ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES IN SOUTHERN ETHIOPIA

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Monograph

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Primedia eLaunch
in collaboration with European Scientific Platform

EUROPEAN SCIENTIFIC PLATFORM

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Bassa, A., and Marisennayya Senapathy. *Adoption of Soil and Water Conservation Practices in Southern Ethiopia.* Dallas, USA: Primedia eLaunch LLC, 2022. 172 p. ISBN 979-8-88796-792-9
DOI 10.36074/aosawcpise-monograph.2022

Soil erosion must be reduced to a tolerable level to control soil fertility decline and sustainable agricultural development. Different SWC works have been done in many parts of Ethiopia. Still, the farmers' perception of soil erosion and their responses to soil and water conservation practices need investigation. Often contact between planners and stakeholders used to be minimal. The failure of conservation programs partly emerges from the fact that planners and implementing agencies ignore or fail to consider the socio-economic factors as critical determinants of the success or failure of conservation programs. Therefore, this study's objective was to identify what factors affect the adoption of physical soil and water conservation practices and examine farmers' perceptions of soil and water conservation practices. Both primary and secondary data were collected for this purpose. The primary data were collected from 108 proportionately and randomly selected sample households from 5 Kebeles in Kindo Koysha Woreda, while secondary data were from group discussions of different sources. A multinomial logit model was applied to identify the socio-demographic, Economic, Institutional, Psychological, and Physical factors that affect Soil and Water Conservation Practices' adoption. This study indicated that farmers' adoption of the Soil and Water Conservation decision was influenced more by socio-demographic, economic, institutional, and physical factors. The household head age, education levels, family size, and dependency ratio influenced socio-demographic factors; economic factors influenced farm size and household income. The slope category of the farm was of physical factor that influenced the adoption of soil water conservation practices. Of these significantly influenced variables, the dependency ratio was negatively affected, while the rest of the factors positively influenced the adoption of SWC practices. Based on the obtained result, the following recommendations were made: There should be a clear understanding of the socio-economic conditions of a given locality to undertake SWC activity; a closer relationship will need to be developed between land-use planners and soil conservationists; strengthening resettlement in unused areas; the way of farming culture has to be investigated before planning to undertake conservation activity of a given community; To implement SWC, exploring existing local resource and availability of farmland is vital because most farmers who have stones availability in their locality were replayed that they choose stone bunds to protect their farm.

ISBN 979-8-88796-792-9

Publisher [ISBN]: Primedia eLaunch LLC
TX 75001, United States, Texas, Dallas. E-mail: info@primediaelaunch.com

Co-Publisher: NGO European Scientific Platform
21037, Ukraine, Vinnytsia, Zodchykh str. 18, office 81. E-mail: info@ukrlogos.in.ua
Certificate of the subject of the publishing business: ДК № 7172 of 21.10.2020.

PREFACE

Introduction

Agriculture production depends on soil fertility and its characteristics on the surface of this earth. Greater demand for food production and consumption leads to increased land utility for cultivation. Sub-Saharan Africa has many challenges, and the complex inter-linkages between poverty, growth, and environmental degradation offer another dimension to the land degradation problem. Adam Smith said that the land is the free gift of nature. Soil is a supplementary gift to human beings and other living organisms. The surface soil is exposed to exploitation in many ways, and it continues to face threats from erosion, which leads to low agricultural production. The soil and water conservation measures solution led to planting trees on slopes and protecting the landscapes by involving the local communities through institutional interventions. The detailed research was undertaken in Kindo Koysha Woreda, Wolaita Zone, Southern Ethiopia.

Review of Pertinent Literature

Chapter 2 covers different pieces of literature from various sources that enriched the quality of the research. Soil erosion is the leading cause of land degradation. In most developing countries, environmental degradation takes soil nutrient depletion and loss of food production potential. Soil degradation has been commonly understood as a severe threat to supporting soil and water conservation. Ethiopia faces serious land degradation problems due to faulty cultivation practices and inadequate knowledge about Soil and Water Conservation Practices. The consequences of land degradation have concentrated on soil and water conservation and the Adoption of soil and water conservation practices, including the approaches and techniques of soil and water conservation. Some empirical literature supports the study's conceptual framework covering five types of factors with many independent variables.

