AN EVALUATION OF ADOPTION AND SUSTAINABILITY OF SOIL CONSERVATION PRACTICES UNDER SMALL SCALE FARMING SYSTEM OF ADAMA DISTRICT IN OROMIA REGION, ETHIOPIA

BY

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ABSTRACT

Over the years, numerous intervention approaches have been launched to promote improved technologies in order to attain sustainable development. However, extension approaches, which have been the dominant rural development strategy, have been slow in transforming agriculture resulting from low adoption rate of SWC technologies that were aggressively promoted through extension programmes. Thus, this study examines the adoption and sustainability of soil conservation practices looking into the major factors dictating the SWC technology adoption. The study is based on a critical review of literature including analysis of data collected from 120 farmer households and 40 extension field staff. In the study, two analytical techniques, descriptive statistics and logistic regression function, were employed in analyzing data. The results of the study reveal that rural development strategies have been formulated without due consideration to farmers' indigenous knowledge and participation in development process. Specifically, literature confirms that past extension approaches have been biased against natural resource management and in this regard, except physical soil bund structure, other components of soil conservation packages were found marginalized and the major reason behind the better attention to soil bund is because of the support that the practice has received from SWC related projects over the past years. In this regard, a host of factors, most of which are policy related, were responsible for poor technology adoption and sustainability and the socio-economic factors also were found to be significant in dictating the adoption process. Overall, both the historical review and survey results reveal that integrated natural resource oriented approaches were not adopted and natural resources aspect was neglected. Therefore, from the findings of this study it is strongly recommended that policy

makers and technical institutions should readdress the policy related issues and extension system should be revised in such a way that holistic approaches to ensure environmentally sustainable rural development are employed in small-scale farming system.

DECLARATION

I, GERISHU BATI WARITU, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work, and has never been submitted, nor concurrently being submitted for a degree award at any other University.

_____ _____

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_____ _____

Prof. Z.S.K. Mvena Date
(Supervisor)

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TABLE OF CONTENTS

ABSTRACT…….i

DECLARATION…….....iii

COPY RIGHT……iv

ACKNOWLEGMENTS…….v

DEDICATION…… .vii

TABLE OF CONTENTS…… viii

LIST OF TABLES……... . xi

LIST OF FIGURES……. xiii

LIST OF APPENDICES……. xiv

LIST OF ABBREVIATIONS AND ACRONYMS…….xv

CHAPTER ONE……...1

INTRODUCTION…….....1

1.1 Background information……1

1.2 Problem statement…….7

1.3 Justification of the study……8

1.4 The scope and limitation of the study……9

1.5 Objectives of the study…….10

1.5.1 General Objective……...10

1.5.2 Specific Objectives……11

1.6 Research hypothesis……11

CHAPTER TWO……. .12

LITERATURES REVIEW……. .12

2.1 Introduction……..12

2.2 Natural resources degradation and related effects……...12

2.3 Soil degradation and related effects in Ethiopia……..14

2.4 Remedial extension intervention approaches in Ethiopia……....16

2.4.1 Comprehensive and minimum package approaches……...17

2.4.2 Participatory Demonstration and Training Approach……19

2.4.3 Soil conservation extension efforts in Ethiopia……..20

2.5 Determinants of innovation Adoption…….22

2.5.1 Institutional and infrastructural conditions…….23

2.5.2 Economic variables…….25

2.5.3 Social and psychological variables…….26

2.5.4 Innovation related factors…….....30

2.6 Sustainability of adopted innovations……..30

CHAPTER THREE……35

METHODOLOY…….....35

3.1 Introduction…….35

3.2 Geographical location and description of the study area…….35

3.3 Sampling methods and data collection…….42

3.4 Methods of data processing and analysis…….44

3.4.1 Model specification…….45

3.5 Conceptual framework of explanatory variables of the study…….48

CHAPTER FOUR…….....49

RESULTS AND DISCUSSIONS…….....49

4.1 Introduction……..49

4.2 An over view of agricultural potential of the study area…….49

4.2.1 Crop production……...50

4.2.2 Livestock production……...53

4.3 Comparison of physical and biological soil conservation adoption…….....54

4.4 Social and Economic characteristics association to soil bund adoption……..55

4.5 The social characteristics of the respondents……...59

4.5.1 The age distribution of sample households……...59

4.5.2 Family size and related characteristics of sample households……....61

4.5.3 Educational level of sample households…….....63

4.5.4 Gender and marital status of household heads……....64

4.6 Economic and farm characteristics of respondents……..67

4 .6.1 Estimated yearly income of sample households……....67

4.6.2 Land holding of sample households……...68

4.6.3 Farm distance from the residence of households and public services....69

4.6.4 The main occupation of sample households……...72

4.6.5 Physical conditions of farmland in relation to soil bund adoption……73

4.7 Availability of institutional support to farm households……..74

4.7.1 Agricultural Extension services and the effects of mass media…….....74

4.7.2 Credit facility and farmers access to financial support……...76

4.7.3 Farmers experience in SWC projects and level of participation……78

4.8 Sustainability of major physical and biological soil conservation practices…80

4.9 Extension field staff (DAs) perception on soil conservation adoption……....83

4.10 The Logistic regression summary and discussion…….....88

CHAPTER FIVE……...…….....95

CONCLUSIONS AND RECOMMENDATIONS……..95

5.1 Introduction……..95

5.2 Conclusions……..95

5.3 Recommendations…….....99

REFERENCES…….....102

APPENDICES…….....112

LIST OF TABLES

Table 1: Respondent's peasant association and sample distribution.....43

Table 2: Comparison of different Soil conservation practice adoption (N=120)…....55

Table 3: The summary of means difference for continuous explanatory variables.....56

Table 4: Test of association between categorical variables and soil bund adoption.....58

Table 5: Age categories of respondents in relation to soil bund adoption (N=120)....60

Table 6: Adoption of soil bund in relation to family size (N= 120)……....62

Table 7: Adoption of soil bund in respect to Educational level (N= 120)……...64

Table 8: Adoption of soil bund stractures in respect to sex composition of the respondents(N=120)…….....66

Table 9: Adoption of soil bund structure by respondents in respect to marital status of the rtespondents (N= 120)……....66

Table 10: Adoption of soil bund by the respondents in respect to yearly income of households (N=120)……..67

Table 11: Adoption of soil bund stracture by respondets in relation to landholding or land size(N=120)…….....69

Table 12: Effect of farmland distance from residence of respondents on soil bund technology adoption (N= 118)…….71

Table 13: The effect of DC distance on soil bund structures adoption (N= 119)…....71

Table 14: Influence of distance from primary road on soil bund adoption (N=119)....71

Table 15: Main occupation of household head and adoption of soil bund (N=120).....72

Table 16: Observed erosion problem on household farmland (N= 120)…….74

Table 17: An average development agent’s visit to farmer in a month (N=118)…....75

Table 18: Farmers access to financial support and its effect on adoption (N=117)....77

Table 19: Farmers experience in soil conservation projects/ programs (N= 116)…...79

Table 20: Level of farmer Participation in planning and evaluation of developmemnt projects/programs process (N=117)…….....79

Table 21: Comparative evaluation for sustainability of SWC practices (N=120)…...82

Table 22: Reasons why extension package program was production oriented in the past implementation years (N= 40)……84

Table 23: Comparative evaluation of developments agents'(DAs) perception on extension system efficiency (N=.40)…….....85

Table 24: Assessment of soil conservation practices adoption rate by deveolpment agents (DAs) (N= 40)……..86

Table 25: Comparative scaling of SWC practices sustainability by DAs (N=40)…..87

Table 26: Definition of abbreviations of variables included in the model……..89

Table 27: Parameter estimate for adoption of physical soil bund structures……..90

LIST OF FIGURES

Figure 1: Rain fall situation in Adama district (1996-2006)……37

Figure 2: Administrative Map of Oromia Regional state to showing E.S. Zone…….39

Figure 3: Administrative map of E. S. Zone showing study district.....40

Figure 4: Administrative Map of Adama District showing the study PAs……...41

Figure 5: Hypothetical variables relationship in adoption and sustainability of soil and water Conservation Practices…….....48

Figure 6 : Area coverage (%) of major crops in the study area……....51

Figure 7: Productivity of major crops in Adama District (Qt/ha)……....52

LIST OF APPENDICES

Appendix 1: The summary for means difference of continuous variables……....112

Appendix 2: Summary of categorical variables in respect to SWC adoption…….....112

Appendix 3: Conversion factors applied to Estimate Tropical Livestock Unit…….113

Appendix 4: Multi-collinearity diagnosis for non categorical variables ……....113

Appendix 5: Farmer's interview schedule for primary data collection……..114

Appendix 6: The questionnaire to be completed by Extension field staff……..129

LIST OF ABBREVIATIONS AND ACRONYMS

ADLI	Agricultural Development Leads Industrialization
ARDD	Agricultural and Rural Development Department
CACC	Central Agricultural Census Commission
CADU	Chilalo Agricultural Development Unit
CATAD	Center for Advanced Training in Agriculture and Development
CBDC	Cross Breed Dairy Cow
CSA	Central Statistical Agency
CT	Conservation Tillage
DA	Development Agent
DC	Development Centre
EEA	Ethiopian Economic Association
EMTP	Extension Management and Training Plot
EPID	Extension and Project Implementation Department
FAO	Food and Agriculture Organization
FFW	Food For Work
FFWP	Food For Work Projects
FTC	Farmers Training Centre
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
ILRI	International Livestock research Institute
LEISA	Low External Input and Sustainable Agriculture
MOA	Ministry Of Agriculture
MPP	Minimum Package Project
NAEIP	National Agricultural Extension Intervention Program
OADB	Oromia Agricultural Development Bureau
OPEDB	Oromia Planning and Economic Development Bureau
PA	Peasant Association
PTD	Participatory Technology Development
PADEP	Peasant Agriculture Development and Extension Project
PADETES	Participatory Demonstration and Training Extension system
REFAC	Research-Extension and Farmers Advisory Council
RELC	Research Extension Liaison Committee
RTCC	Reduced Tillage and Cover Crops
SG2000	Sasakawa Global-2000
SIDA	Swedish International Development Authority
SWC	Soil and Water Conservation
TFAE	Task Force on Agricultural Extension
T & V	Training and Visiting
TLU	Tropical Livestock Unit
TOL	Tolerance Level
USAID	United States Agency of International Development
VIF	Variance Inflation Factor

WADU	Wolamo Agricultural Development Unit
WFP	World Food Programme

CHAPTER ONE

INTRODUCTION

1.1 Background information

The agriculture sector must nearly double biological yields on existing farmland to meet food needs, which will double in the next quarter century that must tremendously increase due to high growth rate of the world population. In many developing countries, agriculture constitutes an important proportion and contributes significant share to the family food self-sufficiency and national food security, playing an important role in the development of national economy (Howlett and Nagu 1997). Similarly, according to different documents, example, Ethiopian Economic Association (EEA, 2005), agriculture is the mainstay of national economies in sub-Saharan Africa including Ethiopia, where in Ethiopia it accounts for about half (47 percent) of the Gross domestic product (GDP) in recent years.

In addition, EEA (2005), reported that, like in many developing countries, agriculture is the predominant sector in Ethiopian national economy in which more than 80 percent of the economically active rural population earn their livelihood from crop and livestock production and also the same document suggested that, it generates over 82 percent of the country's foreign export earning for year 2003/04. Besides, Central Agricultural Census Commission (CACC, 2003a) indicated that 70 percent of the raw material requirements for the large and medium sized industries are met by the agricultural sector. Due to this fact, several studies repeatedly suggested that the performance of the national economy has been greatly affected by what happens in the agricultural sector but the Ethiopian economy remains an agrarian economy

which is extremely vulnerable to climatic and environmental shocks. Due to this fact, sustainable agricultural development will therefore be crucial for food security, to maintain the livelihood of rural majority of population and as a foundation for development of the national economy.

Similarly, in Oromia region, agriculture constitutes the main sources of livelihood for its population and it is estimated that 89 percent of the population is engaged in agriculture and thus, agricultural production accounts for 75 percent of regional Gross Domestic Product (OADB, 2003). According to Workneh and Rowlands (2004), Oromia Regional State is the largest region covering over 30 percent of the country land area and characterized by immense geographical and climatic diversity with altitudes ranging from below 500 to over 4300 meters above sea level (masl) and the same source indicates that the annual rainfall in the Region is variable, ranging from 1600-2400mm in the highlands and less than 400mm in the semi-arid lowlands.

Oromia strategic planning and management document estimates the total population of the region to 21 million, accounting for 35 percent of the total national population and about 90 percent of the population live in rural areas entirely depending on agricultural activities, while 10 percent are urban dwellers (Workneh, *et al.* 2004). The same document estimates the literacy rate of the region about 22 percent, while unemployment rate is estimated at 2 percent and the life expectancy in the region is 51 years. On the other hand, the region has twelve administrative zones including East Shewa Zone which, geographically, occupies the central part of the region and country. The surface area of East Shewa Zone is estimated to around 9 997.34 Km^2

(CSA, 2006) which is also estimated to be about 10 percent of the regional land surfaces (OPED, 2000). According to Central Statistical Abstract (CSA, 2005), the total population of East Shewa Zone is estimated to be around 1.7 million, among which 50.8 percent and 49.2 percent is male and female, respectively, with population density of about 170 persons per km^2. This is the most densely populated zone in Oromia Regional State, where the reported average regional population density is only 56 persons per km^2.

The dependency ratio of population is an indicator that shows the size of the population that depends for its livelihood on the active age group of 14-59 years and according to the OPED (2000), the East Shewa zonal dependence ratio for the year 1994 was 97.21 percent, which indicates that every 100 persons in the active age group support nearly 97 more persons. The major feature of East Shewa Zone is the Rift Valley in which the zone accounts for about 34 percent of the total land covered by the Rift Valley in Oromia. It is suggested in many documents that the altitude of the East Shewa Zone ranges from 1 000m to 3 100m above sea level (OPED, 2000).

Furthermore, the same source document reported that the high altitude part of the zone with elevation of over 2 300m usually experiences the 10-15^{0}C of mean annual temperature and other parts of the zone including lowest Rift Valley scarps and higher part of the rift valley floor with elevation of 1 500-2 300m register 15-25^0C mean annual temperature. Due to its low elevation and its distance from the rain bearing winds, the rift valley floor of East Shewa Zone receives medium mean annual rainfall which ranges 700-800mm but southeastern highland section of the zone usually receives up to 1 400mm mean annual rainfall (OPED, 2000). In

Ethiopia, in general and in Oromia region in particular, the main features of the economic development has been the central importance of the agricultural sector over the whole past period and for the foreseeable future, agriculture will continue to have a major role in the Ethiopian national economy. However, despite its importance for the national development and food security, agricultural land productivity is declining as the time progresses forward while the population is increasing with fast growth rate and the main reason behind low productivity of agricultural sector is the land degradation which is commonly concerned with soil degradation of the arable land. As indicated by Pla (2002), the problems of soil degradation and derived effects are increasing throughout the world, partially due to a lack of appropriate identification and evaluation of the degradation processes which is the result of generalized use of empirical approaches to select soil and water conservation practices to alleviate the problems. According to his argument, a sound understanding of the potential causes and processes of land degradation would prevent implementation of costly and non effective soil and water conservation projects which lead to inexpensive and more sustainable land use practices.

In addition, Pla (2002) suggested that the development of new and improved technologies for increasing production of farming system, to satisfy requirements, must ensure the natural resource is not depleted and sustainable land management must focus on technology that minimizes risk, increases production and ensures the integrity of the natural resource to protect land degradation process, so that it can be conserved for future generations. In this aspect, the economic use of soil resources is a fundamental concern of the farming systems approach, because land is an essential input in agricultural production process, in the sense that no output will be produced

without its appropriate utilization and management. This is particularly true for Africa and many other developing countries where non-labor inputs in agriculture are negligible and agricultural land is the critical resource for the survival of the vast majority of the population (Barbier, 2003). However, in the process of using land, farmers expose the land to physical, chemical, and biological forms of degradation and as a result, this crucial resource is under continuous threat in which its long-term productive potential is being impaired.

Concerning land degradation process in Ethiopia, Ethiopian highland reclamation studies (EHRS), mentioned by Tesfaye (2003), indicates that half of the highland areas (27 million hectare) were estimated to be significantly eroded and other 14 million hectare were seriously eroded and left with relatively shallow topsoil which significantly support agricultural productivity. The same source also estimated soil loss in the Ethiopian highlands at 1 900 million tones annually, among which the loss from cropped land is estimated at around 100t ha^{-1} every year and about 80 percent of highlands erosion occurs on croplands.

Furthermore, Tesfaye suggested that the resulting on-site effect of soil erosion in Ethiopia was estimated to be at about 2 percent annual reduction in grain production. Tesfaye also pointed out in his study that the forested land is declining in Ethiopia from time to time at a rate of six percent per annum, which estimated in ha, between 150 000 to 200 000 hectares per annum and according to the findings of Ethiopian Forest action plan (1994), cited by Tesfaye (2003), at this rate of deforestation, the country's forest resource will vanish within fifteen to twenty years. In Ethiopia in general, East Shewa Zone in particular, agricultural land has been under continuous

cultivation for the last several years and it is structurally, physically, and chemically degraded and the central rift valley (the study area), inhabited by vast human and livestock population, is among severely degraded areas, where the severity of the problem is usually aggravated by erosive agricultural practices. In relation to soil degradation problem, the evidence of different literature review reveal that the traditional farming systems and natural resources management by any means can not sustain the attempted improvement of the agricultural sector to attain domestic food and local market commodity demand, and can not improve the quantity and quality of agricultural outputs to compete in the international market which sufficiently influence the profitability of agricultural sector in the national economy.

Thus, the fundamental attempts for the agricultural and rural development necessitate the extension intervention to promote improved agricultural technologies and appropriate natural resources management in order to attain intended development objectives. To this end, to reduce the land degradation problem, the Ethiopian government has initiated a massive program of afforestation and soil conservation with the support of international organizations through Food for work (FFW) program (Wagayehu, 2003). In addition to these efforts made through conservation related projects, considerable attention has been put in place to promote soil and water conservation (SWC) practices through regular extension service delivery system and national extension package program as a part of the agricultural development strategy.

In this regard, from early 70th onwards Ethiopian government initiated significant efforts during the introduction and implementation of soil conservation practices in

combination with tree planting which is regularly supported by the World Food Program (WFP) to rehabilitate the observed land degradation in the country. The programs were launched to mobilize farmers in which the ultimate goal was soil conservation technology promotion and popularization in the farming system and stimulate the smallholder's adoption of soil conservation practices to ensure soil resources sustainability. However, even though different extension approaches and soil conservation related projects have been implemented in the country, experiences over the past four decades appears to have not made progress with respect to bringing major impacts on the adoption and sustainability of modern technologies and natural resources management to improve the productivity of small scale farming system.

1.2 Problem statement

Despite the efforts made to attain the optimum soil conservation practices implementation to maintain sustainable productivity of the land, the success of the massive effort was very limited and insignificant to bring fundamental change in the agro-environment of small farming system. Furthermore, in spite of rapidly growing awareness about soil degradation, its physical causes and effects, together with increased understanding of methods of protecting and multiplying conservation efforts in the past few decades, soil degradation remains widespread and adoption and sustainability of conservation practices by farmers remain limited.

However, despite the widespread of soil degradation and low level of Technology adoption, limited efforts that have been made at very few location of the country to identify the nature of adoption of the technologies in the farming system were not

sufficient to summarize defined conclusion and especially, it is insignificant concerning SWC practices. Therefore, there is a need to understand the adoption situations for the purpose of designing policy and strategy that promote conservation behavior which necessitates adoption and sustainability studies of soil and water conservation practices. Thus, the major concern of this study is to analyze the existing situation of the SWC technologies adoption and sustainability including its determinants under small farming system of Adama Districts, with emphasis on physical soil bund structure technologies.

1.3 Justification of the study

The Ethiopian Rift valley mid and low lands, which inhabited by vast majority of rural population, are under continuous threat from soil degradation process. Land degradation induced by soil erosion is considered to be among the major factors responsible for the recurrent malnutrition and famine in Ethiopia. Conservation efforts made during recent decades have not succeeded neither in triggering voluntary adoption of conservation practices nor in mitigating soil erosion problems. Thus, the result of this study could shed light on the dynamics of adoption and sustainability of natural resource oriented agricultural technologies; which ultimately help farmer's participation in extension planning, promotion of demand driven service delivery system and also facilitate adjustment and redirection in working with farmer for rural development.

A clear understanding of the major causes for the poor adoption and sustainability of environmentally safe agricultural technologies has practical implication at the different levels to assist policy makers and planners for formulation of appropriate

extension policies and strategies. Furthermore, the result of the study would supplement the current efforts that are to make agricultural extension service delivery system client oriented and demand driven approach to attain maximum sustainability in the farming system. In addition, it is expected to generate information on diverse sets of factors that influence the adoption of the soil and water conservation packages among the farmer's households and this generated information would help in the design of appropriate extension policy and programs directed at fostering the adoption of the soil conservation technologies and the same information would considerably improve the planning of the development activities. The empirical results of the study could also support other similar detailed and comprehensive study in the region or a country.

Further more, this study was based on adoption and sustainability analysis of SWC practices in the Adama areas. However, the findings of this study could be extended to other areas with similar agro-ecological and socio-economic settings with a certain level of adjustment: which actually requires precaution and supplementation of results with further studies because of differences in the farming environment.

1.4 The scope and limitation of the study.

The focus of the study was on major conservation technological packages that have been extended through National Agricultural Extension Intervention Programme (NAEIP) and Food for Work Projects (FFWP). The target population in this study was farmers who are living in the Peasant Association (PA) of Adama District that have participated in extension package programme during its implementation years and related soil and water conservation projects. In this regard, the study was

concentrated to determine the existence of specific soil conservation adoption and sustainability in the study area. Including identification of factors that hampers the adoption efficiency of the farmers in the district and it is hopped that, the isolation of the causes of the poor adoption and sustainability would permit the formulation of the specific remedial measures for improvement. Thus, it is worth noting that the findings of this study would help policy makers and development workers to focus on those factors which have been identified as the principal constraints of poor adoption and sustainability of conservation packages in the study area.

However, this study has certain limitations, which emanate from shortage of time, budget, and facilities to conduct complete detailed investigations. In this regard, as mentioned in the objectives of the study, more emphasis has been made on the adoption and sustainability of SWC technology packages without including impact assessment in order to identify whether the interventions influenced the life of the farmers. In addition, given the limitation of the resources, the study covered only 120 farmers which is 4.4 percent of PAs' population, as the representatives of the farmers of the community, which practically does not constitute optimum proportion of the total number of the farmers in the sample PAs and study area.

1.5 Objectives of the study

1.5.1 General Objective

The overall objective of this study was to evaluate the adoption and assess the sustainability of soil conservation practices with emphasis on soil bund structure in selected villages of Adama District of the Oromia Regional State in Ethiopia.

1.5.2 Specific Objectives

In the process of determining the adoption and sustainability of soil and water conservation practices in the study community**,** the following are the specific objectives of the study.

(i) To identify and describe the available soil conservation practices and improved soil conservation technologies in the study area.

(ii) To identify the pattern of adoption and sustainability of soil conservation practices and technologies with emphasis on physical soil conservation structures adoption.

(iii) To determine and describe the factors influencing the adoption and sustainability of the soil conservation practices and improved technologies in the study area.

1.6 Research hypothesis

In the process of achieving the mentioned above objectives of the study, the following research hypothesis assumed to be tested in order to identify the effect and association of socio-economic variables on soil conservation technological package adoption including its sustainability in the study area.

H_0: Farmer's and Farm characteristics; social and institutional factors do not significantly influence the farmer's adoption and sustainability of the soil conservation practices.

H_a: Farmer's and Farm characteristics, social and institutional factors do significantly influences the farmer's adoption and sustainability of the soil conservation practices in the study community.

CHAPTER TWO

LITERATURES REVIEW

2.1 Introduction

This chapter deals with the natural resources degradation including its effect on agricultural production in relation to resultant impact on national economy. Specifically, this section presents wide ranges of soil related problems that hinder productivity of the farmland on the world in general and in Ethiopia in particular. Furthermore, the chapter examines the past experiences of extension intervention in general and soil and water conservation efforts in particular. Finally, the review of the empirical study of technologies adoption and sustainability with emphasis on soil and water conservation technologies are included in this chapter in order to compare with the findings of this study.

2.2 Natural resources degradation and related effects.

Natural resource is the stock of goods derived directly from nature that have the potential to contribute to the long-term economic production and welfare of societies (Barbier, 2003). In this aspect, like other natural resources, soil is a stock of goods derived directly from nature that has the potential to contribute to the long-term economic productivity (Wagayehu, 2003).

Natural capital stocks are commonly divided into renewable and exhaustible categories based on their capacity for reproduction. In this regard, in order to ensure sustainable production, the use of renewable resources should not exceed the natural rate of regeneration. The issue of whether soil is a renewable or exhaustible natural

resource depends on the resource management system employed in the production process. As discussed by Dasgupta & Heal (1979) cited by Wagayehu (2003), arable land is considered as a renewable resource so long as it is utilized carefully, and regenerates itself over the annual cycle. However, concerns arise when the rate at which it is depleted through cultivation is faster than the rate of regeneration which transform the renewable natural resources into the category of exhaustible resources through mismanagement and in view of the often-slow soil formation process and high rate of soil erosion the soil resource is best characterized as an exhaustible resource (Hurni, 1988).

