Land degradation and Determinants of Farmers' Investment In Sustainable Agricultural Practices: The Case of Dangila District. Amhara Region, Ethiopia

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I hereby certify that I have read this thesis prepared under my direction and recommend that it be accepted as fulfilling the thesis requirement.

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We certify that, as members of the Examining Board after open thesis defense, we have read and evaluated the thesis prepared by **Haimanot Atinkut "Land Degradation and Determinants of Farmers' Investment In Sustainable Agriculture Practices (SAPs'): The Case of Dangila District, Amhara Region, Ethiopia"**, and recommend that it be accepted as fulfilling the requirements for the degree of Master of Arts in Environment and Development Studies.

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DEDICATION

This Thesis is affectionately dedicated to my mother ***Dasash Berie,*** *for her unthinkable to pay, spiritual encouragement and many sacrifices for me to reach this level.*

DECLARATION

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BIOGRAPHY

The author of this research was born from Dangila District, Amhara region, Ethiopia, in April 29, 1988. He attended Chara Primary School and Dangila General Secondary and Preparatory School. He completed his B.Sc. degree in Rural Development and Agricultural Extension from Wolaita Sodo University, Ethiopia, in 2010.

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ACRONYMS

ANRS	Amhara National Regional State
BoFED	Bureau of Finance and Economic Development
CC	Contingency Coefficient
CSA	Central Statistics Authority
DA	Development Agent
DAP	Di-Ammonium Phosphate
EEA	Ethiopian Environmental Authority
EMA	Ethiopia Mapping Agency
FTC	Farmer Training Center
GDP	Gross Domestic Product
GO	Government Organization
GTP	Growth and Transformation Plan
IPMS	Integrated Pest Management System
NGO	Non-Governmental Organization
Ha	Hectare
IFAD	International Fund for Agricultural Development
MDGs	Millennium Development Goals
MOA	Ministry Of Agriculture
MOARD	Ministry Of Agriculture and Rural Development
SAPs'	Sustainable Agricultural Practices
SCRP	Soil conservation Research Project
SMS	Subject Matter Specialist
SWC	Soil and Water Conservation
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor

Land Degradation and Determinants of Farmers' Investment In Sustainable Agricultural Practices: The case of Dangila District, Amhara Region, Ethiopia

Haimanot Atinkut **Addis Ababa University, 2014**

ABSTRACT

Agriculture is an engine for Ethiopian economy; however, its productivity still low due to land degradation reaches hostile situation. The recommended treatment for land degradation may be shift the all previous conventional farming into sustainable agricultural practices. Sustainable agricultural practices(SAPs') is a set of practices that increase productivity while conserving soil, which put on firm foundation of conservation tillage, use of compost, fallowing farm, legume intercropping and crop rotation. Despite use of sustainable agriculture is a panacea for aggravated land degradation particularly, for soil erosion and nutrient depletion and maximizing crop produce, but it seems a plateau for farmers in the study area. This is due to many factors hampered negatively farmers' perception and investment in SAPs' in the year 2013. This study, therefore, assessed land degradation status and factors that facilitating or impeding farmer's decision on investment in SAPs' in Dangila district, Amhara Region, Ethiopia. The multistage sampling procedure was used to identify kebeles and sample respondents. In the first stage, the study area was purposively selected because of the presence of SAPs' practices and researcher's preference. Then, sample rural kebeles in the district were stratified into agro ecology; woina dega and kola, of which, Demisa and Wufta-Datie kebele were selected randomly and a total of 120 sample respondent were selected randomly proportion to size from identified kebeles. Both qualitative and quantitative data were collected from sample respondents. While qualitative data were generated from observation, focus group discussion and key informant interviews using checklists, Quantitative were collected from selected sample respondents using structured interview schedule during survey time from January to February 2013. The questionnaire was pre-tested, revised and administered by well trained enumerators recruited from the study area. Descriptive statistics such as frequency, mean, standard deviation, t-test and x^2 were used to summarize the data while binary logit model was used to identify the most important factors that determine households decision to invest in SAPs'. Among total sample respondents, 21.7 were investors and the rest 78.3 were non-investors. Age, farm size, and plot distance were had significant mean difference between non-investors and investors. On the other hand, sex, educational status of household head, participation in kebele administration, soil fertility status and slope of plot were correlated to investors of SAPs'. Results of binary logit model indicated that sex of household, age of household, soil fertility status, slope of the plot, number of plot, plot distance, land use, labor availability, TLU, extension contact and participation in kebele administration had significant influence on farmers' investment of sustainable agriculture practices. Generally, the result of this study indicates that land degradation is the aggregate of many factors, which should be given due attention in the innovation and transfer of agricultural technologies like SAPs'.

Key words: Land degradation, Sustainable agricultural practices, Dangila district, Binary logit

INTRODUCTION

1.1 Background of the Study

Ethiopian Economy is based on agriculture, which accounts 46 percent of GDP and 85 percent's of total employment. Moreover, agriculture is the single most important source of food for the nation (World Bank, 2013). In countries where agriculture is the mainstay of the economy, land degradation in smallholder farming is one of the fundamental consequences of environmental problems causing low agricultural productivity. The dependency of livelihoods of majority of the people on agriculture results in fast and vast land degradation. Land degradation mainly in the form of soil and nutrient depletion from the top horizon of soil has become one of the most important environmental problems (Genene, 2006). Coupled with fast growing population, erratic rainfall and poverty; land degradation poses a serious threat for declining of agricultural productivity of the nation (Bekele and Holden, 1998). This sector also suffers from poor cultivation practices and frequent drought, but recent joint efforts by the government of Ethiopia and donors have strengthened with terrible starvation (Genene, 2006; Mesfin, 2010).

Land is the most important natural resource in this planet. It is a place from which humans beings are exploiting a number of resources (Taffa, 2002). Almost all necessary inputs and source of food found from land. However, land is losing its productivity due to a rising trend of land degradation (Woldeamlak, 2003; Genene, 2006). The well known proximate causes of land degradation are deforestation, overgrazing, limited soil and water conservation, burning of dung and crop residues, limited use of organic matter and declining use of fallow (Bekele and Holden, 1998; FAO, 1995; Wagayehu, 2003).

Land degradation is an old problem for Ethiopia but new in attracting attention of policy after 1973/74 the devastating famine in Wollo. Although following this worse effect of land degradation, to overcome the problem, Ethiopia has been launch afforestation and conservation programs since 1980s with the support of GO and NGO; however, success of it is limited (Bekele and Holden, 1998; Genene, 2006; Derejaw, Bekabil, and Wagayehu, 2013). Among many reasons inappropriate farm practices manifested by frequently growing cereal crops without using crop rotation, continuous and long term tillage and less planting of cover crops

(Guto *et al.*, 2011). This rooted practice invite excessive soil erosion by wind and water (runoff) and consequences the loss of soil productivity (Ibid). Land degradation in the form of soil erosion gets attention in this study. Similar to other parts of country, Agriculture in Dangila district is dominantly practiced rainfed and small irrigation. The vivid mixed farming practices in the study area includes conventional tillage, over grazing, less use of inorganic and /or organic fertilizer which resulted in decline of productivity due to land degradation reaches hostile situation. Despite of natural resource conservation program held in 1980s throughout the country including the study area, thus, have made conservation structures were not maintained. Investments in soil and water conservation measures mainly in the construction of terraces, soil and stone bunds, gully treatment, BBM, irrigation, drainage, use of inorganic fertilizers, etc. contribute to improved land management. Most of land conservation activities done through campaign, forceful and unwillingly participation of farmers, money punishment followed absence during construction and constructed by unskilled practioners like traditional midwifery in the study area.

Moreover, due to different reasons farmers removed previously constructed SWC structures from their lands (Yeraswork, 2000).The household decision to invest on land conservation may be thus depend on perception on the erosion problem, willingness, knowledge of household, technology, land, labor and farm attributes (Ervin and Ervin, 1982; Bekele & Holden, 1998). Besides, most of farming households have risk averse behavior; problems come following sustainable land management practices such as insecurity of land tenure, lack of incentives, unsuitability of land for farm operation, shortage of land and overpopulation (Bekele and Holden, 1998; Dessalegn, 1994). Significant progress has been made in increasing production over the last four decades; however, productivity has not increased significantly (Pretty et al., 2011). The major increase in production comes from expansion of land under cultivation and shorter fallow periods. Population growth is continuing, however, arable land is shrinking in many areas (Birhanu and Swinton, 2003). Thus, the extensification path and the practice of letting the land lie fallow for long periods are rapidly becoming difficult, making continuous cropping a common practice in many areas. This leads to land degradation, low productivity, and poverty in the nation. Increasing productivity through expansion of agricultural technologies is a key, if not the only, strategy option to increase production (Hailemariam, 2012). The new agricultural paradigm concerns on save and grow strategy compatible with idea of sustainable

agriculture system. The principles of sustainable agricultural practices (SAPs') are environmentally friendly, resource conserving, technically viable, economically and socially acceptable (FAO, 1989). SAPs' is not a single practice instead have multiple components such as reduced tillage, fallowing of land, use of manure or cattle dung and leguminous cropping (Ibid). Among multiple components of SAPs' reduced tillage, legume cropping, fallowing farm and use of compost get focus in this study. This agricultural practice helps to arrest land degradation problems and curb to productivity. Hence, use of SAPs' has deserved the environment, increase soil fertility, and increasing agricultural productivity has been well recognized all over the world. Moreover, it makes better use of agricultural resources through the integrated management of available soil, water and biological resources, combined with limited external inputs and additionally contributes for environmental conservation. Empirical studies (Bekele and Holden, 1998; Kassie et al., 2012) indicated that to reverse soil erosion and to go optimistic direction fulfilling the needed requirement, adopting and adapting more resilient, intensified and sustainable agricultural production systems is a priority action for smallholder farmers.

Unluckily, Smallholder farmers may fail to fully accept suggested agricultural technology packages due to many factors including resource and information constraints in line with land tenure right, credit and market (Bekele and Holden, 1998). Different stakeholders' linkage includes researchers, extension workers and farmers work without or with weak cooperation and consideration of local situation introduction of new technology that exacerbates the problem instead of minimizing the problem (Isaac *et al.*, 2009; Oreszczyn *et al.*, 2010). Nevertheless, SAPs' is option less and hospitable to land, water, livestock husbandry and crop management practices that aim to improve productivity, profitability and sustainability. Cognizant the potential benefits that SAPs' may preserves advocacy for stakeholders specially, the lion-share, smallholder farming households involve in this sector. Moreover, introduced technology package are disseminated as blanket for all areas without considering agro ecology and farmers participation but should be smart, flexible and adaptable to local conditions by (Moti, Bekele, and Menale, 2012).

1.2 Statement of the Problem

Transforming agriculture and expanding eco friendly agricultural practices is a precondition for sustained economic growth. In Ethiopia, population is increasing at alarming rate; farm size had shrunk from 2 ha to less than one ha in recent years. This results land degradation in the form of soil erosion and nutrient depletion, gets attention in this study. The main responsible causes of soil erosion include wind, runoff, overgrazing, expansion of cultivation and improper farming practices manifested by continuous cultivation and plough of highly steep slopes.

This study was conducted in Dangila district, found in Amhara regional state, which was highly productive area in the region. This area has a potential of produce all varieties of crops and livestock with both rain fed and irrigation farming. The district was gifted with abandoned fertile soil, inclined and highly steep slopes and natural amenities like Tiski waterfall. Agriculture is the major livelihood activity and source of income generation for Ethiopia, in particular Dangila district farmers with slash and burn farming, frequent tillage including highly steep slope ends up with soil erosion, moisture loss, low crop and livestock productivity.

Nowadays, this area exposed to soil fertility depletion, moisture shortage, erratic rainfall, food insecurity and decline of agricultural productivity. These results brought due to practicing cereal mono cropping, collection of crop residue after harvest, free and overgrazing of communal land, population growth, and deforestation like other highlands of northern Ethiopia. Unbalance land management interventions with the current level of land degradation is still a growing challenge to smallholder farmers on the degraded area to meet both immediate economic objectives and sustainable environment. Thus, adoption of sustainable agricultural technologies and innovations gain due attention because of it is assumed to provide increase productivity to assure food security and arrest soil erosion, in line with millennium development goals (MDGs) and GTP of the country. Agricultural technologies like SAPs' (e.g. improved crop varieties, chemical fertilizer, pesticides, fallowing farm, compost use, legume cropping) are quit important to replenish soil erosion, water shortage and food insecurity. These practices play non-commensurate role in terms of safeguarding the environment, keeping soil health, moisture, adding humus, increasing productivity and assuring food security. In Sub Saharan Africa indicate that most of adoption studies to date conducted in the country broadly focused on emphasized on green revolution technologies e.g. adoption of improved crop varieties, chemical fertilizer, modern beehives, SWC measures in both arid and watershed areas, and crop protection

(Kassie et al., 2011). The attention given for adoption of SAPs' up to now is very low. Research into the determinants of investment in SAPs' has, however, been limited. Different soil conservation activities have been undertaken throughout the country including the study area by government like communal terrace, trench, soil bund, broad bed maker (BBM), stone bund, cut off drain and the like. Despite of this, most of resource conservation activities have been one season and couldn't so far from becoming buzzword. Furthermore, effectiveness, technical feasibility and sustainability of physical SWC structures also questionable. Farmers' decision to accept and implement multiple components SAPs' which are interrelated activities may be impede by their perception to land tenure, farm size, labor and cattle holding. Thus, soil erosion problem still become visible and persist major causes for low productivity. In Ethiopia, in response to extensive degradation of the resource base, new land conservation technologies were introduced in some degraded and food deficit areas, mainly through food-for-work in the early 1980s (Bekele and Holden, 1998). Despite these efforts, the natural resource base is deteriorating from time to time. It will be difficult protecting the natural resource base, unless perception of farmers to land degradation hazards changed towards the natural resource management. Farmers perceive level of land degradation differently. They have different perception levels for the environmental benefits of their farmlands they are willing to get. In the same manner, farmers have different tackling actions based on their perception levels.

Soil erosion due to high tillage frequency and other soil management problems has seriously affected over 25 % of the Ethiopian highlands (Kruger *et al.*, 1996). Such detrimental effect of soil erosion and water stress can be improved to some extent by other management options like SAPs', including reduced tillage, use of fallow, constructing SWC structures with regular maintenance, use of manure and legume cropping. Concurrently, farmers condition and know how about new technology in Dangila district is limited because of lack of information on the practices, escalating price of inputs and demand for crop residue as fodder. This inhibits investment in reduced tillage, leguminous cropping and compost use. The objective of this paper is to fill this gap, identify farmers' perception and understating soil erosion, explore factors that affect farmer's decision to invest in sustainable agricultural technologies and practices.

1.3 Objectives of the Study

The overall goal of this study is to explore farmers' perception of land degradation and factors that determine farmers' decision to invest in SAPs' in Dangila district. Specifically this study intended to address:

- To identify farmers perception and understanding of soil erosion problem
- To assess factors affecting for the use of selected SAPs' in the study area.
- To explore the association of between soil erosion and SAPs'.

1.4 Significance of the Study

This study will be important for the Agricultural office of Dangila district by providing information and good opportunities to extend for other areas having the same agro ecological and some other characteristics with slight modification. This study was investigating level of soil fertility status, crop-livestock productivity, and related problems and provides information on the study area. SAPs' have ample benefit like safe guard the environment, improving agricultural productivity, saving labor and time. SAPs' are applicable to all crops including annual crops, horticultural crops and tradable crops. It is a holistic approach to farming and includes integrated pest management system (IPMS). Moreover, SAPs' will be the future development direction of our country because it is a key to adapt and mitigate climate change, to conserve water and soil, keep the quality of soil , increase agriculture and safeguard environment as a viable concept towards sustainable development. This study was generate information on farmers understanding problem of land degradation and their decision behavior on investment in some components of SAPs' such as crop rotation, use of compost, reduced tillage, and legume cropping which provide calls for the need to bring on desk various stakeholders including farmers, farmer organizations, government and its agents, NGOs, the private sector in Dangila district.

1.5 Scope and Limitation of the Study

Since the study is focus in investigating the level of soil erosion and farmers reaction as a treatment using locally viable SAPs' in Dangila district is the first of its kind. The study was carried out by surveying a sample of 120 farm households from two rural kebele administrative. The study was generate information on sample households by assessing mainly four factors such as personal and demographic, socio-economic, plot characteristics and institutional factors that may hinder farmers decision to invest in SAPs' in order to taste the fruits of it. Since this study take assuming representative sample of the district population because of budget and time the study may or not representative of the entire population of the district. Therefore, its scope is limited in terms of coverage and depth owing to financial and time resources.

1.6 Organization of the Thesis

The rest of this thesis is organized into five chapters. Chapter Two reviews the relevant literature that includes definition of important terms and concepts of land degradation, causes and consequences of land degradation, farmer's perception of land degradation, and the concept of sustainable agricultural practices. In Chapter Three, brief descriptions of the study area and research methodology are presented. Survey results are discussed in Chapter Four. Finally, Chapter Five presents conclusions and recommendations of the study.

2. LITERARUTE REVIEW

This chapter contains mainly concepts of land degradation, causes and consequences of land degradation, farmers' perception of land degradation and in part two concepts of sustainable agriculture and conceptual framework of farmers' decision to invest in SAPs'.