Methodology

Chapter 3 focuses on the particular research study conducted in Kindo Koyshe Woreda, Wolaita Zone. The study area's background includes geographical information like land, population and crop cultivation, and soil and water conservation practices in Kindo Koysha Woreda. Both Quantitative and Qualitative data supported the study. The Multi-stage sampling method was employed to select the respondents from three different Agro-Ecological Zones, such as Dega and Woyna Dega, and Kolla concentration is significantly less. The researcher has focused only on Dega and Woyna Dega only. The study used Descriptive statistics like average, percentage, chi-square, and t-test using SPSS 16 Version software. The Inferential Statistics, such as the Multinomial Logit Regression model, were used to analyze the physical soil and water conservation practices of Dependent Variable Y_0 = Soil Bunds, Y_1= Stone Bunds, Y_2= Soil Bund, and Stone Bund. In addition, there are 16 Independent variables hypothesized either positively or negatively.

Data Analysis and Results

Chapter 4 dealt with results and interpretations of all the Independent variables included in the study's conceptual framework. The Independent variables are Age, Education, Sex, Social position in the Kebeles, Family size, Dependency ratio, Farm size, Livestock holding, Household Income, Farmers' Perception, Attitudes of the Farmers, Extension Service, Security of Tenure, Assistance in soil, and water conservation, Past Awareness about the Technology and slope of the farm.

Conclusion and Recommendations

Agriculture is the leading economic sector of Ethiopia. Ethiopia has made technical efforts to rectify the Soil and Water Conservation problem at the farmers’ farm level. The scientific techniques are blended with indigenous knowledge of maintaining soil and water conservation with the Watershed Development and Management by the Ministry of Agriculture's direction. As a result, the institutional interventions have become more robust in implementing soil and water conservation practices and Watershed Development to maintain land quality, soil fertility, and land management activities at the community level. However, contact between development practitioners and stakeholders often used to be minimal. This situation necessitates shifting from top-down intervention methods to participatory throughout the process and well-understood new technology for smallholder farmers. It is effective when the farmers fully participate in all types of watershed management activities in the community.

Conclusion

Ethiopia has three agro-ecological topography: Dega, Woyne Dega, and Kolla. Land degradation has become more intense and has been focused on mitigating soil erosion and increasing agricultural productivity per hectare. The new scientific methods of soil and water conservation technologies were introduced in the highlands' degraded and food deficit areas. Traditional soil and water conservation practices identified those farmers who have usually practised indigenous methods such as stone bunds, soil bunds, and cut-off drains.

Recommendations

Thorough investigations have to be conducted to measure the farmers' problems concerning soil and water conservation methods before implementing the soil and water conservation practices. Having identified the land degradation problems at the farm level, there is a need to invite land-use planners to provide suitable techniques to prevent and control soil erosion in steep sloppy areas. Moreover, land-use planners must better understand the ground reality problems. People's Participation could be a successful strategy to achieve effective watershed management at the Kebele level. Each Kebele is also recommended to have Watershed Committee and Water User Associations (WUA) in consultation with District and Zonal Agriculture Offices. In Ethiopia, there is a good beginning of watershed management activities have been implemented in most parts of the country with the support of Non-Governmental Organizations.

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FOREWORD

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ICT influence on the Digital Platform

New ICT technologies and recent advances have brought revolutionary changes in the conventional print-based industry of newspapers, magazines, and books. More recently, electronic reader devices have flourished in the leisure-reading market. These devices can be used with read-only format electronic books. However, this shift has been a much slower process in the education market. Electronic textbooks are expected to play a significant role in changing the students' conventional book-reading practice in the library with increasingly demanding digital content. The students will use their cell phones to download all the necessary electronic documents to read themselves to become more familiar with E-books. The modern digital age has brought an e-publishing revolution. E-books are becoming shared, and technological innovations support this trend by allowing users to download, customize, print, or send e-books instantly, anywhere, anytime. The increasing number of students seeking an electronic form of information as a digital mode is familiar with available immediately. These students are the early adopters of the new digital technologies providing digital content in the new digital environment.