As indicated in many documents, in many regions of the world, agricultural production practices have changed over the last century, becoming highly mechanized, emphasizing labor-substituting technologies, which focus on the generation of short term cash flow and in the absence of sufficient economic incentives for conservation and this type of agricultural approaches bears no concern for long-term sustainability of production. In addition, population growth and lack of resources have obliged to intensify the use of marginal lands without appropriate conservation practices, which is leading to land degradation and non sustainable agricultural production (Pla, 2002).

Global climate changes may contribute to accelerate some land degradation processes and their effects in some regions of the world, but in any case, land use changes, including deforestation and other human farm and non farm activities leading to soil degradation processes which may affect more the processes (Pla, 2002). Human activities which expose the soil to erosion and induce depletion of this

natural resource include deforestation and removal of the vegetation. Among the human induced soil degradations, loss of topsoil through water erosion is the most important phenomenon that occurs in almost every country under a great variety of climatic and physical conditions, and land use systems.

Wagayehu (2003), contended that among different forms of erosion, water erosion contributed about 47 percent of induced land degradation in South America, whereas about 34, 15, and 3 percent are attributed to nutrient decline, wind-erosion and water logging, respectively, and further more, the same literature suggested that about 80 percent of the world's agricultural land suffers moderate to severe erosion, and 10 percent suffers slight to moderate erosion. These figures clearly indicate that the natural stock of soil, which is the main productive asset of poor farmers in developing countries, is under threat of rapid depletion due to soil erosion and requires considerable attention. However, accelerated soil erosion process can be reduced by a combination of proper land management systems with appropriate SWC efforts, to mitigate adverse effects of soil degradation through soil erosion.

2.3 Soil degradation and related effects in Ethiopia.

The natural process of soil erosion has been accelerated in nearly all of Africa during the 20th century due to a marked increase in human and livestock population resulting from the relatively recent provision of veterinary and human health services in rural areas, which brought increased deforestation, overgrazing, shortening of fallow periods, expansion of cultivated land into marginal land (Dregne, 1982). As a result, soil erosion has become a serious environmental concern in the sub-humid regions of Africa, including Kenya, Ethiopia, Tanzania, Nigeria and other countries lying along

the south side of the Sahara (Wagayehu, 2003). Among different forms of land degradation processes in Ethiopia, soil erosion by water is the most important environmental problem that poses an ominous threat to the food security of the population and future development prospects of the country and this is particularly true where farmers often seek to increase food production through expansion of cultivated land. The process of erosion is further aggravated by the intensity of the tropical rainfall and the dissected nature of the terrain, with nearly 70 percent of the highlands having slopes in excess of 30 percent, that favor severe soil erosion once the vegetation is reduced (Hurni, 1988).

Ethiopia has been described as one of the most serious soil erosion areas in the world with an estimated annual soil loss of about 42 tones ha^{-1} per year from croplands, resulting in an annual crop production loss of one to two percent (Hurni, 1993). According to the Ethiopian Land Reclamation Studies (1985), it is estimated that only 20 percent of the total area of the Ethiopian highlands have relatively minor problems of erosion; 76 percent are significantly or seriously eroded and four percent have outstripped their capacity to be of any value for production (Wagayehu, 2003). Moreover, other sources, for instance, Dejene (1990) and Gamachu (1990), suggested that almost about 75 percent of Ethiopian highlands were estimated to need soil conservation measures of one sort or another if they are to support sustained cultivation and it was estimated that, if this trend continues, about 18 percent of the highland will be bare rock by the year 2010, which corresponds to about 10 million people who will not be able to produce food from the farm land.

2.4 Remedial extension intervention approaches in Ethiopia.

Despite the vast agricultural potential in the country, small-scale farmers following a traditional low input farming system and low output farm technologies. According to CACC (2003), the sector is further characterized by smallholders, mostly private peasant, traditional farming system and low level of literacy among the holders. Over the year, farmer has received different extension services and agricultural technologies in one way or another to improve their land productivity. This is done through what can be described as supply oriented approaches whereby improved agricultural technologies are passed to the farmers without farmers participating in technology generation, dissemination, planning and evaluation.

In this regard, agricultural extension work in Ethiopia is traced back to 1931 with the establishment of Ambo first high school offering general education with a major emphasis on agriculture. Moreover, it was with the creation of the Ministry of Agriculture in 1943 that the country witnessed the commencement of formal but limited extension activities in different areas in the country. However, according to Belay (2003), real agricultural extension work began in the early 1950s following the establishment of the College of Agriculture and Mechanical Arts (now renamed Haromaya University) and the college was given the mandate to develop and deliver a national programme in agricultural extension. The same source suggested that in 1963 the mandate of agricultural extension transferred from the College to the Ministry of Agriculture (MOA), with the suggestion that the college concentrates its outreach efforts to help farmers in the vicinity only and since this time the MOA has been responsible for the nationwide extension service deliveries.

2.4.1 Comprehensive and minimum package approaches

Following the transfer of the responsibility to the Ministry of Agriculture, extension service became one of the departments in the Ministry and considering the fact that the country's resources were insufficient to modernize peasant agriculture in all areas of the country simultaneously, the government opted for the comprehensive package approach. In the Ethiopian context, the comprehensive package approach involved the coordinated application of different but fundamentally related strategies in selected potential areas (Belay, 2003). The first comprehensive package project, the Chillalo Agricultural Development Unit (CADU) was established in the Arsi Zone in 1967 and was financially backed by the Swedish International Development Authority (SIDA) to facilitate the program (Belay, 2003).

Based on the experience gained from CADU, in the following years, other comprehensive package projects such as Welamo Agricultural Development Unit (WADU) and others with varying objectives and approaches were initiated with the financial assistance obtained from different countries. It was soon realized that the comprehensive package projects failed to serve the people for whom they were intended. As it turned out the approach was too expensive, both financially and in terms of trained manpower requirements, to warrant replication in other areas of the country. As a result, the government, in co-operation with SIDA, designed an alternative strategy to be compatible with the availability of resources called the Minimum Package Project-1 (MPP-I).

According to Task Force on Agricultural Extension (TFAE, 1994), the MPP-I was to cover for five years and was designed to provide small-scale farmers with services

considered to be the minimum essential elements for agricultural development. In addition, this document suggested that the Extension and Project Implementation Department (EPID) be established in the Ministry which was commissioned to administer the minimum package projects and supervise the comprehensive package projects as well. Though EPID was able to provide agricultural services in many districts including improvements in terms of the adoption of improved inputs, MPP-I failed to have a significant impact on the agricultural sector because the government was reluctant to put in place the necessary reform measures in the areas of land tenure system and organization of administrative systems of the different institutions for agricultural development in the country (TFAE, 1994).

Although, there was plan to undertake Minimum package project-2 (MPP-II) at the end of MPP-I, it was not possible to carry out this plan until the beginning of 1980s, because of political instability and major structural changes in the rural areas, including the formation of peasant associations and cooperatives as well as the implementation of the land reform (Belay, 2003). The Minimum package project-2 (MPP-II) was assisted by the World Bank, the International Fund for Agricultural Development (IFAD) and SIDA. According to TFAE (1994), during its implementation, the MPP-II did not attain its stated objectives because the limited number of extension agents available in the country were made to cover as wide areas as possible without adequate facilities and logistical support and overloaded with different assignments.

Another factor responsible for the mediocre performance of the extension of MPP-II was the poor research and extension linkage and limited budget. The MPP-II was

phased out and replaced by another strategy called the Peasant Agriculture Development Extension Programme (PADEP). The strategy was based on a critical evaluation of past extension strategies and underscored the importance of stratifying the country into relatively homogeneous zones, decentralizing the planning and execution of agricultural development activities and empowering and giving considerable attention to zones which were to be the centre of development efforts (Belay, 2003).

As the poor research and extension linkage was considered to be an essential factor affecting the efficiency of extension work, Research Extension Liaison Committee (RELC) were formed both at the national and zonal levels to serve as a formal linking mechanism between research and extension. However, only six out of the eight PADEP programmes secured funding from both donors and government and even in areas where extension activities were undertaken it was not possible to bring together farmers and extension workers. Furthermore, extension messages were not entirely devoid of political objectives and the farmers saw agents as government spokesmen rather than development workers (Befekadu and Berhanu, 2000).

2.4.2 Participatory Demonstration and Training Approach

Following the terminating of PADEP project, the T & V extension approach was adopted as a national extension system with major government financing until its replacement by the Participatory Demonstration and Training Extension System, (PADATES). The PADATES approach was adopted from Sasakawa Global-2000 (SG2000) extension experience which fundamentally based on the extension management training plot (EMTP) demonstration method to transfer technology to

the ultimate clients. According to the result from document review, on the basis of the availability of improved varieties and recommendations from research and extension, technology packages for maize and wheat production were defined and demonstrated to farmers in some of the districts in 1993 by SG 2000, and the approach was expanded both in terms of area coverage and technology packages in subsequent years.

Good weather conditions, coupled with material and technical support that participating farmers received from SG 2000, resulted in substantial yield increments and impressive yield increments obtained by the farmers initiated the government to adopt the approach in order to attain food self-sufficiency in the country (Belay, 2003). Consequently, the government took the initiative to run the program on its own and launched the PADETES as the national agricultural extension system. The major objectives of the system include, improving productivity of small-scale farmers through research generated technologies, empowering farmers to participate in development process, increasing the level of food self-sufficiency by ensuring the rehabilitation and conservation of the natural resource of the country (TFAE, 1994).

2.4.3 Soil conservation extension efforts in Ethiopia

Crop failure due to soil degradation and climatic variability is not a new phenomenon in Ethiopia which consequently resulted to drought situations, throughout human history in the country. However, the problem of land degradation attracted the attention of policy makers only after the consequences of soil erosion became very serious during recent decades (Haile, 1988). The government has initiated a massive program of afforestation including soil conservation programs

with the support of international organizations in which the Packages of soil and water conservation practices and technologies were prepared for implementation through FFW schemes (Wagayehu, 2003). Besides the introduced SWC measures, reports indicate that peasants have been aware of problems related to soil erosion and developed different indigenous conservation practices that sustained agriculture for centuries. These include different conservation practices in the Northern Highlands and well developed terracing systems of Konso (FAO,1990), ditches in Northern Shewa in the Central Highlands and different techniques in the Eastern Highlands of Ethiopia (Alemayehu,1996).

In this relation, Tesfaye (2003), reported in his study that the soil and water conservation in Konso (Ethiopia) is marked by the combination of physical and biological conservation measures, which includes, stone bund, tied-ridge, trash lines, agroforestry, intercropping, fallowing, manuring, minimum tillage and commercial fertilizers. However, the massive campaign in soil conservation and afforestation, with a huge layout of financial and manpower resources under FFW, does not seem to have succeeded either in triggering widespread voluntary adoption of the practices by farmers in a sustainable manner or in solving problems related to soil erosion and the soil erosion problem persists with increased mass poverty in rural areas prevailed (Wagayehu, 2003).

Furthermore, extension service experiences indicate that past extension approaches have failed to attain intended paradigms shift in agricultural land productivity in order to maintain sufficient production for domestic and international demands. In this regard, the major problems that can be highlighted from the past experiences are

poor adoption and sustainability of improved agricultural and natural resource management technologies and cultural practices which were promoted through different projects and national Extension package programme to small-scale farmers. According to Habtemariam (2005), mentioned in EEA (2006), one of the factors that seriously undermines the proper implementation of the agricultural extension system in Ethiopia is the inadequate understanding of what agricultural extension should and should not do and what indicators should be used to measure its success and failure, and the Ethiopian extension system operate without concrete extension policy

2.5 Determinants of innovation adoption

In the history of research on diffusion and adoption of innovation, the first diffusion and adoption of agricultural technologies was conducted on hybrid corn by Royan and Gross in 1943 (Rogers, 1971). Stephenson (2003) suggested Rogers' definition of diffusion process as one, which is the spread of a new idea from its source of invention to its ultimate adopters. Rogers defines the adoption process as the mental process through which an individual passes from first hearing about an innovation to final adoption decision. Rogers (1971) argued that, the new innovation has to have a relative advantage over the old practice and it has to be consistent with existing cultural patterns in order to attain optimum adoption. The variables most often considered in SWC adoption decisions are erosion problem perception, age, educational status, cash crop production, income level, off-farm income, farm size, land tenure, and debt status of farmers. Further more, these and other adoption influencing factors are discussed in the following section.

2.5.1 Institutional and infrastructural conditions

According to Clearfield (1986), institutional and infrastructures factors such as credit, extension service delivery, market and road accessibility could have significant influence on technology utilization. Of all the variables affecting the adoption of conservation practices, institutional variables are among the most influential and may have the greatest impact on adoption and use of conservation practices and in general, the higher the number of institutional contacts, the greater the likelihood farmers will use conservation practices. As Clearfield (1986) stated, research on innovation-adoption suggests a complimentarlity between the two sources of information, that is interpersonal and mass media. Mass media make the innovation known, but interpersonal sources make it respectable. In this regard, early adopters appear to have greater exposure both to mass media and to interpersonal sources of information.

Feder *et al* (1982) argues that the need to undertake fixed investments may prevent small farmers from adopting new innovations. According to this source, access to capital in the form of either accumulated savings or capital markets are necessary in financing the adoption of many agricultural technologies. In addition, he insists that change programs must have financial support and financial risk protection for farmers in order to be successful and financial accessibility should be in place particularly for small farmers since it will enhance their willingness to take risks of promoted new technology.

The constraints to poor adoption or non-adoption of innovations involves factors such as lack of credit, limited access to information, aversion to take risks, in

adequate farm size and inadequate incentives associated with land tenure arrangement. Early studies on adoption have shown a positive relationship between a farmer's use of credit and use of conservation practices and practices that can be shown to maintain or increase profits (such as conservation tillage) will be more likely to be adopted than more costly conservation practices (Clearfield, 1986). According to Mlozi (2005), an extension agents' role is to provide smallholder farmers with the necessary agricultural and livestock production knowledge and skill to enable them to make rational production decisions for increasing production that ultimately improves their socio-economic status. The same source suggested that the level of adoption of improved agricultural technologies and practices is clearly related to the quality of the extension workers and services.

In addition, as Leonard (1977), cited in Mattee and Mvena (1988), pointed out, one way of evaluating job performance in extension is to look at extension agent output, which is basically to communicate improved agricultural practices to farmers. Thus, the same report suggested that it is necessary condition for his success in his work if the agent is conversant with technical information he is supposed to transmit to farmers which is the indicator of technical capability of the extension agent to influence technology adoption in the farming system. An important criterion of a fully effective extension service, as Leonard (1977) asserts, is the extent to which it is engaged in making intelligent adaptation of research recommendations to local conditions and in this relation, the performance of extension agent is positively influenced by the ability of the extension agent to visit individual farmers and providing them with appropriate information which ultimately influences the process of technology adoption and sustainability.

2.5.2 Economic variables

Feder *et al.* (1982) suggested that among many economic variables, the farm size is one of the factors on which the empirical adoptions study should be focused. According to this literature, farm size can have different effects on the rate of adoption depending on the characteristics of the technologies and institutional setting. More specifically, this document states the relation of farm size to adoption is dependent on such factors as fixed adoption costs, risk preferences, human capital, credit constraints, labour requirements and tenure arrangement. With respect to economic capability of farmers, CIMMYT (1993) contended that wealthier farmers might be the first to try new introduced technologies and this is due to the fact that wealthier farmers (with more land and capital) are more capable to take risks or have better access to extension information with other material and financial resources to experiment the new technique. The same source suggests that many farmers who do not utilize new technology may complain the lack of cash or credit as the principal factors limiting utilization of technologies.

In addition, type of non-farm occupation could also affect conservation behavior and in this regard, educated part-timers (part time workers) might be more likely to adopt because of higher education level and availability of cash income. Farm structural variables related to the adoption of conservation practices include: size of operation, net income per farmland, land tenure system, and farm specialization or diversification in which overall studies on farm size and the use of practices show either a significant effect or a strong positive relationship (Ervin and Ervin, 1982). Most studies indicate that the larger the farm size and the more income produced by the farm enterprise which leads to the use of SWC practices (Clearfield, 1986).

Moreover, some studies associating land tenure to use of conservation practices show that ownership is significantly related to use of profitable practices but not to use of unprofitable practices (Pampel and van Es, 1977).

Furthermore, even when practices are not controlled for profitability, the relationship of farm ownership and use of conservation practices has been found to be in a positive direction and nonetheless, theory and empirical evidence suggest that erosion control decisions on rented land will differ markedly from similar owner-operator decision (Clearfield, 1986). The same source suggested that the relationship between the degree of farm specialization or diversification and use of conservation practices shows mixed results and one study found more specialized farms used significantly fewer practices and expended little effort in reducing soil erosion. On the other hand, Wagayehu (2003), in his study conducted in Eastern Ethiopian highland reported that the significance and direction of influence of the factors are in agreement for the positive effect of farmers' perception of the erosion problem and the negative effect of cash crop production.

2.5.3 Social and psychological variables.

The effect of social characteristics play significant role in farm operations in many small scale farming system. According to Clearfield (1986), the social psychological variables associated with conservation use fall into two subcategories: individual level characteristics of the farmers and attitude variables. Characteristics of farmers include age, years of farming, education, off-farm employment, and social participation in farm organizations to which a farmer belongs and suggested that the research results show a varied relationship between age and conservation adoption

behavior. The literatures describe that innovators are younger, more cosmopolitan, have higher incomes than later adopters and have the largest operations of all adopter categories (Rogers, 1995).

In addition, adopter categories differ in their source of information on innovations and in this regard he suggested that, the innovators relying on primary sources and later adopters relying on secondary information (Stephenson, 2003**)**. The same source documented the importance of interaction among farmers in which the acceptance by more farmers offers new stimulus to the remaining groups and the decision to adopt is a product of the influence and incentives brought through interaction which is termed as the interaction effect. In respect to influence of sex, Moshi (1999) cited in Yisehak (2002), contended that if women are endowed and/or equipped with resources they can increase productivity through utilizing innovations and ensure greater return on their labour more when compared with men farmer.

Likewise, World Bank (1999) argued that when women are given an opportunity to own resources and decision making power, they can maximize productivity through utilization of new agricultural innovations. But according to Haji (2002), the association between sex and adoption of the cross bred dairy cows was found to be insignificant which is consistence with other findings from Arsi zone in Ethiopia. On the other hand, family size is also positively related to the number of practices used, as is the degree to which married couples share in farm decisions and the degree to which the family is involved in gathering farm related information (Clearfield, 1986). In different studies, age is considered among many factors which can influence an individual’s involvement in community development activities.

According to Ishengoma (1992), age of the farmers might influence adoption of innovations in many ways and it has been indicated in this literature that younger people are expected to be more active and ready to participate in development programs, as they are more mobile they can learn many things in other places where they visit and on average they are more educated. Concerning the age, the study conducted on cross bred dairy cows indicate that most of the farmers (about 92 percent) were found in the age categories of 31-60 years and only eight percent below 31 years old and the findings are consistent with other findings of the Arsi zone, which show that the proportion of youth farmers was low because of lack of access to land and as the results most of the youth look for wage labour and other activities outside their residence (Haji, 2002).

Some studies, for instance, CIMMYT (1993), have found that age has significant influence on technology adoption and rejection in the farming community. In this regard, the same document contended that younger farmers are more likely to adopt a new technology, because they have had more schooling opportunity than older farmers and perhaps they have more chance to be exposed to new ideas as migrant labourers. Still other studies, argue that younger farmers are more likely to adopt reduced tillage technologies, while older farmers are more likely to adopt structural practices and other cultural practices (Clearfield 1986).

In addition, John (1995) further argued that older farmers have more experiences in the farming system but their receptivity to adopt new innovations typically decrease with age. Schooling may provide substantial externality benefits by increasing farm output and shifting the production frontier outwards and evidence of production

externalities was presented in Weir and Knight (2000), who analyzed the internal and external benefits of schooling in rural Ethiopia using both average and stochastic frontier production functions. They showed that education externalities in production might be primarily mediated through the role of education in shifting the production frontier outwards.

Furthermore, the same study showed that education is an important component which enables one's behavior to change and it is believed that, education broadens horizons beyond habits and traditions of individual, encouraging involvement of individuals in development activities and ingredient for faster socio-economic development in any economy**.** As reported in Wagayehu (2003), the educational status of household head, slope of a plot, and plot area generally influence conservation decisions positively, whereas age of household head and distance of plot from dwelling affect conservation adoption decision negatively.

A positive association has been found between education and the use of conservation practices (Ervin and Ervin, 1982; Pampel and Van Es, 1977). In addition to the use of practices, education is positively related to perception of erosion problems, knowledge of government projects, and positive attitude toward these projects. Furthermore, as the literature indicates, social participation such as membership in local organizations has a positive relationship with the use of conservation practices and in this aspect, farmers who are local leaders are more likely than other farmers to adopt conservation practices and this is probably related to the fact that local leaders tend to be better educated, manage larger farms, and have a good understanding of soil erosion problems found on their farmlands (Clearfield, 1986).

2.5.4 Innovation related factors

In relation to innovation adoption, Rogers (1995), suggested that a decision making process to technology adoption could be enhanced or impeded partly by the intrinsic characteristics of the technology, such as observability, complexity, and divisibility/trialability and partly from its extrinsic characteristics such as compatibility and relative advantage to the household domain. In many instances farmers failed to adopt technologies because of the failure of the technologies to fit into their farming practices or their needs (Adugna *et al.*, 1991) cited in Yisehak (2002). In this regard, the same literature suggested that efforts to introduce improved sorghum technologies in Ethiopia, that is short stalked sorghum varieties, were not accepted by many sorghum-growing farmers due to short stalk and less biomass, particularly in the areas where there is a high demand for sorghum stalk for fuel and construction. In addition, researchers identified a number of other characteristics of innovations that relate to their adoption: innovations that are less complex, divisible, readily observable, low cost, profitable and that are congruent with previous innovations are quickly adoptable than other innovations (Rogers, 1971 and Stephenson, 2003).

2.6 Sustainability of adopted innovations.

According to World Commission for Environment and Development (1987) as cited by Mattee (1994), sustainable agricultural development refers to environmentally safe agricultural production that meets the needs of the present without compromising the ability of the future generations to meet their own needs. Furthermore, as pointed out by Mattee (1994), Ragland (1989) sees sustainable agriculture as the management and conservation of the natural resources base and the

orientation of technological change to ensure the attainment and continued satisfaction of human needs for present and future generation.

In addition, other document, Rao and Rogers (2006), defined sustainability in relation to agriculture, suggesting that sustainable agriculture is defined as a practice that meets current and long-term needs for food, fiber and other related needs of society while maximizing net benefits through conservation of resources to maintain other ecosystem services and functions, including long-term human development. In relation to sustainability, USAID (1999), suggested that more attention late in project life should be given to simplification of project approaches and to checking that they are not only within the technical capacity of the agency but also within likely budget resources limitation under local community and this process would be helped by a slow phasing out of external assistance rather than sudden cessation of a high level of external inputs.

Gradual phasing out of external assistance or follow up activities may also help to focus later project years towards more sustainable methods. In particular, projects should operate in their last year with levels of local funding similar to those expected to exist post-project. A sustainable approach to providing agricultural extension services in developing countries-minimal external inputs, a systems orientation, pluralism, and arrangements that take advantage of the best incentives for farmers and extension service providers will release the local knowledge, resources and organizing ability of rural people to undertake ongoing project (World Bank, 1999). As indicated in many other documents, for instance, Lovell (1992), sustainability with regard to development programme is the ability of the local community to meet

the programme cost in order for the program to continue and benefits of the programme to be maintained after external interventions or donors funding has been withdrawn but it is reported in many study documents that, except for a few cases, it is common that agricultural development projects collapse when donor support is withdrawn.

On the other hand**,** Clare *et al*. (2004) pointed out in the study of suitability of Reduced Tillage and Cover Crops (RTCC) that an indication of the likely sustainability of the approach is the extent to which farmers participating in the initial trials continued to use the RTCC package in subsequent seasons. Furthermore this study indicated that during the qualitative study it was found that in Tanzania, all farmers continued to apply aspects of RTCC in the long rain of 2003, usually with some modification. According to Center for Advanced Training in Agriculture and Development (CATAD, 1988) the concept of sustainability is reduced to the question of whether local institutions will be able to continue providing the services that have been provided by the donor aided projects. But this document suggested other aspects of sustainability, which at least equally important for safeguarding and improving the living condition of the target population.

In this regard, the sustainability of any project should include, institutional, ecological, economical and social sustainability including whether the target groups are in position to help themselves to a high degree and effectively articulate their interest to the supporting projects to takeover the activities when project terminated. This document, further pointed out that the analysis of sustainability should not be narrowed to the intended achievements of the projects but should take into

consideration the direct or indirect impact on living conditions of the target populations. In this regard, a development project is sustainable when it is able to deliver an appropriate level of benefits for an extended period of time after major financial, managerial and technical assistance from external donors is terminated. Reid (1995), suggested that, attempts to devise widely acceptable sustainability indicators are being made by a range of organizations, but there have been problems in reaching consensus over indicators. Reid observed that these are partially due to the number of organizations involved in different approaches, they have developed and lack of openness to other groups, but also partially due to the difference on ensuring that potential indicators are accepted as accurate, reliable and relevant.