2.1. Definition and Concepts of Land Degradation

Land degradation: It is defined as the loss of utility or potential utility through the reduction of or damage of physical, socio-cultural or economic feature, and/or reduction of ecosystem diversity. There may be a single cause or a complex mix of causes. According to (FAO, 1994), land degradation is the temporary or permanent lowering of productive capacity of the land.

Nutrient depletion: nutrient depletion refers to the deterioration in soil physical, chemical and biological properties. Soil nutrient depletion occurred when the inflows of nutrients to the soil through manure, chemical fertilizers, biological nitrogen fixation, addition of waste or plant materials from outside the system, atmospheric deposition, and sedimentation are less than outflows due to the crop harvesting, removal of crop residues, erosion, leaching and gaseous losses (Stoorvogel and Smaling, 1990).

Soil degradation/soil erosion/: soil degradation is caused by natural and human factors. According to (Oldeman et al., 1991) soil degradation is a process that describes human induced phenomena, which lower the current and/or future capacity of the soil to support human life.

In a general sense, soil degradation could be described as the deterioration of soil quality, or in other words the partial or entire loss of one or more functions of the soil.

Soil and water conservation: are not simply structures defined strictly by engineering parameters: they are the sum of practices involved in managing soil and water in agricultural setting also include agro-forestry, agronomic and tillage practice (Reij, 1991).

Land being the critical agricultural resource (Carlson et al., 1993), it is the basis for survival of most people in Ethiopia. The largest proportion of the GDP and employment for labour is contributed from the agriculture sector. Despite of this, land is seriously threatened by land degradation throughout the country, threatening both the economic and survival of the people.

Land degradation in Ethiopia is a severe problem that leads to low agricultural productivity, which enforces the government to introduce land conservation technologies. Natural resource

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 (Genene, 2006). Land degradation and soil degradation are often used interchangeably; however land degradation has a broader concept and refers to the degradation of soils, water, climate, and fauna and flora (Alemeneh et al., 1997).

Land degradation refers to changes 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). Though there are many forms of land degradation, soil degradation is the main focus of this research work. Soil degradation is a specific subset of land degradation that describes a decline in the soil quality encompassing the deterioration in physical, chemical, and biological attributes, which commonly manifest itself through soil erosion, soil fertility depletion, soil compaction and soil pollution (Alemneh et al., 1997; SADAOC, 2002).

Soil erosion is not a new phenomenon: it has been a problem since human beings started cultivating the land (Gete, 2000). In much of the Ethiopian highlands soil degradation that is caused by soil erosion has reached a stage where it is increasingly difficult to even maintain the present day production of basic foods, a level that is already insufficient in some regions (Gete, 2003). Soil degradation is a major environmental problem causing wide spread and serious impacts on water quality, biodiversity and the emission of climate changing green house gases.

In African context the introduction of conservation practice as an aspect of public policy is related to colonial history (Atakilite, 2003). It is widely perceived to be a major problem in sub-Saharan Africa (Scoones et al., 1996). In Ethiopia the exact time when accelerated erosion became a human problem is not known (Thomas, 1991). Among the different human interventions that accelerate soil erosion process, agriculture is the most important and most soil erosion occurs on cultivated lands (Hudson, 1986; cited in Wagayehu, 2003). A potential consequence of more intensive agricultural production is increased soil erosion from cropland (Carlson et al., 1993).

2.1.1. Causes of land degradation

There are four major causes of land degradation: deforestation, overgrazing, agricultural activities, and over exploitation (McClelland, 1997). The well known proximate causes of land degradation include deforestation, overgrazing, limited SWC measures, limited application of nutrients/organic matter, burning of dung and crop residues and declining use of fallow (FAO,

1995; Wagayehu, 2003). In Africa, the contribution of different management factors towards land degradation is estimated to be 49%, 24%, 14%, 13% and 2% for overgrazing, mismanaged agricultural activities, deforestation, overexploitation and industrial activities (Vanlauwe et al., 2002), respectively.

Agricultural mismanagement of soil and water resources include non-adoption of soil and water conservation practices, improper crop rotation, use of marginal land, insufficient and/or excessive use of fertilizers, mismanagement of irrigation schemes and over pumping of ground water (FAO, 2001). Lack of early awareness about soil erosion and soil fertility decline by farmers is another possible cause of land degradation (Bekele, 1998). These all are direct causes of land degradation primarily caused by human intervention exposing natural resources to depletion and loss. Human interventions expose the soil to erosion and induce depletion of natural capital asset of society (Wagayehu, 2003). In the sub-Saharan Africa, the major agents of land degradation are water erosion, wind erosion and chemical degradation that affected soil loss by 47%, 36% and 12 % respectively (Tilahun, 2002).

Population increase, land shortage, insecure land tenure, poverty and economic pressure are indirect causes of land degradation (FAO, 2001; Terefe, 2003). Population growth has long been considered a prime cause of environmental degradation. It forces farmers to cultivate marginal land (FAO, 1995). With current trend of population growth there is a poor prospect for ecological sustainability and economic viability of the current agricultural practice unless an effort is made to integrated development in family planning, environmental rehabilitation, and agriculture supported with enabling policy (Yohannes, 1999). Following the dire predictions of Thomas Malthus, population pressure is a cause to poor soil fertility leading to decreasing crop yield (Million, 1996). As a result of reduced size of land holding owing to high population density, intensive cultivation, steep slopes, over grazing, and intensive rainfall have resulted in much of the topsoil being washed away (Ibid). Through intensive mismanaged cultivation, man has destroyed the original crumb structure and depleted the nutrient make up of soils.

Significant numbers of studies from Africa have also presented the optimistic view that the population increase leads to intensification of production, tree planting and conservation activities, for example the Kenyan Machakos district (Yohannes, 1999; Atakilite, 2003).

A study made in north western Ethiopian highlands by (Gete, 2000) concluded the absence of sound land use tenure policies (frequent changes in the tenure systems and frequent distribution of land), population pressure, weak economic development strategies, unstable institutional frame works, and weak link between research and extension have all been found to be root causes of soil degradation and are major policy constraints discourage the farmer from making any sort of investments in the land to use it in a suitable way (Ibid).

A study made by (Dione, 2002), on land tenure systems in Africa reported that, farmland held under exclusive and secure land rights (e.g. titled land) is more productive than farmland under other forms of rights (e.g. communal lands). He reported that, when families believe that the land tenure system is unfavorable to them, they are reluctant to invest in good agricultural practices, such as soil and water conservation and management (Dione, 2002).

In similar fashion, in Ethiopia with the lack of land ownership, farmers have the tendency to make the land less attractive to others (FAO, 2001). The current land policy of Ethiopia, i.e., the right to use and transfer to their children is expected to affect long term investments including construction of conservation bunds, planting trees, short term fallowing and the like (Tilahun, 2002). In addition to insecure tenure, communal grazing land and wooded areas for the extraction of firewood give rise to land degradation.

2.1.2. Consequences of land degradation

Land degradation has a negative connotation that implies the loss of value within the environmental-economic system (Gretton and Salma, 1997). Land degradation effects on agricultural productivity are manifested through their impacts on both, the average and variance of yield, as well as the total factor productivity of agricultural production (FAO, 2001). It affects agricultural productivity, leads to clearance of forests and native grasslands as existing land loses productivity, and leads to off-site pollution and loss of productivity and amenity values (Gretton and Salma, 1997). Soil degradation has resulted in decreased food production, droughts, ecological imbalance and consequent degradation of the quality of life (FAO, 1995).

The soil conservation research project (SCRP) has estimated that about 1.5 billion tones of soil are eroded every year in Ethiopia (ibid). Similarly, the Ethiopian high lands reclamation study estimated that between 1985 and 2010 the rates of land degradation will cost 15.3 billion Ethiopian Birr, most of which 78% is due to crop failure or low yields and 22 % is due to

decreased live stock population (Thomas, 1991; Kruger, 1996). The natural capital asset depleting effect, soil erosion also induces immediate on site effects, those that happen at the site where erosion occurs, and off-site effects which have positive or negative effects as the soil leaves the boundary or the field due to erosion and /or watershed (Wagayehu, 2003).

2.1.3. Farmers' perception of land degradation

Adoption of conservation technologies is likely to increase with recognition of the erosion problem, slope and area of the parcel, availability and diffusion of information about conservation needs and options, increased in land-labour ratio, and anticipation of higher returns with conservation (Bekele and Holden, 1998). These findings emphasized the association of soil erosion status in relation to adoption of Sustainable agricultural practices.

The responses, commitments and responsibilities required for the success of formulation of appropriate resource management policies depend on perception of the problem by smallholder farmers (Ayalneh, 2002). Factors like land tenure, size of farm holdings, availability of credits, the use of farm inputs, availability and effectiveness of agricultural extension service, farmers' awareness of available technologies, farmers' ability to afford and apply technologies, and overall agricultural infrastructure contribute significantly to the achievement of sustainable land use (Genene, 2006).

2.2 Sustainable Agricultural Practices

2.2.1 Definition and Concept of Sustainable Agricultural Practices

Sustainable agriculture can be broadly defined as an agricultural system involving a combination of sustainable production practices in conjunction with the discontinuation or the reduced use of production practices that are potentially harmful to the environment (DeSouza et al., 1993; FAO 2008; Kassie et al., 2009). The Food and Agricultural Organizations (FAO) argues that sustainable agriculture consists of five major attributes: it conserves resources (e.g. land, water, etc), and it is environmentally non-degrading, technically appropriate, and economically and socially acceptable (FAO, 2008).

Investment: It is a combined decision and /or effort of asset like time, labor and resources implemented in land conservation and maximizing agricultural productivity.

In practice, sustainable agriculture uses fewer external off-farm inputs (e.g., purchased fertilizers) and employs locally available natural resources, as well as purchased inputs, more

efficiently (Lee, 2005; Kassie et al., 2009). In Ethiopia where the agriculture sector, the most important sector for poverty reduction has been undermined by lack of adequate plant-nutrient supply, depletion of soil organic matter, and soil erosion (Grepperud, 1996). In an effort to overcome these challenges, the government and non-governmental organizations have consistently promoted chemical fertilizer as a yield-augmenting technology. Despite this promotion, chemical fertilizer adoption rates remain very low (Byerlee et al., 2007), and in some cases, there is evidence suggesting a retreat from fertilizer adoption (EEA/EEPRI, 2006), possibly due to escalating fertilizer prices and production and consumption risks (Kassie, Yesuf, and Köhlin, 2008; Hailemariam, 2012).

Moreover, the water-retention characteristics of conservation tillage (Twarog, 2006) make it especially appealing in water-deficient farming areas, as is the case in one of our study areas. Consequently, since 1998, Ethiopia has included conservation tillage as part of its extension packages to help reverse extensive land degradation (Sasakawa Africa Association, 2008). Although encouraging adoption of conservation tillage is important, an equally if not more important aspect is whether or not it enhances productivity. In Ethiopia the economic returns to soil and water conservation investments, as well as their impacts on productivity, are greater in areas with lower rainfall than in more humid areas (Sutcliffe, 1993; Benin, 2006).

For this paper, the researcher examined the productivity gains associated with farmer's investment decision on sustainable agricultural practices, with a particular focus on use of reduced tillage, use of manure, fallow and legume crop rotation and legume intercropping. A finding suggested in areas with lower rainfall, reduced tillage had significant impact on crop productivity, and in higher rainfall areas, chemical fertilizer had higher significant productivity impacts (Kassie et al., 2012). This implied that technology performance varies by agro ecology.

Conservation agriculture and the use of organic fertilizers (e.g., compost) are two examples of sustainable agriculture practices. Conservation agriculture seeks to achieve sustainable agriculture through minimal soil disturbance (i.e., zero- or minimum-tillage farming—stubble tillage), permanent soil cover, and crop rotations (Kassie et al., 2009). The potential benefits from conservation agriculture lie not only in conserving but also in enhancing the natural resources (e.g., increasing soil organic matter) without sacrificing yield levels. This makes it

possible for fields to act as a sink for carbon dioxide, increases the soil's water-retention capacities, and reduces soil erosion. It also cuts production costs by reducing time and labor requirements, as well as costs associated with mechanized farming, e.g., costs of fossil fuels (FAO, 2008). Despite to this, its adoption status in this study area has been limited.

The agriculture sector in Ethiopia is the most important sector for sustaining growth and reducing poverty. However, lack of adequate nutrient supply, the depletion of soil organic matter, and soil erosion are major obstacles to sustained agricultural production (Grepperud, 1996; Kassie et al., 2008). The key to a prolonged increase in agricultural production is to improve productivity, which can be achieved through better technology and efficiency. Inorganic fertilizer remains the main yield-augmenting technology being aggressively promoted by the government and institutions. Despite this, inorganic fertilizer adoption rates remain minimal.
Thus, given the aforementioned challenges to inorganic fertilizer adoption, a key policy intervention for sustainable agriculture is to encourage adoption of agricultural technologies that rely, to a greater extent, on renewable local or farm resources. Organic farming practices, such as compost and conservation tillage, are among such technologies. The water retention characteristics of these technologies (Twarog, 2006) make them especially appealing in water deficient farming areas, such the Tigray region of Ethiopia. Most countries in sub-Saharan Africa, including Ethiopia, heavily depend on agriculture that is dominated by subsistence smallholder farmers. The fate of the agricultural sector directly affects economic growth, food security, poverty alleviation, and social welfare. The performance of agriculture in this region has not lived up to expectations, characterized by decades of ups and downs. Its low level of productivity is emphasized by the statistic that while the sector employs about 67 percent of labor force, it contributes only about 17 percent of the total gross domestic product. The average intensity of fertilizer use in sub-Saharan Africa is only 8 kilograms per hectare of cultivated land, much lower than in other developing countries (Morris et al., 2007).

The adoption and diffusion of specific sustainable agricultural practices (SAPs) have become an important issue in the development policy agenda for sub-Saharan Africa (Aiayi, 2007), especially as a way to tackle these impediments. These practices are conservation tillage, legume intercropping, legume crop rotations, improved crop varieties, use of animal manure, complementary use of organic fertilizers, and soil and stone bunds (De Souza et al., 1999; Kassie

and Zikhali, 2009; Wollni et al., 2010). The potential benefits of SAPs' lie not only in conserving but also in enhancing the natural resources e.g. Land and water without sacrificing yield levels.

Furthermore, by retaining fertile and functioning soils, SAPs can also have positive impacts on food security and biodiversity (Wollni et al., 2010). Crop rotation and diversification via intercropping enable farmers to grow products that can be harvested at different times and that have different climate or environmental stress-response characteristics (Hailemariam, 2012). The same is true in Ethiopia, where, despite accelerated erosion and considerable efforts to promote various soil and water conservation technologies, the adoption of many recommended measures is minimal and soil erosion continues to be a problem (Bekele and Holden, 1998). Moreover, relatively little empirical work has been done to formally examine the socioeconomic factors that influence the adoption and diffusion of SAPs, especially conservation tillage, legume intercropping, and legume crop rotations (Arellanes and Lee, 2003).
Given that resource degradation and climate change can irreversibly destroy the resources needed for food production and agricultural income generation, it is critical to identify the factors, incentives and policies that promote farm-level adoption of SAPs. Many studies have been performed on the adoption of new technologies by agricultural producers. However, relatively little empirical work has been done to formally examine the socio-economic factors that influences the adoption of SAPs (Hailemariam, 2012).

In general, cognizant of the problems land degradation motivates farmers decision to invest in sustainable agricultural practices. Disappointedly, farmers decision of investment in sustainable agricultural practices may be hindered by intertwine and interrelated factors like personal and demographic factors, socio-economic factors, plot characteristics and institutional support as shown below diagrammatically.

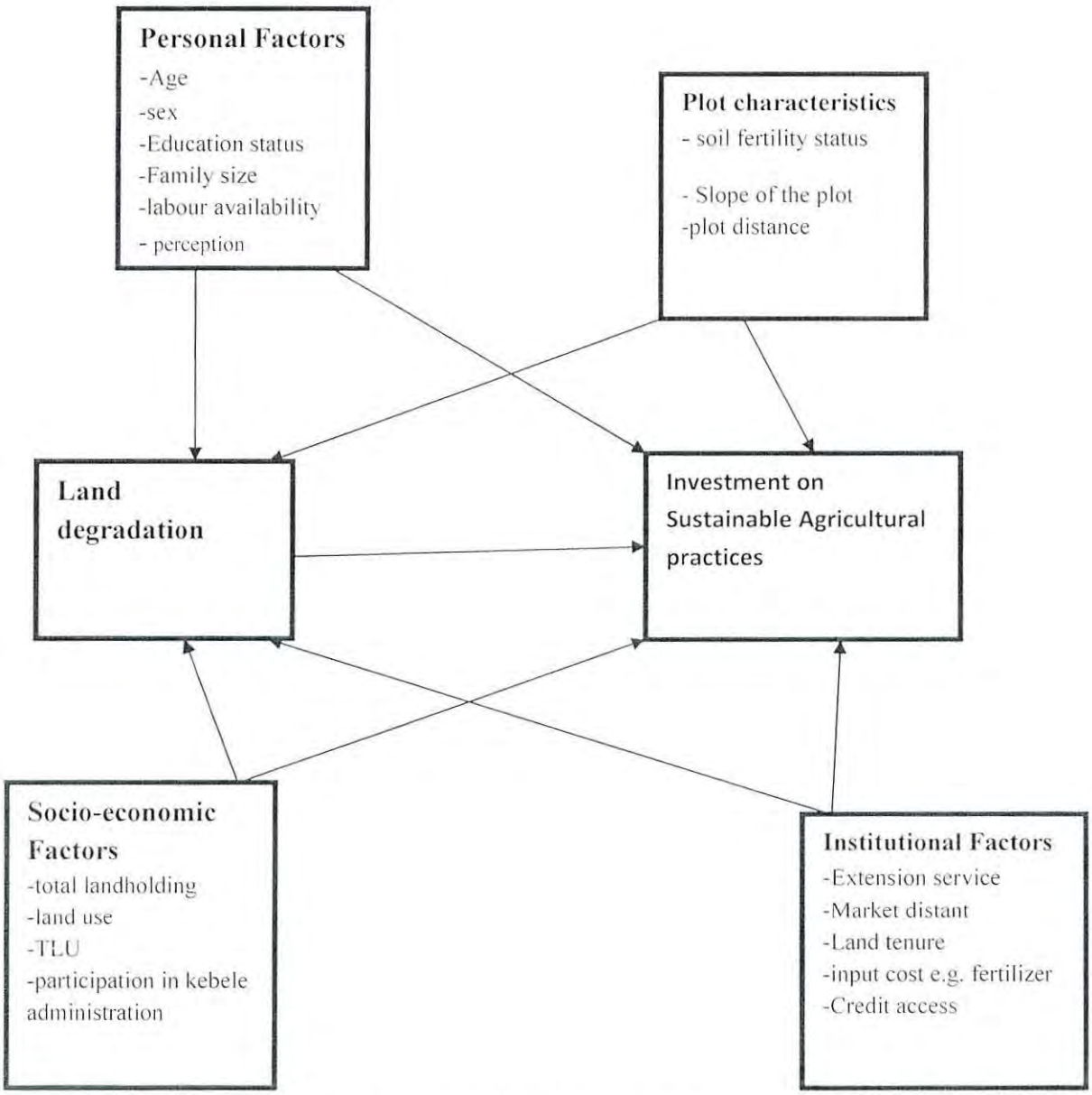

Figure 1: Conceptual framework on land degradation and farmers' decision to invest in SAPs'.