One of our academic staff Dr.M.Senapathy from the Department of Rural Development and Agricultural Extension, College of Agriculture, Wolaita Sodo University, has taken dynamic steps to publish this E-book. It is designed for Graduate students and research scholars abroad who are pursuing research on Rural Development background or Sociology or Social work disciplines. Its main aim is to help research scholars looking for African countries' research studies. Moreover, those who have chosen Rural Development and Agriculture research mainly focus on methodological frameworks in their diverse and pluralistic nature and demonstrate their purpose, relevance, and effectiveness.

Distinctive Advantages of E-Books

This E-Book has many distinctive features. This has made the task of Internet users easier to publish any kind of information. It is easy to create these electronic books on the internet. This format is accessible and portable on multiple platforms. Computer users can access these digital books on any system with a different configuration. The user can easily open and view the digital books on the computer system. It is also easy to store and carry digital books on portable devices like pen drives, Digital Video discs, or iPods. It can have numbered pages, a table of contents, pictures, and graphics, exactly like a printed book. E-books are virtual books used to display information on any subject on a digital medium. The significance of electronic books is that they can be used for several purposes.

First and foremost, full coverage of the Master Thesis on Rural Development has been compiled and contributed to world readers and users in general. This E-Book has five chapters: Introduction, Literature Review, Methodology, Results and Discussion and Summary, Conclusion, and Recommendations, including Appendices. In this sense, the E-Book is concise and comprehensive and offers a complete research analysis of the particular research title of information in a relatively small space.

The E-book enlightens the knowledge of budding research scholars/Graduate students at the M.Sc. and Ph.D. levels. It also covers many relevant literature reviews, detailed information about the study area and methodology, and statistical tools applied with final results with recommendations. Finally, the E-Book presents social research as a dynamic process leading from beginning to end, showing how researchers progress from one stage to the next, how decisions are made, how sampling methods are selected, and how conclusions and recommendations are drawn.

The E-Book offers Graduate students the need to know about social research: what it is, what it does, how it is used when it is used and for what purpose, what methods it employs, and a critical understanding of rural locality-based research. Such an intensive analysis may be accomplished through further reading to update the modern trends in research. As a result, Social work, Psychology and Anthropology, and other social sciences could also have been focused on in general.

Ideally, this E-book is prepared for beginners who wish to understand the Master Thesis and intend to conduct an elementary investigation. Nevertheless, an intelligent scholar may find the E-Book a good model for ordering, categorizing, and integrating the embodiment of complete knowledge of research in the social sciences.

I assure you that this E-Book will provide enormous knowledge to critical academic stakeholders. They are looking for additional constructive research information about rural development and agriculture. Any comments and suggestions for improving the document would always be welcome.

Finally, I appreciate the earnest endeavours of our staff, Dr.M.Senapathy, who always supports our students in teaching, guiding, and motivating them morally and intellectually. I hope this E-Books publication output will impart a new E-learning opportunity to our University students in Ethiopia and the world student community.

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ACKNOWLEDGEMENTS

First, I want to thank my Lord God, who encouraged me to start and go through my studies and for his mercy upon me during all my study times.

I want to thank Wolaita Sodo University officials for their restless effort to open the School of Graduate Studies in the infant university, enabling me to pursue my career without detaching from regular work.

Next, I would like to express my deepest gratitude to **Dr. Senapathy Marisennayya** for his continuous support in writing this book and **Prof. Dr. Daniel Temesgen**, Ambo University, for his genuine support from the research proposal to interview schedule preparation.

I am also most deeply grateful to my parents and my families for helping me realize my potential, encouraging me during an inconvenience, and for their tremendous support and patience during my work time. Finally, sincere appreciation goes to my wife, W/ro Hana Abraham, for her invaluable encouragement, support, advice, and prayer during my research and the entire course of my study.

Finally, all participating Concern World Wide Ethiopia South Area Coordination Office's community extension workers and farmers who participated in the study deserve my most profound appreciation for their unreserved collaboration and good working environment. Finally, I would like to acknowledge all individuals and organizations that directly or indirectly contributed to the successful completion of this research study.