According to FAO (1993) sustainability of rural development projects has several aspects, institutional development and economic viability. Some of the indicators of sustainability include the choice of technologies appropriate to local conditions, adequate maintenance and support systems, economic soundness for the beneficiaries and active involvement of the local authorities, gender sensitive projects cycle management and capability of the intervention with socio-cultural environment of the primary stakeholders (ILO, 1990 and Reid, 1995).

According to Reijintjes *et al.* (1992) and Waters-bayer (1989), cited by Mattee (1994), the means of attaining sustainability in agriculture include the concept such as the Low External Input and Sustainable Agriculture (LEISA), which is concerned with seeking to optimize the use of locally available resources by combining with the different components of farming system and Participatory Technology Development (PTD), including technology dissemination process in the farming system. In other

words, these two sustainability concepts associated not only enable the generation of technologies that are adaptable to the local environment, but also develops the local capacity, socio-cultural structures and organizational linkage necessary to sustain the technology in the production systems.

CHAPTER THREE

METHODOLOY

3.1 Introduction

This chapter presents briefly the general features of the study area and outlines the procedures of collecting primary and secondary data from respective offices and individuals at different levels. The chapter also deals with the research methodology employed in the study. Furthermore, it shows how field survey and individual farmer and extension field staff interview was conducted and appropriate data analysis procedures used to process the collected data.

3.2 Geographical location and description of the study area

The intended study was conducted in Adama District which is geographically located in East Shewa Zone, Oromia Regional State, in Ethiopia. The region has a total area of 36 700Km2, covering roughly 30 percent of total area of the Ethiopia and being located between 34^0 08 East and 43^0 11 East longitudes and 3^0 40 North and 10^0 31 North latitudes (OADB, 2003). In Oromia region, agriculture and allied activities have been described as the main source of the raw materials, investment capital, foreign exchange and labor needed for economic growth (CACC, 2003b).

In this regard, in rural areas of Oromia Region, the total number of agricultural holders was estimated to be 4 072 489 (97.7 percent) and this is composed of holders producing crop production 18.7 percent, livestock producers 3.3 percent and holders that are engaged in mixed crop and livestock production is 78 percent (CACC,2003b). In this view, in Oromia, improving the performance of agricultural

sector is of critical importance for fast development of the national economy and local community. According to the recently restructured Peasant Association, administratively, Adama is divided into 42 Peasant Association (PAs) with estimated population of 422 490 among which only 148 648 (approximately 35 percent) are rural population and remaining 273 842 (about 65 percent) are urban dwellers. On the other hand, the sex composition of the population in the district is 49.7 percent female and 50.3 percent is male, which is relatively higher than national male and female proportion of 49 to 51 percent, respectively (CACC, 2006a).

Adama district has an area of 1 007.66 km^2 constituting about 10 percent of the total land area of East Shewa Zone which sub divided into different agro-ecologies. According to the information from Adama Agricultural and Rural Development Department (ARDD), the district is sub-divided into 42 Development Centers (DC) which are primarily located in each Peasant Association in order to more facilitate the promotion of improved agricultural and natural resource management technologies to attain national agricultural development objectives. Generally, the agro-ecological condition of the district varies from highland to lowland in which it extends from the highest altitude of 2 800m above sea level to as low as 1 500m above sea level. An annual unpublished report of the Adama district shows that the highland, mid highland and lowland constitutes 4, 95 and 1 percent, respectively.

The annual maximum temperature of the district is reported to be 38^0C with minimum temperature of 12^0C and rainfall of the area is characterized by a bi-modal type of patterns in which short rains are usually received from late march or early April to May and long rain (main season rainfall) which normally take place from

June to September with the estimated annual rainfall range from 600mm to 700mm and the summary of rainfall situation is presented in Fig. 1 below.

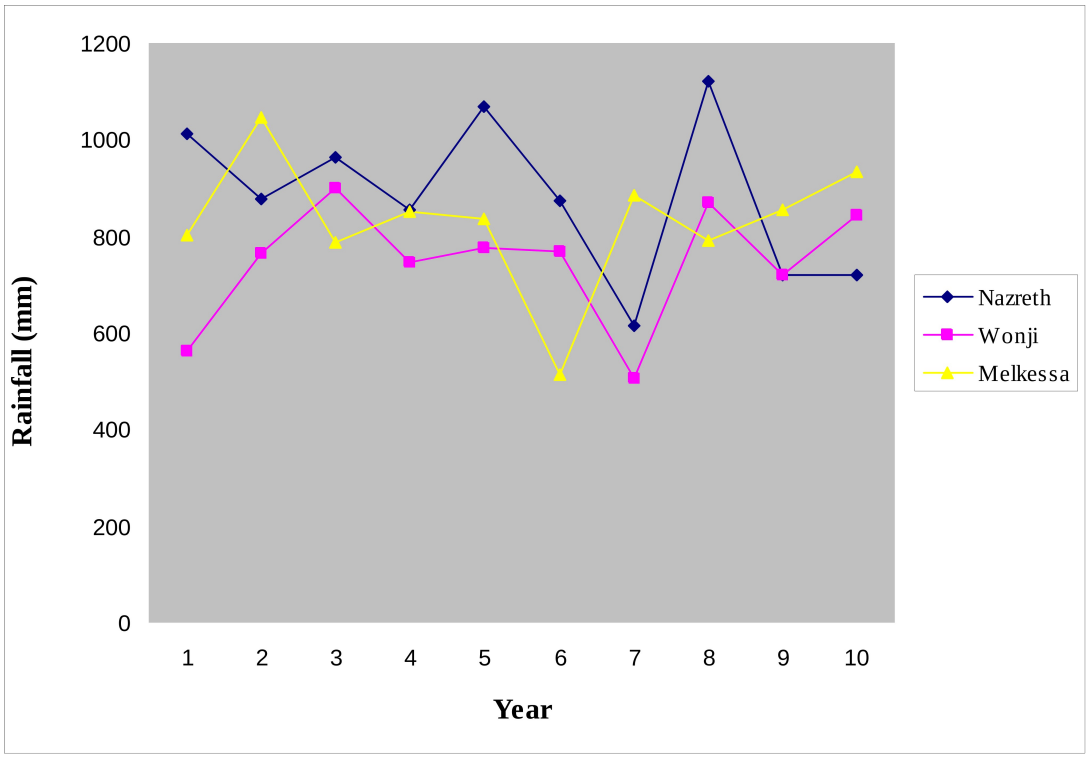

Figure 1.Rain fall situation in Adama district (1996-2006).
Source: Melkasa, Wonji and Nazreth Meteorological stations' secondary data (2006)

On the basis of the characteristics of the study area, soils are mainly classified into three major categories, which are 15 percent sandy soil, 80 percent sandy loam and the remaining five percent is estimated to be constituted by other different soil type. According to the current restructuring and allocation of government structures, East Shewa Zone consists of ten districts which Adama is one of the districts that is located in the central part of the East Shewa Zone and is found within the great east African Rift Valley, sharing common boundary with Lume, Bosat and Dhera districts with relatively similar in agro-ecology. Review of different documents indicates that in Adama District a mixed farming consists of crop and livestock production being

the predominant practice that supports livelihood of the rural households. Crop production is mainly carried out under rainfed condition which is usually supplemented by semi-irrigation practices. Moreover, currently, irrigation practices are increasing in the locality concentrating on high value crops such as vegetables and fruits on small-scale farmers' fields for the local markets demand and some few commercial farmers are producing high value crops for export. Regarding the land use patterns and crop production situation, the review showed that seasonal crops occupy 37.5 percent, perennial crops 6.8 percent, grazing land 3.4 percent, vegetation coverage 11.1 percent and the remaining 41.2 percent is used for different purposes.

Adama is one of the potential districts that contribute or supply surplus production to the national agricultural production and is one of the food self-sufficient districts in the country for a long period of time. But, recently, with the radical shift of the weather conditions (especially poor rain distribution) half of the members of the peasant association have been affected by abnormal drought of 2003/04. Thus, despite the surplus production of the district, a few pockets of the lowland areas (along Awash River) are affected by drought and run out of food depending on the rain distribution. In addition to the rainfall problem, agriculture is characterized by its low productivity due to the declining of soil fertility resulted from continuous cropping and limited use of modern agricultural technologies and poor management of soil capital resource in order to maintain sustainability of farmland productivity.

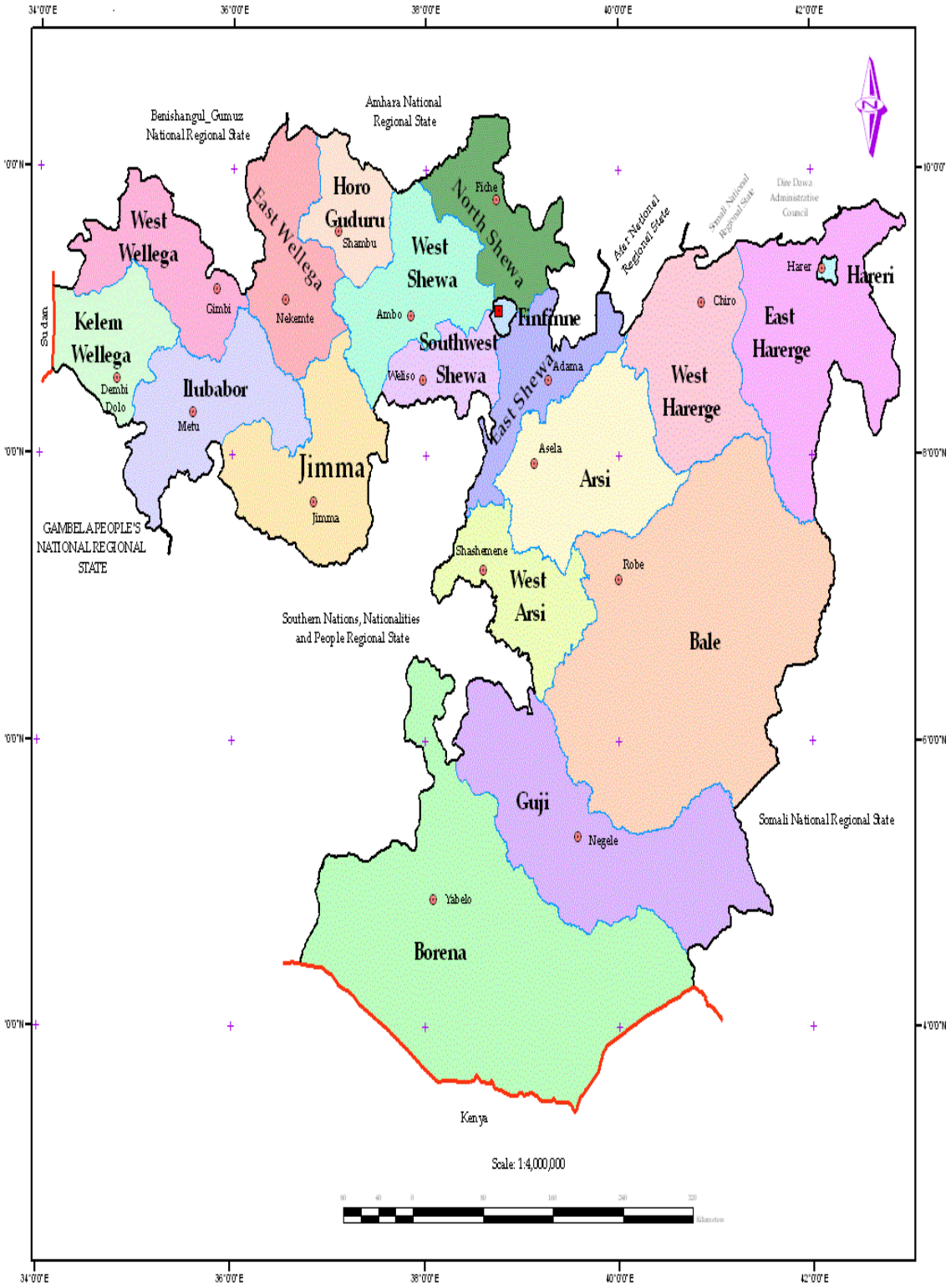

Figure 2: Administrative Map of Oromia Regional state to showing E.S. Zone.

Source: Oromia Planning and Economic Development Bureau (2000)

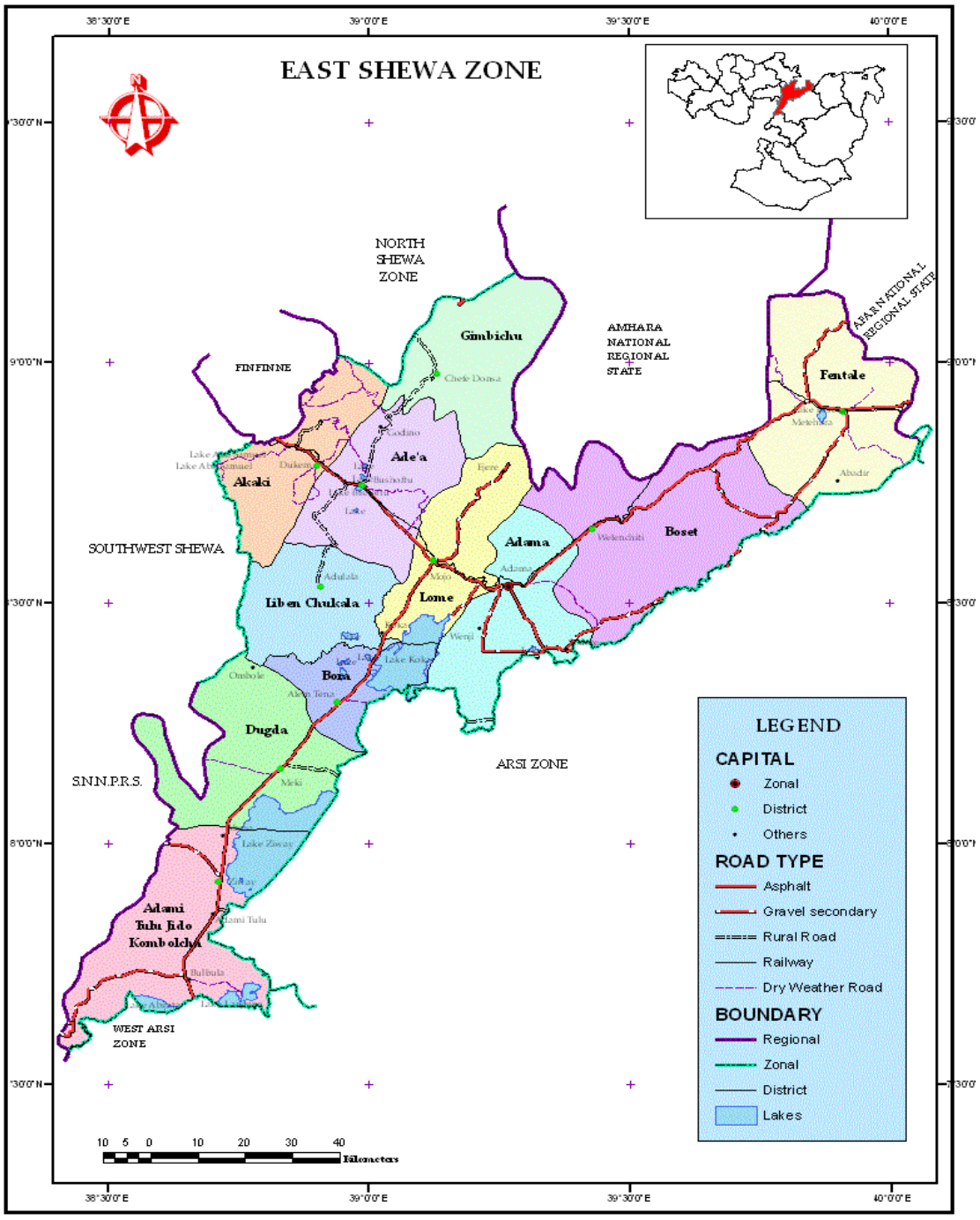

Figure 3: Administrative map of E. S. Zone showing study district.
Source: Oromia Planning and Economic Development Bureau (2000)

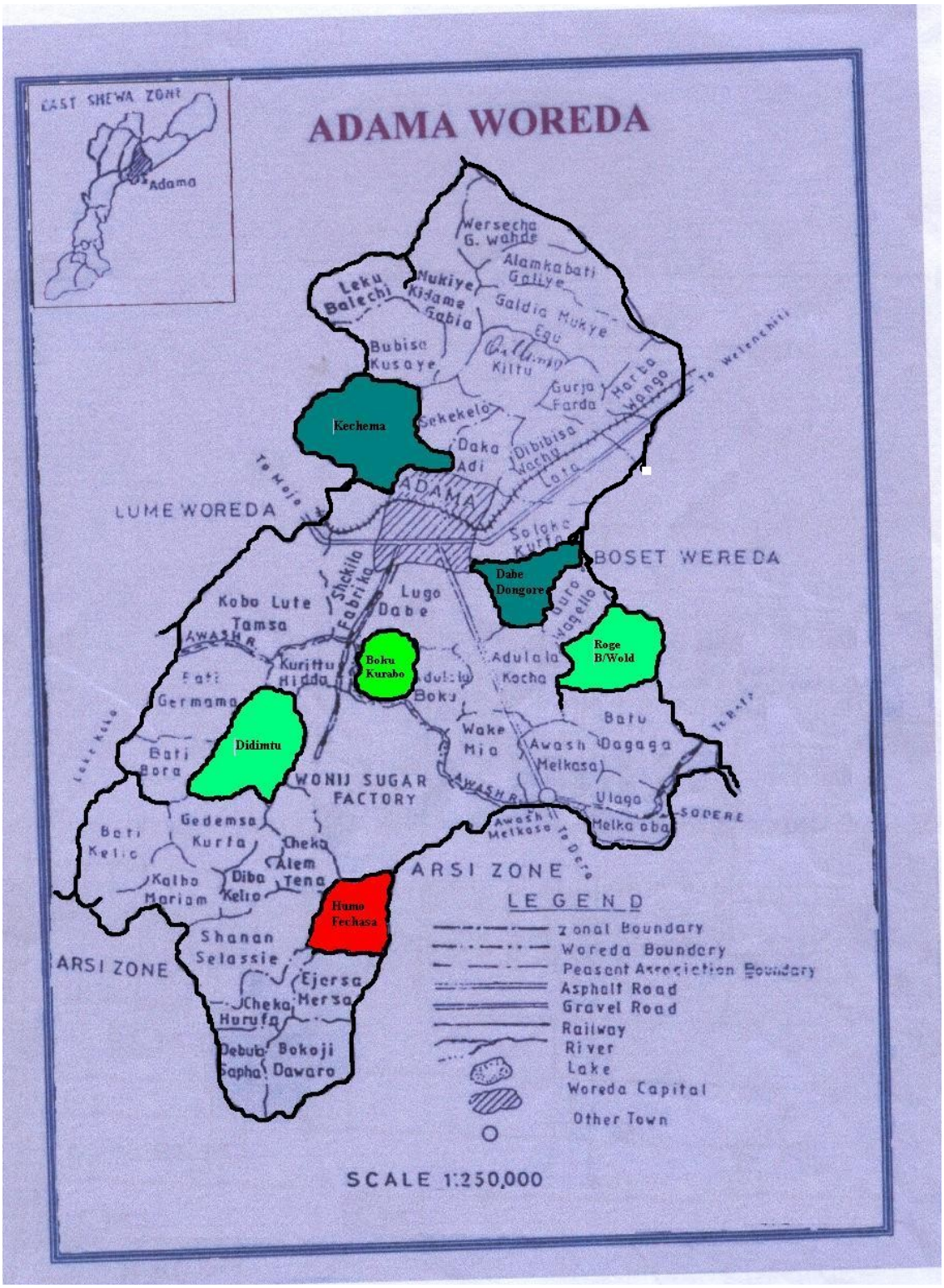

Figure 4: Administrative Map of Adama District showing the study PAs.
Source: East Shewa Planning and Economic Development (2000)

3.3 Sampling methods and data collection

The sampling procedure adopted was stratified cross-sectional sampling method. The district was divided into three sub-groups based on the proportion of agro-ecology (high land, mid highland and low land) of the districts and then two sample peasant associations were selected among the peasant associations of each zone within the district. Sampling frame was prepared from list of farmers who have been registered for the PAs membership on the membership registration book and this was easy and reliable to establish the appropriate sample frame for the sampling process of the study target group.

In order to maximize the reliability of the study, relevant information were collected from the primary and secondary data sources, from national, regional, zonal, district and PAs level for the analytical purpose as well as for crosschecking of the information. In this regard, the secondary sources of data include published and unpublished information about the study area and these were collected from different government, non-government offices and individuals. To maximize the validity of the data six peasant associations (two from each category) were included in the study target samples among the peasant associations and one hundred twenty farmers (20 from each sample PA) were selected by random sampling procedure.

The selection of sample peasant association was also conducted by random sampling procedure within each sub-category of peasant association. When the population size of each PA is not equal, the use of simple random sampling to select PAs and farmers would not give equal probability for each farmer. However, since the population of each peasant association is relatively closer to each other (more than 60 percent of

PAs have population of between 501-575), employment of random sampling to select sample PAs and farmers was considered appropriate for this study. Therefore, based on Poate and Daplyn (1993) suggestion, in the first stages of sampling, six Peasant association were selected based on the random probability sampling techniques in each category and in the second stage of sampling twenty farmers were selected from each selected PA using simple random sampling technique. The primary information was collected from sampled farmers by enumerators who administered the structured questionnaires. For this purpose, four enumerators were recruited and trained for one day on how to administer the survey instrument and Table 1 presented below shows how the total sample farmers were selected.

Table 1. Respondent's peasant association and sample distribution.

	Population of PAs			Sampled farmers			
Sampled PAs	Male	Female	Total	Male	Female	Total	percent
Roge- belawold	489	86	575	17	3	20	3.5
Dhabe-dangore	391	110	501	14	6	20	4.0
Bokku-kurabo	268	75	343	16	4	20	5.8
Humo-fachassa	434	92	526	15	5	20	3.8
Kechama-saboka	431	95	526	16	4	20	3.8
Didimtu-hidda	171	90	261	12	8	20	7.7
Total	2181	551	2732	90	30	120	4.4

Source: Secondary data from Adama ARDD (2006).

Furthermore, a total of forty development agents (extension field staff) were selected from the district extension personnel by employing a simple random probability sampling from total of 70 development agents and primary data were collected by using the self administered questionnaires and this information was used to complement primary data collected from farmers. In summary, research instruments like self-administered questionnaires and interview schedules were used for development agent and farmers, respectively. In addition, comments of experienced

staffs, project leaders and community leaders' views were collected through focused group discussions using a checklist of important aspects of technology adoption and sustainability.

3.4 Methods of data processing and analysis

As it has been mentioned in the previous sections, the main objective of this study was to evaluate the adoption and sustainability of the soil and water conservation practices which means, the major investigation is the estimation of the rate of adoption and sustainability with the identification of the socio-economic factors that influence the adoption of the technologies. In this regard, data collected from different primary and secondary sources were summarized, coded and transferred into relevant computer packages. The primary data were analyzed using the Statistical Package for Social Sciences (SPSS) computer program.

The SPSS sub-program "frequencies" was employed to find out the percentages, means and frequencies to describe variability and central tendency of the variables. Furthermore, the sub cross-Tab chi-square test was employed to determine the relationships between different variables. Qualitative and quantitative data were categorized, summarized and presented in a relevant format. The unit of analysis was individual farmers or development agent that responded to the questions or information required. Furthermore, in order to improve the reliability of the results and produce relevant conclusion, relevant models were identified based on the review of the relevant literature. In this case, based on suggestion from literature review, the technology adoption is represented by binary variables which take value of one for adopters and zero for non-adopters depending on whether farmers make

decision to use technology or not to use it. Commonly, most literatures on technology adoption indicate that for such type of dependent variables suggest qualitative response which are logit and probit models.

According to Feder *et al.(*1985), the logit model, logistic distribution function is appropriate technique in estimating the probability of technology adoption. Furthermore, he pointed out that the logit model is simpler in estimating the parameters than probit model. Given its popularity in estimating the unknown parameter in the technology adoption research, the logit model selected and employed to estimate parameters using binary variable against several set of continuous and binary dummy variables that are believed to influence the adoption decision of SWC technology.