Source: adopted and modified from Bekele and Holden (1998)

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

In this chapter description of the study area, methods of data collection and analysis as well as definition of variables and formulation of hypothesis are discussed in detail.

3.1.1 Brief Description of Dangila District

Dangila is one of the seven districts in Awi zone with an area 772.3 square kilometer. It is known to be the fourth largest in the zone with respect to its area coverage. Its border linked in East with Mecha district (West Gojjam), in West direction with Jawi district, south with Fageta Lekoma (Adis kidam) district and to the Northeast direction with Achefer district (West Gojjam). The capital city of Dangila district is Dangila town and located 38 kms from Awi zone town Enjebara, 78kms from Amhara region city Bahir Dar and 485kms to the Northeast from Addis Ababa, the capital city of Ethiopia. The district has 27 rural kebele administrative and six-urban kebele administrative. The district has largely Orthodox Tewahedo Christian believers' residential area and small numbers of Muslim followers live since its establishment after 1928 Italian invasion still now. The study was conducted in two rural kebeles called Demisa and Wufta-Datie. They have in sum comprises a total population of 7883.

3.1.1.1 Population characteristics

Based on 2007 population and house census and 2009/10 ANRS sample survey report projection results, about 190,943 people was expected to live in Dangila district . Among those, 94,160 were predicted to be male (49.3%) and 96,783 (50.7%) to be female.

In addition, the prediction results indicated that, 155,466 (81.4%) people expected to live in rural areas and the remaining 35,477 (18.6%) people in towns. The population density of the district is about 247.3 people per kilometer. The economically active population (15-64) years of age accounts 51.8% of the total population.

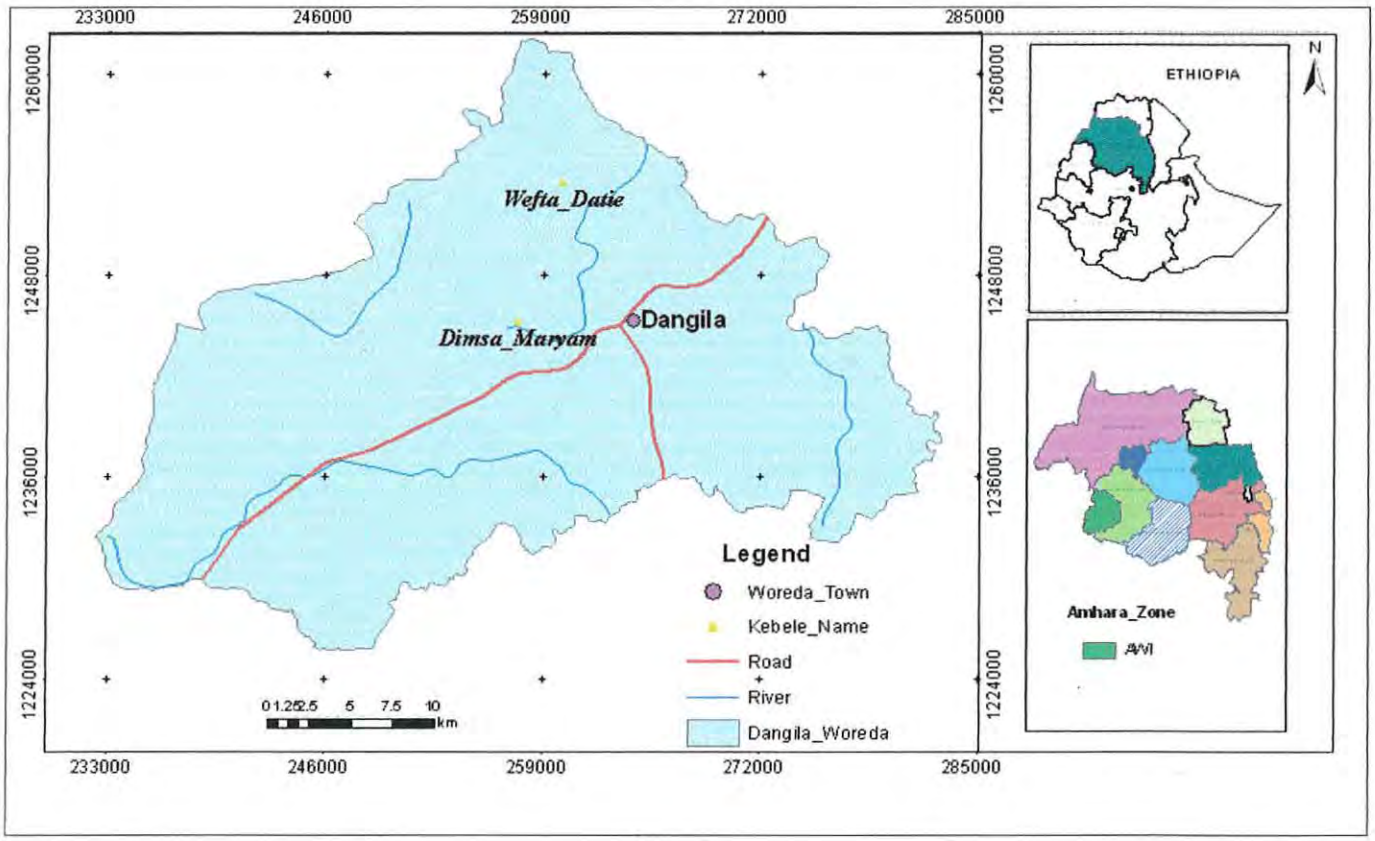

Figure 2: Map of Dangila district adopted and modified from topographical map of EMA (1987)

3.1.1.2 Climate

In terms of traditional agro ecology classification, the district can be categorized mainly into two Agro ecological zones. These are Woina Dega (middle altitude), which mask large about 86 percent of the total land mass, and 22 rural kebeles and all urban kebeles, and the Kola (low altitude), which covers about 14 percent of the total land mass and 5 rural kebeles. The district annual rainfall ranges from700-1200mms and annual temperatures ranges from 16-35 ^{0}c as the information obtain refers BoFED (2010).

3.1.1.3. Topography and soil

Gradient and plain are the two major topographical features of Dangila district. Those kebeles in the woina dega have highly plain topography. On the other hand, about 3 kebeles have flat type of topography. The type and texture of the soil varies to a great extent. Those kebeles that are located at low to mid-altitude mostly have heavy red to brown soil. On the other hand, lowland kebeles have gray, red whitish and black soil (unpublished data).

3.1.1.4. The farming system

The farming system in the Dangila district is characterized by mixed farming. The agro-climatic condition of the district conducive for: Teff, Maize, Millet, Barley, potato, linseed, Niger seed (Nug), chick pea, pea, bean, wheat and barley are the dominant crops frequently grown in the district. Production is undertaken mainly by waiting the rainy season that is once per year. In addition rainfed in some part of kebeles use irrigation to support their income and family food supply. The land use system is mainly influenced by the land tenure. Regarding the land tenure system, all farm households in the study area as in the rest of the country, had been entitled to use their holdings but not allowed mortgaging or selling it. The land size varies from one kebele to another due to the differences in the available land resource and the population size among the kebeles. Farmers in the study area use their land mainly to produce cereal, oil, cash crop and vegetables and spices and to some extent to graze their animals. They never leave their lands as fallows, because there is an obvious trend of shrinking land-holding from time to time, which is already below the optimum holding size to provide a living with the available technology being used by the community.

3.1.1.5. Agricultural extension

In Amhara region, the Bureau of Agriculture and Rural Development is the principal responsible to run extension of agricultural technologies that are developed and released by research centers. At present the extension approach is undergoing a transition from one DA in each kebele or village to 4 specialized diplomas or degree graduate DAs in each farmers training centers (FTC). When we see the composition and integration of extension worker one specialized and work in agricultural extension, one specialized and work in plant or crop science, one specialized and work in animal and range science and one health extension worker allocated per one rural kebele. The main task of the DAs in the former system/approach was to demonstrate, popularize and disseminate agricultural technologies and modern farming systems. On the other hand, the task of DAs in the new system is a bit different. It mainly focuses on training farmers at FTC for longer time.

3.1.1.6. Livestock production

Livestock play a significant role in the mixed farming system of the area. Their main contribution is in providing draft power, cash generation, food (example milk), and as a wealth

status (symbol). Livestock types kept by the farmers include cattle, sheep and goats, donkey and poultry. Oxen are kept to provide draft power, cows to provide farm households with milk and butter for consumption and sale, donkeys for transporting goods, whilst sheep, goats and poultry are mainly kept for sale as well as for their meat. The feed sources commonly used for livestock, include natural grazing, Hay, crop residues and in rare cases forest tree leaves. The contribution of natural pasture as sources of feed is very limited due to the extensive mask of the land by crops. Consequently, natural grazing for cattle in particular is limited to farm boundaries and the lower slopes of the hillsides. Goats and sheep are, entirely fed from the natural vegetation in the bushes and hillsides but sheep feed as additional during in lengthy winter season residues of crops like Niger seed and straw of millet. At present, livestock based farming is becoming reduced and has got lesser emphasis in the study area. Two contradicting forces play their role for the reduction in livestock population.

On the one hand, due to the ever-increasing trend of population growth, even marginal lands are becoming under cultivation, leaving minimum and even no land allocated by household heads for grazing and animal production. The other cause for the reduction of animal population in the area is that farmers use traditional and extensive system of animal production that cannot cope up with the prevailing shortage of grazing land. Therefore, the regional and district agricultural experts and other concerned parties have to do a lot to improve the existing problem.

3.1.1.7. Infrastructure

Presence of infrastructure is an important vehicle for the transformation of a rural economy. Roads and communication net works, health and educational infrastructures, and potable water supply, availability and access to input and output markets are some of the infrastructure components that are necessary to improve the production and productivity of the rural poor. In Dangila district, there are about 29 satellites and farmer back yard, 9 kinder gardens, 48 elementary, three high schools and one preparatory school. With respect to health infrastructure, there are 5 health center and 28 health posts. Among total rural kebele administrative 12 kebele as administrative have movable wireless telephone services. All 6 urban kebeles have permanent postal box is install and get services in the district. When we see the road coverage, about 2 kilometers asphalt, 32 kilometers all weathered and 43 kilometers dry weathered roads are available BoFED (2010).

There are two major marketing places in the district called Dangila and Chara market places. The Dangila market is larger in its volume of transaction than the Chara. In addition to the above two marketing places, there are others such as Gesa, Abadra and Rob-Gebeya which farmers use to exchange industrial and farm products. Pack animals are the main means of transportation and larger share of farm produce is transported using them. Human labor is another means to transport farm produce to the local market (unpublished).

3.2 Method of data collection

In this study, both qualitative and quantitative data were collected to hit the stated objectives from primary and secondary data sources. Primary data was collected from Focus group discussion, transect and key informant interview (to pre-test the questionnaire and to get in depth knowledge of farmers perception and decision to accept new technology and from survey by using structured interview schedule.

3.2.1 Primary Data Collection

The researcher was employed face to face individual interview with help of structured questionnaire, Key informant interview, Focus group discussion and transects to generate both qualitative and quantitative data.

Household survey: An individual interview was held after a couple of days training enumerators about the questionnaire details and how they administered the structured questionnaires used to collect primary data from selected sample households. At household level, the necessary data related to the personal information, socio-economic, plot characteristics and institutional factors that explain farmers level of understanding and attitude develop about land degradation and attributes that facilitate or hinder investment in SAPs was collected using structured questionnaire through interviewing the household heads. Interviews were conducted at early morning and late the afternoon and full working day time during holiday between January-February 2013. The enumerators were selected on the basis of their educational status, local knowledge, colleagues, close to farmers in their work and the like criteria.

Key Informant Interview: The researcher was made single interview with individuals who have knowledge of the study area to generate qualitative information specifically problems

overwhelming and solution had been taken. A total of 7 key informants (district agricultural experts, religious leader and experienced farmers) was interviewed by the researcher himself on issues related to Agricultural polices direction, introduced technology and implementation, land use and patterns, agricultural productivity, SAPs' status (reduced tillage, manure use, use of fallow, legume cropping), and related issues.

Focus Group Discussions: To investigate deeply and get adequate information on the farmers' perception of soil erosion and their decision to invest in SAPs' 8 discussants was selected. These sample discussants was selected on basis of wealth status of local condition on random basis. From two rural kebeles four FG discussants in each based on wealth status rank was taken for discussion. The discussion was take place on local areas near to their farm lands under the shadow of big indigenous trees and given high care for fair participation.

Transect: The researcher himself was make informal (on site observation) of sample kebeles land use and patterns, cropping system, animal husbandry, vegetation, landscape and biophysical conservation structures made previously by local farmers through systematic walking. At the time of transect, the researcher was take picture of biophysical structures constructed by local farmers both traditional and modern ones.

3.2.2 Secondary Data

Secondary data was reviewed and collected from related to institutional, bio-physical and socio-economic features of the trend SAPs'. Hence, to get such important data the investigator was gather information on SAPs such as Dangila district Agriculture and Rural Development Office, Amhara Regional Bureau of Agriculture and Rural Development, Ministry of Agriculture and Rural Development, Relevant GO's and NGO's, Addis Ababa University library (both documentation and internet) as well as published and unpublished documents and other pertinent documents.

3.3. Sampling procedures and sample size Determination

For this study a multistage stratified sampling techniques was applied by a researcher. In the first stage, purposive sampling was utilized to select Dangila district because of the researcher preference. In the Second stage, from this district among 27 rural kebeles administrative (RKA) stratified based on agro ecology then two kebeles' was selected. Finally, 120 sample households

were selected by use of gender and random sampling technique; from the two RKAs according to proportion to size the sample was taken.

Table 1: Sample household selection proportion to size

Name of Rural kebeles administrative	Agro ecology	Total households	Total Sample taken	
			No of sample households	Percent
Demisa	Woina dega	530	41	34.2
Wufta-Datie	Kola	1017	79	65.8

Source: own survey, 2013

3.4 Method of Data Analysis

The researcher for data analysis of this study was used both descriptive statistics (frequency, percentage, mean, standard deviation, t-test, and x^2-test, and Econometric model. A binary logit model was used to explain factors impede or facilitate farmers investment decision on SAPs and helps to identify key variables determine farmers' decisions to invest in this practice with the support of Stata software version 11.0 was analyzed.

3.4.1 Descriptive Statistics

For this study descriptive statistics like frequency, percentage, mean, standard deviation, t-test and x^2-test were employed for analysis, summarize and compare results of demographic, socio-economic, plot characteristics and institutional data to have a clear picture of farmers perception and level of understanding soil erosion problems and to know differences between investors of SAPs and not. The result obtained is an indicator of the relationship between explanatory variables and dependent variables.

3.4.2 Econometric Models

There is no inherently ordering in the decision process of investing in SAPs'. Whether or not a farmer invests a new technology assumes a yes or no answer, a typical case of dichotomous variable. For such type of response, a discrete model is a popular tool of analysis. In this model, the dependent variable is a binary assuming two values, 0 and 1. Hence, for a farmer who invests the SAPs', the value (y=1) and for a farmer who does not invests, a value (y=0) will be assigned.

Several models such as simple correlation, linear probability function, etc, can be used to analyze adoption behavior of farmers. But these models have limitations in that the t-ratios are incorrect, exhibit hetroscedasticity, non-normality, their estimated probabilities (Pi) may be greater than one or below zero, and assume Pi increases linearly with X (Maddala, 1983; Gujarati, 1995). The logit and probit models overcome these problems since both are based on a cumulative distribution function.