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SPECIAL ACKNOWLEDGEMENTS

First, my sincere thanks to the Almighty God, have given me enormous strength and courage to succeed in this new publication attempt. The idea of starting with compiling the information covering the master thesis and important components were incorporated by many multi-disciplinary experts who helped me attain this stage for publication. The authors have thankful to all the academic communities from multi-disciplinary experts' from abroad who have strenuous support and encouragement throughout the preparation of the document, kind suggestions, and critical comments for the improvement of the Thesis material into an E-Book are duly acknowledged.

I am indebted to **Dr.Barry Hayes**, Veteran Geologist, Geomite, Australia, who has supported me wholeheartedly in publishing this E-Book. He transferred his project technical knowledge while compiling the information for this E-Book.

I must thank Professor **Dr. Daniela Toneva** who gave me the idea of publishing an E-book make into reality. Without her assistance, commenting on the material could not have been accomplished. Furthermore, her valuable input has been critical for choosing and organizing content throughout the book chapter-wise.

I am indebted to express my respectful thanks to Professor **Dr.Leslie Villanueva Flores**, Chile, who has given the digital knowledge and ideas. I have appreciated the Professor's perspectives and insights, who have encouraged me to publish these E-books with good standards. I have had helpful conversations with Professor Leslie Villanueva over the phone and by email frequently.

My special heartfelt thanks to Professor **Dr.Valentin Vasilev** who has helped me in designing constructive ideas for the content part of the E-Book. However, without them, it would have been impossible to steer this material through the shoals of the strategy field.

I also need to express my appreciation for the help; I received intellectual input on modern library techniques from **Kyndra Cross**, Texas, USA, during my compilation as an E-book. I must thank her for her continuous sportive ideas to materialize into E-Book.

I am gladly expressing my sincere thanks to **UKRLOGOS.IN.UA, NGO "European Scientific Platform"** Ukraine has been remarkably helpful in publishing my e-book material. Furthermore, they have guided me through all the critical grammatical corrections for choosing and organizing content throughout the book.

I am indebted to **Dr.Daniela Fontenelle-Tereshchuk, Canada** who has wished me incredible support and motivation for this publication. She gave more useful constructive ideas to categorize into many chapters in the book.

The e-book is supported by some figures and videos for more clarity and understanding for the users. I am glad to express my sincere thanks to **YouTube** Administrators, USA.

Last but not least, my family deserves tremendous thanks. It will take me a long time to repay their kindness and generosity. My special thanks to my mother, **Susila Marisennayya** and my brother **Dr.M.Pandikumar**, brother-in-law **Er.T.Ramesh**, Production Engineer, Chennai Petroleum Corporation Limited (CPCL), Chennai, my sister **R.Amuthavalli Ramesh**, M.A., her children **R.Srihari** and **R.Sriya** and brother son **P.K.Lokajit** have given moral support throughout the preparation of these E-Books.

This E-Book is an output of the following experts from different disciplinarians who had encouraged and provided valuable inputs as and when I approached them.

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LIST OF ABBREVIATIONS

AGEHH	:	Age of Household Head
ASSCOSOIL	:	Assistance in Soil Conservation Practices
CSA	:	Central Statistical Agency
CVM	:	Contingent Valuation Method
DA	:	Development Agent
DPNCY	:	Dependency Ratio
EDUCHH	:	Education Level of Household Head
EXTSRS	:	Extension Service
FAO	:	Food and Agriculture Organization
FARMERATID	:	Attitude of the Farmer
FAMSIZ	:	Family Size of a household
FARMSZ	:	Farm Size of the household
FGD	:	Focused Group Discussion
FHH	:	Female-Headed Household
GDP	:	Gross Domestic Product
HH	:	Household Head
LURDMoA	:	Land Use Regulatory Department of Ministry of Agriculture
MHH	:	Male-Headed Household
NGO	:	Non-Governmental Organization
FINCOM	:	Estimated amount of Farm Income in Birr
SECTEN	:	Security of Tenure

LIST OF ABBREVIATIONS (CONTINUED)