3.4.1 Model specification

The most commonly used econometric models in adoption studies are the limited dependent variable models such as logit regression and probit model and these models are used to examine relationship between adoption and determinants of adoption which involve a mixed set of qualitative and quantitative analysis (Karki *et al.*, 2004). As pointed out by Hosmer and Lemshow(1989) cited by Mulugeta (2000), the logistic distribution function has an advantage over the others in the analysis of dichotomous dependent variable due to the fact that it is extremely flexible, relatively simple from mathematical point of view lending itself to a meaningful interpretation. The statistics are based on multiple regression analysis to determine the relationship between dependent and independent variables; of which dependent variable is adoption of SWC practices by farmers and independent variables are

socio-economic factors that can influence the technology adoption. Thus, based on Gujarati (1988) and Bohrnstedt and Knoke (1994) the following Logistic distribution model was selected and employed to determine the adoption of physical soil bund structure by respective farmers in the farming community.

$$P_i = \frac{1}{1+e^{-z_i}} \text{ ----------} \quad (1)$$

Where P_i, is the probability of adopting soil bund conservation practices for i^{th} Farmers and range from 0 to 1, Z_i is the function of n explanatory variables and expressed as follow.

$$Z_i = b_o + \sum b_i x_i + u_i \text{ ----------} \quad (2)$$

Where b_0 is the intercept, b_i is the vector of unknown slope coefficient, x_i is explanatory predictors and u_i is random error term. Thus, the relationship between p_i and x_i can be written as follow.

$$P_i = \frac{1}{1+e^{-b_0+b_1x+\text{-----}+b_n x_n}} \text{ ----------} \quad -(3)$$

The slope tells how the odds in favor of adopting conservation practices change as the independent variables change. If P_i is the probability of the adopting a given conservation technology, then, 1-P_i, represent probability of non-adopting and can be written as follow.

$$1-P_i = 1-\frac{1}{1+e^{-z_i}} = \frac{1+e^{-z_i}-1}{1+e^{-z_i}} = \frac{e^{-z_i}}{1+e^{-z_i}} \text{ ----------} \quad (4)$$

When divided the probability of adopting by probability of non-adopting, it will give,

$$\frac{P_i}{1-P_i} = \frac{1/1+e^{-z_i}}{e^{-z_i}/1+e^{-z_i}} = \frac{1/(1+e^{-z_i})}{e^{-z_i}/(1+e^{-z_i})} = \frac{1}{e^{-z_i}} = e^{z_i} \text{ ----------} \quad (5)$$

Equation (5) indicates simply the odd-ratio in favor of adopting conservation practice. It is the ratio of the probability of that farmer adopt the technology to probability of that farmer did not adopt the technology. The logit model can obtain by taking the logarithm of equation (5) and can be presented in the following manner.

$$Log\left[\frac{P_i}{1-P_i}\right] = Log\left(\frac{1}{e^{-z_i}}\right) = Log\left(e^{z_i}\right) = Z_i \text{ ----------} \quad (6)$$

Where; L_i is the log of the odd-ratio, which is not only linear in X, but also linear in the parameters. Thus, if the stochastic disturbance term e is taken in to account, the logit model (logistic distribution function) will be as follow.

$$L_i = Log\left[\frac{P_i}{1-P_1}\right] = Z_i = b_0 + b_1x_1 + b_2x_2 + --+b_nx_n \text{ ----------} \quad (7)$$

Thus, the logit (L_i) multiple regression model (logistic distribution) containing 12 predictors (binary and continuous variable) were specified and regressed against dependent binary of soil bund technology adoption. In order to estimate the probability of adoption of the physical soil bund conservation structure, the above model was employed considering that technology adoption is dichotomous dependent variable (see Table 26 for list of variables).

3.5 Conceptual framework of explanatory variables of the study.

The success and effect of agricultural extension programs are influenced by several socio-economic factors which ultimately impact the technology adoption process. In this study, the attempt has been made to conceptualize the interrelationship of some of those factors and their assumed interaction is presented in the below diagram.

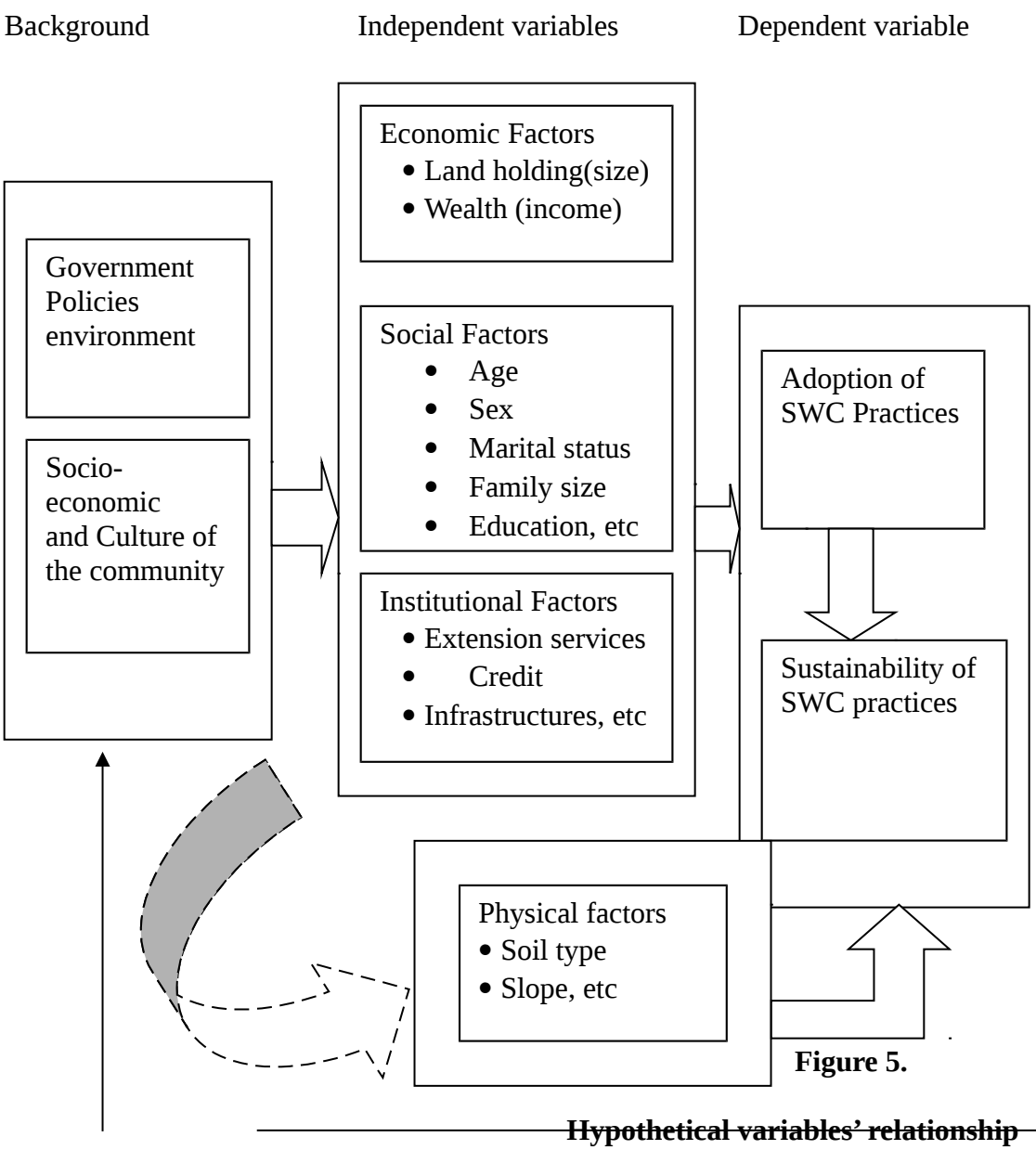

Figure 5. Hypothetical variables' relationship in adoption and sustainability.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter the survey results are presented and a range of tables are provided showing the results of the study. The study results presented in this chapter were based on two sources of data, which are primary and secondary sources of data. Wherever appropriate, the number of respondents providing data are included in each table and the data analyzed based on the single responses to the questions and descriptive statistics was used to analyze the information collected from respondents. Furthermore, in addition to percentage and other descriptive statistics, this chapter presents results from econometrics model, which is the result of logistic distribution function.

4.2 An over view of agricultural potential of the study area

Agriculture is the main economic sector for the Oromia region in general and in East Shewa Zone in particular, in which 90 percent of the population earn their living from agriculture. East Shewa Zone has very fertile soils with suitable climatic conditions and sufficient amount of rainfall which is conducive for agricultural production.

As mentioned in the previous section of this paper (Chapter three), in the study area, relatively a mixed farming system consisting of crops and livestock husbandry is commonly practiced to sustain livelihood of the rural population and the land use pattern of the area also follows this farming habit of the community. In this regard,

based on secondary data collected, the current situation of crop and livestock farming situation of the East Shewa Zone and Adama District is summarized and presented in the section below.

4.2.1. Crop production

Due to conducive agro-environment for crop production, the review of different documents, reveal that cereals, pulses, oilseeds, various types of horticultural crops and sugar cane are produced or grown in East Shewa Zone in general and in Adama District in particular. According to the secondary data from zonal office, in East Shewa Zone the land cultivated under cereals, pulses and oilseeds increased by 6.8 percent, 7.5 percent and 14.3 percent, respectively in 2005/06 over the land under cultivation last 2004/05, and in the same manner, secondary data review shows that the total land under cultivation for these crop categories is expanded by seven percent over 2004/05 in the same year.

In similar manner with area expansion, production of these crops (cereals, pulses and oilseeds) increased by 25.3 percent, 16.9 percent and 63.2 percent, respectively, with total increment of 24 percent in the mentioned one year. On the other hand, in the study district, crop production is a major farming practice supporting the livelihood of the rural community. In the study district, the wide range of the altitude within the district makes it possible to produce varieties of crops. In this regard, Teff is the leading crop which constitutes 55 percent of total cultivated land and this crop is followed by maize covering 14 percent of the area. Furthermore, each wheat and pulse is occupying similar 10 percent of total land under crop production and the remaining 11 percent of the cultivated land is under other crops (Fig. 6). In the study

areas, among traditional practices used to increase the crop production, the most widely used practice has been maintaining soil fertility through long fallow periods. However, gradually this is be coming impossible due to the prevailing rapid and uncontrolled population growth, which led to reduction of the fallow land and as result of this fact the other practice to increase crop production was based on expansion of cultivable cropland.

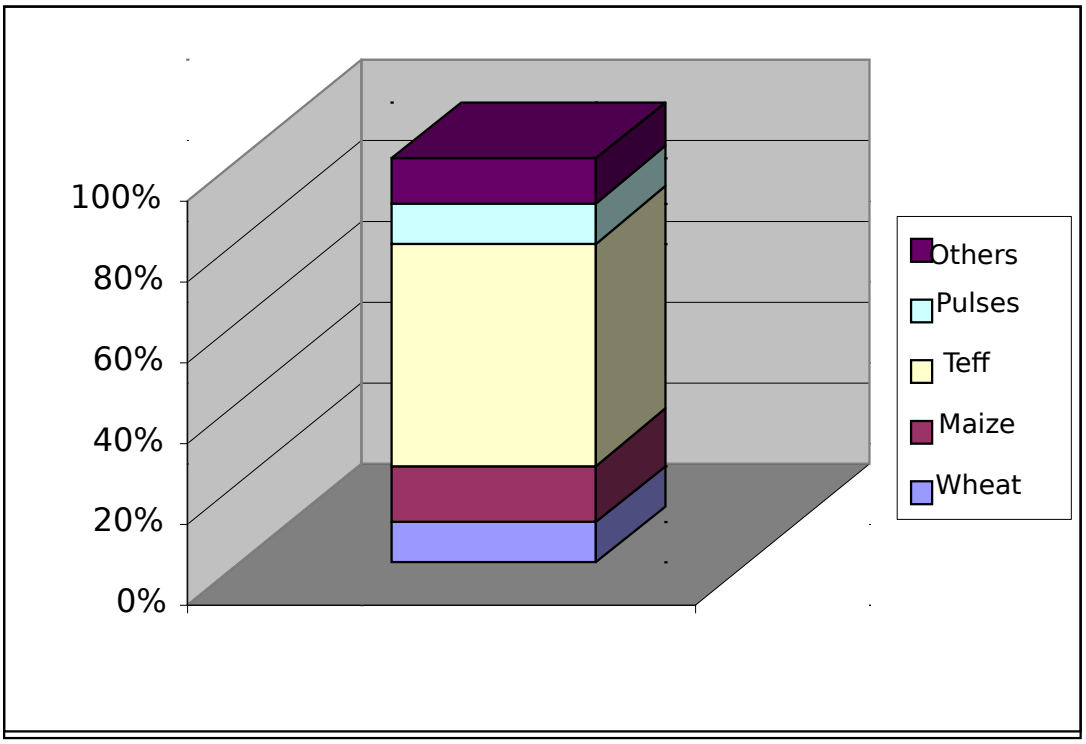

Figure 6: Area coverage (%) of major crops in the study area.
Source: Secondary data from Adama ARDD (2006)

In the study district crop production is carried out in two seasons known as *belg* and *mehar* in which the *mehar* is the main season for crop production. Crops such as maize, wheat, and teff and haricot beans are the major crops grown in the district and as shown in the Fig. 6 above, they occupy the largest proportion of the cultivated

land in both growing seasons. As indicated in the Fig. 7 below, the average productivity of teff, maize, wheat and haricot beans are, 11, 21, 23 and 15 quintals (1qt equivalent to 100kgs) per hectare, respectively.

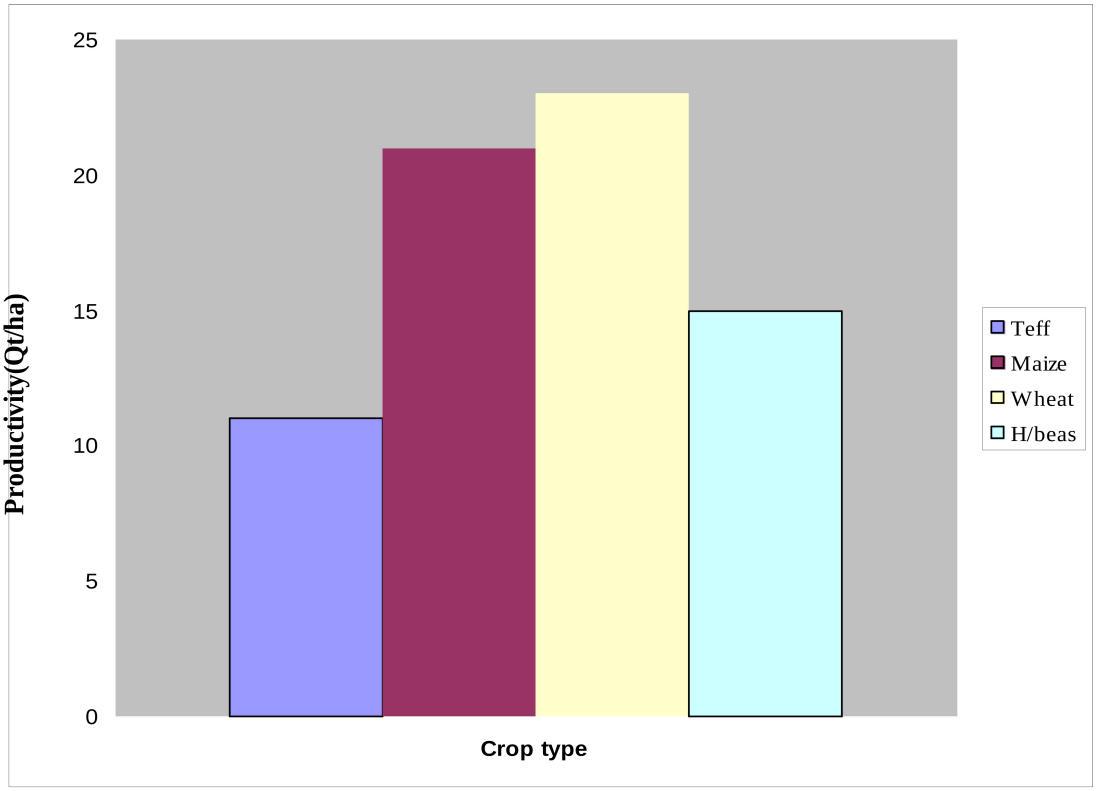

Figure 7: Productivity of major crops in Adama District (Qt/ha).

Source: Secondary data from Adama ARDD (2006)

As it was realized from document review, in general there is an increasing trend in crop production and productivity in the study area in the past years. However, the increment of production was assumed to be contributed by the application of external inputs, mainly chemical fertilizer and farmland expansion, without the concern of environmental sustainability of the ecosystem. Furthermore, the increase of cultivated land between 2004/05 and 2005/06 indicates that the expansion of farmland by removing natural vegetation still remains a threat to natural environment which ultimately results into land degradation. However, In Ethiopia in general, in

the study area in particular, increasing productivity of various field crops is the only realistic option to raise the living standard of the rural population, and to ensure food security and poverty alleviation and this reality necessitate the effective promotion of improved agricultural production related innovation and improved natural resources managements.

4.2.2 Livestock production

Livestock farming is common and most important practices in East Shewa farming community and the zone is one of the livestock rich zones of Oromia Region. Currently, the East Shewa Zonal information show that there is a total of 1 416 460.1 Tropical Livestock Unit (TLU) of livestock population in the zone. According to these source documents, cattle population constitutes 72.4 percent of the zonal livestock population which is followed by equines with 20.5 percent and sheep and goats contributes about 2.7 and 4.4 percent to zonal livestock population, respectively.

The presented livestock population indicates the importance of livestock in farming system of the zone which play an important role in providing draught power, food and cash income for rural poor farmers. However, as it is true elsewhere in Ethiopia, there is high competition for land resources among livestock, crop and forest sub-sectors and grazing land, especially, in the intensively cultivated areas, have reduced in size over time which adversely affected the livestock productivity and production. Moreover, prevailing overstocking situation is leading to overgrazing which has ultimately resulted in land degradation.Similarly, in the study district, animal husbandry is commonly practiced to satisfy family needs, local and external market

demand. According to Adama Agricultural and rural Development Department (ARDD), it is estimated that 48.5 percent of livestock population are cattle, followed by 45.7 percent small ruminants and 16.1 percent equines. Based on this information, there is about 74 106.1 TLU in the district with average 22.8 TLU per hectare of the available grazing land that estimated to be 3 254.5ha in the district. In general farmers freely graze their animals which are primarily carried out on communal grazing land with few private grazing lands. Thus, there is very high TLU per hectare of grazing land which lead to low feed availability that ultimately results in low productivity of animal and this low productivity is mainly attributed by poor feeding of animals due to inadequate pasture and feed resulting from overstocking.

4.3 Comparison of physical and biological soil conservation practices adoption

The overall statistical analysis for many soil conservation practices were conducted and presented in Table 2 in order to make relative comparison between different practices in respect to farmers adoption of each practices which can help the researcher to generate conclusions concerning the attention and support of those particular practices and recommendations which is the ultimate goal of the study. As shown in Table 2, nearly 82 percent adoption rate for physical soil bund is found to be an encouraging and ignoring the resources consumed in respect to the promotion of these practices in past Food For Work (FFW) project implementation years.

On the contrary, the adoption rate of conservation tillage 0.8 percent, fallowing 2.5 percent and alley cropping five percent were found to be discouraging and they are first, second and third from the last, respectively. The other worst condition of these practices is that 80.8 percent, 77.5 percent and 76.7 percent of respondents are not

aware of conservation tillage, alley cropping and fallowing, respectively. From agricultural point of view, land is an indispensable factor for crops production, raising of livestock and other ancillary agricultural activities and the proper utilization of land holdings under different component would contribute to the development of the national agricultural production (CACC, 2003). However, the results of this study indicate that the attempt to promote proper land utilization to sustain agricultural land productivity looks minimal in the study community.

Table 2: Comparison of different Soil conservation practice adoption (N=120).

Conservation practices	Adopters		Non adopters		No awareness	
	No	Percent	No	Percent	No	Percent
Soil bund	98	81.7	22	18.3	Nil	Nil
Crop rotation	85	70.8	29	24.2	6	5.0
Intercropping	47	39.2	29	24.2	44	36.7
Conservation tillage	1	0.8	22	18.3	97	80.8
Reforestation	74	61.7	31	25.8	15	12.5
Use of Crop residue	9	7.5	22	18.3	89	74.2
Contour farming	58	48.3	39	32.5	23	19.2
Area closure	81	67.5	33	27.5	6	5.0
Fallowing	3	2.5	23	19.2	92	76.7

***Note*:**-‘No’ represent frequency of respondent (consistently throughout this document).

4.4 Social and Economic characteristics association to soil bund adoption

Before moving on to look at the detailed analysis of most common farmer’s and farm characteristics effect on technology adoption, the usual procedure to test for means differences and tendency of association between variables was conducted using independent T-test and Chi-square test techniques, respectively. The result of these

two test statistics is presented in Table 3 for continuous variables and in Table 4 for categorical variables, and furthermore, the extensions of these two groups of variables are attached in Appendix 1 and 2 to include some more variables. As shown in the Table 3 below, except land holding, all selected variables was found to be statistically significant indicating that SWC technology adoption decision had significant association with mentioned respective variables.

In this aspect, the characteristics of the household, such as age, education level attained by farmers and family size of respondent appeared highly significant at one percent. These results show that the SWC technology adoption is strongly associated with the age, education level and family size of the sample households. More over, the remaining variables, that is livestock holding in tropical livestock unit and yearly income of the household also were found statistically significant at five percent ensuring dependency of SWC technology adoption on these two variables.

Table 3.The summary of means difference test for continuous explanatory variables.

Continuous Variables	Mean for different categories			T-Test	
	Adopters	Non adopters	Mean difference	T-Value	P-Value
Age of respondent	43.35	54.10	-10.74	-2.829	0.009***
Education level	3.84	1.43	2.41	3.300	0.002***
Family size	6.53	6.05	0.48	0.804	0.003***
Land holding (ha)	2.51	2.66	-0.15	-0.505	0.614(NS)
Livestock (TLU)	3.81	2.75	1.06	1.278	0.025**
Yearly income	3281.23	1905.67	1375.57	2.024	0.045**

Note:- ***,**,* represent significance at (P<1%, P<5% and P<10%), respectively, and consistent through out this document and 'NS' represent non significant.

According to the findings provided in the above Table 3, age of the household head is negatively associated with physical soil bund structure adoption which is similar with different study findings, while the result of negative association of the

landholding is unusual phenomena. However, Feder *et al.* (1982) suggested relatively closer or similar result with this findings stating that farm size is one of the factors on which empirical adoption study is focused but the farm size can have different effect on the rate of adoption depending on the characteristics of technologies and institutional setting of the service delivery system.

On the other hand, the relationship between physical soil bund structure adoption and some other variables, like education level of the household, family size, livestock holding and yearly income of the household were found, as expected, positive association. In general, these findings indicate that physical soil bund structure technology adoption is significantly dependent on age, family size, education level, livestock holding and income characteristics of the households and it is independent of landholding or the association is insignificant.

According to Wegaheyu (2006), age of household head can influence the availability of labor that is one of the most important factors of production to farmers in rural areas, and in turn determine the decision of households as to which SWC type to adopt on their farmland and this result is consistent with his findings. However, Haji (2002) reported non significant T-test, which leads to conclusion that there is no significant difference in age between adopters and non adopters of Cross Bred Dairy Cows (CBDCs), in Arsi zone, Ethiopia. As mentioned in the literature, the sex of households, marital status, and social participation of the household, especially, in farming community has the significant effect on technology adoption. According to Wegayehu (2006), sex of household determines access to SWC technological information provided by extension agents and SWC related projects operating in the

area. Apparently, the marital status and social participation (responsibility in PAs) also would influence the adoption of any particular technology.

Table 4.Test of association between categorical variable and soil bund adoption

Categorical variables	Adoption (%)		Chi-square	
	Non adopter	Adopter	X^2-Value	P-Value
Gender (sex)				
Male	11.7	66.7	4.988	0.026**
Female	5.8	15.8		
Martial status				
Married	15.0	78.3	57.408	0.000***
Single	2.5	4.2		
Responsibility in PAs.				
Yes, have	2.5	30.0	1.833	0.176(NS)
No, don't have	15.0	52.5		
Availability of credit.				
Yes, available	14.2	70.0	25.757	0.000***
Not available	3.3	12.5		
Access to mass media.				
Yes, accessible	15.0	69.2	0.007	0.933(NS)
Not accessible	2.5	13.3		
Sources of information				
Extension staff	14.2	66.7	17.652	0.000***
N/extension staff*	3.3	15.8		
Main occupation				
Crop farming	15.0	56.7	13.672	0.000***
Mixed farming	2.5	25.8		

* N/extension is represent non extension staff.

The results of this survey also indicate strong association between these social characteristics of the farmers and SWC technology adoption. The sex of the respondent with chi-square(X^2) of 4.99 and the marital status of the household with Chi-square (X^2) value of 57.41 were found statistically significant at five and one percent, respectively. However, the social participation of the farmer remain non significant in this particular study. In addition, the main farming system of the respondent is also another area requiring attention in this study and it was found statistically significant with Chi-square (X^2) value of 13.67, indicating the strong

association between SWC technology adoption and farming system. Among many institutional variables (Table 4), availability of credit facility, accessibility to mass media and source of extension information were examined to determine their association with SWC technology adoption, and it was realized that credit facility with Ch-square (X^2) value of 25.76 and source of extension information with Ch-square (X^2) value of 17.65 are statistically significant in both cases. The detailed and entire discussions of these two continuous and categorical variables are presented in the subsequent section of this chapter.