For the present study, however, we selected the logit model for the following reasons: 1) Probit and logit models are non linear (in the parameters) statistical models that achieve the objective of relating the choice probability Pi, to explanatory factors in such a way that the probability remains in the (0, 1) interval (Griffiths, et al., 1993: 2) The logistic function is used because it represents a close approximation to the cumulative normal and is simpler to work with. The close similarity between the logit and probit models is confined to dichotomous dependent variables and; 3) In many cases logistic regression is preferred to the probit due to its link to other models such as linear probability model, and its simpler interpretability as the logarithm of the odds ratio and its eminence effort to retrospectively collected data analysis (Mcculaah and Nelder, 1998). Following (Gujarati, 1995; Aldrich and Nelson, 1984) the logistic distribution for the investment of SAPs can be specified as:

$$Pi = \frac{1}{1+e^{-Zi}} \quad \text{.....[1]}$$

Where, Pi is the probability of farmers invest in SAPs' for the ith farmer, e represents the base of natural logarithms and Zi is the function of a vector of n explanatory variables (X's) which is an underlying and unobservable index for the ith farmer (when Zi exceeds some threshold level (Z*), the farmer is observed to be an investor; otherwise he is a non-investor when Zi falls below the threshold value), and expressed as:

$$Zi = \alpha + \sum \beta i Xi \text{.....[2]}$$

Where α is the intercept, β i is a vector of unknown slope coefficients and X1, X2....Xn represent the n explanatory variables.

The logit model assumes that the underlying stimulus index (Zi) is a random variable which predicts the probability of investment of SAPs'. The slope tells how the log-odds in favor of investment on SAPs change as independent variables change.

One way of approaching the (0, 1) constraint problem that is imposed on the probability is to transform P to eliminate one or both constraints (Aldric and Nelson, 1984) in a ratio form. If p is the probability of investing on SAPs then 1 - Pi represents the probability of not investing and can be written as:

$$1\text{-}Pi = 1-\frac{1}{1+e^{-zi}} = \frac{e^{-zi}}{1+e^{-zi}} = \left(\frac{1}{1+e^{zi}}\right) \quad \text{.....[3]}$$

Dividing equation (1) by equation (4) and simplifying gives

$$\frac{Pi}{1-Pi} = \left(\frac{1+e^{zi}}{1+e^{-zi}}\right) = e^{zi} \quad \text{.....[4]}$$

Equation (4) shows the odds ratio, which defines the probability of investing relative to non-investing.

Finally, the logit model is obtained by taking the logarithm of equation (5) as follows:

$$Li = \ln\left\{\frac{Pi}{1-Pi}\right\} \quad \text{.....[5]}$$

Where, Li is log of the odds ratio in favor of SAPs' adoption, which is not only linear in Xj, but also linear in the parameters. Thus, if the stochastic disturbance term, (Ui), is introduced, the logit model becomes:

$$Zi = \beta^{c} + \beta 1Xi + \beta 2X2i + \cdots + \beta nXni + ui \quad \text{.....[6]}$$

3.4.3 Parameter Estimation

When using either probit or logit model with individual observation the most suitable estimation technique is that of maximum likelihood (Pindyck and Rubinfeld, 1981). The estimation procedure has a number of desirable statistical properties. All parameter estimators are consistent and also efficient asymptotically, i.e., for large sample. In addition, all parameter estimators are known to be (asymptotically) normal, so that the analog of the regression t-test can be applied. As noted by (Pindyck and Rubinfeld, 1981; Gujarati, 1995), the method of maximum likelihood

consists in estimating the unknown parameters in such a manner that the probability of observing the given Y's is as high (or maximum) as possible. Before computing the models, it would be necessary to check whether there is multicollinearity among the candidate variables and verify the degree of association among discrete variables. The reason is that the existence of multicollinearity will affect seriously the parameter estimates.

According to (Gujarati, 2003), there are various indicators of multicollinearity problem. Of various indicators of multicollinearity, the variance inflation factor (VIF) is used in this study to check whether there is multicollinearity or not among continuous explanatory variables. Where each continuous explanatory variable is regressed on all the other continuous explanatory variables and coefficients of determination for each auxiliary or subsidiary regression will be computed. Furthermore, (Gujarati, 1995) stated that a high R^2 obtained could only be a serious indicator of multicollinearity. Hence, a measure of multicollinearity associated with the variance inflation factors is defined as:

$$VIF\ (Xj) = 1/\ (1\text{-}R^2)^{-1}$$

Where R^2 is the coefficients of determination when the variable; Xj is regressed on the other predictor variables. A VIF value greater than 10 is used as a signal for strong multicollinearity (Gujarati, 1995). In similar fashion, there may also be interaction between two qualitative variables, which can lead to the problem of multicollinearity or association. To detect this problem, coefficients of contingency were computed from the survey data. The contingency coefficients are computed as follows.

$$C = \sqrt{\frac{X^2}{N + X^2}}$$

Where: C = coefficients of contingency

X^2 = chi-square of random variable

N = Total sample size

The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. This yields unbiased and asymptotically efficient and consistent parameter estimates.

3.5 Outcome and Hypothesized Explanatory Variables

Dependent variable: It represents the observable decision of farmers investment on SAPs' and otherwise, a dummy variable. This outcome variable will be analyzed by binary logit model that will take the value 1 investor, and 0 non-investor. It is hypothesized as farmers use SAPs' more than one year and had practice at least two components of SAPs' considered as investor and take the value "1", and a farmer not totally practiced or invest will considered as non-investor and take the value "0".

Independent variable: It was hypothesized as farmer's decision to invest or reject multiple components of SAPs' to gain its profit will highly influenced by different factors. On the basis of previous studies, the researcher hypothesis these factors categorized as personal, socio-economic, institutional and plot characteristics will determine farmer's decision behavior to invest in SAPs'. Based on the previous findings and the research objectives in the study area, the following **14** potential variables were hypothesized to determine farmers' decision of investment in sustainable agricultural practices.

Sex (SEXHH): It represents sex of household head. Male headed households may have more experiences of different agricultural activities, technology use that increase productivity because of their position on Kebele's and other social association. They can easily get training while new agricultural technology introduced and may have more exposure in practical farming fields as compared to counterpart female headed households. Thus, Sex of household head hypothesizes as being male is positively correlated to invest on SAPs' and, whereas, female is opposite of this.

Age (AGEHH): It is a continuous variable measures age of household head in years. Rural households mostly devote their time for farming activities. As age of household increases, they can acquire more knowledge and experience about SAPs' benefits and its feasibility direction. Hence, in this study increased age is hypothesized as positively related to investing in SAPs'.

Education (EDULEVEL): It is a discrete variable defined as the level of grades or schooling years attained the household heads. This variable is an important determinant of household adoption of SAPs' in that, educated households have a better chance of gaining information adopting soil conservation practices, crop rotation and /or intercropping, use of manure which in

turn increases crop production. Thus, education level will be hypothesized to have a strong positive impact on household head's decision to invest in SAPs' that match his/her farm land.

Participation in local administration (PARTADMIN): This variable defines whether respondent has an assumed any type of responsibility in his/her village or kebele level during in this survey. If the household head assumed any type of responsibility, the chance of access to information may increase and thus become adopter and extent of use of the technology positive. Therefore, this variable is expected to associated positively to investment in SAPs' and otherwise.

Farm Size (FARMSIZE): This is a continuous variable which may determine individual household's decision of investing and not investing of SAPs' in his/her farm. A Farmer who own more plot of land may help his/her to fallow, crop rotate from cereal to leguminous and mulching of crop residues. Hence, this would positively hypothesize to the decision of invest in SAPs'.

Land use (LANDUSE): Land-use refers to the purposes for which human exploit the land and its resources. It is a discrete variable that refers to the use of farm plots for crop or fallowing or pasture/ woodlands, 0 for pasture/woodland; 1 for cropland and 2 for fallow land. Land degradation is different from plot to plot-based on land-use and land-cover of the plot. The degree of land degradation is different from plot to plot based on its use. For fallow land farmers did not apply any soil improving activities, low or minimum plant cover and uncontrolled grazing and low microbial activity. In cropland farmers apply different indigenous and/or improved soil conservation technology and fertilizer. The soil of cropland are tilled repeatedly and left without a productive cover vegetable. In grazing and woodland the soil is not disturbed, it is covered with grasses and woods with controlled grazing. It is likely less eroded than cropland. Therefore, land-use is hypothesized to have a positive effect on land degradation.

Land tenure (LANDTENURE): A dummy variable, which is a feeling and attitudes farmers towards land tenure that takes a value, 1 if the farmer perceive as secure and, 0 otherwise. The incentive to land improvement decision is based in part on secured future access to land. In many studies, insecurity of tenure has been found to be a deterrent factor to conservation investment (Reardon and Vosti, 1995). In this study, the farmer's feeling of using a given plot at least during

his/her lifetime was hypothesized to have a positive effect on his/her decision to participation in conservation activities.

Distance of the plot from the residence (PLOTDIST): It refers to the average distance of a given plots from the residence of the household in minute. Farmers whose plots are nearer to their residence apply organic matter to substitute soil nutrient loss and soil conservation structure to minimize soil erosion, because the time and energy they spent is lesser for nearer plots than distant plots. Compared to plots closer to homestead, collection of crop residue from distant plots for livestock feed and other purposes could be laborious (Moti, Bekele, and Menale, 2012). Thus, the close distance will be hypothesizes as have positive relation with investment in SAPs'.

Soil fertility status (SOILFERT): It is represents the status of soil fertility. The current level soil fertility hostility determines farmers will grow the type of crop and the amount of yield gain. Due to this farmers may be selective in adoption decision to invest in SAPs' as measure on the basis of their past experience they got from their plot fertility status. Thus, the level of soil fertility as changes from fertile to less fertile would be hypothesized as had positively affect on investing conservation activities and otherwise, negatively.

Slope of the plots (SLOPE): slope of the field is the only indicator used as a proxy for the erosion potential. Although erosion potential depends on the rainfall pattern, soil physical characteristics and slope. In addition, rainfall may not vary much from field to field with in the study area. The land surface configuration that relates to topography is described in terms of slope. The slope of the plot affects soil erosion or soil development. Steep slope are subject to more rapid runoff surface water and need large number of soil conservation technology (Ervin and Ervin, 1982; Hurni, Wagayehu and Drake, 2003). Thus the slope of the plots is hypothesized to directly affect severity of land degradation. Therefore, increase the degree of slope was hypothesized as have positive association with investing in land conservations.

Number of Plot (PLOT): considering all other things the same (equal) adoption of introduces SWC technology and applying fertilizer, especially cow dung is a function of the area of a plot. Soil conservation structure may take some area especially that would have been used for cultivation. Farmers who managed larger size plots can allocate some part of the land for soil

conservation than those who have smaller farms (Wagayehu and Drake, 2003). Despite to this, large plot size may demand higher labour, capital, credit, and fertilizer. Labour, capital or other constraints may limit the ability of farmer to invest in large plot size area than small plot area. Therefore, the effect of plot size is indeterminate.

Livestock owned (TLU): This variable is a continuous variable defined as the total livestock (cattle, donkey, horse/mule, sheep, goat, and chicken) owned by a household heads measured in Tropical Livestock Unit (TLU). Livestock is an indicator of wealth, which requires more grazing land to rearing, ranch and use is important source of income, draught power and organic fertilizer. Those farmers who have large number of livestock may have more animal dung to improve the fertility of the soil and more capital to invest in soil conservation practice. This affects the use of conservation agriculture measures positively ILRI (2003). Moreover, most of the time livestock rearing creates burden on communal grazing land. Thus, livestock owned will be hypothesized as have both positive and negative relation with adoption decision of SAPs'.

Labour availability (LABOUR): This is a dummy variable referred that the household's access of labour based on his/her farm operation requirement and with peak agriculture seasons (land preparation, seeding, weeding and harvesting of yield). This determines farmers' decision on adoption of more labour–consuming technologies at the very scratch like compost preparation. More economically active labour accessed farmers will perceive positively and make sound decision on adoption of compatible soil fertility maintained and increasing crop yield. Therefore, household head's have more number of productive labour would influence positively for investors of soil conservation technologies like SAPs' and for non-investors, otherwise.

Extension contact (EXTENSION): it is a dummy variable that indicates whether a farmer gets visited by development agents (DAs) and /or practioners, training about new technology and practices. The farmer involve and get such may be highly weigh new technologies benefits and losses of particular technology and fast to adoption decision. Thus, this variable will be hypothesized as positively associated with investment of SAPs'.

Table 2: Definition and units of measurement of the explanatory variables

Variables	Definition and units of measurement
SEXHH	Sex of household head (1=Female , 2=Male)
AGEHH	Age of household head in years
EDUHH	Educational status of household head (0=illiterate, 1=literate)
PARTADMIN	Household head's participation in kebele (0=no, 1=yes)
DISTPLOT	Distance from residence to the plot(in minute)
FARMSIZE	Farm size in hectare
LANDTENURE	Land tenure (0=insecure , and 1=secure)
SOILFERT	Soil fertility status (0=non-fertile, 1=less fertile and 2=fertile)
TLU	Respondent's owned livestock (in tropical livestock unit)
SLOPEPLOT	Slop of the plot (0= flat and 1=otherwise)
PLOT	Number of plots (in number)
EXTENSION	Extension agent visit (0=not-visited and 1=visited)
LANDUSE	Land use (0=forest/woodland, 1=cropland and 2=pasture
LABOR	Labor availability (0=not-available and 1=available)

Source: own extraction

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics Results

This part is mainly concerned with the description and interpretation of the findings. As already noted, a structured questionnaire was administered to 120 sample households in Dangila district. The questionnaire was designed in such a way that it enables to collect data on demographic, socio-economic, plot characteristics and institutional support of farm households' decision to invest components of SAPs'.

In this section the results of descriptive statistics and econometric model for the farmers' decision behavior to invest in sustainable land conservation and agricultural yield maximizing practices are discussed in detail.

4.1.1 Demographic characteristics of Respondents'

4.1.1.1 Sex of Sample Respondents

Gender of household head can influence adoption of new technology either being female headed or male headed. Male headed households have better chance for investing on land conservation because of the position they have and access of information as compared to their counter parts in the study area. Out of total sample respondents, female- headed accounted for only 17.5%, while the rest 82.5% were male headed, respectively. Among female-headed respondents 20.9%, 6.9% were non-investors, and investors of sustainable agricultural practices (SAPs), respectively (Table 3). Accordingly, from total sample respondents75.8% were non-investors and 24.2% were investors of among multiple components of SAPs. A chi-square result indicated that there is significant and positive association the household head being male with the probability of the household decision to be investor of SAPs' in the study area.

Table 3: Distribution of household heads by gender in investment categories

Sex of HH	Non-investors(n=91)		Investors (n= 29)		Total(n=120)		X^2-value
	No	%	No	%	No	%	
Female	19	20.9	2	6.9	21	17.5	2.978**
Male	72	79.1	27	93.1	99	82.5	
Total	91	75.8	29	24.2	120	100.0	

** Significant at 5% probability level

Source: own survey, 2013

4.1.1.2 Age of household head

The mean and standard deviation age of sample respondents were 43.7 and 10.9, respectively. The age composition of sample respondents were revealed significant difference of the investors, and non-investors, 50.2 and 41.7 mean of years, respectively. The maximum age observed was 74 and the minimum was 20 years (Table 4).

Increase age of farmers already engaged in farming operation, it gives time for farmers to learning from directly observed and evaluate problems and profits of the crop produce. As the mean of age revealed that investors in SAPs are relatively older than non-investors of among multiple components of SAPs. The t-test result indicate that age has positive and significant difference with investors of SAPs and, otherwise.

Table 4: Distribution of sample household heads by age categories

Age Category	Non-investors		Investors		Total		T-value
	No	%	No	%	No	%	
20-40	59	49.2	8	6.7	67	55.8	-3.872***
40-64	31	25.8	18	15	49	40.8	
>64	1	0.8	3	2.5	4	3.4	
Total	91	75.8	29	24.2	120	100.0	
Mean		41.7		50.2		43.7	
SD		10.40		9.91		10.9	

*** Significant at 1% probability level

Source: own survey, 2013

4.1.1.3 Educational level of the household heads

As education status of household head increases, it is considered to increase the transfer of relevant information, awareness and mutual understanding about new idea, technology and innovation and as a results increase farmers' knowledge about the benefits, constraints and opportunities gain from implementing sustainable agricultural practices. Education provides something for farmers to arrest loss of soil fertility using various ways of soil fertility improving

practices, maximizing productivity at the same time keeping soil health, traditional and improved soil conserving technologies, compost and agronomic practices.

Out of total respondents 48.3% were literate and 51.7 were illiterate. To put this in grade level groups, 19.2% were read and write from informal and formal up to 4^{th} grade, 15.8% were educated to 5^{th} -8^{th} grade, 9.2% were educated 9^{th} -10^{th} grade and the rest 4.2% were educated more than 10^{th} grade level (Table 5). This means as sample respondents not educated it may increase the possibility of farmers' rejection of new technology and innovation and if educated more, otherwise is true. The chi-square result revealed that there is positive and strong positive relationship between education and farmers investment in SAPs'.

