs to be paid to the agro ecological variations of the farming environment and socio-economic characteristics of the target groups, and the need for designing and implementing appropriate policies and programs that will influence farmers' behavior towards the introduction of soil and water conservation measures in their agricultural practices.

Nonfarm income of the farmers, land size, livestock ownership, family size, risk perception, land tenure on non-arable lands, labour organization, characteristics of technology, physical factors; distance of the plot and off-farm income, farm size, plot area, participating in training or access to extension, knowledge of the existence of conservation technologies ,perceived security of tenure and availability of labor force were found to be statistically significant in influencing the decision to adopt soil conservation investment practices and intensity of investment.

Livestock holding, distance of the plot, availability off farm income, knowledge of conservation practices or knowledge of the extension technologies, perception to security of tenure or farmer's belief of land ownership, access to extension, farm size, participation in training, fertility, wealth status, formal schooling and availability of labour force determine the intensity of soil conservation investments. Also poverty-related factors seem to have a mixed effect on both the adoption and intensity decisions. This implies selecting priority intervention for soil conservation investment practices should be needed by considering various socio-economic, Institutional and physical factors.

Also, the review result would provide firsthand information on the factors influencing the use of improved soil conservation technologies for different government and non-government organizations, extension agents working on this sector and other similar areas. Researchers would also use as stand point for further detail investigation. Therefore, the review show that even if, majority of the farmers have perceived the problem of soil erosion on their farm plots, farmers' perception on the problem of soil erosion on their farm plots was not significant on probability and intensity use of improved soil conservation technologies. This might be due to lack of willingness and/or ability of farmers to use improved soil conservation technologies. Which needs focus on enhancing the willingness and/or ability of farm household heads to use improved soil conservation technologies.

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