4.5 The social characteristics of the respondents

4.5.1 The age distribution of sample households

To determine the influence of the age characteristics of the sample households on the adoption of physical soil bund structure, a comparison was made between different age categories of the respondents and tested using frequency of each category. The age of sample farmers was categorized and presented into five age categories and Table 5 presents the age characteristics of the surveyed farmers in relation to SWC technology adoption decision. The subsequent discussion of this section is supported by the information in this table. Based on this categorical approach, about 68 percent of the respondents are in the age group of below 50 years (including 50 years age), while the remaining, about 32 percent, was above 50 years of age category (Table 5). The survey results show that the largest group of the respondents (about 78 percent) found in the age category of 30 to 60 years which is the effective age group to produce food, where as 10 and 11.7 percent are below 30 and above 60 years, respectively. These findings are consistent with other findings in Arsi zone, Haji (2002) which indicated that the proportion of young and older farmers are lower

compared with other age categories and the same source stated that the low proportion of this age group is due to lack of access to land resources.

Table 5: Age categories of respondents in relation to soil bund adoption (N=120).

Age category	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
< 30 years	10	8.3	2	1.7	12	10.0
30-40 years	35	29.2	7	5.8	42	35.0
41-50 years	22	18.3	6	5.0	28	23.3
51-60 years	22	18.3	2	1.7	24	20.0
> 60 years	9	7.5	5	4.2	14	11.7
Total	98	81.7	22	18.3	120	100.0

On the other hand, about 68 percent of physical soil bund structure adopters were found to be within the age range of below 50 years (including 50 years age group, while the remaining 32 percent of the adopters are found above the age of 50 years. These findings are consistent with literature which confirms that the younger farmers are more likely to be adopters of technology. When a comparison is made between the different categories, the farmers within age category of 30-40 years were found to have more adopters (of total respondent, 29.2 percent) of the physical soil bund structures, while only 5.8 percent of this group had not adopted the technology. On the contrary, out of the total respondents, only 8.3 percent of the farmers within the age category below 30 years have found to be adopters. The proportion of the elder farmers (above 60 years) in the whole sample was about 12 percent and within this age category 9.2 percent was found to be adopters of soil bund structure technology. These findings were also consistent with the findings from North Shewa Zones by

Mulugeta (2000) which stated that, as the age increase the decision to invest on land conservation decreases.

4.5.2 Family size and related characteristics of sample households

Family members are considered to be all persons related to the particular farmers and dependent on family farmland (Mulugeta, 2000). The survey results show that, the average family size of the respondents was found to be 6.54 persons which according to CSA (1995) cited by Mulugeta (2000), is above the national average of 5.17 persons per family and also greater than the regional average of 5.4 person which reported in Central Agricultural Census Commission (CACC, 2003a). Among the total sample farmers 2.5 percent was found to have more than 11 family members, whereas 3.3 percent of the farmers have below three family members. When adoption situation of the respondent is considered, about 67 percent of soil bund technology adopters were found to be those respondents with 3-8 family size out of total sample farmers, whereas this figure constitutes about 82 percent when considered only among adopters group.

Table 6: Adoption of soil bund in relation to family size (N= 120).

category of family size	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
< 3 members	1	0.8	3	2.5	4	3.3
3-5 members	29	24.2	5	4.2	34	28.3
6-8 members	51	42.5	10	8.3	61	51.0
9 and Above	17	14.2	4	3.3	21	17.5
Total	98	81.7	22	18.3	120	100.0

The proportion of non-adopters in such categories of family size (3-8 family members) was found to be only 68.2 percent, whereas the remaining 31.8 percent are within the family size categories of below three and above eight when considered from non-adopters only. Concerning the religious affiliation of the respondents,

about 92 percent were Orthodox and the remaining 8 percent of the respondents belonged to other religious groups including the traditional *wakefacha* religion. Also the results of the study show that about 68 percent of the respondents do have some kind of public responsibility in the community, while the remaining 31.7 percent do not have any public responsibility.

The results of the survey also show that about 95 percent of the respondents have family members of one to five involved in farm activities as fulltime workers, whereas 70.8 percent of the respondents have family members one to five involved in SWC activities as fulltime workers. On the other hand, the proportion of the respondents that have additional occupation outside farming practices were found to be only 20 percent of the sampled group and these include part time workers in government or community based institutions. In addition, the size of the population depends on the active age group (dependency ratio) was found to be relatively as high 114 percent and higher when compared with zonal dependency ratio of 97.21 percent reported in1994 (OPED, 2000).

4.5.3 Educational level of sample households

Regarding educational level of household head, the level arranged into five categories and the comparison made between these categories. Based on the survey information, the results related to educational level of the respondent is summarized and presented in the Table 7 below on which the discussion of this section is partly dependent up on. According to these findings, out of a total sampled households, total of 80 respondents (about 67 percent) have attended formal education including adult to secondary education.

Thus, the findings from this survey reveal that the proportion of farmers that can read and write is about 67 percent in the study area. As shown in Table 7, of total adopters, about 65 percent attended formal education, whereas the remaining nearly 35 percent is adopters with no formal education. Many soil conservation related literatures, example, Tesfaye (2003), confirm that the better educated farmers show better positive response to soil conservation technology adoption and better decisions on soil bund retention on their farm land which is adequately consistence with these findings.

Table 7: Adoption of soil bund in respect to Educational level (N= 120)

Educational level	Adopter		Not adopters		Total	
	No	Percent	No	percent	No	Percent
No formal education	34	28.3	6	5.0	40	33.3
Adult education	6	5.0	3	2.5	9	7.5
Primary education	35	29.2	10	8.3	45	37.5
Junior-secondary	15	12.5	1	0.8	16	13.3
Secondary education	8	6.7	2	1.7	10	8.3
Total	98	81.7	22	18.3	120	100.0

More specifically, the number of those who attended primary education is relatively high in both adopters and non adopters having about 36 and 45 percent of each category, respectively. On the other hand, survey results show that out of 71 respondents who attended above adult education, nearly 82 percent adopted physical soil bund structure and this result is more or less closer to the findings from

Mulugeta (2000) who reported 89.7 percent of farmers who attend formal education were users of physical soil conservation structures and also Weir and Knight (2000) suggested in the study conducted on adoption and diffusion of agricultural innovations in Ethiopia, by comparison, indicating that the more educated farmers the more rapid adoption and diffusion would take place.

4.5.4 Gender and marital status of household heads

Table 8 below provides the sex composition of the respondents as related with farmer's physical soil bund structure adoption trend in the sample farmers. Based on the survey results, it is realized that out of a total of 120 respondents, about 78 percent of respondents were found to be male-headed households, while about 22 percent of respondents were female-headed households. The ratio of female headed household to male headed households is 0.3 to 1 which is below 50 percent which is contrary to population composition of the area, where women population constitutes 51 percent according to secondary data from Adama ARDD office.

The proportion of household heads among the males is substantially higher than that of females, reflecting the fact that males in most Ethiopian societies assume execution of the major roles of the agricultural activities and the head is considered as the main bread winner in the household as well as the one who merely bear responsibility. In general the findings of the survey indicates that there is strong relationship between technology adoption and sex of the respective farmer and this result is consistent with the result reported by Yisehak (2002), from his study conducted in Ethiopia at Bolosso-Sore district, which indicated the existence of

significant relationship between sex of the respondents and use of improved seeds and proper weeding.

On the other hand, it is realized that out of a total of 94 male respondents, about 83 percent were found the adopters of physical soil conservation (soil bund) structure, whereas the proportion of female adopters in female category is nearly 77 percent. In addition, about 80 percent of the adopters were male and 20 percent is female adopters in the adopters category of respondents and in the same manner, the proportion of male respondents is higher than female respondents in the category of non adopters (Table 8 and 9). Furthermore, the analysis of survey data shows that among the total respondents the majority of them (93.3 percent) were married (coupled), whereas the rest 6.7 percent were found to be single household headed (non coupled), due to either not being married, widowed or divorced and among total non adopters, the large proportion (about 82 percent) of respondent was found to be married and only the remaining 18 percent of the non adopter is single farmers.

Table 8: Adoption of soil bund in respect to sex composition of respondents (N= 120)

Sex category	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
Female	20	16.7	6	5.0	26	21.7
Male	78	65.0	16	13.3	94	78.3
Total	98	81.7	22	18.3	120	100.0

Table 9: Adoption of soil bund in respect to marital status of respondents (N= 120)

Marital status	Adopters		Non adopters		Total	
	No	percent	No	Percent	No	Percent
Married	94	78.4	18	15.0	112	93.3
Single	4	3.3	4	3.3	8	6.7
Total	98	81.7	22	18.3	120	100.0

Concerning physical soil bund conservation adoption, nearly 96 percent in the adopter category was found coupled male and the remaining 4 percent was married female respondents. The proportion of female respondents in the sample was based on the proportion of female registered in the membership of PAs and these results (low number of female in the PAs) show that the accessibility of female to secure land ownership or land title and the chance of being heads of the households is extremely limited unless they are divorced or widowed.

4.6 Economic and farm characteristics of respondents

4 .6.1 Estimated yearly income of sample households

Concerning family yearly income, Table 10 shows the distribution of household income in respect of physical soil conservation practice adoption in the study peasant associations. The minimum income of the respondents that was reported is 300 *birr* and the highest were found to be 23, 260 *birr*. The results of the survey indicate that an average household income of the respondent was 3038.5 birr with 2863.04 *birr* standard deviation.

Table 10: Adoption of soil bund in respect to yearly income of households (N=120)

Income category (*Birr*)	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
<1000	8	6.7	5	4.2	13	10.8
1000-3000	50	41.7	11	9.2	61	50.8
3001-5000	25	20.8	4	3.3	29	24.2
5001-7000	9	7.5	1	0.8	10	8.4
7001-10,000	4	3.3	0	0.0	4	3.3
>10,000	2	1.7	1	o.8	3	2.5
Total	98	81.7	22	18.3	120	100.0

Furthermore, the results show that the majority of the respondents (50.8 percent) earned yearly income estimated between 1000 *birr* to 3000 birr which is closer to the adopters of physical soil conservation practice (41.7 percent) in the study group. For those in the yearly income categories of less than 1000 *birr* and those with greater than 7000 *birr* constitute nearly 11 and 6 percent, respectively, in the study group (Table10). In general, based on these results it is possible to predict that the better the yearly income the more that such people would adopt the introduced conservation technology.

4.6.2 Land holding of sample households

The discussion of this section is based on the results summarized in Table 11, in which the overall average farm landholding of the households was found to be 2.54 hectares with corresponding standard deviation of 1.2 hectare and this includes any form of land ownership except rented land. Concerning farm land holdings of the study group, it was realized that the average farm landholding of the study PAs is greater than one hectare of national average in the country, as reported by Ethiopian Economic Association (EEA, 2000) cited in Haji (2002) and as well as the regional average of 1.36 hectares per household.

In the study group of the district, a total of 64 respondents (53.4 percent) is reported to be in the range of farm land holding category of 0.5 to 2.51 hectares of land and these findings are closer to 52.1 percent reported by Central Agricultural Census Commission (CACC, 2003a) and the 39.1 percent of the respondents were the holders within the range of 2.51 to 4 hectares. While the remaining 7.5 includes the

holders of less than half and greater than four hectares. Regarding land holding and land use, CACC (2003b), reported that in Oromia Regional State, the total number of agricultural holders that are involved in all types of farm-holding activities and reported land use of Oromia Region was estimate to be about 4 168 441and out of total holders those who are engaged in crop production, livestock and both crop and livestock production were estimated to be about 18. 8 percent, 3.2 percent and 78 percent, respectively.

Table 11: Adoption of soil bund by respondents in relation to land holding (N= 120)

Land size categories (ha)	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
<0.5 ha	2	1.7	1	0.8	3	2.5
0.5-1.5 ha	27	22.5	5	4.2	32	26.7
1.51-2.5 ha	25	20.8	7	5.8	32	26.7
2.51-4 ha	41	34.2	6	5.0	47	39.1
> 4 ha	3	2.5	3	2.5	6	5.0
Total	98	-	22	-	120	100.0

As the data in Table 11 shows, a total of 41 farmers (34.2 percent) in the land holding category of 2.51-4 ha were adopters of the introduced physical soil conservation practice in the study Peasant Associations with the corresponding 5 percent of non adopters. Furthermore, among total sample group who owned farm land size of between 0.5 and 2.5 hectares, adopters constitutes 43.3 percent of total respondents with corresponding 10 percent of non adopters in the same category. The results show that optimum land size ownership might be the major factor in promoting technology adoption in small scale farming system of Ethiopia in general and Adama District in particular.

4.6.3 Farm land distance from the residence of households and public services.

Details of the respondent's farm land distance from the residence of the respondents and from different public support giving service were summarized in the Tables 12, 13 and 14 below, respectively. It was realized from different adoption literature that farmland distance from the residence of the respondents and its distance from different public services like development centers (DC) and primary road (s) significantly affect the rate of technology adoption. This study also confirms the same relationship between adoption and distance of farmland from the mentioned public service centers and residence of the households.

As shown in Table 12 below, out of the total respondents, 63 farmers (53.4 percent) whose location of farmland is less than two kilometers from home were found to constitute physical soil conservation adopters, farmers constitutes 24 percent of total respondents in 2-4km distance category were adopted introduced technology and only 4.2 percent from the category with farmland located more than 4 km distance were found adopters. In the same manner, about 68.9 percent of total respondents, whose farmland is within the near and medium distance (below 4km) category to development centers, were found to be more likely to adopt physical soil conservation practice. On the contrary, 17.7 percent of the respondents were non adopters in the same distance category (Table 13).

On the other hand, 42 percent of the total sample who found the adopter of the physical soil bund structure were those whose farmland is greater than 6 km, which is relatively higher than 39.5 percent of the total respondents whose farmland is

within the distance of below 4 Km from primary road(s) and found to adopt physical soil bund structure (Table 14). As argued by EEA(2006), this finding also revealed that the under development of the infrastructure through making research and extension process extremely challenging and costly, the topography and poor infrastructure in the country in general and in the study area in particular is raising doubt on economic feasibility of the technology adoption.

Table 12: Effect of farmland distance from residence on soil bund adoption (N= 118)

Distance categories (Km)	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
Not far (< 2km)	63	53.4	16	13.6	79	67.0
Medium (2-4km)	29	24.6	5	4.2	34	28.8
Far (above 4 Km)	5	4.2	0	0.0	5	4.2
Total	97	82.2	21	17.8	118	100.0

Table 13: The effect of DC distance on soil bund structures adoption (N= 119)

Distance categories (Km)	Adopter		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
< 2 Km	43	36.1	14	11.8	57	47.9
2-4 Km	39	32.8	7	5.9	46	38.7
5-6 Km	5	4.2	1	0.8	6	5.0
> 6 Km	10	8.4	0	0.0	10	8.4
Total	97	81.5	22	18.5	119	100.0

Table 14: Influence of distance from primary road on soil bund adoption (N=119)

Distance category (Km)	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent

<2 Km	15	12.6	4	3.4	19	16.0
2-4 Km	32	26.9	12	10.1	44	37.0
5-6 Km	13	10.9	3	2.5	16	13.4
> 6 km	37	31.1	3	2.5	40	33.6
Total	97	81.5	22	18.5	119	100.0

4.6.4 The main occupation of sample households

Different occupational opportunities to farmers were investigated in this study and in this study, survey results show that there are two major occupations in the farming community which are crop farming and mixed farming and as shown in Table15, livestock farming (pastoralist) is not commonly practiced in this particular study area. In this aspect, the results indicate that about 71.7 percent of the total respondents are engaged in crop farming among which 56.7 percent were found to be adopters of physical soil bund conservation structure, whereas the rest, 15 percent of whole sample size were not adopters. On the other hand, of total 120 sample farmers 34 (28.3 percent) were engaged in mixed farming and 88.2 percent of this group were found to be the adopters of physical soil bund conservation structure.

Table 15: Main occupation of household head and adoption of soil bund (N=120)

Main occupation	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
Crops farming	68	56.7	18	15.0	86	71.7
Live stock farming	Nil	Nil	Nil	Nil	Nil	Nil
Mixed farming	30	25.0	4	3.3	34	28.3
Total	98	81.7	22	18.3	120	100.0

In addition to agricultural practices, the survey data revealed some few farmers who are involved in additional activities outside the farming business and in this respect,

it was realized that about 20 percent of the sample farmers were engaged in additional activities to generate cash income in order to satisfy family demand among which 75 percent were the adopters of physical soil bund conservation practice, whereas 80 percent of the respondents did not engage in additional activities outside farming practices and 83.3percent of this group were also found to be the adopters of physical soil bund conservation structure.

4.6.5 Physical conditions of household farm in relation to soil bund adoption

Natural farmland characteristics and the erosive features of the soil are the major factors in dictating human intervention in the small farming system. Without going into details of biophysical characteristics of the soil that affecting the farming process, land resource management would be inadequate to maintain sustainable production. Therefore, soil physical factors are important for shaping farmers soil and water conservation decision making process of the farmers (Rolling, 1997), cited in Tesfaye (2003).

Based on the survey results, this section presents the perception of farmers on different soil physical and chemical degradation processes including soil erosion, fertility decline and water logging problems of the farmland. Table 16 shows the perceived level of soil erosion process and its relationship to physical soil bund adoption decision. As presented in Table 16, the overwhelming majority of respondents (95 percent) reported very severe and severe soil erosion problem including fertility decline and water logging on their farm lands, and of this group, about 85.1 percent adopted physical soil bund conservation practice, while 5 percent of total the respondents feel no problem and minor problem on their farmland. Of

this group, only 16.7 percent adopted the physical soil bund conservation practice, while the remaining 83.3 percent reported that they have no relevant reason to adopt physical soil bund conservation structure.

Table 16: Observed erosion problem on household farmland (N= 120)

Category of Soil erosion status	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
Very severe	65	54.2	7	5.8	72	60.0
Severe	32	26.7	10	8.3	42	35.0
Minor	1	0.8	3	2.5	4	3.3
No problem	Nil	Nil	2	1.7	2	1.7
Total	98	81.7	22	18.3	120	100.0

4.7 Availability of institutional support to farm households

4.7.1 Agricultural Extension services and the effects of mass media

Agricultural extension service is one of the services provided by public institutions in the local area, in order to promote agricultural technologies to the farmers (Haji, 2002). In this regard, in the study district the concerned institution for agricultural extension, Agricultural and Rural Development Department (ARDD), has established the extension structure up to grass root level which is development centers (DC), where the development agents (DAs) are responsible to provide extension services to clients in that particular area. Currently, one DC is established in each PA with an attempt of reducing DAs to farmers' ratio and to increase DAs to farmers contact per month.

In this regard, the survey results indicate that, of total respondents, about 36.4 percent confirmed that they were visited 1-2 times (days) per month by development

agents, followed by 34.8 percent being visited by DAs 3-4 days in each month. On the other hand, 6 percent of the total respondents reported no visit by DAs to their home or farmland and this is unexpected because at the time when there are DC and DAs at each PA there is no relevant reason to justify this problem. However, in this connection field extension workers indicated that there was no satisfactory facility such as transport and teaching materials which are helpful to carry out their extension service responsibility in the respective working environment. In this regard, Rutatora and Rutachokozibwa (1995) argued that extension workers must be provided with adequate necessary field facilities with good working environment so that they can be initiated and conduct frequent farmland and/or home visit.

Table 17: An average development agent's visit to farmer in a month (N=118)

DAs contact (days)	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
No visit	3	2.5	4	3.4	7	6.0
1-2 days	28	23.7	15	12.7	43	36.4
3-4 days	40	34.0	1	0.8	41	34.8
5-6 days	5	4.2	0	0.0	5	4.2
> 6 days	20	17.0	2	1.7	22	18.6
Total	96	81.4	22	18.6	118	100.0

The results of DAs visit to farmers are summarized in Table 17 which shows that the farmers who were visited 3-4 days per month by DAs were 41 farmers among which 40 (97.6 percent) were found adopters implying that the more visited by development agent the more likely to adopt physical soil bund conservation structure in the study community, while of total respondents, only few (2.5 percent) of non visited farmers were found adopters of the promoted soil bund technology. In the extension information delivery system mass media are most common extension

channel to reach out even to the extreme remote areas of the country and helpful to reach majority of rural population within short time. It was confirmed in this study also that mass media which is radio in this case played significant role in technology promotion. In this regard, the survey results reveal that 88 farmers (73.3 percent) of total the respondents had access to mass media and helped by mass media to adopt physical soil conservation practices, while the remaining 32 farmers (26.7 percent) did not have accessibility to any kind of mass media in the past three to five years. Furthermore, of the total farmers who had access to mass media (which is radio), 72 farmers (81.8 percent) were found to be adopters of physical soil bund conservation practices to sustain agricultural land productivity in order to support their livelihood. In addition, of the 32 farmers who did not have access to any kind of mass media, 26 farmers accounting for 81.3 percent were found to be adopters of physical soil conservation practices.

4.7.2 Credit facility and farmers access to financial support

The review of different literature confirms that the financial accessibility to farming community would influence agricultural technology transfers which ultimately have impact on the productivity of the farmlands or particular crops. Based on this reality the accessibility of farmers to financial sources in the form of credit was investigated in this study and the results of the survey are compiled in Table 18 below.

The results of the survey data concerning financial accessibility to farming community shows that about 85.5 percent of all respondents have had accessibility to credit facility in the past cropping seasons. However, all respondents confirmed that the credit facility was only available for agricultural inputs excluding soil and water

conservation activities. According to the survey results, of the total farmers who had access to credit to support farm activities, 79 percent were found to be adopters of physical soil conservation practice that are introduced in the study area in the past extension package and/or SWC related project implementation years, while the remaining 21 percent of the farmers who have access to credit were non-adopters. These findings are relatively consistent with the results reported by Kedir (1999) on fertilizer (DAP) adoption of 70 percent of farmers who participated in SG-2000 project (who received credit) comparing with corresponding 58 percent adoption out of non SG-2000 project farmers.

Table 18: Farmers access to financial support and its effect on adoption (N= 117)

Average Credit received (birr).	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
<500	33	28.2	9	7.7	42	35.9
500-1000	27	23.1	11	9.4	38	32.4
1001-1500	11	9.4	1	0.9	12	10.3
1501-2000	5	4.3	0	0.0	5	4.3
>2000	3	2.6	0	0.0	3	2.6
No access	16	13.6	1	0.8	17	14.5
Total	95	81.2	22	18.8	117	100.0

Moreover, the findings of this study are relatively higher when compared to 33 percent rate of adoption reported by Haji (2002) from Arsi zone in Ethiopia. Similarly, although he conducted on maize technology adoption, Sebsibe (1999), suggested in his study conducted in Awassa District (Ethiopia), provision of credit was found as the highest predictor of adoption of improved maize varieties which significantly support the results of this particular study. Furthermore, Jugal (1992), insisted the importance of credit facilities suggesting that it facilitates the adoption

process of improved technologies due to the fact that credit enables small farmers to satisfy the cash need that can be caused by use of improved technologies

4.7.3 Farmers experience in SWC related projects and level of participation

Farmers' experience in SWC conservation related project is indirectly refers to any form of assistance rendered to the farmers in the area of soil conservation with an ultimate goal to promote SWC technology adoption by avoiding resource limitation. In the survey process, the issue of farmers' experience (support of different projects to farmers) in the soil conservation related projects and/or programs were examined to the level of support they received in the past years. Along with this process the level of farmers' participation in the process of different level of conservation projects also similarly examined in order to see the effect of external support and farmers participation on the adoption of physical soil bund conservation practice.

Concerning these two issues, Table 19 and 20 shows the details of farmers experience in the conservation related projects and/or programs and level of farmers' participation in planning and evaluation process, respectively. As summarized in Table 19, the majority (98.3 percent) of the eligible respondents were involved (supported by) in different soil conservation related projects and/or programs for more than five years, of this group of farmers about 83.3 percent were found adopter of physical soil bund conservation structure in the study respondents.

Table 19: Farmers experience in soil conservation projects/ programs (N= 116)

Farmers' experience	Adopt		Non adopter		Total	
	No	Percent	No	Percent	No	Percent
No experience	1	0.9	1	0.9	2	1.7
<5 years	4	3.4	2	1.7	6	5.2
5-10 years	39	33.6	14	12.0	53	45.7
11-15 years	13	11.2	0	0.0	13	11.2
16-20 years	17	14.7	1	0.9	18	15.5
> 20 years	22	19.0	2	1.7	24	20.7
Total	96	82.8	20	17.2	116	100.0

Table 20: Level of farmer Participation in planning and evaluation process (N=117)

Level of farmers participation	Adopters		Non adopters		Total	
	No	Percent	No	Percent	No	Percent
very good	1	0.8	Nil	Nil	1	0.8
Good	13	11.1	1	0.8	14	12.0
Satisfactory	23	19.7	2	1.7	25	21.4
Poor	37	31.6	5	4.3	42	35.9
No at all	22	18.8	13	11.1	35	29.9
Total	96	82.1	21	17.9	117	100.0

As mentioned above, Table 20 shows the level of farmers' participation in planning and evaluation process of the projects and about 65.8 percent of the relevant respondents reported their participation in planning and evaluation as poor and some of them even have no participation. However, 76.6 percent of this particular group was found to be adopters of physical soil bund conservation practices. Whereas the remaining 34.2 percent reported their participation from very good to satisfactory and the adoption rate within this group also about 92.5 percent which is very good

implication to show the influence of participation. Furthermore, the survey process related to level of farmers participation went beyond to include assessment of farmers' participation in problem identification, priority setting and decision making toward particular technologies and practices.