Table 5: Distribution of sample household heads' by educational status

Educational level of HH	Non-investor		Investors		Total		X^2-value
	No	%	No	%	No	%	
Illiterate	55	60.4	7	24.1	62	51.7	11.662**
Read & write	14	15.4	9	31.0	23	19.2	
Grade 5-8	12	13.2	7	24.1	19	15.8	
Grade 9-10	7	7.7	4	13.8	11	9.2	
Above grade 10	3	3.3	2	6.9	5	4.2	

** Significant at 5% probability level

Source: Own Survey, 2013

4.1.1.4 Distribution of sample households by Family size

The total family sizes of sample household were found to be 256 and 483 in Demisa and Wufta-Datie kebeles, respectively. In the study area, household head with family size of less than or equal to 4 members constitutes 22.5%; 5 to 8 members constitute 65.8%; and 9 and above members constitutes 11.7 % (Table 6).

The average family sizes for investors were found to be 6.3, and that of non-investors were 6.1. This is slightly above national average number children of one woman delivery between 15-49 ages 5.1 children.

The maximum and the minimum household size of the sample respondents were found 11 and 2. About 38.3% of the household heads of non-investors, and 24.2% of investors had above 6 numbers of family members. The economical active family members are inputs and advantageous for farm worker and otherwise is burden and have negatively influence for farm technology users.

To illustrate this the one household who has more economical inactive family members, the household head always enforced to cultivate the same crop from season to season and year to year in order to close family members mouth. In contrary, economically active family members are assumed as labour. Thus, family members have indeterminate influence on investment of SAPs' in the study area.

Table 6: Distribution of sample household by Family size

Family size in No	Non-investors (n=91)		Investors (n=29)		Total (n=120)	
	No	%	No	%	No	%
1 to 4	19	15.8	8	6.7	27	22.5
5 to 8	49	40.8	30	25.0	79	65.8
>9	9	7.5	5	4.2	14	11.7
Mean		6.1		6.3		6.2

Source: Own survey, 2013

4.1.1.5 Household heads' responsibility in village or kebele administration

The survey results shown in Table 7, 26.7% were assumed some responsibility at their village or kebele level. Among none participants 70.4% and 29.6% were non-investors, and investors, respectively.

The higher the figure for respondents may indicate that as the household head assumed some responsibility, the chance of getting information and hence, understanding about uses of SAPs' will increases. This contributes to the decision to implement SAPs'. The result of chi-square indicated that household head had position in kebele administration has significant and positive association with the probability of farmers to be investor in SAPs' on their farm plot.

Table 7: Distribution of Sample respondents' responsibility in village or kebele

responsibility in community level	Non-investors		Investors		Total		X^2-value
	No	%	No	%	No	%	5.210**
No	62	70.4	26	29.6	88	73.3	
Yes	29	90.6	3	9.4	32	26.7	

** Significant at 5% significant level

Source: Survey result, 2013

4.1.2 Socioeconomic Factors

4.1.2.1 Land Characteristics

The land size holding of the sample farmers ranges from 0.25 to 3 hectares. The average land holding is known to be 2.1 hectares with a standard deviation of 0.9 hectares. This is slight greater than national average 1.5 hectare of land.

The survey result indicated that about 15.8% of the respondents had a farm size of 1 hectare or less, 40% of respondents had a farm size ranges 1.0-2.0 hectares and the rest 44.1% of respondents had farm size of greater than 2 hectares of land. On the average investors hold more land 2.4 hectare, and non-investors 2.0 hectare of land, respectively (Table 8).

The t-test result revealed that there is significant mean difference between non-investor and investor households was significant at 5% level. This illustrates as household own more unit of land, the household inspired to make decision to adopt and invest new agricultural technology alternative.

Table 8: Distribution of sample households by farm land holding in hectare

Farm size	Non-investors		Investors		Total		T-value
	No	%	No	%	No	%	-2.299**
0.25-1.0	16	84.2	3	15.8	19	15.8	
1.1-2.0	40	83.3	8	16.7	48	40	

2.1-3.0	35	67.3	17	32.7	52	43.3
3.1-4.0	--	--	1	100	1	0.8
Mean		2.0		2.4		2.1
SD		0.1		0.2		0.1

** Significant at 5% significant level

Source: Own survey, 2013

4.1.2.2 Distribution of sample household by land tenure

Land tenure security is important not only for the development of efficient land markets, but also for investment in land improvement (Dessalegn,1994). Land in the study area has been subject to periodic re-distribution with government substitution. The present government redistributed the rural land in 1997 in the study area.

Farmer's perception to soil erosion and the measures they take will depend on their feelings of security of land tenure. According to the survey results indicated 68.3% of respondents feel insecure and the rest 31.7% feel secure tenure right, respectively.

Table 9: Distribution of sample respondents by land tenure

Feelings of land tenure	Non-investors		Investors		Total (n=120)	
	No	%	No	%	No	%
Insecure	61	50.8	21	17.5	82	68.3
Secure	30	25	8	6.7	38	31.7

Source: survey result, 2013

Sharecropping, rent-in, rent-out with (different type of renting system), inherited from family and own land are the most common land holding arrangements. In addition, sharecropping and rent-in are important means of land acquisition for young and small farm holders in the study areas.

As population increase the only option for young farmers for acquisition of land is sharecropping/rent-in arrangement from their family members and other households. Land transaction (sharecropping and fixed rent) is widespread in the study area. Out of the 220 ha holdings of the sample farmers, 55 ha was cultivated in sharecropping and 11.2 ha was rented in.

It could be expected that land quality and expected yield of grains and straw may affect the terms of sharecropping arrangements. However, if sharecropping serves as a balance, then land quality may not be important determinant of share cropping arrangements in the study area. Although there are variations in sharecropping arrangement Erub (one fourth), Siso (one third), Ekul tamisho (two to three) and Gimash (one half), the modal appears to be towards equal share between the owner and the tenant. In sharecropping, except labour the owner of the land is not required to contribute any input. Sharecropper covers all other required input costs. In most cases the reasons for giving land for sharecropping are disability (old age, women headed household) and lack of oxen whereas the reasons for sharecropper to take land in are shortage of land, interest to get more production, have excess labour and oxen.

Renting is based on direct cash payment when the term of payment is money and it is based on the fertility of the plot. There are three type of lease in the study area (i) transferring the land with fixed amount of money through long term renting that means using 25 years renting agreement (disguised selling), (ii) legal renting with fixed amount of money for fixed cropping years, and (iii) renting the land until the owner will repay his debt (mortgage). The reasons for renting in land were almost the same as that of sharecropping.

The management attention of renting and sharecropping farmers was different from farmer to farmers based on the amount of their own plot holdings. Some farmers gave more attention for planting and weeding on his land than for share cropping/rent-in land. On the other hand some others gave more attention to sharecrop and rent-in land than his own due to shortage of farmland and being afraid of owner takeover if the sharecropper/renter doesn't manage properly. However, farmers gave more attention to their own plots for the application of organic fertilizer and maintenance of soil and water conservation (Table 10). The chi-square test indicated that there is systematic relationship between the application organic fertilizer and plot ownership at 5% level of significance ($\chi 2=5.054$).

Table 10: Plot management difference with the application of organic fertilizer

Organic fertilizer	Share cropped in/rent in	Own	Total	X^2
No	69.6	48.6	56.7	5.054**
Yes	30.4	51.4	43.3	

Total	100.0	100.0	100.0

** Significant at 5% probability level

Source: Own survey, 2013

The use of seed and ploughing were relatively the same for different plot ownership whereas the application inorganic fertilizer depends on the fertility of the plot. However, there is a significance relation between inorganic fertilizer application and plot ownership (Table 11).

Table 11: Plot management difference with the application of inorganic fertilizer

Chemical fertilizer use	Share cropped in/rent in	Own	Total	X^2-value
No	--	2.7	1.7	1.264
Yes	100.0	97.3	98.3	
Total	100.0	100.0		

Source: Own survey, 2013

4.1.3 Plot Characteristics

4.1.3.1 Slope of the plot

Slope is one of the farm attributes that aggravate soil degradation. Based on the Natural Resource Management Department classification for construction of SWC technology, plots based on slopes (which is measured in degree) were classified as *Meda* for Flat (0 - 2) and Gentle sloping (3 - 6) plots, *Zekzaka* for moderately steep sloping (6 - 15), and, *Kulkulet* for steep slopes (15 - 30) and *Gedelama* for very steep slopes and mountain (>30). According to field observation and sample respondents reported as shown in the Table 12, 11.7% of plots were flat, 25% of gentle, 34.2% of moderately steep, 18.3% of steep slope and the rest 10.8% were mountainous. The highest portions of investors' plots were under steep slope 34.5% and moderately steep 34.5% categories, respectively.

As the results of chi-square indicated that there is positive association between increment of the degree of slope and land conservation measures taken by farmers. Table 12: Distribution of sample respondents by slope of the plot

Slope of the plot	Non-investors		Investors		Total		
	No	%	No	%	No	%	X^2-Value
Flat	13	14.3	1	3.5	14	11.7	9.592**
Gentle	23	25.3	7	24.1	30	25	
Moderately steep	31	34.1	10	34.5	41	34.2	
Steep slope	12	13.2	10	34.5	22	18.3	
Mountainous	12	13.2	1	3.5	13	10.8	

Source: survey result, 2013

4.1.3. 2 Plot Distance

With reference to distance traditionally land users classified their plots into two. Plot near to homesteads called back yard, whereas the farmstead plots are referred as *Ersha.*

Plot distance from the residence of the farmer affects, management attention, of the farmer by affecting the average time need to travel for applying manure and cattle dung, tree planting, and for SWC construction and timely maintenance.

The survey result indicated that some plots were located at considerable distance from homestead, that will take up more than 60 minutes walking and the minimum was located at the garden. About 94.2% of the plots are located at one way walking distance of less or equal to an hour. The average time for non-investors and the dwelling was 36.8 minutes and for investors and their dwelling was 30.1 minutes. The t-test result revealed that there is significant mean difference between non-investors and investors with respect to plot distance (Table13).

Table 13: Distribution of number of plots from the dwelling place

Distance to the plot in minute	Non-investors		Investors		Total		T-value
	N	%	N	%	N	%	
0-30	58	48.3	18	15	76	63.3	1.448*
31-60	26	21.7	10	8.3	36	30	
>60	7	7.7	1	0.8	8	6.7	

Mean		36.8	30.1		35.2
SD		25.3	18.7		24.0
Minimum	2			Max	120

** Significant at 5% probability level

Source: own survey, 2013

4.1.3.3 Farmers' perception of land degradation

Land degradation results low agricultural production and productivity. In order to have a clear picture of farmer's perception the researcher posed questions to farmers to get information on the current land degradation status. According to sample respondents response almost all perceive as land is severely degraded. Farmer's have experience of using organic fertilizer like animal dung, manure, domestic waste swept and ash as a treatment of land degradation.

Traditionally, farmers have been practicing to some extent soil fertility improving and organic matter increasing, enhance water holding capacity and boost crop produce in the study area. These includes, use of compost and animal dung, fallowing, crop rotation, plantation of cover crops, mixed cropping and intercropping as a means of dual purpose modifying soil fertility loss and low crop productivity. Farmers' perception depends on the knowledge they have and from observations and evaluation of neighbor farmers benefit gain from adoption of new ideas, technology and innovations. Farmers perception for SAPs' can be determine by age, educational status, farming experience, farm size, land tenure, understanding of level of soil fertility and methods they use to solve the problem.

Table 14: Farmers' perception for soil fertility status

Soil fertility trend	Number	Percent
Decrease	85	70.8
Not changed	35	29.2
Severity level of soil fertility loss		

High	52	61.2
Medium	30	35.3
Low	3	3.53

Source: own survey, 2013

Out of total sample respondents, 70.8% reported as decrease and 29.2% were reported as had no change still in soil fertility in survey year 2013. Among sample respondents observed soil fertility decrement asked to rank the severity level, of which 61.2% said high, 35.3% said medium and 3.53% said as become low. The percent describes how much farmer's perception and understanding to soil degradation is go one pace for change and they may come to on adoption of soil improving technology.

4.1.3.4 Soil Fertility status

In the study area, farmers' perception to new technology can be seen with knowledge and understanding of soil fertility status, especially they compare with crop produce either increases or decreases. Farmers perceive and rated soil fertility of their land as fertile, less fertile and not fertile in the study area. The reason for farmers reach such decision on soil fertility depletion with the amount of fertilizer they use, compost and other organic matter adding nutrient application and the type of crop grown and yield obtain. Farmers explained during focus group discussion, less fertile and none fertile land is used for cropping of pea, bean and *Gebeto* and gives better yield if the soil color is close to red and less moisture land.

On the other hand, these farmers reflected their position and knowledge of soil erosion and nutrient depletion by actions they will ready for adoption of any soil improving and maximizing crop produce if the soil is highly depleted and decrease crop yield. This indicates that farmers' perception to their surrounding is good to keep soil fertility as the reaction they took to keep the produce in a way they want to produce the amount and type of crop.

The survey result indicated that out of total respondents, 17.5% replied as, 73.3% less fertile and 9.2% replied as non-fertile, respectively. As the chi-square result (6.014), indicated that there is positive and significant association between soil fertility decline and investment of sustainable land conservation activities at 5% probability level.

Table 15: Distribution of soil fertility status with investment category

Soil fertility attributes	Non-investors		Investors		Total		X^2-value
	No	%	No	%	No	%	
Fertile	18	19.8	3	10.3	21	17.5	6.014**
Less fertile	62	68.1	26	89.7	88	73.3	
None fertile	11	12.1	0	0	11	9.2	

Source: Own survey, 2013

Understanding of the perception of farmers about trend of crop productivity and their reasons for yield reduction or not, gives insight to do on adoption of locally in situ technology options like SAPs'. As the response obtain from sample respondents indicated that productivity of crops not increase while we use fertilizer as recommended and improve varieties of crops although in the year 2003/2004 reaches maize productivity maximum, like green revolution was in India .

Farmers asked to justify and rank other causes for loss of yield other than nutrient depletion such as continuous cultivation, less fertilizer use, not fallow, less organic fertilizer use, and dominantly mono cropping. Accordingly, as farmers ranked 1st, 2nd , 3rd , 4th , and 5th main responsible cause of yield reduction generated from continuous cultivation, mono cropping, not fallow, less use of organic and inorganic fertilizer (DAP, Urea), respectively. This in turn indicates how farmers' perception changed about soil degradation and searching alternatives of technology to arrest problem and sustained increasing demand of crop yield.

Table 16: Farmers opinion the causes of soil erosion and crop yield reduction

Cause of crop produce decrement	Very high	High	Medium	Low	Very low	Rank
Continuous cultivation	45.0	25.8	12.5	4.17	12.5	1st
Less use of fertilizer	0.83	5.00	12.5	16.7	65.0	5th
Not use of fallowing	6.67	24.2	25.8	40.0	3.33	3rd
Less use of organic fertilizer use	8.33	11.7	35.0	30.8	14.2	4th
Mono cropping	41.7	33.3	14.2	10.0	0.83	2nd

Source: Own survey, 2013

In addition to the above, in order to get in depth information on crop yield reduction farmers were posed different questions their opinion of soil erosion in the study area. As the investigator understand from discussion held with farmers, the main causes of soil erosion is unseasonal drop of heavy rainfall combined with improper farming practice (cultivation of gentle and steep slopes with high soil disturbance), wind (wash away powdered soil and uncovered with crop residues at the time of dry land preparation), overgrazing or free grazing of communal grazing land, and lack of ownership feeling especially shared and rented land are overwhelming in the study area. Consecutively, as farmers ranked based on raise severity level put as overgrazing, high rainfall, cultivation of gentle, cultivation of steep slope, lack of ownership feelings on land and wind were the main causes' soil erosion in the study area, respectively.

Traditionally, farmers were employ fire to burn plot for the purpose to reduce weed occurrence, to control insect-pest infestation and to suit for tillage during land preparation in the study area. Remarkably, currently this practice shows fall due to farmers understanding to soil is grow and they understood burning of farm cause moisture stress, extreme land dryness and difficult for land preparation. Besides, farmers understood the aggravation of moisture shortage and highly drying of soil were not practice burning except the plot's crops and trees has needle-like sharp corner (*Eshoh*) and cause nuisance for humans and animals. Out of total sample respondent's burn their farm plot 70% to control weeds, 39.2% to burn pests and the remaining 80.8% were burn to make suitable for tillage operation in the survey year.

Table 17: Distribution of sample respondents by causes of soil erosion

Cause of soil erosion	Very high	High	Medium	Low	Very low	Rank
High rainfall	35.0	27.5	20.0	13.3	4.2	2nd
Cultivation of gentle slope	15.0	34.2	26.7	15.8	8.3	3rd
Cultivation of steeply slope	9.2	16.7	30.0	37.5	6.7	4th
Wind	0.8	5.00	6.7	10.8	76.7	6th
Overgrazing	44.2	18.3	12.5	15.0	10.0	1st
Lack of ownership feelings	2.5	3.3	6.7	6.67	80.8	5th

Source: Own survey, 2013

4.1.4 Sustainable agricultural practices

4.1.4.1 Compost use, leguminous crop rotation and legume intercropping

Among the pillars of sustainable agricultural practices, and agronomic measures to defense erosion, both mixed and crop rotation is the prominent one. Mixed cropping is a task of planting the right mix of crops in the same field. Whereas intercropping is a practice of growing two or more crops at the same piece of land, similar to mixed cropping but the pattern is different. Compost can be prepared from cattle dung and manure and plant residues. On the other hand, fallow land is the best way to recover damaged soil fertility. These agronomic practices help the soil to fix nitrogen and increase soil fertility level.

On the basis of this practice as sample respondents reported as 72% were burn farm, 50.8% were mulching with mowed weed especially maize crop, 88.3% were use compost, 94.2% were use crop rotation and 65.8% were use resting their farm. Local soil fertility replenish mechanisms could be encouraged and advisable to integrated with other scheme but the nature of these practices are also sensitive, restricted and intricate to other factors such as ownership of plot, land size, TLU, and family size of households'.