SNNPR	: South Nation Nationalities and Peoples' Region
SOCPOSN	: Social Position in Kebele
SLO	: Slope Category of the Farm
SWC	: Soil and Water Conservation
SM	: Soil Management
SSA	: Sub-Saharan Africa
TECHAWARE	: Past Awareness about Technology
PERCP	: Farmer's Perception of Erosion Hazard
PSNP	: Productive Safety Net Program
WD	: Woyna Dega
WA	: Woreda Agriculture
WFEDO	: Woreda Finance and Economic Development Office
WZSEP	: Wolaita Zone Socio Economic Profile

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ABSTRACT

Soil erosion must be reduced to a tolerable level to control soil fertility decline and sustainable agricultural development. Different SWC works have been done in many parts of Ethiopia. Still, the farmers' perception of soil erosion and their responses to soil and water conservation practices need investigation. Often contact between planners and stakeholders used to be minimal. The failure of conservation programs partly emerges from the fact that planners and implementing agencies ignore or fail to consider the socio-economic factors as critical determinants of the success or failure of conservation programs. Therefore, this study's objective was to identify what factors affect the adoption of physical soil and water conservation practices and examine farmers' perceptions of soil and water conservation practices. Both primary and secondary data were collected for this purpose. The primary data were collected from 108 proportionately and randomly selected sample households from 5 Kebeles in Kindo Koysha Woreda, while secondary data were from group discussions of different sources. A multinomial logit model was applied to identify the socio-demographic, Economic, Institutional, Psychological, and Physical factors that affect Soil and Water Conservation Practices' adoption. This study indicated that farmers' adoption of the Soil and Water Conservation decision was influenced more by socio-demographic, economic, institutional, and physical factors. The household head age, education levels, family size, and dependency ratio influenced socio-demographic factors; economic factors influenced farm size and household income. The slope category of the farm was of physical factor that influenced the adoption of soil water conservation practices. Of these significantly influenced variables, the dependency ratio was negatively affected, while the rest of the factors positively influenced the adoption of SWC practices. Based on the obtained result, the following recommendations were made: There should be a clear understanding of the socio-economic conditions of a given locality to undertake SWC activity; a closer relationship will need to be developed between land-use planners and soil conservationists; strengthening resettlement in unused areas; the way of farming culture has to be investigated before planning to undertake conservation activity of a given community; To implement SWC, exploring existing local resource and availability of farmland is vital because most farmers who have stones availability in their locality were replayed that they choose stone bunds to protect their farm.

Keywords: Soil fertility; soil management; sustainable agriculture; soil and stone bunds.

CHAPTER I

1. INTRODUCTION

1. INTRODUCTION

1.1 Background of the Study

Soil fertility decline remains the major biophysical root cause of the reduction in per capita food availability on smallholder farms of Sub-Saharan Africa (SSA). Recent estimates indicate that by 2020, the SSA annual cereal imports will rise to more than 30 million metric tons. The per-capita food production continues to decline against a background of the rapidly growing population estimated at 3% per annum. This failure to match food supply to demand is mainly attributed to soil nutrient depletion following an intensification of land use without proper land management practices and inadequate external inputs (Aklilu, A. 2006).

Literature reveals that in the predominantly agrarian societies of Africa, one of the most ominous threats to food supply is environmental degradation, the deterioration of croplands, grasslands, and forests (Alemneh and Dejene, 1990). Land degradation and continuous agricultural productivity fall in Sub-Saharan African countries have raised serious international concerns (World Bank, 1992). In many agriculture-based developing countries, environmental degradation mainly takes soil nutrient depletion and loss of food production potential. Reversal of the erosion-induced productivity decline and ensuring adequate food supplies to the fast-growing population in these countries pose a formidable challenge (Shiferaw and Holden, 1998). Shiferaw and Holden emphasized that the complex inter-linkages between poverty, population growth, and environmental degradation offer another dimension to the land degradation problem.

Ethiopia is one of the countries in Sub-Saharan Africa faced with pervasive poverty, high population growth, insufficient food production, and natural resource base degradation. Food production in Ethiopia failed to keep pace with the population growth in the last 30 years. For example, in the 1980s, the food gap widened from 1 and 2 million metric tons of cereals annually (Wolday, 1999). In Ethiopia, agriculture employs about 80 per cent of the population and generates 50 per cent of the GDP. According to CSA (1995), about 72 per cent of farm households cultivate holdings of less than 1 hectare, and the average holding size is 0.8 hectare.