In this regard, it was realized that about 24.4, 39 and 37 percent of the relevant respondents confirmed that problem identification, priority setting and decision making, respectively, were no participation and poor: Whereas the remaining proportion reported their participation in problem identification stages, priority setting and decision making process as very good, good and satisfactory. On the other hand, it was observed from survey results, that there was positive correlation between farmers' participation in problems identification, priority setting and decision making process and technology adoption behavior of the farmers. However, many literatures and the finding of this study indicate that in the past extension intervention process in Ethiopia in general and in the study community in particular, farmers' participation in the decision making process of the development project was found extremely neglected and the problem looks worst in soil and water conservation related projects and /or programs.

4.8 Sustainability of major physical and biological soil conservation practices

The sustainability aspect of this study is an assessment that examines the persistence of previously adopted recommended physical soil bund conservation practice in the small scale farming system without external support or after the external support was terminated. In this regard, the aspect of sustainability can be explained by different financial and physical contribution of farmers to sustain the introduced practices in

order to maintain sustainable farmland productivity. To achieve sustainable productivity objective of the farmlands, appropriate soil conservation practices must fit into the existing farming system throughout the effective use period of land resources in a sustainable manner.

However, as one can realize from Table 21, the sustainability of many introduced soil conservation technologies are discouraging and only very few practices maintain more than 50 percent rate of sustainability in the study group. In this aspect, among nine different physical and biological soil conservation practice that were investigated, only soil bund, crops rotation and area closure appear to be sustainable in the farming system and the remaining practices are either poorly sustainable or not introduced into the farming system. As shown in Table 21, of total sample respondents, about 69.2, 63.3 and 57.5 percent reported that they are using the soil bund, crop rotation and area closure, respectively, in a sustainable manner to support the effort to reverse the soil degradation process, while the remaining practices were score below 50 percent sustainability. On the other hand, some of the soil conservation practices like conservation tillage, crop residue management, alley cropping and fallow farming were found to be the least sustained practices in the farming system.

Table 21: Comparative evaluation for sustainability of SWC practices (N=120)

Types of SWC practices	Sustained		Non sustained		No awareness	
	No	Percent	No	Percent	No	Percent

Soil bund	83	69.2	34	28.3	3	2.5
Crop rotation	76	63.3	36	30.0	8	6.7
Intercropping	41	34.1	33	27.5	46	38.3
Conservation tillage	1	0.8	19	15.8	100	83.3
Reforestation	52	43.3	57	47.5	11	9.2
Crop Residue	6	5.0	26	21.7	88	73.3
Contour farming	56	46.7	36	30.0	28	23.3
Area closure	69	57.5	42	35.0	9	7.5
Fallowing	4	3.3	18	15.0	98	81.7

With the national attempt to improve crop yield per unit of cultivated farmland, the Ethiopian government has adopted Participatory Demonstration and Training Extension System (PADATES) approach which is usually based on high external input without optimum attention to promote soil conservation practices, especially those technologies which are important to improve soil fertility and this approach ultimately contributed for poor sustainability of these particular practices. However, the challenge encountering the Ethiopian small scale farmers is to find mechanisms that help poor rural communities to improve the environment and their capacity to produce crops without becoming dependent on external inputs which mainly are chemical fertilizers to compensate yield reduction due to soil degradation.

4.9 Extension field staff (DAs) perception on soil conservation adoption

Before launching the PADETES approach in the country, through national extension package program, the extension service in the study area and elsewhere in the

country was limited to some pocket areas focusing on potentially productive crops using the very limited number of development agents. However, this approach dramatically changed and currently, there are 70 development agents who are stationed in 40 development centers established in each Peasant Associations in the study district. The survey conducted to determine the nature of development agents and their perception on SWC practices were summarized in different forms to illustrate the existing condition in relation to this aspect.

In this regard, the survey results show that about 5,12.5 and 82.5 percent of the DAs are secondary school, college certificate and college diploma, respectively. On the other hand, concerning the field of study, each of plant and animal science constitutes 30 percent, whereas natural resource management and general agriculture contribute 22.5 and 17.5 percent, respectively, to the total number of development agents.

Furthermore, the survey results indicate that about 65 percent of the DAs are single youngsters and the remaining 35 percent are married in which their family is living outside the development centers. Concerning field experience of development agents, nearly 70 percent of total development agents are within the range of two to three years field experience. Whereas the rest 30 percent are reported to be within the range of four to twelve years field experience in this particular extension field staff and this empirical result shows that the turnover of the development agents is high which significantly affects the efficiency and effectiveness of the extension service delivery system. In this survey development agents were requested to assess the orientation of past years extension approaches and majority of them (98 percent)

suggested that the past extension approaches were more production oriented than conservation and the reasons reported is presented in Table 22 below.

Table 22: Reasons why extension package program was production oriented (N= 40)

Suggested Reasons dictate extension orientation	Respondents	
	No	Percent
More attention on crop at different level	30	75.0
Soil degradation was not serious	3	7.5
Poor farmers recognition of soil degradation	3	7.5
Lack of soil conservation technologies	2	2.5
More availability of Production technologies	2	2.5
Total	40	100.0

Moreover, according to respondent's view about pre-service training (college level), only 47.5 percent perceive the training is addressing all fields equally and the remaining group suggested that pre-service training is either, more crop and livestock production oriented or only natural resource oriented and the response to the nature of in-service training were also similar with nature of pre-service training in the study group. Similarly, they suggested that even extension package program which was launched before 15 years was not devoid of crops production orientation by undermining natural resources management and in relation to this point, 65 percent of the respondents evaluated the extension package program as crop production oriented strategy and the suggested major reason (see Table 22) was due to more attention for crop production at different stages including national level.

As it is indicated in the survey results, past experience in the Ethiopian extension system and approaches were crop production oriented than any other agricultural areas which in fact resulted from the national attempt to attain short term household and nation food security, but this concept extremely promoted top-down approaches marginalizing the farmers' participation in the decision making process.

Table 23: Comparative evaluation of DAs' perception on system efficiency (N= 40)

Categories of the statements	Agree		Disagree	
	No	Percent	No	Percent
Past SWC efforts were sufficient	15	37.5	25	62.5
Attention for SWC were satisfactory	22	55.0	18	45.0
Available SWC technologies were satisfactory	18	45.0	22	55.0
Adoption of SWC Practices is satisfactory	23	57.5	17	42.5
Sustainability of SWC practice is satisfactory	15	37.5	25	62.5

Furthermore, the members of the study group responded differently to SWC related issues and farmers reaction to soil conservation practices in relation to their respective socio-economic contexts. As indicated in Table 23, 62.5 percent of the development agents do not recognize SWC efforts as sufficient enough to reverse the soil degradation in the farming system and in addition they believe that attention in extension service delivery system and availability of SWC technologies were poor enough to change the existing soil degradation process which was aggravated by erosive agricultural practices. Moreover, even though, they (respondents), relatively supported better adoption of SWC practices (57.5 percent), they reported sustainability of the SWC practices as discouraging enough which is 37.5 percent to reverse the fast soil degradation process in the small-scale farming system. On the

other hand, 97.5 percent of development agents witnessed the soil degradation problem being from severe to very severe and only 2.5 percent of them considered soil degradation problem as minor issue in the farming community.

Table 24: Assessment of soil conservation practices adoption rate by DAs (N= 40)

Category of SWC Practices	Poor		Medium		High	
	No	Percent	No	Percent	No	Percent
Soil bund	7	17.5	17	42.5	16	40.0
Reforestation	4	10.0	17	42.5	19	47.5
Crops rotation	2	5.0	19	47.5	19	47.5
Intercropping	19	47.5	20	50.0	1	2.5
Crop residue use	13	32.5	11	27.5	16	40.0

According to the assessment of the development agents (as shown in Table 24), nearly 18, about 42 and 40 percent of them assess the rate of adoption for soil bund as poor, medium and high, respectively. Furthermore, about 48 percent and 33 percent of them scale the rate of adoption for intercropping and crops residue management as poor enough to contribute in soil conservation efforts, whereas the remaining 52 and 67 percent for intercropping and crop residue management, respectively, scale the rate of adoption from medium to high in the respective farming community. Furthermore, the sustainability aspect of this study was summarized in Table 25 concerning perception of development agents on different soil conservation practices in their particular community. The operational definition of sustainability in this study is simply the persistence of particular soil and water conservation technology in the farming system of individual farmer for not less than three years after the specified conservation technology adoption.

Table 25: Comparative scaling of SWC practices sustainability by DAs (N=40)

Types of SWC Practices	Good		Satisfactory		Poor	
	No	Percent	No	Percent	No	Percent
Soil bund	19	47.5	8	20.0	13	32.5
Crops rotation	24	60.0	10	25.0	6	15.0
Intercropping	5	12.5	12	30.0	23	57.5
Reforestation	13	32.5	13	32.5	14	35.0
Crop résidu manag't	9	22.5	17	42.5	14	35.0
Conservation tillage	5	12.5	9	22.5	26	65.0

According to the responses from the development agents, in general, as it happened in the case of rate of adoption, the sustainability of different soil and water conservation practices (SWC) appears discouraging to influence the soil degradation process. In this regard, as indicated in Table 25, large proportion of respondents evaluate the sustainability of many soil conservation practices as poor to support the farming system and especially, the sustainability of conservation tillage and intercropping appears the poorest of all in the respective farming system.

4.10 The Logistic regression summary and discussion

In the process of carrying out logistic regression analysis to look for fitting model for particularly selected variables among total independent variables, different techniques and tools were employed to establish relatively more fitting regression line to determine the relationship between dependent and independent variables included in the model. The dependent variable which is adoption of physical soil

conservation structure was taken as categorical (dichotomous) variable with binary representation; while independent variables included in the model were a mixture of continuous and categorical variables, which in fact categorical variables were arranged in binary manner. Therefore, in this model building process, six continuous and six dummy explanatory variables were selected to predict expanded logistic distribution model.

As the usual procedure testing for multicollinearity was conducted to avoid collinearity effect(s) on the parameter estimates of the selected model resulting from redundancies in independent variables effects. To this end, tolerance (TOL) and variance inflation factor (VIF) testing technique was employed (Appendix 4), and the result of this diagnosis indicated that there was no implication for existence of multicollinearity among the included continuous variables in which tolerance level for variables were found to be more than 0.1 and VIF result were less than 10 which are the threshold level for tolerance and VIF, respectively (Menard, 1995). Furthermore, collinearity diagnostics was conducted for variance proportion test and the result of this collinearity identification technique was indicated the weak and insignificant collinearity between gender and marital status: income and education level including livestock holding of the respondents.

Table 26: Definition of abbreviations of variables included in the model

Abbreviations of variables	Definition of Abbreviation of variables	Measurement of variables
TECADOPT	Technology adoption(dependent)*	Dummy(Binary)
EDULEVEL	Education level of household head	Year of schooling
HEFAMAGE	Head of family age	Number of years
LABSHORT	Labour shortage for farm activities	Dummy(binary)
SOURCINF	Source of extension information	Dummy(binary)
FARMEXP	Farmer’s experience in SWC projects	Number of years
MEDIA	Access to mass media to farmer	Dummy(binary)

EXTRAIN	Access to extension training	Dummy(binary)
FARDIST	Farm land distance from DC.	Kilo-meter
GENDER	Gender of the household head	Dummy(binary)
FARMSIZ	Farm land size owned by household	Hectare
LANDRENT	Experience of land renting by HH.	Dummy(binary)
LIVSTOK	Livestock holding by household	Number in TLU

Note: DC represents the development centre and HH, represent the household head
* Except technology adoption variable, all others are explanatory independent Variables that were included in the model to test parameter estimate.

In addition, the analysis for correlation coefficient shows similar weak collinearity effect of these variables. Due to this reason, marital status and income were excluded from the model based on the magnitude of their contribution to regression model to influence the change in odd ratio of technology adoption. In general there was no indication of serious multicollinearity between explanatory predictors and after two mentioned variables were omitted from regression, collinearity effects were found insignificant among variables. Therefore, those variables tested for multicollinearity and found statistically insignificant were included to predict fit model for this study.

Table 27: Parameter estimate for adoption of physical soil bund structures.

Explanatory Variables	**Parameter estimates**			
	Coefficient	Wald statistics	Exp(B)	P-Value
Constant	1.629	0.901	5.101	0.343(NS)
HEFAMAGE	-0.084	7.180	0.919	0.007***
GENDER(1)	1.843	4.765	6.317	0.029**
EDULEVEL	0.231	2.979	1.260	0.084*
LABSHORT(1)	-0.729	1.226	0.482	0.268(NS)
INFSOURC (1)	0.678	0.536	1.969	0.464(NS)
FARMEXP	0.043	0.740	1.044	0.390(NS)
DISTANC	0.479	3.713	1.615	0.054**
LANDSIZE	0.458	1.871	1.580	0.171(NS)
MEDIA1(1)	2.724	3.392	15.249	0.066*

EXTRAIN(1)	0.260	0.147	1.297	0.701(NS)
RENTLAND(1)	-1.462	3.050	0.232	0.081*
LIVSTOK	0.130	0.428	1.139	0.513(NS)

-2log likelihood ratio----------69.72
Model chi-square(X^2) ----------35.39
Hosmer-Lemeshow test(X^2) ----------5.31
Overall correct prediction----------87.5 %
Sensitivity prediction----------95.7 %
Specificity prediction ----------50 %
Note:- *****, ***** and ***** significant at p< 1%, p<5% and P<10%, respectively.

The quality of established regression model can be determined by looking into different measures of goodness of fit to the available data and level it can predict the probability of occurrence and non occurrence in particular event. In this study, log likelihood ratio (-2log likelihood), Model chi-square (X^2), sensitivity and specificity prediction, and Hosmer-Lemeshow test were the selected techniques among the others to determine and justify the goodness of fit of selected model based on particular statistical significance level. The wald Chi-square statistic, which tests the unique contribution of each predictor, in the context of the other predictors, by holding the other predictors constant for eliminating any overlap between predictors effect, was used in this study. As realized from model outputs, adding those selected explanatory variables in regression equation reduced the -2Log Likelihood statistic to 69.72 from poorly constructed initial model. In addition, the model chi-square (X^2) 35.39 appeared statistically significant indicating that including selected explanatory variables significantly reduced the log likelihood ratio of the model when compared with the model established using only intercept. Notice that in the model, -2Log Likelihood statistic has dropped (reduced), indicating that new expanded model is doing a better job at predicting adoption decisions than it was with only intercept predictor logistic regression model.

Using the default threshold of 50 percent classification rule, SPSS program was classified a subject into the adoption category if the estimated probability is 50 percent or more and classified a subject into the non adopters' category if the estimated probability is less than 50 percent. Thus, the classification table shows that this rule allows to correctly classify 95.7 percent of the subjects where the predicted event (adoption) was observed, which is known as the sensitivity of prediction or correctly predicted event, that is, the percentage of occurrences correctly predicted. We also see that this rule allows to correctly classify 50 percent of the subjects where the predicted event was not observed which is known as the specificity of prediction or correctly predicted event, that is, the percentage of non-occurrences correctly predicted. Overall prediction of model were correct 98 times, for an overall success rate of 87.5 percent which is relatively high when compared with that of original model only with intercept.

The Hosmer-Lemeshow technique is the tests of the null hypothesis that states there is a linear relationship between the predictor variables and the log odds of the criterion variable. Expected frequencies are computed based on the assumption that there is a linear relationship between the weighted combination of the predictor variables and the log odds of the criterion variable. A chi-square statistic is computed comparing the observed frequencies with those expected under the linear model. A non-significant chi-square (X^2) of 5.31, which is the Hosmer-Lemeshow test indicates that the available data fit the model well in this particular study in contrary to null hypothesis that suggested no significant difference between new model and original regression model which established only with intercept and disproved the assumption of linear relationship between log odds estimate and predictor variables.

From regression analysis mass media was found to be leading variable in contributing to change in odds ratio of the technology adoption. The 15.249 odds ratio for accessibility of farmers to mass media indicates that the odds of approval (adoption) is higher for each one point increase in respondent's accessibility to any kind of mass media compared to other predictors. That is for each one point increase on the mass media scale there was a 15.249 time increment in the odds that the respondent would adopt the technology. On the other hand, odds ratio of land renting effect is smallest of all, with the opposite direction, indicating that with a one point increase on the experience of land renting scale being associated with the odds of disapproving (non adoption) the technology would increase by a multiplicative factor of 0.249 point. For the gender (dummy variable), the 6.317 odds ratio means that the odds (probability) of approval of the technology adoption would increase by this point as binary dummy changed to one point.

Furthermore, as shown in Table 27, among the rest of the explanatory variables included in the model, seven explanatory variables (education level, source of information, distance of the development centre, land size, farmers experience in conservation related projects, livestock holding and farmer training) have the different unique contribution of odds ratios to the expanded model that vary between greater than one and less than two, indicating positive association between predictors and technology adoption. However, some three explanatory variables such as age of the respondent, labour shortage to carryout agriculture and related activities, an experience of land renting influence the odd ratio of technology adoption by less than one factors, indicating negative association between explanatory variables and binary technology adoption.

In general, eleven explanatory variables (about 92 percent) except distance of development centre from the farmland of the respondent, provided similar association as predicted (hypothesized) in the model specification section of this paper. The observed result of the distance of development centre from farmland is in opposite direction to hypothetical proposal which suggested as negative association with technology adoption. The proposed reason for this outcome is that in most cases in this particular district, soil and water conservation activities largely carried out by SWC related project rather than regular extension program or extension package program, which usually the implementation procedures depend on the nature and distribution of soil degradation.

On the other hand, the significance of included explanatory variables was determined using formal statistical procedures employed anywhere to determine the effect of variables and out of selected twelve explanatory variables 50 percent were found significant at different probability levels. In this regard, the age of respondents was statistically significant at one percent among variables included. Two explanatory predictors (gender and distance of development centre) were found to be statistically significant at five percent and the remaining three explanatory predictors (education, mass media and land renting) also found statistically significant at 10 percent among variables attained significance at different statistical significance levels (see Table 27). The model result confirm that the educated farmers are more likely to adopt physical soil bund conservation structure compared to those who did not attain formal education due to the fact that educated farmers would have more access to information and this indicate that farmers with formal education being likely to be

aware of soil degradation severity which enhance them to seek for appropriate innovation in order to mitigate the problem.

Concerning effect of education, this result is similar with other findings; for example, Mulugeta (2000) and Haji (2002) which were conducted in Ethiopia on soil conservation and cross breed dairy cows (CBDCs) adoption, respectively. As one can realize from Table 27, the effect of remaining category of predictors that included in the model remain non significant in proposed regression model, however, it is obvious that there is important association between those independent variables and the outcomes as indicated by parameter estimates which in actual sense statistically non significant.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The primary objective of this study was to determine the adoption and sustainability of soil conservation practices with emphasis on physical soil bund structure. Furthermore, in the process, the study enabled to generate a wide range of data on various aspects of soil conservation practices, which assist to suggest relevant technical, institutions and policy related conclusion and recommendations. Thus, based on survey results, below conclusions and recommendations are made with intention to back up the process of sustainable socio-economic development of the rural community.

5.2 Conclusion

Given the crucial condition of natural resources degradation, this study was concentrated on investigation of adoption and sustainability of soil conservation practices in the small-scale farming system. According to the findings of the study, household's decision to adopt soil conservation technologies greatly affected by ranges of factors and these helped the researcher to suggest the following conclusions.

(a) The study revealed that almost all predicted socio-economic factors appeared to have influence on adoption decision of farmers to use soil conservation technologies. In this regard, participation of farmers in conservation program and adoption of introduced technologies are predominantly influenced by economic variables such as land size, livestock holdings and yearly income of the households, and institutional factors which mostly concerned with credit and extension service provision. As confirmed from the findings of the study, farmers with more resources are more likely to participate in the program and then adopt the introduced technologies than resources poor farmers. Furthermore, logistic regression technique was employed to determine the effect of selected predictors and the result of this technique have shown that among included variables, education level, age, gender, experience of land renting, distance of development centre (DC) from the farmlands and accessibility of mass media to farmers appeared to have significant influence on physical soil bund structure adoption and sustainability.

(b) The survey result indicated that about 95 percent of respondent perceived soil erosion problem as the major threat to their farmland and nearly 92 percent of respondents' reported that their farm lands are suffering very severe and sever problem in soil fertility declining. In this relation 98 percent of the respondent confirmed that the problem is very serious on cropping land than other land use systems. However, in this study, a comparison was made between rates of adoption of soil conservation practices with other agricultural technologies. The results showed that adoption rate of other disciplines (crops and livestock) technologies are by far better than adoption rate of SWC practices indicating that poor attention and promotion of SWC technologies.

(c) The study has further revealed that participation of farmers in development project process as poor which is contrary to stated principles of PADETES. In reality, most of the approaches were lacking the elements of participatory and it was not encouraging the farmer's active participation in development project process. In this aspect, out of total respondent, only about 47 percent of respondents appreciated farmers participation in development project process while the remaining 53 percent of farmers reported their participation as poor in the past implementation years. Though the number of farmers involving in the extension program is growing over the last few years, the real farmers' participation in project planning and evaluation was found to be very limited.

(d) The formulation of appropriate technological package with optimum assembling of potential resources is crucial to attain the intended development program objectives under any circumstances. However, this study indicated

that the past extension program and project approaches were lacking inputs of appropriate packaging of the technologies. The problem of technology packaging appeared very worst especially in the field of natural resources management and conservation. Basically, practices such as crops rotation, intercropping, fallowing, conservation tillage and crop residue management are essential components of soil conservation package to enhance restoration of soil fertility of farmlands, however, adoption rate and sustainability of those practice was found to be minimal compared with the adoption rate of soil bund structure which is the clear indication of poor packaging system. Further more, there were no clear evidences to suggest that the packages are being refined to fit into the various agro-ecological zones of the country and biodiversity.

(e) The findings of the study show that participation of the farmers in extension package programs has improved the use of agricultural technologies among the farming community. However, integration of agricultural technologies with environmentally sound technologies and managements is far less than the theoretical recommendations which leading to natural resources degradation and becoming threats to environmental sustainability.

(f) The crucial limitation of natural resources management innovations were found to be main constraints of soil conservation practices. In relation to this point, majority of respondents (nearly 53 percent) were found unsatisfied with existing natural resource management innovations as all of them are not integrated with local practices and promotion of indigenous knowledge and developing of new innovation for the past years were very limited which in real

judgment enforcing the farmers to depend on introduced external innovation that may not compatible to local conditions.

(g) On the other hand, poor attention for soil conservation technology promotion at different level was confirmed by majority of respondent farmers (90 percent) and extension field staff. In this regard, due to poor attention in extension service delivery system in the past extension package and soil conservation related projects implementation; almost all SWC practices were neglected and marginalized through out past many years leading to non sustainable agricultural land productivity.

(h) Overall, in the study process, it has realized that an existing land use right policy of the country was found to be far from satisfying the interest of the farmers and it is not with positive direction to encourage soil conservation technology adoption and sustainability. In addition, the study clear out that lack of clear extension and land use policy including institutional instability in the government and farmers' structures are negatively affecting the efforts to mitigate the natural resource degradation processes in general and farmland degradation in particular.

5.3 Recommendations

The results from this study indicated that Ethiopian farmers are skeptical to the adoption of soil conservation practices resulting from lack of appropriate technical and institutional support to the farmers including inadequacy of the right policy direction. Hence, based on the survey findings, the following policy, technical and

institutional related recommendations are made to influence technology adoption and sustainability.

(a) The evidence from this study suggests that much policy related issues need to be considered to promote economically and environmentally sustainable development approaches. Specifically, according to this study and other empirical study results, land ownership and extension system policy of the country need redesigning to attain intended development goals. In this regard, there should be well designed locally fitted rural extension and land ownership policy using integrated grass root opinion to foster sustainable rural development approaches.

(b) It was realized that among many factors, natural resource degradation is the immediate effect of miss-utilization of land resources. In this regard, environmentally sound and effective natural resources use and management policy can influence the attitude of society to conserve the natural resources. Therefore, it is recommended that land use and management policy should be in place to supplement technical and local efforts, that addressing the natural resources degradation problem.

(c) The process of land degradation is the results of erosive agriculture which resulted from high population pressure. Therefore, appropriate population policy should be established and promoted with immediate effect to regulate fast growing population which is the major threat to natural resources sustainability.

(d) The effectiveness and efficiency of rural development strategies in general and agricultural extension systems in particular is a function of appropriate technical recommendations and technologies. However, this study reveals many technical limitations, such as lack of technologies, poor packaging of the technologies and practices, lack of appropriate integrations and insufficiency in promoting indigenous knowledge are major area of concern for farmers to attain sustainable rural transformation. Therefore, redesigning of research and extension approaches in the way that the system can accommodate the interest and the indigenous knowledge of farming community have paramount importance to attain optimum sustainability of approaches and technologies in the farming system.

(e) The evidence from this case study showed that the poor linkage among potential stakeholder is a crucial setback during program implementation and technology promotion. Hence, to improve the linkage between stakeholders, there should be technical forum and established system which can sustain the efficient relationship and communication among the potential stakeholders in order to facilitate resolution of conflicting development interests.

(f) An institutional stability and capacity are critical components of development systems to attain optimum efficiency and effectiveness. In this aspect, the result of the study suggested that there were low institutional capacity and frequent restructuring of the respective farmer's and government institutions. Thus, the system should not be subjected to frequent change and due attention should be given prior to implementation during design and proposal of institutional

structures to avoid frequent change of the institutional service delivery systems and technology promotion approaches.