Table 18: Distribution of sample respondents by agronomic practices

Types of agronomic practices	% share
Compost use	88.3
Fallowing farm	34.2
Mixed legume cropping	41.6
Crop rotation	94.2
Intercropping	59.2
Burn farm	72.0
Mulching	50.8

Source: Own survey, 2013

Crop rotation is a key component of sustainable agricultural practices because it improves the soil structure and fertility, and it helps to control weeds, pests and diseases that have soundly been practiced throughout 27 kebeles of Dangila district. Despite of this, sample respondent farmers had been practicing crop rotation; the practice is still in question. This is due to as farmers reported, they had been practicing crop rotation is not properly done in exchange of crops season, type of crop and terms of exchange.

According to Ministry of Agriculture of Ethiopia guideline, at maximum one cereal crop can be grown for two cropping season consecutively yet in third season it must be replaced or changed by either pulses or oil seed crops. Among sample respondents experienced in crop rotation, 62.5% were rotate cereal to cereal, 19.2% cereal to legume cropping and the remaining 18.3% were practicing leguminous to cereal cropping in the survey year 2013.

Table 19: Distribution of sample respondents by crop rotation sequence

Crop rotation sequence	% Share
Cereal to cereal cropping	62.5
Cereal to leguminous cropping	19.2
Leguminous to cereal cropping	18.3

Source: Own survey, 2013

4.1.4.2 Conservation tillage practice

Conservation tillage (includes, Zero tillage / minimum tillage), along with other soil conservation practices is a corner stone of SAPs' can be practiced by smallholder farmers. Minimum tillage seems a plateau and feels inconvenience for farmers as compared other components of SAPs' in the study area. They had been practicing minimum tillage selectively on the basis of type of crop, especially for leguminous crops. As it has been presented in the Table 21, 52.5% had been practicing minimum tillage in their plot; whereas the 47.5% had not been practicing in their plot. Out of the total sample respondent had been observing changes in soil fertility; 11.7% bring increment, 10% decrement, 9.2% no change and 69.2% were said do not know the changes brought in soil fertility.

As sample households' forwarded their opinion on implementing minimum tillage, 75% decrease productivity, 23.3% difficulty to control weed, 0.8% cause's insect-pest outbreak and 0.8% cause other productivity reducing constraints like termite and rodents emergence.

Table 20: Distribution of sample respondent by Experience in minimum tillage

Minimum tillage(MT)	Total		Changes observed after MT	Total	
	N	%		N	%
Attributes					
Practiced	63	52.5	Increment	14	11.7
Not practice	57	47.5	Decrement	12	10.0
Farmers opinion on MT			The same	11	9.2
Decrease productivity	90	75.0	Do not know	83	69.2
Difficult to control weed	28	23.3			
Insect-pest out break	1	0.8			
Other	1	0.8			

Source: own survey, 2013

However, conservation tillage instrument not known by most farmers other than local moldboard named *Maresha*[5] in the study area. Those farmers inherent from their parents or spent a decade's plowing instrument is Maresha. Among sample farmers had not been practicing minimum tillage reasons indicated that 51.7% reduce immediate crop produce, 18.3%difficult to control weed,

2.5% because insect-pest outbreak, 6.7% because of labor shortage, 8.3% land shortage and 12.5% because of other reasons (the land provider may cancel the sharecropping agreement).

Farmers put these reasons in order; reduce productivity, difficult of control weed, others (cost of technology), land shortage, labour shortage, and insect-pest outbreak. These factors either individually or interdependently impede farmers from implementing minimum tillage in their plot in the study area.

Table 21: Reasons for not practicing minimum tillage

Reasons not practicing minimum tillage	Total		Rank
	Number	Percent	
Reduce productivity	62	51.7	1st
difficulty of control weed	22	18.3	2nd
Insect-pest outbreak	3	2.50	6th
Labour-shortage	8	6.67	5th
Land-shortage	10	8.33	4th
Other	15	12.5	3rd

Source: own survey, 2013

4.1.4.3 Soil and water conservation Practices

In the study area, both traditional and improved soil management and soil conservation measures practiced, include trench, grass vegetation (water logging plot), broad bed maker (BBM), check dams, compost making, manure use, mulching & crop residues, traditional diversion ditch, terracing, soil bund and stone bund when excess stone exist at the plot and high runoff prone plot. Trenches are constructed inside the plot to harvest water as reserve for crops grown with shortage of rainfall in dry lands. Elephant grass and sasbanean are planted for multipurpose in water logging farm lands. BBM is also used to as ditch tied with local ploughing instrument *Maresha* to form soil bed during plowing time.

According to reports of Dangila district Agriculture and Rural Development office in the last 5 years except 2010 unavailable data at the time of data collected; about 11977.75 ha terrace of which 3216.9 were maintained, 636 km covered diversion ditch made of which only 29.5 km maintained, 50.445 km trench constructed of which 7.55km maintained and 478.45km mask broad bed maker (BBM) were done.

Table 22: soil and water conservation (SWC) measure done in the past four years

Year	Terrace (ha)	Maintained	Diversion ditch(km)	Maintained	Trench (km)	Maintaind	BBM(km)
2007	1137.5	1389.2	234	-	9	-	125.0
2008	120.0	380.0	108	-	3	4.6	91.8
2009	127.0	321.0	156	-	9.25	3.0	125.5
2011	10593.3	1126.8	138	29.5	29.4	-	136.3
Total	11977.8	3216.9	636	29.5	50.6	7.6	478.5

Source: Dangila district Agriculture and Rural Development office, 2013

However, other SWC measures were done like communal terrace, check dams, grass vegetation with and without terrace and stone and soil bunds but quantified into figure data were unavailable at the time of survey. Besides, performed new SWC practices, there was no or less measure taken for maintenance of the old SWC physical structure constructed in the study area. Furthermore, the data in the year 2007 as compared to the rest years were high in almost all parameters due to segregation and become self autonomous *Jawi* district from Dangila after this year.

As the information obtained from focus group discussion and survey indicated that previously constructed SWC structures are destructed. The main responsible causes of destruction were shortage of farm land, expected reconstruction by government, poor quality during construction, difficulty in turning oxen, places of rodents and others like not fenced.

Table 23: Causes for the destruction of improved SWC technologies

Causes of destruction	% share
Shortage of farm land	7.5
Expected reconstruction by government	5.8
Poor quality during construction	31.7
Difficulty in turning oxen	50.0
Places for rodents	3.3
Others	1.7

Source: Own survey, 2013

4.1.5 Agricultural Production

4.1.5.1 Major Crops produced and yield

The productivity of the land in the study area is become poor mainly due to less fertility of the soil. This poor soil fertility is due to continuous soil erosion and loss of topsoil over the past years, which is exacerbated by cultivation of sloppy plots of the landscape.

As survey result revealed that in average sample respondents produce 1.90 quintal barley per 0.281 ha, 10.79 quintal maize per 0.701 ha, 3.75 quintal of Teff per 0.605 ha, 1.98 quintal of millet per 0.328 ha, and 0.74 quintal of pea per 0.107 ha of plot. The result of paired t-test indicated that there was no significant difference between before investment and after investment of sustainable agricultural components like crop rotation, legume cropping and compost use in crop produced in the last 2 years. This ensures the previous empirical works done on adoption of conservation tillage (Kassam, 2009), reported as it does not bring increase in crop yield, it

consumes more labour, herbicide, fertilizer and farm power including fuel in short-term since adoption and implementation done by smallholders and mechanized farm but it may bring amazingly soil fertility improvement.

Table 24: Mean comparison of the type of crop yield produced with investment

Type of crop	**Before invest**		**After invest**		**Total**	
	Area(ha)	Qt.	Area(ha)	Qt.	Area(ha)	Qt.
Barley	.196	1.43	.380	2.52	.281	1.90
Maize	.617	9.92	.750	11.1	.701	10.8
Teff	.525	3.10	.804	4.52	.605	3.75
Millet	.324	1.97	.345	2.09	.328	1.98
Pea	.081	0.46	.153	1.59	.107	0.74

Source: own survey, 2013

Based on the respondents opinion given on the changes had been gain due to implementing of SAPs' before the last 2 years from 2012/13. The independent t-test was used to check whether there is significant mean difference between non-investors with that of investors. As the results of t-test indicated that there is significant mean difference between non-investors and investors in only teff crop production at 10% probability level. Hence, this tells investment of multiple SAPs' in short term has not brought a big change in crop produce.

Table 25: Mean difference between crop yield and investment category

Type of crop produce	Non-investors		Investors		Total		T-value
	Area(ha)	Qt.	Area(ha)	Qt.	Area(ha)	Qt.	
Teff	0.525	3.49	0.641	4.24	0.605	4.00	-1.669*

Barley	0.196	2.20	0.319	2.27	0.281	2.24	-0.179
Maize	0.617	11.0	0.739	10.9	0.701	10.9	0.039
Millet	0.324	2.89	0.330	2.75	0.328	2.79	0.401
Pea	0.081	0.93	0.118	0.95	0.107	0.94	-0.073

*significant at 10% probability level

Source: Own survey, 2013

4.1.5.2 Livestock production

Livestock in the study area have been kept for different purposes. They are kept to provide food, draught power, sharecropping, threshing, transportation, wealth status, fiber, as a means of saving due to farmers regard livestock as safeguard for sudden cash requirement as they are considerable liquid resources. These animals are sold in time of need for food, credit repayment, to pay taxes and other expenses. Oxen are kept both for plough and fattening purpose, whereas cows are kept for dual purpose of give birth of calf, plowing and fattening.

As result of animals are used in farm operations, supplementary between crop and livestock enterprise is a common event for smallholder farmers of the study area. They interact with each other in that animals offer farm power and cattle dung in exchange for fodder from the crop residues and by products. The availability of cash from the sale of livestock and livestock products serve as a source of cash when farmers are in urgent need of cash for their crop production activities.

The survey results indicated that cattle, donkeys and goats are the most important animals reared in Demisa kebele. On the other hand, in Wufta-Datie kebele cattle, sheep, goats and donkeys are the most important animals reared. Like the parts of the district the animals kept in the two kebeles are mostly indigenous breeds. These animals are reared in both kebeles due to the suitability of the environment, presence of better feed and farmers' preference. On average, in both kebeles farmers kept 2.541 cows, 2.63oxen, 0.071 bull, 1.05 heifers, 0.415 calves, 0.489 goats, 0.481 sheep and 0.688 donkeys, 0.053 mules, 0.009 horses and 0.456 chickens.

Table 27: Mean difference between total livestock unit owned (TLU) and investment

TLU	Non-investors		Investors		Total		T-value
	N	%	N	%	N	%	-1.727**
<5	13	10.8	15	12.5	31	25.8	
5-10	15	12.5	26	21.7	53	44.2	
11-15	7	5.83	13	10.8	25	20.8	
>15	2	1.67	6	5.00	11	9.17	
Mean		7.39		8.90		8.43	
Min 1.80	Max 21.9						

** Significant at 5% probability level

Source: survey result, 2013

The result of t-test indicated that there is significant difference between non-investors and investors of SAPs' components. In other words, as the household has more cattle, it increase the probability of become non-investors of SAPs' and, otherwise. This is because more cattle demand more grazing and pastures land. In the study area, the main sources of feed for livestock are communal grazing, crop residues and by products, purchase of feed from local farmers and use of farm plot before sowing and after harvesting of crops as grazing and source of feed.

Accordingly , 99% were use communal grazing, 62.5% were use fallow land of them or neighbor farmers, 93.3% were use crop residues and its byproducts, 33.3% were use purchase and 89.2% were use their own farm plot as animals feed. The paradox of crop residue use as of soil cover and also used as the main fodder for livestock. The main types of crops serve dual purpose which includes teff and millet straw and maize husk. As the survey results indicated that 99.2% were used communal grazing land; 71.7% were used hay collected after the crop collected and protected grazing land, 97.5% were use straw, 97.5% were use maize husk, 87.5 % were use mowed grass and weed, and the rest 76.7% were use residue of local beer and alcohol(Atella) as addition of feed of cattle.

Table 27: The type of cattle feed main sources

Source of feed	N	%	Types of Crop residues used as fodder	N	%
Communal grazing	119	99.2	Hay	86	71.7
Fallow land	75	62.5	Straw	117	97.5
Crop residues and by products	112	93.3	Mowed grass	105	87.5
Purchase	40	33.3	Maize husk	117	97.5
Farm land	107	89.2	Atella(local beer by product)	92	76.7

Source: own survey, 2013

This means that crop residue use as soil cover and mulching is more likely affected by the livestock population as one farmer owns livestock-land proportion balance or not balance. This noted with livestock production and competing with crop residues use either feed or mulching (soil cover). Communal grazing areas, crop residues and private pasture are the most important source of feed in both kebeles. During discussions with farmers told that the availability of feed is serious constraint to livestock production in between March to August.

Furthermore, shortage of grazing land fodder, inconvenience grass for cattle *Wajima*[3], water born parasite(Alekit) and absence of animal clinic in both kebeles of the distant related to the district were common and terrible problems. Among total respondents in both kebeles accordingly, 71.7%, 75%, 95%, 65%, 61.7%, 80.8% and 85% were respond as shortage of grazing land, disease, fodder, shelter problem, water shortage, clinic and lack of shepherd are the main constraints, respectively(Table 24).

4.1.4. Institutional Factors

4.1.4.1 Extension contact

Agricultural extension is of paramount importance to introduce better agricultural practices and improved technologies to smallholder farmers in a country like Ethiopia where traditional practices are dominant. In the study area, like the other district of the region, the office of

Agriculture through its technical experts and DAs at community level provides agricultural extension. The agricultural extension service in the study area mainly focused on providing basic agricultural education, teaching, and demonstration about the use of agricultural inputs, forestry development, soil conservation and livestock production aspects. The survey result indicated that 95.35% of the respondent had access to agricultural extension agents.

The Agricultural Desk under department of Agricultural and Rural Development was the main government institution responsible for implementation, monitoring, and evaluation of the agricultural extension services at zonal level. It has a technical expert (SMS) both at the zonal and district level to provide technical assistance and trainings for DAs and supervisors. Development agents are responsible for the actual implementation at the extension program at grass root level. Extension service is provided by extension workers and to some extent by non-governmental organizations. Three to four development agents were assigned at each kebele to give frequent and continuous technical support and advice. Almost all sample households of the survey had responded that development agents been assigned, but most of them complained that they do not get sufficient agricultural extension services. The chi-square test also shows insignificant difference between households visited by extension agents and Investor of SAPs' status in the study area (Table 28).

Table 28: Distribution of sample respondents by extension contact

Extension	Non-investors		Investors		Total		X^2-value
	No	%	No	%	No	%	5.749**
Visited	53	44.2	24	20.0	77	64.2	
Not visited	38	31.7	5	4.2	43	35.8	

Source: Own survey, 2013

4.1.4.2 Market distance

Farmers buy household goods and other farm inputs from markets in addition to selling surpluses, if any. Markets are mostly located in open rural villages and small towns. The major market is located in Dangila town. Most markets operate once a week except the major ones. The local markets are characterized by inadequate marketing facilities and services, such as good sanitation, product protection, shelter, storage, package, price information and so on.

Table 29 shows, the distribution of sample household head by market distance in minutes from the residence. The maximum and the minimum time from the market were 180 minute and 40 minutes, respectively. About 80% of the respondents walk more than 1 hour to reach the nearest market.

Table 29: Distribution of sample households by distance from the market in minutes

Respondents response	Walking to market in minute		
	<60	60-120	>120
No	24	81	15
%	20.	67.5	12.5
Mean	105.8		
Minimum	40	Maximum	180

Source: Own survey, 2013

4.1.4.3 Agricultural Input supply

Availability and use of modern inputs is an integral parts of the extension system required to increase agricultural production through the use of modern agricultural technologies like fertilizer, improved seeds, farm implements, etc. Most of the time farmers use inorganic fertilizer for improved seed, particularly for maize and for millet, *teff*, and barley.

DAP and Urea is the only inorganic fertilized used by farmer to increase or maintain agricultural production. Of which most farmers use DAP more than Urea because the impact of DAP were observed in the seed of crop whereas the impact of Urea is observed on the leaves of crop. From the total of 120 sample respondents who were asked whether they feel the price of fertilizer costly or proportional, about 38.3% reported as costly, and the rest 61.7% replied as reasonable.

Table 30: Distribution of sample respondents by opinion of Fertilizer cost

Fertilizer price	Non-investors		Investors		Total		X^2-value
	No	%	No	%	No	%	9.114***

Costly	28	30.8	18	62.1	46	38.3
Proportional	63	69.2	11	37.9	74	61.7

Source: Own survey, 2013

4.1.4.4 Credit access

Moreover, credit in the form of cash or kind was provided to sample households. There are different sources of credit. Among all, institutions like micro finance and office of agriculture take the leading role in providing credit in cash or in kind to farmers. As reported from the survey result, about 45.4 percent of sample households got credit either in the form of cash or in kind from government, informal local institutions, and private money lenders and from friends and relatives.

Table31. Distribution of sample households by credit access

Credit attribute	Number	Percent
User	50	41.7
Non-user	70	58.3

Source: Own survey, 2013

4.2 Econometric results

Binary logit model was used to identify potential variables determine farmers investment decision on sustainable agricultural practices. Multicollinearity diagnostics test was done to check the presence of high colinearity among and between each independent variable. Different methods were employed to check the presence of multicollinearity for continuous and discrete explanatory variables. Variance inflating factor (VIF) was used to check for multicollinearity problem among and between continuous variables. For continuous variables coefficient of contingency (CC) was computed using Stata software. For this case, based on the results of the diagnostic tests for both discrete and continuous variables, no variable was found to be highly correlated or associated with one or more of other variables (Appendix Table 2and 3).

Fourteen variables were hypothesized to influence farmers' decision to invest on SAPs' and all variables were entered to the model. Out of the variables analyzed, the coefficients of 11 variables, namely sex, age, participation in kebele, soil fertility status, slope of the plot, number of plots, plot distant, land use, labor, TLU, and extension contact were significantly different

from zero and found to be significant to affect the investment on SAPs' of the households in the study area.

The maximum likelihood estimates of the binary logit model result shows that the household investment in SAPs' is determined by the interaction of several potential socio-economic factors. To check measure of goodness of fit in logistic regression analysis, the likelihood ratio test (LR) that follows chi-square distribution with degree of freedom (DF) equal to number of explanatory variables included in the model (Gujarat, 2003). Accordingly, the chi-square computed shows that, the model was significant at 1% significance level. This indicates that the null hypothesis stating the coefficients of explanatory variables less the intercept are equal to zero was rejected and the alternative hypothesis of non- zero slope was accepted.

Another comparatively simple measure of goodness of fit was the count R^2 obtained by dividing the number of prediction to the total number of sample. In this regard the count R^2 was calculated to be 77% (72 out of 91 for non-conserving and 20 out of 29 for land conserving households) that indicate the model correctly predicts the observed values. The sensitivity, the number of investor households correctly predicted by the model was 70 percent and specifies, the number of non-investor households correctly predicted was 91.1 percent observation. Thus the model predicts both non-investor and investor household groups fairly and accurately.

Table 32: Empirical result of binary logit model

Variable	Coeff	Odds ratio	S.E	Significance level
_CONS	-15.369		3.965	0.000
SEHH	3.540	34.474	1.588	0.018
AGEHH	0.158	1.171	0.748	0.001
EDUHH	0.015	1.016	1.240	0.984
PARTADMIN	3.374	0.034	0.405	0.007
FARMSIZE	0.219	1.245	0.822	0.588
LANDTENURE	-1.087	0.337	0.727	0.186

SOILFERTLITY	1.564	4.780	0.020	0.031
SLOPEPLOT	-2.767	0.131	0.449	0.011
PLOT	-2.445	5.087	0.671	0.000
DISTPLOT	-0.021	0.980	0.090	0.100
LANDUSE	-1.327	0.265	1.006	0.048
LABOR	1.570	25.406	1.519	0.045
TLU	-0.161	0.851	0.134	0.073
EXTENSION	3.359	28.774	1.021	0.001

Source: Own survey, 2013

Sex: Sex of household head was significant at 5% significance level and positively related with investment of SAPs' the households in the study area. This implies that, other things remaining constant, male-headed households are more likely to be investors in SAPs' than female headed households. The possible explanation for this would be male headed households have better access to farmland, labour, agricultural technologies and improved practices which all these increase crop yield and thus more investor on SAPs' than female headed households by a factor of 34.474. This result is similar to the findings (Green, 1993) were found a significant positive relationship between sex of the household and their decision to retain conservation measures.

Age: This variable is significant and positively related to investors of SAPs' in the study area. This implies that, other things remaining the same, as age of house hold head increases by one year, the likely probability to become investor increases. However, other findings in different areas contrast this finding, for instance, (Long, 2003; Wagayehu and Lars, 2003) found negative and significant association between adoption of conservation structures and age. An increase in age of the household gives the chance to evaluate pros and cons of sustainable agricultural technologies. Thus, an increase in age is related negatively with non-investor on SAPs' of households. This finding was in agreement to some research evidences, that age has positive and significant impact on investment of land conservation technologies.

Education: Impact of education on farmers' decision to invest in SAPs' was found insignificant and positive relationship. This positive and insignificant relation implies that the more educated farmers are more likely to make a decision to invest in SAPs' than their counterparts with low level of education attainment. The justification of this finding was that education influences farmers' decision to adopt technologies by enhancing farmers' ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers. This finding is also in line with previous studies (e.g. Bekele, 1998) found insignificant association between level of education and decision to retain conservation structures. But contrary to the findings of (Derjaw, 2008) were found the significant contribution of education on the conservation efforts.

Farm size: Total farm size of the households was found to have insignificant relation with the investment in SAPs'. Hence, there is no sufficient evidences to reject the null hypothesis and can be concluded that farmers having small farm size are not less likely to be investor than their better landholding counterparts. Similar to the prior expectation, its coefficient has positive sign indicated that the less farm size the farmers owned seems the better to be investors than the farmers who have large farm size. Therefore, in the study area large landholders are more sensitive to erosion problems and they seemly more likely to implement and maintain conservation structures than those farmers who have small cultivated lands. But the difference was insignificant. This finding is in line with the findings of (Aklilu, 2006), he found and reported that farmers who hold large farms were found to be more likely to invest in conservation technologies.

Participation in kebele administration: This variable was strongly significant at 1% significance level and positively related to investors in the study area. This implies that, other things remaining constant, as a farmer get position and participate in kebele administration, it gives the chance to familiar with new information and continuous to update as compared to non-participant being investor will be decrease 0.034 as not participate in kebele administration.

Soil fertility status: This variable was significant at 5% significant level and positively affects investor farmers in the study area. This implies that, assuming other things constant, as the soil fertility level decrease by one category from fertile to less fertile; the probability of the farmer's decision to invest SAPs' to be increase by a factor of 4.780 and the reverse is true. This variable affects the decision of farmers to use soil and water conservation technologies in which farmers who perceive more about the severity of erosion problems on their agricultural production and

natural environments are more likely to be sensitive and to have better intention of mitigating the problem through adopting the technologies. This finding is also in line with and supported by other previous studies like (Bekele, 1998).

Slope of the plot: This variable was significant at 1% probability level and negatively affects investor farmers as the degree of slope increases. This implies that, the remaining things constant, as the slope of the plot increases by a unit degree the probability of the farmer become investing on among multiple components SAPs' increases. As slope of the plot increase by one degree the respondent farmer to be investor likely decrease by a factor of 0.131 as compared to non-investors. This is consistent with other studies undertaken in different parts of Ethiopia (Bekele, and Holden, 1998; Wagayehu and Lars, 2003; Aklilu, 2006) were reported the positive association between slope and farmers' decision to adopt and implement SAPs'.

Number of plot: This variable was strongly significant at 1% significant level and negatively affects investor farmers when the number of plot increases. This implies that, assuming the remaining things constant, as the number of plot increases by one plot farmers exposed to transportation transaction cost on foot. As the number of the plot increase by a unit the household to be investor decease by a factor of 5.087as compared to non-investor farmers.

This finding is consistent with the findings of (Bekele and Holden, 1998) following plot number increment farmer will be busy and less invest in land conservation activities.

Distance to the plot: This variable was significant at 10% significant level and negatively affects investor farmers as the distance increases by a minute in the study area. This implies that, the remaining things the same, as the distance of the plot to the resident increases by one minute the probability of farmers investing SAPs' on his/her plot will likely decrease by 0.980 as compared to non- investor farmers. The farm found at far distant may not be frequently getting visited, difficult to transport compost and manure and overall management. This finding is consistent with previous studies (Wagayehu and Drake, 2003; Getachew, 2005) distant from the plot has positive relation for land degradation yet for investment in SAPs' related negatively.

Land use: This variable was significant at 5% significant level and negatively influences farmer's decision to investment on sustainable land conservation strategies. This implies that, the remaining things constant, as the land use changes by season from crop land to wood or from crop land to grazing land the probability farmers investing on SAPs' will likely decrease by

0.265 as compared to non-investors and , otherwise. This finding is in contrary to previous findings (Getachew, 2005) had found to be insignificant relationship with investment in SAPs'.

Labor availability: This variable was significant at 5% level of significance and positively influences decision of farmer's investing on SAPs' as they have one more labour unit. This implies that, assuming other things remaining the same, as labor availability increases by one unit the probability of farmers shift to investing on SAPs' will likely increase by 25.406 as compared to non-investors. This finding is consistent with the findings of (Wagayehu and Drake, 2003) in Eastern Hararghe. This implies that the investment cost per unit area in terms of human labour invested and area lost to structures make the investment less costly and more rewarding.

Total livestock owned: Livestock had a significant and negative impact on the household adoption of SAPs in the study area. The negative sign of slope coefficient indicates that when livestock owned increase by one TLU, the probability of a household to become investor of SAPs', decrease by a factor of 0.851. The possible explanation for this result is that as farmers have large number of livestock (ox, cow, heifer, calf, donkey, goat, sheep and chicken) they become in low position to be investor than farmers who have few livestock. Moreover, livestock (ox) serve as non-human labour, and source of dung i.e., draft power in land preparation that directly contributes to supply of labor and organic fertilizer. The finding that livestock holding is negative related to investment in SAPs' is consistent with the finding of (ILRI, 2003).

Extension contact: This variable had significant and positive impact on farmers motivation to invest on SAPs' in the study area. This implies that, the remaining things constant, as the frequency of training and extension contact and /or visit of farmers by extension agents' and experts either from district or zonal level changes farmers mindset and increase knowledge of land conservation technologies. When extension contact and visit increases by frequency of contact or visit the household to be investor increase by a factor of 28.774 as compared to non-investor. Previous study conducted in Ethiopia (Wagayehu and Lars, 2003) were indicated that if there is close contact with the extension agents, the farmers are more likely to receive better information and advice from extension agents and they tend to be willing to invest in land conservation activities.

5 CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

Land degradation is the process of reducing or depleting the productive capacity of land caused by improper and poor farming system, improper land use practices, deforestation and overgrazing. It needs land conservation investment. Land degradation affects many dimensions of well-beings. The main persistent solution to arrest problem of land degradation is mobilizing farmers to invest on sustainable agricultural practices such as: reduced tillage, fallow of farm, compost use, and legume crop rotation and intercropping.

This research was designed with the objectives of examining land degradation status, assessing the status of soil fertility and identifying determinants of farmers' decision of investment in sustainable agricultural practices in Dangila district area. Despite Agriculture is the leading sector, in the Ethiopian economy, was and still is characterized by low productivity in general and low yield per unit area in particular. Many people attribute the problem with population explosion, immense environmental degradation, limited accessibility and use of technology, insufficient infrastructure, poor traditional practices and ill-thought-out polices.

This outdated and tied with bottlenecks, agricultural sector manifested by coupled with population growth at a faster rate, soil fertility depletion and decrease of crop yield, motivate to adopt multiple sustainable agriculture practices, which is agricultural-environmental management at short term or long term will be taken as a panacea.

This study has tried to look demographic, socio-economic, plot characteristics and institutional and other related factors, which can influence farmers', decision of investment in SAPs' components. For this, data were collected from 120 farm households drawn randomly by considering purposive inclusion of female headed households from Dangila district. The primary data were collected from interview schedule and focus group discussion. Secondary data were collected from relevant GOs and NGOs and from pertinent documents to supplement the data obtained from survey.

Fourteen variables were hypothesized to determine farmers' investment of SAPs' and their decision to keep it. Evidences from descriptive analysis indicated that investor farmers have more age, being male, own little number of plots, less fertile soil, own greater size of land,

minimum distance between the residence and plot, cultivated own land instead of sharecropped and rented, participated in kebele or village administration and takes social responsibility and better accessed extension services in the form of field visit, demonstrations, farm training on sustainable land management specifically, soil and water conservation, legume cropping and compost use. On the other hand, non-investor farmers were highly negatively affected by those cited variables.

The results of binary logit model analysis indicated that five variables at ($p<0.01$), four variables at ($p<0.05$) and two variables (10%) were found to significantly influence farmers investment on SAPs'. Sex of respondent was found to positive and significant impact on farmers decision of investment SAPs' at (5%) level of significance implying that male headed farmers have more information on new agricultural technologies and increase them to be investors.

Age of respondent was found to be positive and significantly affect farmers decision and accept SAPs' at ($p<0.01$) level of significance implying that elder farmers with age will have more information about soil fertility problems and solutions so that as age of respondent increases their investment of SAPs' also increases. On the other hand, as age of farmers becomes younger, the farmers' possibilities to lag in investment of SAPs' will likely increases.

Distance from home to the plot was negative and significant impact at ($p<0.1$) level of significant that indicated as the distance from resident to plot increases, farmers to be found investor of SAPs' decreases. This means too much nearby and backyard plot is more advantageous to accept and implement SAPs' components: such as transporting compost and cover soil, to make proper crop residue management and to plant cover crops and to integrate with soil and water conservation measures.

Soil fertility status of both own and sharecropped and rented land was positive and significant to affect farmers decision on investors of SAPs' at ($p<0.05$) level of significant and associated with as soil fertility level changes from fertile to less fertile farmers to be found investor would be increases.

Total tropical livestock unit was negative and significant to affect investment of SAPs' at ($p<0.1$) level of significant implying that as farmers own more TLU, farmers decision to be found investors of SAPs' decreases. This implying that as farmers own more livestock unit requires more grazing land, green pasture and fodder in turn it decreases the land to be invested by

investor farmers for SAPs'. In contrary to the earlier, as farmers own more livestock unit it increases farmers to be found non-investors of SAPs'.

Participation in kebele administration or in social position was positive and significant to affect investment of SAPs' at ($p<0.01$) level of significant implying that as farmers get the chance to participate in kebele or village or in social position, farmers decision to be found investor of SAPs' increases. This indicates that as farmers have better position in kebele or village administration increases the probability of gaining training and new information about best agricultural practices in turn increases investor farmers of SAPs'.

Number of plot was significant and found to be influence investment of SAPs' negatively at 1% probability level. Therefore, awareness creation should be made to inspire farmers who have more number of plots to be investors of SAPs' as small number of plot holder farmers

Slope of the plot was found to affect investment of SAPs' negatively and significant at 1% probability level. Therefore, emphasis should be given to change attitudes and investment decision of farmers who show low motivation to invest SAPs for sloppy farm plot with support and incentive.

Land use was significant and found to affect investment of SAPs' negatively at 5% probability level. Therefore, emphasis should be given to farmers treat uniformly the land they use for different purposes.

Labor availability was significant and found to be influence investment of SAPs' positively at 5% probability level. Farmers who have easily access of labor at the time of labor requirement are investors of SAPs'. This is due to SAPs' by its nature is labor consuming at the very scratch.

Extension contact made was found to be influence investment of SAPs' positively and significantly at 1% probability level. Therefore, emphasis should be given to assign sufficient number of development agents equipped with knowledge and skills so that farmers can access support that help them to scale up their knowledge towards enhancing their creativity and productivity.

5. 2 Recommendations

Some implications for this study were found to be relevant. Promoting the investment of sustainable agriculture practices is important for smallholder farmers for sustainable development of agricultural sector through expanding environmental health practices which

needs cooperation and integration work by various stakeholders especially farmers, development workers, experts, researchers and political leaders.

Sustainable agricultural practices have multiple components which require knowledge, skill, attitudinal and behavioral change and management help to save land from degradation. This finding indicated that farmers generate knowledge continuously and shared among them. However, they are not well invest in sustainable agricultural technology and sustainable land management their time, labor and resources. Therefore, researchers and extension staffs need to continuously keep in touch with these farmers for further research to address the issues need to resolve.

1. It was found that sex of household heads significantly affects investment of sustainable agricultural practices. Women self group is important to transfer information and to bring attitudinal change of women farmers at required speed and direction this suggesting the regarding body should work on women farmers' access of basic education, poster, and training to bring them equal participants of land conservation investment.
2. Results of this study indicated that the type of land use significantly affects sustainable agriculture. The result shows that sustainable agriculture components is more likely to be adopted by farmers with crop land suggesting research, extension and planning agencies to be sensitive to the needs of smallholder farmers through developing and disseminating technologies and strategies that are relevant to their needs as well as creating awareness on wood land and grazing land management benefits.
3. It was found that age of respondents' has significant and positive relationship with investment in sustainable agricultural practices. Therefore, the concerning body should work a lot on youth and sharecropper and renter to change their attitude of risk averse in long term land conservation investment plan and bring sense of ownership.
4. It was found that farmers' participation in kebele or village administration and other social organization significantly influence the decision and implementation of recent coming, sustainable agriculture practices. Thus, the concerned body should work on farmers' access to different forms of on field, demonstration and farmer days training.

5. It was found that total livestock holding has significant and negative influence in land conservation investment like Sustainable agricultural practices. However, farmers who have more livestock unit not motivated to invest in SAPs' because of their cattle needs more grazing land, crop residue (straw), and difficulty for management. Thus, the regarding body should offer training for farmers on how o balance livestock with own plot of land and better able to use their manure for land appreciation.
6. In similar fashion, frequency of contact and trained with extension agents has positively and significantly influenced investment in SAPs' suggesting the need for more targeted and continued extension services. Thus, the extension system operating in the areas and elsewhere, need to be strengthened further to increase the flow of information for rural development. Participatory community based approaches involving the stakeholders in planning and implementation are necessary in order to create a higher ownership attitude. Clear messages on sustainable agriculture practices should be included in the normal extension packages and training of both village extension workers and farmers should be emphasized so as to improve their understanding and skills.