(g) According to the study results, the role of farmer's organization and indigenous institutions were found to be neglected. Therefore, policy makers and technical staff should pay particular attention in integrating indigenous institutions in development process, which can harmonize indigenous location specific knowledge and improved technical recommendations which ultimately enhance technology adoption and sustainability in the farming system.

(h) It was realized from the findings of the study that the involvement of extension field staff (DAs) in non-extension education related responsibilities are adversely affecting the credibility and smooth relation of the extension workers with target community. Therefore, it is worth to recommend that the field extension agents should not be given such responsibilities which ultimately affect their efficiency and effectiveness in implementing their core responsibility.

REFERENCES

Alemayehu, M. (1996). Traditional ditches in northern shewa, the Ethiopian highlands. In: *Sustaining the soil: Indigenous soil and water conservation in Africa.* (Edited by *Reij, C., Scoones, I. and Toulmin, C.*), Earthscan publications Ltd, London, UK. pp. 12 - 54.

Barbier, E. B. (2003). The economics of soil erosion: Theory, methodology and examples. [http://www.eepsea.org/publications] site visited on 08/01/2006.

Befekadu, D. and Berhanu, N. (Eds.) (2000). *Annual Report on the Ethiopian Economy,* Vol. I. Ethiopian Economic Association (EEA), Rehobot printers, Addis Ababa, Ethiopia. 436pp**.**

Belay, K. (2003). Agricultural Extension in Ethiopia: The Case of Participatory Demonstration and Training Extension System (PADETES). *Journal of social development in Africa* 18(1): 49 - 83. [http://www. Extenza eps, Com/ goog] site visited on 26/06/2005.

Bohrnstedt, G.W. and Knoke, D. (1994). *Statistics for Social Data Analysis*. 3rd Edition. Peacock publisher. Inc. Illinois F.E, USA. 574pp.

CATAD (1988). *The sustainability of the impact of the integrated rural development programme (IRDP) in northern west Zambia*. Technical University of Berlin, Berlin, Germany. 68pp**.**

Central Agricultural Census Commission (CACC) (2003a). Statistical report on socio-economic characteristics of population in agricultural households of Oromia Regional State. Part I. Central statistical agency, Printed in CSA, Addis Ababa, Ethiopia. 340pp.

Central Agricultural Census Commission (CACC) (2003b). Statistical report on Land use of Oromia Regional State. Part II. Central statistical agency, Printed in CSA, Addis Ababa, Ethiopia. 320pp.

CIMMYT (1993). *The Adoption of Agricultural Technology. A Guide for survey design*. CIMMYT, Mexico. 88pp.

Clare, B., Joseph, K., Wilfred, M., Marietha, O. and Fatima, R. (2004). Conservation agriculture as a labour saving practice for vulnerable households: Suitability of Reduced and Cover Crops (RTCC) for Households Under Labour Stress in Bobati and Karatu Districts, Northern Tanzania. Working document of the International Fund for Agricultural Development and Food and Agricultural Organization. IFAD and FAO, Rome, Italy. 73pp.

Clearfield, F. (1986). Sociological aspects of the adoption of conservation practices. [http:// www. Ssi.nrcs.usda.gov/ publication] site *v*isited on 14/10/2005.

CSA (2006). Annual crop production sample survey for 2005/06: Preliminary report on area and crop production forecast for major crops. Statistical bulletin 351. Central statistical agency, printed in CSA, Addis Ababa, Ethiopia. 45pp.

CSA (2006). Livestock statistical bulletin 331, 2006. Central statistical agency, printed in CSA, Addis Ababa, Ethiopia. 38pp.

CSA (2006). Statistical abstract for 2006. Central statistical agency, printed in CSA, Addis Ababa, Ethiopia. 345pp.

CSA (2005). Statistical abstract for 2005. Central statistical agency, printed in CSA Addis Ababa, Ethiopia. 242pp.

Dejene, A. (1990). Peasant, environments, resettlement. In: *Ethiopia: options for rural development.* (Edited by *Pausewang, S, Cheru, F. Brune.S. and Chole, E*), Zed Books Ltd, London and New Jersey. pp. 213 - 236.

Dregne, H.E. (1982). Historical perspective of accelerated erosion and effects on world civilization. In: *proceedings of a symposium sponsored by the soil science society of America.* (Edited by Schmidt, B.L.), 5 - 6 August 1979, FortCollins, Colombia. 28 - 60pp.

Ervin, C.A. and Ervin, D.E. (1982). Factors affecting the use of soil conservation practices and technologies: Evidence and policy implication. *Journal of Land Economics* 58(3): 277 - 292.

EEA (2006). *Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System (PADETES).* Ethiopian Economic Association (EEA)/Ethiopian Economic policy research institute, Rehobot printers, Addis Ababa, Ethiopia. 270pp.

EEA (2005). *Report on the Ethiopian Economy. Transformation of the Ethiopian Agriculture: Potentials, Constraints and Suggested Intervention Measures.*

Volume IV, *2004/05*. Ethiopian Economic Association (EEA)/Ethiopian Economic Policy Research Institute, Rehobot printers, Addis Ababa, Ethiopia. 460pp.

FAO (1993). *Assessing Forestry Projects: Issues and Strategies for Rural Development*. FAO, Rome, Italy. 119pp.

FAO (1990). The conservation and rehabilitation of African lands: International schemes.[http:// www. Fao.org/docrep/] site visited on 10/11/06.

Feder, G., Just, R.E. And Zilberman, D. (1985). Adoption of the Agricultural Innovations in Developing Countries: *Survey journal of economic development and cultural changes*. 33: 255 - 297.

Federe G., Just, R.E. and Zilberman, D. (1982). Adoption of agricultural innovations in developing countries. S*urvey journal of economic development and cultural changes* 542: 248 - 290.

Gamachu, D. (1990). Environment and mass poverty. In: *Ethiopia: Rural development options.* (Edited by *Pausewang, S, Cheru, F, and Brune.S. Chole, E.),* Zed Books Ltd, London and New Jersey. pp. 175 – 213.

Gujarati, D. N. (1988). *Basic Econometrics.* 2nd edition. Published by McGraw Hill. Inc. New York. USA. 705pp.

Haile, T. (1988). Causes and characteristics of drought in Ethiopia. *Journal of Agricultural Science* 10(2): 85 - 97.

Haji, B. (2002). Adoption of crossbred dairy Cows in Arsi Zone. Dissertation for Award of MSc Degree at Alemaya University, Dire-Dawa, Ethiopia, 103pp.

Howllett, D. and Nagu, J. (1997). *Agricultural development planning in Tanzania*: *A hand book on cycles and sequence, participation, identification, planning and design, economic and financial analysis and environmental assessment of agricultural projects*. Institute of development management, Mzumbe, Tanzania and development and project planning centre, University of Bradford, UK. Printed by Mzumbe Book project. 278pp.

Hurni, H. (1993). Land degradation, famine and land resource scenarios in Ethiopia. In: *World soil erosion and conservation. (*Edited *by Pimentel, D.*), Cambridge university press, Cambridge, UK. pp. 27 - 62.

Hurni, H. (1988). Degradation and conservation of the resources in the Ethiopian highlands. Journal of *Mountain research and development* 8(3): 123 - 144.

ILCA (1990). Livestock research manual. Working paper 1. Vol. I. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. 84pp.

ILO (1990).*The socio-economic impact on technological cooperation projects and programs concerning rural development*. International Labour Office, Geneva, Switzerland. 253pp.

Ishengoma, C. (1992). Prevalence of child malnutrition and factors associated with it: A case study of Morogoro Urban. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 244pp.

John, A.C.S. (1995). Social factors constraining the uptake of technologies in agriculture. Thesis for Award of PhD Degree at the University of New Castle, New Castle, United Kingdom, 340pp**.** [http://www. Newcastle.edu.au] site visited on 20/06/2007.

Jugal, V.B. (1992). *Theories of Agricultural Finance*. Atlantic publishers and distributors, New Delhi, India. 156pp.

Karki, L. B. and Bauer, S. (2004). Technology adoption and household food security; Analyzing the factors determining technology adoption and impact of projects intervention: A case of the smallholder peasants/Farmers in Nepal. [http://www.tropentagde/2004/abstracts/full/107] site visited on 22/10/2005.

Kedir B. (1999). The role of Sasakawa Global 2000 project credit system on the adoption of improved wheat technologies by smallholder farmers in Ethiopia: The case of Hetosa District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 131pp.

Lasley, P. and Michael, N. (1981). Landowner Attitudes Toward Soil and Water Conservation in the Grindstone Lost Muddy Creek Project. *Evaluation for Sustainable Land Management in the Developing World*. 2(12): 49 - 87.

Lovell, C.H. (1992). *Breaking the Cycle of Poverty: The BRAC Strategy*. Kumorian Press. Ince. Bloomsfield, USA. 205pp.

Mattee, A.Z. (1994). Sustainable Agriculture: Its implications for training research and extension at Sokoine University of agriculture. In: *Proceedings of Sokoine University of Agriculture convocation on sustainable agriculture and*

conservation of the environment. (Edited by Hatibu *N, et al.),* 26 - 27 July 1994, Morogoro, Tanzania. 102 - 115pp.

Mattee, A.Z. and Mvena, Z.S.K. (1988). Extension job performance in Tanzania. In: *Proceedings of National workshop on training for effective agricultural extension in Tanzania*. (Edited by Mattee, A.Z, Lupanga, I. J. and Mvena, Z.S.K.), 1– 2 December 1987, Uyole Agricultural Training Centre, Mbeya, Tanzania. 1 - 10pp.

Menard, S. (1995). *Applied Logistic Regression Analysis*: *Quantitative Applications in the Social Science.* 1st edition. Sage University paper series. Thousand Oaks, London and New Delhi. 469pp.

Mlozi, M.R.S. (2005). Efficacy of conventional extension approaches: A case of morogoro District in Tanzania. *Journal of Continuing Education and extension* 2(1): 113 - 127.

Mulugeta, I. (2000). Determinants of Adoption of soil conservation practices in central Highlands of Ethiopi: The case of three weredas of Selale. Dissertation for Award of MSc degree at Alemaya University, Dire-Dawa, Ethiopia, 120pp.

OADB (2003). Oromia regional government, agricultural development bureau strategic planning and management. Oromia Agricultural Development Bureau, Government printer, Finfinne, Ethiopia. 180pp**.**

OPED (2000). Zonal Atlas of East shewa zone. Office of planning and economic development, Government printer, Finfinne, Ethiopia. 120pp.

Pampel Fred J. and Van Es, J.C. (1977). Environmental quality and Issues of adoption Research. *Rural sociology* 42(1): 57 - 71.

Pla, I. S. (2002). Assessment of environmental impacts derived of Soil and Water conservation practices. [http://www.Tucson.ars.ag.gov/isco12/volume3] site visited on 14/10/2005.

Poate, C.D. and Daplyn, P.F. (1993). *Data for agrarian development*. Cambridge University Press, Cambridge, UK. 387pp.

Rao, N.H. and Rogers, p.p. (2006). Assessment of agricultural sustainability. *Current Scienc*e *Journal*: *Indian Academy of Science* 91(4): 439 - 449.

Reid, D. (1995). *Sustainable development*: *An introductory guide*. Earthsean, London, UK. 231pp.

Rogers, E.M. (1995). *Diffusion of Innovations. 4th Edition*. The Free Press, New York, USA. 519pp.

Rogers, E.M. and Floyd F.S. (1971). *Communication of Innovation: A cross cultural change approach.* 2nd Edition. The Free Press, New York, USA. 476pp.

Rutatora, D.F. and Rutachokozibwa, V. (1995). The future of agricultural education and extension in Tanzania: Issue to be re-examined by the extension service in the year 2000 and beyond. In: *proceeding of a National conference on the future of agricultural Education and Extension.* (Edited by Lugeye, S.C. and. Ishuza I.L), 27 - 29 November 1995, Dodoma, Tanzania. 86 – 95pp.

Stephenson, G. (2003). The Somewhat Flawed Theoretical Foundation of the Extension Service. Oregon State University. *Journal of Extension* 41(4). [http://www.joe.org.google.com] site visited on 27/06/05.

Sebsibe, T. (1999). Factors influencing adoption of improved maize production technologies and practices in the National Extension Intervention programme in Awassa District, Ethiopia. Dissertation for Award of MSc degree at Sokoine University of Agriculture, Morogoro,Tanzania, 133pp.

Tesfaye B. (2003). Understanding farmers: Explaining Soil and Water Conservation in Konso, Wolaita and Wello, in Ethiopia. Thesis for Award of PhD Degree at Wageningen University and Research Center, The Netherlands.245pp.

TFAE (1994). A Study on the Ethiopian Agricultural Extension Systems (Amharic version), Ministry of Agriculture (MOA), government printer, Addis Ababa, Ethiopia. 77pp.

Tsigedingil, M. M. (2002). Potential and Limitation of smallholder seed production in Ethiopia. The case of Soro District. Dissertation for Award of MSc at Sokoine University of Agriculture, Morogoro, Tanzania, 138pp.

USAID (1999). Sustainability in rural development projects: Targeting poor farmers for Contribution to rural development in Thailand. [http://akwa.ausaid gov.au/] site visited on 28/06/2005.

Wagayehu, B. (2003). Economics of Soil and Water Conservation: Theory and Empirical Application to Subsistence Farming in the Eastern Ethiopian Highlands. [http://www.diss.epsiton. slv.se/] site visited on 10/10/2005.

Wegayehu, G. (2006). Determinants of farmer's decision on Soil and Water conservation practices in Dire-Dawa Administration. Dissertation for Award of MSc degree at Haromaya University, Dire-Dawa, Ethiopia, 135pp.

Weir, S. and Knight, J. (2000). Adoption and diffusion of innovation in Ethiopia: The role of Education. [http://www. csae. ox. ac.uk] site visited on 4/07/2005.

Workneh, A. and Rowlands, J. (Eds) (2004). *Design, execution and analysis of the livestock breed survey in Oromia regional state, Ethiopia*. OADB (Oromia Agricultural Development Bureau), Addis Ababa, Ethiopia and ILRI (International Livestock Research Institute), Nairobi, Kenya. 260pp.

World Bank (1999). Agriculture and Rural Development. [http://www.worldbank. org/htm] site visited on 24/04/2007.

Yisehak, B. B. (2002). Factors influencing transfer and utilization of selected agricultural technologies in Ethiopia: A case study of Bolosso Sore District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 120pp.

APPENDICES

Appendix 1: The summary for means difference of continuous variables

Predictors/Variables	Mean			T-test	
	Non adopters	Adopters	Mean difference	T-value	P-Value
Farmers experience in SWC related projects (Years).	11.45	13.21	1.76	1.014	0.313(NS)
Distance of DC from farmers farmland (Km).	1.55	2.58	1.03	2.841	0.007***
Contact of DA with farmer Within month (days).	2.81	3.52	0.71	1.149	0.706(NS)
Distance of farm land from primary road (KM).	2.32	3.57	1.25	1.300	0.196(NS)

Appendix 2: **Summary of categorical variables in respect to SWC adoption**.

Categorical variables		Observed proportion (%)		Chi-square	
		N/adopter*	Adopter	X^2-Value	P-Value
Education level					
No formal education		10.8	22.5	0.661	0.416(NS)
Formal education		6.7	60		
Labour shortage	Yes	6.8	42.4	22.279	0.000***
	No	11	39.8		
Off-far. occupation.	Yes	2.5	18.3	6.773	0.009***
	No	15	64.2		
Land renting	Yes	4.2	27.5	12.388	0.002***
	No	13.3	55		
Access to trainings.	Yes	10.1	44.5	47.860	0.000***
	No	6.7	38.7		

* N/adopter represent the non adopter, Off-far. Refers to off-farm

Appendix 3: Conversion factors applied to Estimate Tropical Livestock Unit (TLU)

Categories of livestock	Types of livestock	Livestock's TLU estimation factor	
		Live weight(Kg)	Equivalent TLU
Cattle	• Cows and oxen	250	1.00
	• Heifer	125	0.50
	• Calves	50	0.20
S/ruminant*	• sheep and goat	25	0.10
Equines	• Donkey	90	0.50
	• Horses/Mule	200	0.80
	• Camel	175	1.00

Source: ILCA (1990) * S/ruminant, represent Small ruminant

Appendix 4: Multi-collinearity diagnosis for non categorical variables

Continuous Variables	Collinearity Statistics	
	Tolerance	VIF
Age of respondent (years)	0.730	1.370
Education level HH head	0.628	1.593
Family size of Household	0.917	1.091
land size or land holding (ha)	0.805	1.242
Total livestock holding(TLU)	0.726	1.378
Yearly income of HH*	0.745	1.342
Farmers experience in SWC projects	0.876	1.142
Distance of DC from HH (KM).	0.901	1.110

* HH represent house hold.

Appendix 5: Farmer's interview schedule for primary data collection.

A) Introduction: Dear respondents, you have been chosen among the farmers participating in soil and water conservation extension package programs and/or any other related conservation projects to provide us with the information related to the Soil conservation practices in your village. The information obtained will be used only for research and academic purposes. All information will be confidential and no information will be related to any particular personality of any body.

B) General Instruction for enumerators:-

1. Make sure that respondent understand question before attempt to give any information and answers according to the questions.
2. Complete this questionnaire with maximum care and responsibility.
3. For the provided boxes for single concept, write 'X' in the correct box.
4. For the question summarized in the table, use the respective information provided.
5. In the case of additional comments and suggestions, use separate paper and attach to this questionnaire.

1. Respondent's characteristics and related information.

1. Respondent's residence and identification.
   (1) District (Woreda): **Adama** (2) Zone: **East Shoa** (3) Region: **Oromia**
   (4) Respondent's code: _____ (5) PA: _____
2. Age of the respondent at the survey period (in year)._____years.
3. What is the sex of the respondent: - (1) Female □ (2) Male □
4. Martial status of the respondent at the survey period.
   (1). Married □ (3). Divorced □
   (2). Single (Unmarried) □ (4). Widowed □
5. Educational condition or level of the respondent.
   (1) No formal education □
   (2) Adult education (reading and writing) (_____years)
   (3). Primary school (Grade1-6) (_____Grade)

(4). Junior secondary (Grade 7- 8) (_____Grade)

(5). Secondary school (Grade 9_12) (_____Grade)

6. What is the Ethnicity (ethnic group) of the respondent?_____.

7. What is the current religious group of the respondent? _____

8. What is the main occupation of the head of household? (One response only)

(1) Crop farming □ (2) Livestock farming □ (3) Mixed farming □

9. Do you have public responsibility (position) in your PA or community?

(1) Yes □ (2) No □

2. Demographic characteristics and economic condition of the respondent.

2.1. Demographic characteristics and labor source of the respondent.

10. What is your family size including your self. (1)Male:__(2)Female:__(3) Total__

11. Based on the family size mentioned in question.10, complete the following table.

(Please write the correct number corresponding to each below category).

No	Family Age category	Male	Female	Total
1	Below 10 years			
2	11-20 years			
3	21-40 years			
4	41-60 years			
5	Above 6o years			

12. Which is the main source of labor for your farm and farm related activities?

(1) Internal (Family) labor □ (2) External local labor □

(3) External immigrant labor □

13. Based on your past 2-3 years experience, did you face labor shortage to conduct your farm and farm related activities? (1) Yes □ (1) No □

14. If the response is yes in No.13, please indicate the season of labor shortage including the practices.

(1)During on-season for crop production □ (2).For animal husbandry □

(3) .During on-season for SWC □ (4) during off-season for SWC □

15. If you have labor shortage, for which activities do you have problem of labor. (Consider only one in which you have serious problem).(1) Crops production □

(2) Livestock management □ (3) Soil conservation practices □

16. Do you have other occupation, outside the farming activities?

(1)Yes □ (2) No □

17. If yes in question.16, in which season do you involve in this additional occupation. (1) During on-season □ (2) during off-season □

(3) Whole year round □

18. If no in No.16, which of the activities do you conduct during off- season (dry season when no more crop farm activities). (1) Soil and water conservation □

(2) Livestock management □ (3) No any work to carry out □

2.2 The Economic aspect of the respondent's household.

2.2.1 Land ownership and utilization.

19. Do you have enough land for your current household (family) use?

(1)Yes □ (2) No □

20. How many hectare of land do you have currently for your household? _____ha.

21. Based on the response in number '20' indicate the utilization (use plan) of land owned by your house hold (write in hectare in the provided space).

(A) Seasonal crops: _____ha (d) Woodlots land: _____ha

(b) Perennial crops: _____ha (e) Closed land: _____ha

(c) Grazing land: _____ha (f) Homestead land: _____ha

22. For which activities do you use land under seasonal crops during off-season (dry seasons)? (1). for grazing □ (2). Implement SWC activities □

(3) No use at all during dry seasons. (4) Others (specify) _____

23. Do you have experiences of renting out your farmland to other people?

(1) Yes (2). No:

24. If yes in Q.23, for how long do you rent out your land to other people in the past 2-3 years? (1) Seasonal (one year only) (2) More than a season

25. What are the main reasons that enforce you for renting out your land?

(1) Excess land (2) Labor shortage (3) Financial limitation

2.2.2 Livestock ownership and feeding habit.

26. Please, indicate the number of livestock owned by your household in the table.

No	Category of livestock	Local	Improved bred	Total
1	Cattle			
2	Goat and sheep			
3	Equine			

27. What do you think the effect of livestock population on soil conservation practices? (1)Negatively affect practices (2)Positively affect practices

(3) No effect

28. What is your feeling to ward improved bred of livestock to regulate livestock population to carrying capacity of your grazing land?

(1) Positive (2) Negative

29. Are you adopting improved bred to limit the number of livestock population to carrying capacity of your grazing land? (1) Yes (2) No

30. In general, how do you feed your animals (grazing habit) during the past years?

(1) Open (free) grazing (2) Stall feeding (Zero grazing)

31. If the response is open grazing in No.30, which field do you use for grazing (put 'X' where it is appropriate in the provide column)?

No	Conditions	Category of grazing lands		
		Private land	Communal land	released crop land
1	During on season			
2	During off-season			

Note: - More than one response is possible.

32. How do you evaluate open grazing in relation to SWC practices implementation?

(1) Negatively affect the practices □ (2) No effect or influence □

(3) Positively affect the practices □

2.2.3 Information on income and source of income of the households.

33. Please indicate your sources and amount of income in the following table using average in come of past two to three years based on the below sources.

No	Categories of sources	Unit	yearly income	Remark
1	Crop products sale	Birr		
2	Livestock sale	Birr		
3	Livestock products sale	Birr		
4	Other sources	Birr		
5	Total	Birr		

3. General information and farmer's perception on natural resources.

34. How do you perceive the nature of land/soil as the natural capital resource?

(1) Non renewable □ (2) Fast renewable □ (3) Slow renewable □

35. The land (soil) is the renewable natural capital, if the rate of degradation is less than regeneration potential, do you agree? (1) Agree □ (2) Disagree □

36. What is the current trend of natural vegetation coverage in your locality or village? (1) Increasing □ (2) Decreasing □

37. If decreasing in Q.36, What is the main reason for the removal of vegetation coverage in your locality or village? (Put ‘X’).

No	Reasons for vegetation removal	Rank of the reasons (causes)			
		1st	2nd	3rd	4th
1	Farm land expansion				
2	Fuel and construction				
3	Income generating (selling)				
4	Animal grazing				

38. What is the current trend of soil fertility or productivity in your locality and on your farmland? (1) Increasing (2) Reducing (3) Constant

39. If the productivity of the soil is increasing in the current situation, what is the reason? (1) Due to external inputs (2) Due to appropriate soil management

(3) Due to potential Soil fertility (4) others (specify): _____

40. What is the current trend of the soil erosion in the community and on your farm land? (1) Increasing (2) Reducing (3) Constant

41. If the soil erosion is increasing, what is the main cause that aggravating the process? (1) Land degradation (3) Loss of Natural vegetation

42. If the response is either of the above in question41, which farm practice is most aggravating the degradation process? (1) Farm land expansion

(2) Open grazing (3) Others (specify) _____

43. What kind of soil related problem did you recognize during last years on your household land? Please, indicate using the below mentioned information.

No	Soil related Problems	year problem recognized	Status of the problem		
			very severe(1)	Severe(2)	Minor (3)
1	Soil erosion process				
2	Water logging				
3	Soil fertility decline				
4	Low water holding				

Note: Use the codes or numbers representing each statement of the problem.

44. Which of your land is more affected by the above mentioned soil related problems. (1) Seasonal crop land □ (2) Perennial Crop land □ (3).Grazing land □

45. What proportion of your household land is exposed to the mentioned soil related problems? (please, make genuine estimation in hectare or Percent).___ha or__%.