Generally, it is not worthy investors, and non-investors have unconcern perceptions on the positive and negative aspects of land degradation and correspondingly, sustainable agriculture practices, but other factor more influence on farmers adoption decision. This suggesting that other unspoken factors such as income and return might explain observed differential adoption. Further research on win-win approach relative benefits gain from implementation sustainable agriculture in short term and long term over conventional farming, locally flexible and adaptable, changes in yield, selective and appropriate for the type of agro ecology and soil type, environmentally healthy practices should get attention.

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APPENDIX- I

Appendix Table 1: Conversion factors that used to estimate tropical livestock unit

Animal category	TLU	Animal category	TLU
Calf	0.25	Donkey (young)	0.35
Weaned calf	0.34	Camel	1.25
Cow & ox	1	Sheep& Goat(Adult)	0.13
Horse & mule	1.10	Sheep& Goat(young)	0.06
Donkey(adult)	0.70	Chicken	0.013

Source: stork *et al.* (1991)

Appendix Table 2: Values of VIF for continuous variables, which were used in binary logit

Continuous variable	VIF	R^2
AGE	1.15	0.866
FARMSIZE	1.13	0.884
DISTPLOT	1.12	0.979
TLU	1.10	0.807
PLOT	1.01	0.993

Appendix Table 3: contingency coefficients for discrete variables, used in binary logit

SEXHH	1									
EDUHH	-0.213	1								
PARTADM	0.079	0.096	1							
LANDTNUR	-0.064	0.059	0.035	1						
LANDUSE	-0.019	0.049	0.078	0.011	1					
SOILFERTY	-0.027	-0.007	0.163	-0.007	0.043	1				
SOILFRTY	0.024	0.037	0.023	0.113	0.136	0.05	1			
EXTENSION	-0.070	0.132	-0.061	0.102	0.090	0.122	0.043	0.340	1	
LABOR	-0.009	0.031	0.078	-0.026	-0.026	-0.082	0.018	0.107	-0.094	1

Source: own survey data, 2013

Appendix-II

Individual Interview schedule

The objective of this Interview Schedule is to collect information from farm Households of sample respondents perception of land degradation and determinants investment in Sustainable agricultural practices in Dangila district in two rural kebeles' from January to February 2013. The study is conducted for academic purpose which is expressed as aforementioned. Hence, we request your honest & fair responses to fill up this interview.

1. General & personal information of the respondent

1.1Respondent'snumber_____Date(dd/mm/yr)_____Respondent's name_____

1.2 Sex; 0 = female 1 = Male 1.3 Age_____years

1.4 Marital status 1.Married, 2.Single, 3.Divorced, 4.Widow/Widower. 5 others

1.5 Rural Kebelie Administration/ Peasant Association_____

1.6 Position in the peasant association___Village____woreda/district/____Zone___.Region____

Enumerator's name_____.signature_____1st checked_____date_____/___/___

1.7 Educational Status: 0 = Illiterate, 1 = Literate

1.8 Educational level:

1. Read & Write, 2.Grade 1- 4, 3.Grade 5- 8, 4. Grade 9- 10, 5.above grade 10

1.9 information of family members

No	Name of family member	Sex; (male=1, female= 0)	Age	Major occupation*	R/n to HHH**	Education***
1						
2						

*Major occupation: 1=dependent, 2= student (at school), 3=house wife, 4=farming, 5=hire labour 6=off farm activity, 7= others (specify if any) _____

**Relation to household head: 1.wife, 2=child, 3.grandchild, 4.brother, 5.sister, 6=hired labour, 7= others

*** Education: 1. Illiterate 2. Read & Write, 3. Grade 1- 4, 4.Grade 5- 8, 5. Grade 9- 10, 6. Above grade 10

2. Farm characteristics (land holding, use and land tenure)

2.1 In which farm activities you/your family involve? 1. on-farm 2. Non-farm 3 off –farm 4.other specify_____

2.2 What is the reason you go to off-farm activities?

2.3 Why you/your family involve in non-farm activities?

No.	Type farm activities	Plot number	Area timad/ha	Tenure status (A)	Soil fertility status (B)	If rented in/out arrangement (c)	Walking distance from home (min/hr/km)

A tenure status: 1= own plot (received from PA) 2= rented in 3=rented out 4 =gift 5=others____

B. soil fertility status: 1=highly manure 2=very fertile 3=moderately fertile 4 =infertile

C. Specific lease arrangement: 1=cash (amount/plot) 2=shared cropped –equal 3=shared cropped (1/3to plot owner) 4= shared cropped (1/4 to plot owner) 5=others_____

Type of Land use: 1) cultivated land 2) fallow land 3) grazing land 4) homestead land 5) others

2.4 Farming experience of the household head_____(years)

2.5 Total landholding size of the household in (ha):

a) Farm land_____ha b) Forest land_____ha

c) Grazing land_____ha d) others_____ha

2.6 For whom do you think that the land belongs? (1) To myself (2) To the government

2.7 If you say land is belongs to the government, do you feel secured the ownership of the plot?
(1) Yes (2) No

2.8 Do you know the right to inherit the entire plot to your children? (1) Yes (2) No

2.9 Do you expect that you will use all the land throughout your lifetime? (1) Yes (2) No

2.10 Do you agree if the government allows the farmers to sell their land? (1) Agree
(2)Disagree (3) Difficult to decide

2.11 Do you believe land tenure right has anything to do with land management/farming practice? (1) Yes (2) No (3) No comment

2.12 If Yes, how? _____

3. Plot Characteristics

3.1 slope of the plot 1) flat 2) gentle 3) moderate steep slope 4)steep slope 5) Mountainous

3.2 type of soil a) Sandy b) clay c) loam/silt d) Others (specify) _____

3.3 colour of soil 1) Red 2) Black 3) Brown

3.4 is there any form of soil erosion occurred on your plots for the last five years? 1 Yes 2 No

3.5 If yes, what is its severity level: 1) low 2) medium 3) high?

3.6 Land degradation status: a) non-degraded b) slightly degraded c) moderately degraded d) severely degraded

3.7 have you practiced any soil and water conservation (SWC) measures? 1. Yes 2. No

3.8 If No, why? (1) No erosion problem (2) Shortage of labour (3) Have doubt on Method of conservation (4) No needs of SWC (5) any other, please specify __

3.9 If yes, which type of SWC measures you practiced? 1. Improved 2. Traditional

3.10 Did you perceive the presence of soil nutrient depletion? (1) Yes (2) No

3.11 If yes, what is the major cause of nutrient depletion (rank)? (1) Intensive cultivation (2) Absent or low inorganic fertilizer application (3) absence of fallow (4) Low or absence of organic fertilizer application (5) absence of crop rotation (6) any other, please specify

3.12 What are the major causes of soil erosion on your all plot (give rank)? 1) Heavy rainfall 2) cultivation of steeper slopes 3) Intensive cultivation without fallow 4) wind

5) Over grazing 6) lack of sense of ownership 7) others specify_____

3.13 What do you think the consequences of soil erosion (rank)?
(1)Decrease Land productivity (yield) (2) Change in type of crops grown (3) Land preparation becomes difficult (4) reduced farm size (5) Poverty (6) Land become out of cultivation (7) Migration (8) others, please specify_____

3.14 Did you believe that investment in the soil conservation practices is profitable in the long run? (1) Yes (2) No

4 Crop production and productivity

4.1 How can you explain crop grown and productivity and practices used during the 2011/2012G.C (2004/2005 E.C)? 1. Increased 2 decreased 3. Remained the same 4. No comment 5. Other please specify_____

Plot No.	Area(ha)	Crops grown	Variety used 1=improved 2=local	Land preparation		Herbicide use 1=yes 2=no	Production kg/Qt
				Method of plowing 1=pair oxen 2=hand hoeing,3=other	frequency		
1.							
2							
3							

4.3 For which crop did you apply organic fertilizer more? (1) __ (2) ____(3) __(4) _____

4.4 Experience in improving soil fertility culturally in all? (1) Soil burning (2) Mulching

(3) Compost manure (4) Green Manuring (5) Crop rotation (6) Fallow

(7) Fertilizer (8) any other, please specify _____

4.5 do you have been heard about sustainable agricultural practices (SAPs')?

4.6 did you have an experience in investment of SAPs'?

4.7 How many years you been practicing?

4.8 Are you practicing crop rotation? 1. Yes 2. No

4.9 If you use crop rotation, specify the rotation sequence and the crops used _____

4.10 What changes you observe in terms of soil fertility while practicing crop rotation?_____

4.11 What changes you observe in terms of crop productivity?_____

4.12 for how many years practiced it?_____

4.13 Do you use inorganic fertilizer (Urea, DAP) in the last two years? (1) Yes (2) No

4.14 Did you use it as per the recommendation? 1) Yes (2) No

4.15 Trends in inorganic fertilizer application? (1) Increased (2) Decreased

(3) Remain the same (4) No comment

4.16 If the answer for question 4.7 is no, what are the factors that affect your fertilizer use?

(1) Shortage of supply (2) High cost of fertilizer (3) Transportation problem (4) low prices of grains (5) Lack of credit (6) Other specify _____

4.17 How do you access it 1. From GO in terms of subsidy 2. Purchasing in cash 3. Credit basis from kebele

4.19 How do you compare crop productivity before and after application of fertilizer?

(1) Increased (2 decreased (3) remain the same (4) no comment

4.20 How many times you plow your farm before sow seed? 1. Two 2. Three 3. Four 4 more than four times

4.21 What do you perceive about conservation tillage/minimum tillage change brought on crop production?

4.22 Do you apply in your farm conservation tillage?

4.23 How do explain crop productivity before and after practiced minimum tillage? 1. Increased 2. Decreased 3. The same 4. I do not know 5. Others_____

4.24 If your answer is no, why?_____

4.25 Doest minimum tillage technology costly? 1. Yes 2. No 3. Do not know

Plot /ha	Types of crop	NT/MT *	Fertilizer 1=DAP 2=Urea 3=others	Labour 1)Save 2)Consume 3)No comment	Herbicide/ pesticide 1 yes 2. no 3. other	Soil fertility 1.increase 2.decreae 3.remain the same 4.don't know	Compost 1,yes 2.no	Yield of crop in 2010/11	Yield of crop in 2011/12

No tillage/minimum tillage technologies*. 1. Hand hoeing 2.animal draught 3.knife roller 4 hand tractor 5. Jap planter 6. Other

4.26 Do you use mixed cropping (two or more type of crops) for improving soil fertility?

(1) Yes _____ (2) No _____

4.27 Do you have burnt crop residue (straw) in last two years? 1. Yes 2. No

4.28 If your answer is yes, what was your reason you reach to the decision to burn?

1. To avoid weed 2. To control pest 3. To make plow easy 4. Other (specify)

4.29 are you practicing intercropping? 1. Yes 2. No

4.30 If your answer is yes, for how many years you practice?

4.31 Are you mulching your farm land by crop residues or mowed weeds? 1. Yes 2. No Kind

4.32 what is the materials you used for mulching in the last two years 1) mulching by compost 2) mulching by straw 3) mulching by crop residues 4) others

4.303What did/do you observe from practicing mulching/cover crop plantation 1) increased crop productivity 2) increased soil fertility 3) minimize soil erosion 4) Save labour 5) reduce weed occurrence 6) reduce cost of draught power 7) others

5. Livestock ownership

Livestock	Category	Local (number)	Improved(number)
Cows			
Oxen			
Heifers			
Calves			
Bulls			
Goats			
Sheep			
Poultry			
Donkey			
Horse			
Mule			
Others			

5.1 Problem related to livestock husbandry (1) shortage in grazing land (2) Disease (3) shortage in feed (4) barn (5) water (6) Supplementary feed (7) clinic (8) shepherded/guard

5.2 Do you have pasturelands? (1) Yes (2) No

5.3 Do you have enough pastureland? (1) Yes (2) No

5.4 Did you graze your pastureland by rotation? (1) Yes (2) No

5.5 Do you use crop residues as main feed since five years back? 1. Yes 2. No

5.6 Type feed: - (1) Grazing (2) Hay (3) Straw 4) Maize and Sorghum hola

(5) Atela (6) Cut-and-carry (7) any other, please specify _____

5.7 Source of feed: - (1) Communal grazing land (2) Fallow (3) Crop product (4) Purchasing (5) from own farm (6) Any other _____

5.8 In general for what purpose, did you use cow dung (rank)? (1) Fuel (2) Soil fertility (3) For sell in form of kubet (4) No used yet

5.9 Which months of cow dung more used for fuel? _____

5.10 Do you prepare compost? (1) Yes (2) No

5.11 If question number 2.14 yes, what is your reason? _____

6. Labour availability

6.1 Do you have labour shortage for your farm activities? (1) Yes (2) No

6.2 If you say yes, which activities are most affected by labour shortage?

1=land preparation (plowing) 2=planting (sowing) 3=weeding 4=harvesting 5= in all times 6=in planting and harvesting 7=others

6.3 If the answer to question to 6.1 is yes, how do you solve labour shortage? (1) Hiring labour (2) by cooperating with other farmers (Debo/Jigie) (3) other please, specify _____

6.4 What is the average perdiem during 2003/2005 cropping season? 1) In kind __ 2) in cash ___

6.5 Can you easily get labour whenever you need? (1) Yes (2) No _____

6.6 In which farming activities female family members participatc? 1=land preparation (plowing) 2=planting (sowing) 3=weeding 4=harvesting 5=garden work 6=others_____

6.7 During which age range farmers work full time farm job? _____?

7. Agrochemicals

7.1 Do you use herbicide 1=yes 0=no

7.2 If you say yes, what are names' of herbicides you frequently use?1) Round up 2) 2-4D 3) others

7.3 If you say no, justify your reasons why you are not using?_____

7.4 Is there insect-pest out break encounter in grass-crop productivity in your plot or local area?

7.5 Do you use pesticide? 1. Yes 2. No

7.6 What is the name of pesticide you use?_____

8. Institutional factor

8.1 Did you get extension service? (1) Yes (2) No

8.2 If yes, who provides the extension service? (1) Development agent (DAs) (2) NGOs (3) Any others, please specify _____

8.3 What the extension agent taught you (rank)? (1) Input supply and use (2) Improved Cultural practice (3) Soil and water conservation (4) Land management practice (5) water harvest (6) Animal husbandry (7) Agro-forestry (8) others, specify_____

8.4 How often have you obtained extension advice on the problem and solution of land degradation? (1) Once per month (2) twice per month (3) three times per month (4) once per three month (5) twice per three months (6) Any others, please specify _____

8.5 During which farm operation extension agent visit you? 1=land preparation, 2=during input provision, 3= during sowing 4=during herbicide application, 5=during credit collection 6=2&4 7=others (specify if any)_____

8.6 Did you get training about minimum tillage? (1) Yes (2) No

8.7 If you say yes, from whom,/which source? 1=ministry of agriculture 2=DA 3=media (radio, television, brochure...) 4=others

8.8 What is the length of time since you first heard about conservation agriculture_____years?

8.9 Do you have practiced conservation agriculture? 1. Yes, fully 2.Yes, partially 3. Not totally

8.10 If you say yes, for how many years practiced conservation agriculture in your farm years?

8.11 What changes you have observed in fertility of soil, crop productivity and moisture holding?

Plot in ha	Type of crop grow	Herbicide 1. User 2. otherwise	fertilizer	Produces before adoption of CA in kg/quintal	Produces after adoption of CA in kg/quintal

8.12 If you say no, what was/is your reason?_____

8.13 From whom/, which source you obtain training? 1. MOA 2. DA 3. IPMS 4 .others(specify)

8.14 For how many years have you practiced CT technology in your farm? _____

8.15 Have you ever participated in field days/visits prepared on CT technology practices in the last five years? 1=Yes 0=No

8.16 If yes, how many times in number----------

8.17 Who arranged for you? 1= District rural development 2= NGO 3= Others (Specify) ---------

8.18 Indicate your access to and frequency of use of the following media?

9 Credit sources and availability

9.1 Do you receive credits for your farming activities during this cropping season? 1. Yes 2. No

9.2 Did you use credit for your farming activity? (1) Yes (2) No

9.3 For what purpose did you ask credit? (1) To purchase fertilizer (2) To purchase Improved seed (3) for sheep production and fattening (4) Oxen fattening (5) any other, specify _____

9.4 When did you repay credit? (1) Any time (2) at the time of harvest season (3) At the end of the budget year (4) based on the credit type

9.5 If no, what matter you, not use credit? (1) Source of credit (2) Interest rate

(3)Absence of collateral (4) distance (5) Term of agreement

(6) No credit for this purpose (7) any other, please specify _____

Marketing information

10.1 From where do you get marketing information?

10.2 What is the distance of the local market from your house (walking minute)? _____

10.3 What is the distance of the main market from your house (walking minute)? _____

11. Awareness, attitudes and perception of farmers

11.1 Do you know the existing differences among conservation practices? 1. Yes 2. No

11.2 If yes, mention some of them_____

11.3 Which of sustainable agricultural practices most suit your interest? List in order of importance? 1. Minimum tillage 2. Compost use and/plantation of cover crops

3. Mixed legume cropping and /crop rotation/ intercropping

11.4 Could you have the point to mention about the disadvantages of sustainable agricultural practices?_____

11.5 If a farmer decides to use the conservation technologies/practices? (Mark if answer is given)

1. Observed the benefits other farmers obtained from using the technology

2. Persuaded by other farmers 3. Persuaded by change agents

4. Persuaded by others specify

11.6 What potential problems one will face under practicing conservation technology?

1. Technological problem 2. Know how 3. Others