46. What kind of measures has been taken to tackle the mentioned soil related problems? (1) Applying SWC practices □ (2) No measure taken at all □

47. Are there traditional (Indigenous) practices for soil and water conservation purpose? (1) Yes □ (2) No □

48. If yes in No.47, indicate their efficiency comparing with modern SWC practices. (1). Very efficient □ (2) efficient □ (3) Less efficient □

49. If yes in No 47, which one is your preference? (1) Traditional □ (2) Modern □

50. If your response is 2 (modern) in No 49, what is the main reason for your preference? (1) Both efficient and effective □ (2) Low cost □ (3) It has assistance □

51. Do you have experience of tree planting in the past years? (1) Yes □ (2) No □

52. If yes, currently, how many tree seedlings are you planting per year and estimate survival rate. (1) Planting____ Seedlings/year (2) Survival____ Seedlings/years

53. What is your future plan of tree seedling planting when compared with current amount? (1) To increase□ (2) To reduce □ (3) remain the same □

54. If your plan is to reduce the amount of seedling planting in the coming years, what is the main reason for such decision? (1) Lack of land □ (2) Lack of seedlings □ (3) Lack of information □ (4) Satisfied □

55. For what purpose are you using crops residue (straw or stalk) and estimate proportion according to the below statements in the table.

No	Description of the purpose	Appropriate use	Proportion (%)	Rank
1	Animal feeding in the field			
2	Animal feeding outside the field			
3	Construction(House thatching)			
4	Selling (additional income)			
5	Farm manure (Soil manag't)			

Note: - Put 'X' for appropriate and 'N' for not appropriate.

56. For what purpose are you using Animal manure, if you have it from any of your animals? (1) Farm manure (2) Fuel (Sell) (3) No any use (disposable)

4. Information on adoption and sustainability of soil conservation practices.

4.1. Adoption aspect of soil conservation practices.

57. Were you aware of different modern soil and water conservation practices in the past years? (1) Yes, I was aware 2). No, I was not aware

58. If you aware of modern SWC practices, were you in favor (interest full to use) of it to alleviate soil degradation process on farmland? (1) Yes (2) Not yet

59. If you are aware of some practices, please, indicate in the table corresponding to which you have awareness and year in which the practices introduced to you (use 'X'for aware and 'N 'for which the respondent is not aware of it)

No	Types of SWC practices	Awareness	When introduced to respondent(years)	Status of awareness
1	Soil bund			
2	Crop rotation			
3	Intercropping			
4	Fallowing			
5	Contour farming			
6	Area closure			
7	Reforestation			
8	Crop résidu management			
9	Conservation tillage			

Note: For status of awareness, excellent (1), very good (2), good (3) and poor (4)

60. Which are the most important sources of information for you to become aware of SWC practices? (1). Extension staff □ (2). NGOs staff □

(3). Neighbor or fellow farmers □ (4) Others (specify)_____

61. Which program/project is most important to help you become aware of the available SWC practices? (1). Regular extension program□ (2).NGO: □

(3).Extension package program □ (4).Gov't SWC related projects: □

62. In your opinion, are there appropriate SWC practices to implement during on season? (1) Yes □ (2) No □

63. In your opinion, do available SWC practices are appropriate to implement during Off-season? (1) Yes: □ (2) No: □

64. Have you ever tried at small scale level to test introduced soil conservation practices for trial on your household land? (1).Yes: □ (2) No: □

65. Have you ever decided in the past years to use at large farm level soil conservation practices to tackle soil degradation on your household land?

(1) Yes: □ (2). No: □

66. If response to Q.65 is yes, please, show which of the practices you decided to use them and time of your decision toward technology utilization. (Use the corresponding numbers to indicate its appropriateness).

No	Types of practices	Decision made -To use (1) -Not to use (0)	Year Decision Made by respondent	On which land (5)
1	Soil bund			
2	Crop rotation			
3	Intercropping			
4	Conservation tillage			
5	Reforestation			
6	Crop residue manag't			

7	Contour farming			
8	Area closure			
9	Fallowing			

Note: Use in Column 5, crop land (1), Grazing land (2), and closed land (3).

67. If you have decided to use some of SWC practices mentioned above (table 66), what is the main reason that helps you for such decision to use it on your household land? (1) Improve soil fertility (productivity)□ (2) Reduce observed soil problems:□ (3). others (specify)._____

68. If you did not decide to use some of the SWC practices mentioned above, what are the main reasons help you to reach decision to reject those practices?(refer to number 65 in the table). (1) No enough information:□ (2). costly to use it: □ (3). Not efficient to solve problems: □ (4). Not suitable to our condition:□

4.2. Sustainability aspect of soil conservation practices.

69. For how long were you involved in the SWC program /projects? ____to ___year.

70. After you graduated from the SWC programs (projects), do you still continue using the introduced conservation practices? (1) Yes: □ (2) No: □

71. Currently, after the withdrawal of external support, are you using (continue using) SWC practices that were introduced by extension programs/ related projects?

(1) Yes:□ (2) No: □

72. In your opinion, did you achieve the intended benefits from the practices you decided

to use it and continued to implement at large farm level?

(1) Yes: □ (2) No: □

73. If yes in No.72, are those benefits similar or equal to what you expected from the practices at the beginning of the program? (1) Yes: □ (2) No**:** □

74. If you adopted some of the technologies mentioned above (Table 66), please indicate its present situation and your future plan whether to continue using or to reject it for some reasons.

No	Category of SWC practices	Year of Adoption (03)	Sustainability of practices		Current Benefits -Positive(1) -Negative(2)
			Current situation (04)	Future plan(05)	
1	Soil bund				
2	Crop rotation				
3	Intercropping				
4	Conservation tillage				
5	Reforestation				
6	Crop residue manag't				
7	Contour farming				
9	Area closure				

Note: - Code (04). Continued or sustained use (1) and rejected/not using (2).

-Code (05). Will continue to use it (1) and will not continue to use it (2)

75. If you rejected some of the practices mentioned in table 74, would you outline some major reasons for rejecting those practices after your decision to adopt the practices? (1) No enough information: (2). Not efficient to solve problems:

(3). Not suitable to our condition (4). Costly to implement:

76. If you will not continue using some of conservation practices (table 74), what would be the main reason (what are the constraints) for such decision to reject the technology(s)? (1) No enough information: (2) Costly to implement:

(3) Not efficient to solve problems: (3) Not suitable to our condition

77. How do you evaluate the existing land use right policy of the country in relation to SWC practices adoption? (1) Positively affect it (2) Negatively affect it

78. If the policy negatively affects the adoption, do you think land ownership right (rather than use right) would favor the adoption and sustainability of SWC technologies? (1) Yes (2) No

79. Which of the following landownership options do you support in relation to technology adoption? (1) Full Farmer's ownership:□(2) Full Gov't ownership □

5. Institutional support and public service facilities.

5.1. Extension services provision and related information

80. Is there development center (DC) in your village. (1). Yes: □ (2). No: □

81. If there is development center, how long since its establishment.____ years.

82. If there is a development center located in your village, is there development agent that responsible to provide extension services? (1) Yes: □ (2) No: □

83. Have you ever received any advice related to SWC practices from DAs during last3-4 years? (1) Yes □ (2) No □

84. If yes in question 83, currently, on average how many time you made extension agent contact or visited by agent per month. _____days/Month.

85. When you compare last three (and before) years, how do you evaluate the trend of current extension contact? (1) Increased:□ (2) Decreased: □

(3) Remain the same: □

86. How do you evaluate the DA's attention for SWC practices during visiting your home or farmland? (1) Good □ (2) Satisfactory □ (3) Poor □

87. In your opinion, how do you evaluate extension services delivery and indicate your opinions which correspond to the statement in the below table.

Description or statement to be evaluated	Agree	Disagree
Attention for SWC practices is satisfactory compared with other discipline in extension delivery system		
Promotion of SWC practices is efficient and effective compared with other discipline in extension delivery system		
Promotion of SWC is more satisfactory compared with		

other discipline in extension service delivery system		
Promotion of SWC is equally satisfactory With other disciplines in extension service delivery system		
Promotion of SWC is less satisfactory compared with other disciplines in extension service delivery system		

Note: Other disciplines in this case are mainly crops and Animal husbandry.

88. When you compare current soil conservation extension service with last years situation (in term of attention), what is your opinion concerning its trend in extension service delivery system? (1) Increased: □ (2) Decreased: □
(3). Remain the same: □

89. Have you ever attended any extension training during last three years (1-3 years)?
(1) Yes: □ (2) No**:** □

90. If yes in No.89, how many times did you attend extension training? _____times.

91. If yes in No. 89, how was the contribution of training in assisting you in adoption of SWC practices? (1) Good □ (2) Satisfactory □ (3) poor □

92. Are you satisfied with the current SWC services to assist you to reduce soil degradation problems on your household land? (1) Yes: □ (2) No: □

93. In your opinion, how do you evaluate farmer's participation in soil and water conservation related program/project development and implementation process?

No	Categories of program or Project's process	Level of Farmer's participation				
		V/ good (01)	Good (02)	Satisfactory (03)	Poor (04)	No at all (05)
1	Problem identification					
2	Technology selection					
3	Priority setting					
4	Decision making					
5	Planning and evaluation					

Note: Use 'X' or respective numbers in the column.

5.2. The public services infrastructure facility and availability.

94. Is there road facility in your village (locality). (1) Yes □ (2) No □

95. On average, how far is your home and farm land from the below facilities.

No	Major public facilities	Distance in Km.	
		Farm land	Home
1	Major (national) road distance		
2	Village primary road distance		
3	Distance from village office		
4	Distance from Development centre (DC)		

5.3. Credit facility and availability for the respondent's household.

96. In the past 2-3 years, is there credit facility that assists your financial capacity to carry out farm and other related activities on your household land?

(1) Yes: (2) No:

97. If yes in No.96, for which type of activities credit was mostly available in the past years._____

98. On average, how much money you are receiving in loan form? ____ money/year

99. Was credit facility available to you for SWC Technology promotion in the past years? (1). Yes, it was available (2) No it was not available

100. In your opinion, is credit important for soil and water conservation practices in your village and for your household? (1)Yes (2) No:

5.4. Communication media facility and comments on technology adoption.

101. In the past 3-5 years of your experiences, do you have access to any kind of mass media? (1) Yes: (2) No:

102. If yes in No 101, which mass media was more accessible to you? _____

103. In your opinion, did these mass media help you in learning about SWC practices and adoption of the available technology(s)? (1) Yes: (2) No:

104. What are your comments for poor adoption and sustainability of SWC practices_____

105. What are your comments and recommendations to improve adoption and sustainability of SWC practices in your village? _____

106. What are the constraints that affecting SWC practices in your locality/ village?

107. What would be the solution for the problems mentioned above? _____

108. What are the observed weaknesses of extension services delivery system?_____

_____

Thank you for your contributions!

Appendix 6: **The questionnaire to be completed by Extension field staff.**

Introduction: Dear respondents, you have been chosen among the extension field staff participated in soil and water conservation extension package programs and/or any other related projects to provide us with the information related to the soil conservation practices in your working environment. The information obtained will be used only for research and academic purposes. All information will be confidential and no information will be related to any particular personality of any body, hence, feel free to suggest your ideas and views openly and transparently.

General Instruction for respondent and enumerators:-

1. Make sure that you understand the question before attempting to give any information or answer to the questions and consult the enumerators for any problem that you come across when you are completing the questionnaire.
2. Please, complete this format with maximum care and responsibility.
3. For the provided boxes, for a single concept put ‘X’ in the given correct box.
4. For provided blanks, please write the required information in the provided spaces.

1. Respondent's residence and identification related information

1. Region: Oromia 2. Zone: East Shewa 3. District: Adama

4. Development Centre (PAs):_____

5. Respondent identification number (code):_____

2. Respondent's Characteristics and related information.

1. What is your age (in Years)? ____Years.

2. What is your gender (Sex)? (1). Male: (2).female:

3. What is your current marital status?

(1) Married (coupled): (2) Single (not married):

(3) Divorced: (4) Widowed

4. What is your highest level of education? (Put "X" in correct box).

(1) Secondary school (Grade 9-12): (2) College certificate:

(3) College diploma: (4) others (specify) _____

5. When did you complete your pre-service training? (Ethiopian calendar):_____

6. What is your field of training? (1) Pl. Sc (2) An. Sc

(3) Natural resources (4) Ag. General

7. How do you evaluate pre-service training (especially at college level)?

(1) More crops production oriented: (2) more livestock production oriented

(3) More Natural resources oriented: (4) It addressed all of them equally

8. When were you employed as extension staff? (Ethiopian calendar): _____year.

9. Have you ever attended any in-service training since you have been employed as extension field staff? (1) Yes: (2) No:

10. If yes, how many times did you attend in-service training?_____ times.

11. How do you evaluate the training arrangement in relation to different disciplines?

(1) More crops production oriented: (2) More livestock production oriented:

(3) More Natural resources oriented: (4) It address all of them equally:

3. General information of the development centre.

12. What is the area (size) of your development center in hectares? _____ ha?

13. Please, estimate Land topography of development center in percentage (for DAs).

(1) Steep slope**:**_____% (2) Gentle slope.____% (3) Flat land ___ %

14. Soil condition of the area (villages) in percentages (%).

(1) Sandy _____ % (2) Sandy loam: _____%

(3) Clay_____ % (4) Others_____%

15. What is the vegetation coverage of the development center? _____%

16. Please, indicate its trend (vegetation coverage) for the past 5-10 years in your development center. (1) Increasing (2) Decreasing (3) Constant

17. If the vegetation coverage is decreasing, what are the main causes (rank them).

No	Expected reasons	Ranking of the reasons (causes)			
		1st	2nd	3rd	4th
1	Farm land expansion				
2	Open Grazing habit				
3	Income generating (Wood marketing)				
4	Natural catastrophe				

18**.** In your opinion, how are the soil degradation problems in your working area.

(1) Very serious (2) serious: (3) medium (4) Minor:

19. What is the current trend of soil degradation in your development center?

(1)Increasing (2) Decreasing (3) Remain the same (constant)

20. Is there soil conservation practices in your development center?

(1) Yes (2) No

4. Common Farming system and cropping habits in the locality.

21. Please, estimate the area under different land use categories including past and present situation in your development centre.

No	Land use categories	Average area coverage (ha)	
		Before 5 years	Currently
1	Crops land		
2	Individual grazing land		
3	Communal grazing land		
4	Forest and bush land		
5	Others		

22. What is the current average landholding in your development center? _____ ha.

23. What is the trend of landholding when compared with past 5-10 years situation?

(1) Increasing □ (2) decreasing □ (3) No change □

24. What is the common animal feeding habit of the farmers in your development center? (1) Free range (open grazing) □ (2) Stall feeding (Zero grazing) □

25. If it is open grazing, on which land commonly grazing is conducted or carried out in your Centre?

(1)Individual/private grazing land □ (2) communal grazing land □

26. If there is free range system, what is the current trend of farmers to change this system? (1) Positive to avoid open grazing □

(2) No progress to change open grazing □

27. What is the farmer's perception to limit livestock population to land carrying capacity? (1) Positive □ (2) Negative □

28. What is the farmer's perception to adopt improved bred in order to limit livestock population? (1) Good □ (2) satisfactory □ (3) poor □

29. What is the major use of Animal manure in the locality (estimate proportion)?

(1) Farm manure____% (2) Fuel (selling) ____% (3) No use (disposable) ____%

30. How do you evaluate the livestock population in relation to SWC practices?

(1) Supplementing □ (2) Competing □

31. What is the main use of crop residue in your development center? (Estimate each proportion in respect to stated use of the crop residue in your centre).

No	Description of the purposes	Percent (%)	Rank	Current trend
1	Animal feeding (in the field)			

2	Animal feeding (Outside the field)			
3	Additional income (Selling)			
4	Remain in the field to improve soil			
5	Construction(House thatching)			

***Note*:** For trend use, increasing (1), decreasing (2) and Constant (3)

5. Extension service delivery system and coverage in the development centre.

32. How many villages were under your development center before five years? ____.

33. Currently, how many villages are under your development center?___ Villages.

34. What was the estimated population in your development center before 5-10 years, taking average of population? (1) Male ___(2) Female ___(3) Total_____

35. What is the current population of your development center?

(1) Male: _____ (2) Female: _____ (3) Total: _____

36. What is the trend of population growth in your development center, when you compare with the past 5-10 years?

(1) Too Fast (2) Too Slow (3) Constant

37. Among total population, what is number of farmers in your development center?

(1) Male: _____ (2) Female: _____ (3) Total: _____

38. Among farmer population that found in your development center, how many of them are receiving extension services :(1)male:____(2)Female:___(3)Total: ____

39. Among farmer population, what proportion are you covering in extension service delivery? (1) All (100%): (2) Half only (50%):

(3) Three fourth (75%): (4) below half (<50%):

40. If it is below half (<50%) in question39, what are the problems that hinder you to perform more: (1) Poor facilities: (2) Poor topography of the villages:

(3) Poor infrastructures: (4) Socio-cultural conditions are unfriendly:

41. Among farmers population found in your development center, how many of them are on average involved in extension package program in the past program implementation years. (1) Male _____ (2) Female._____ (3) Total._____

42. Among the farmers participating in package program, on average how many of them were involving in SWC package program?

(1)Male_____ (2) Female_____ (3) Total _____

43. In your opinion, during past years how do you evaluate extension package program? (1) Production oriented (2) Conservation oriented

(3) Address equally both aspects

44. If extension package program is production oriented, what would be the major reason that dictate the program to be come production orientated?

(1) More attention at national and regional level for production:

(2) Farmers are not concerned to conserve the soil:

(3) Lack of appropriate soil conservation technologies:

(4) More availability of production technologies.

45. What is your opinion concerning statements in the table, in extension service delivery system (indicate your agreement against statements, putting 'X').

No	Categories of descriptions/ statement	Agree	Disagree
1	Farmer's awareness of SWC practices is satisfactory		
2	Farmer's attention/concern for soil is satisfactory		
3	Attention for SWC is satisfactory in extension service		
4	The SWC effort is sufficient to avoid soil degradation		
5	Availability of SWC technologies were satisfactory		
6	Research attention to SWC practices is satisfactory		
7	Adoption of SWC practices is satisfactory		
8	Sustainability of SWC practices is satisfactory		

Note. SWC, represent the Soil and Water Conservation.

46. In your opinion, on which land do farmers more efficient in implementing SWC practices? (1) Individual farm land □ (2) Individual grazing land □ .
(3) Communal grazing land □ (4) Communal non grazing land □

47. To your opinion, what is the trend of implementation of soil conservation practices by the farmers? (1) Increasing □ (2) Decreasing□ (3) Constant □

48. Which kind of conservation practices mentioned below is more efficient in solving the soil degradation problems and indicates their acceptability?

No	Categories of practices	Efficiency	Effectiveness	Acceptability
1	Reforestation			
2	Soil bunds			
3	Crop rotation			
4	Inter cropping			
5	Crops residue application			
6	Fallowing			

Note: Use, Good (1), Satisfactory (2) and poor (3)

49. Is tree planting commonly practiced in your development center?

(1)Yes □ (2) No □

50. If tree planting is common (if yes in Q.49), which kinds of species are common?

No	Tree Species	Proportion (%)	Main purpose of tree planting(rank)		
			Construction and fuel	Income	Conservation purpose
1	Indigenous species				
2	Exotic species				

Note: Rank using 1st, 2nd and 3rd for each purpose.

51. Do you think reforestation carried out last few years is promising to avoid soil degradation problem? (1) Yes □ (2) No □

52. In your extension service delivery system, on average, how many times you visit individual farmer per month? (1). Once □ (2) Twice □
(3) Three times □ (4). More than three times □

53. Did SWC innovations promoted by projects/ programs were spread (copying habit) to non project farmers? (1) Yes □ (2) No □

54. What is the magnitude (estimates) of non participant farmers have got (have copied) the innovations with in 3-5 years? (1)Less than 25%□ (2) Half (50%)□ (3) About 75% □ (4) More than 75% □

6 Adoption and sustainability of SWC innovations.

55**.** How long it is, since SWC introduced to your development center:_____years

56. How many farmers have been graduated from each package categories in the past projects and package implementation years? Please, consider total of all years.

No	Package categories	Unit	Number of Farmer in each stages		
			Graduated	Adopted	Sustained
1	Crops production package	No			
2	Livestock package	>>			
3	Reforestation package	>>			
4	Soil conservation package	>>			

Note: Graduates are farmers involved in the program for two and more years.

57. In your opinion, do you think farmers are adopting disseminated innovations through extension package program in past implementation years?

(1) yes □ (2) No □

58. If yes in question.57, estimate rate of adoption against package categories.

No	Category of package	Estimated rate of adoption			
		25%	50%	75%	100%
1	Crops production package				
2	Livestock production package				
3	Reforestation package/tree planting				
4	Soil and water conservation package				

59. If the high adoption rate for crop/livestock production packages, what is the main reasons for its high rate of adoption compared to SWC package practices?

(1) Technologies are more efficient □ (2) Technologies are easily available □

(3)Technologies more compatible □ (4) More attention for those practices □

60. If rate of adoption for SWC package is low, what would be major reason for less adoption? (1) Soil degradation is not serious problem. □

(2) Technologies are not efficient to solve the problems. □

(3) Technologies are not compatible to local conditions. □

(4) Poor attention in the extension service delivery system. □

61. When you compare different SWC practices which are more adopted by the farmers? Please, indicate in the below table against provided practices.

No	Categories of SWC practices	Adoption of practices			
		Poor (01)	Medium (02)	High (03)	very high (04)
1	Reforestation				
2	Soil bund				
5	Crop rotation				
6	Inter cropping				
7	Use of Crops' residue				

62. If there is high and very high adoption rate in the above table response (in Table 61) what do you think that contribute for high rate of adoption in that particular innovation/ innovations. (1) Easy to apply □ (2) More efficient and effective.□

(3) More attention in extension service□ (4) Low cost of implementation.□

63. If there are poorly adopting practices in the above Table 61, what would be expected reason for poor adoption?

(1) Not efficient and effective□ (2) Poor attention in extension service □

(3) Incompatible to local conditions □ (4) High cost of implementation. □

64. Are there any SWC related projects in your development center in the past 5-6 years? 1. Yes □ 2. No □

65. If there were SWC related projects, please indicate their assistance to farmers in the project area. (1) Technical assistance only□ (2) Material assistance only□

(3) Both technical and material assistance □

66. In what form do the projects support SWC practices in your development center?

(1) Cash payment for work □ (2) Food for work □

(3) Community mobilization without payment □

67. What proportion of farmer's population is included in the project in the past project implementation years? _____%

68. How many farmers were engaged in different SWC programs/projects in your development center in the past implementation years?

(1)Male_____(2)Female_____(3)Total_____

69. How many of them graduated (Completed two years) from the program in the past implementation years? (1) Male: _____(2) Female:_____(3)Total: _____

70. How many of them (graduated farmers) were decided (adopted) to implement the SWC practices to implement without external support?

(1) Male: _____ (2) Female: _____ (3) Total: _____

71. How many of them (graduated farmers) were reject to use SWC practices among graduated farmers? (1) Male_____ (2) Female: _____ (3) Total: ____

72. Among adopted farmers, how many of them were discontinue using the introduced SWC practices? (1) Male: _____ (2) Female: _____ (3) Total: ____

73. In the SWC project area, do farmers carryout conservation works on their own land without payment? (1) Yes □ (2) No □

74. If yes, can you indicate among below list, the SWC works more done without payment? (1) Bund structures □ (2) Reforestation □ (3) Others □

75. Who maintains the bund structures built by SWC projects in your area?

(1) The project (2) The farming community (3). No maintenance

76. Does individual farmer carryout maintenance of structures on his own farm land?
(1) Yes (2) No

77. If not in no 75, who carryout the maintenance work of the structures on individual farmlands? (1) project (2) Community (3) No maintenance

78. Does the land tenure nature contribute to SWC adoption? (1) Yes (2) No

79. Does existing land use right policy of the country have effect on adoption of SWC practices? (1) Yes, positive (2) Yes, negative (3) No effect

80. If lands use policy have negative effect, which would be the right approach to promote adoption of SWC practices?

(1) Full farmer's ownership (2) government ownership

81. Do you think farmers are implementing required Soil and water conservation practices to protect land degradation after the external supports are terminated?
(1) Yes (2) No

82. Do you think farmers are capable to apply improved soil and water conservation practices? (1) Yes (2) No

83. Do farmers share the cost of soil and conservation activities?
(1)Yes (2) No

84. If, yes, in question 83, in what form do farmers share the cost of soil and water conservation practices that you are promoting to farmers (consider the major one). (1) Contribute labor (2). Contribute for labor in cash

(3) Contribute for services in cash (4) Contribute for services in kind

85. In your opinion, do you think recent soil and water conservation approaches will be sustainable after the withdrawal of external support? (1) Yes (2) No

86. What institutional support or collaborations is needed for small-scale farmers to promote sustainable soil and water conservation practices in the farming system?

(1) Technical (Training) (2) Financial (material) (4) Organizational

7. Suggestion in level of Farmer's participation in development process.

87. In your opinion, how do you evaluate farmer's participation in SWC process?

(Put 'X' below appropriate statement or use corresponding number in the table).

No	Category of stages	Level of participation				
		Very good(01)	Good (02)	Satisfactory (03)	Poor (04)	No at all (05)
1	Problem identification					
2	Technology selection					
3	Priority setting					
4	Decision making					
5	Planning and evaluation					
6	Technology generation					

88. What are the constrains/problems that hindering farmer's SWC Technology adoption and sustainability_____

89. What are your recommendations to avoid those problems?_____

_____

90. What are the limitations of small-scale farmers related to SWC practice?_____

_____

***Thank you for your contribution*!**