Soil is a natural gift formed from different rock materials through a long process involving heat and cold. It is also a base for any nature on the earth; Even though it takes a long time to form and develop, it would lose within a brief period if the users do not care.

As Babalola *et al.* (2009) observed, the soil is a limited and irreplaceable resource and continues to face threats from erosion, which poses a significant danger to agricultural production. Moreover, Morgan (1995) asserts that soil erosion is one manifestation of the soil degrading process that reduces soil quality and productivity. It has been projected to become an even more severe constraint in the future (Vernon, 1999). Soil erosion commonly occurs on farmlands though farmers may not notice it. Farmers often notice soil erosion when gullies develop on the farm and only call for assistance (Kirchhoff and Odunze, 2003).

Even though the erosion effects across Ethiopia are expected to decrease due to the very high priority given by the Ethiopian Government to land management in the last 15 years, using Watershed Management Strategies by engaging the local communities in improving natural resources management through food/money for work arrangements, the effort has mainly confined to communal lands rather than private sectors. Most of the soil management works done in these areas such as Soil and Water Conservation structures, planting trees on degraded slopes, protecting landscapes from livestock grazing through ‘area enclosure’, and creating local institutions to sustainably manage the landscapes by strengthening/involving local communities through existing institutional structures, disaster prevention committees and local government bodies. The most significant benefits are when innovations in consultation with surrounding communities accompany physical measures, like bringing short-term benefits in fodder, fuelwood, water, and other resources. Introducing and promoting multipurpose legume trees, with feed, fodder, and wood values, in farm niches, including farm borders, soil bunds, and farm strips, are becoming an essential driver for sustainable Watershed Management (Amede and Tilahun, 2003).

The research area is identified as environmentally degraded because of the area's sloppiness and mountainous nature. According to the Agricultural and Rural Development Office of the Natural resource job process of Kindo Koyesha Woreda, the area is reported to lose around **72.7 tons/hectare** of fertile soil per year (Source: Kindo Koyesha Agricultural Office 2012).

Land degradation is also severe in the crop production area related to population pressure coupled with less effective crop production practices triggered cropland expansion to marginal areas. Of the total population of Woreda, eighty-five per cent of the people live in rural areas engaged in agriculture, mainly a mixed farming system. Therefore, land shortage, erratic rainfall, severe land degradation, high deforestation, and frequent drought are prominent features of Woreda.

1.2. Statement of Problem

Although Ethiopia's biophysical potential is significant, land degradation and poverty continue to challenge sustainable agricultural development opportunities. This problem is further aggravated by high population pressure in rural areas - currently, 86 per cent of Ethiopia's 72 million inhabitants live in rural areas, climatic variability, limited use of sustainable land management practices, the widespread dismantling of constructed soil and water management structures, and a high dependence on rain-fed agriculture. Moreover, deforestation due to farmland expansion and energy needs, as well as fragile soils, undulating terrain, and heavy seasonal rains make the rural family of Ethiopia highly vulnerable to soil erosion and gully formation (Terrence *et al.,* 2002)

Approximately two-thirds of the Omo River Basin area (including the researcher's study area) is located in the highlands that receive relatively high levels of rainfall (800 to 2,200 millimetres per year). Most precipitation falls during the Meher rainy season (June–August). Agricultural production in these areas of the Omo river basin is dominated by cereal crops, which necessitates frequent ploughing and provides minimal ground cover during the Meher rains, thus rendering soil in the Omo river basin more susceptible to erosion
(Vernon 1999).

The on-site effects of land degradation (e.g., erosion and loss of topsoil), measured in lost agricultural production, are estimated to cost 2.0 to 6.75% of Ethiopia's agricultural GDP per annum (Hurni 1996; Bojo and Cassells 1995, Sutcliffe 1993) ;). In addition to on-site costs of erosion, the country also experiences off-site effects. For example, eroded soil washed out of the plot could positively or negatively impact the productivity of plots downstream. The negative effects include crop burial by sediment deposition, gully formation, and crop damage due to excessive overland flow in depressions. On a larger scale, erosion creates the siltation of dams, wetlands, and productive farmlands in foot-slope areas (Yesuf *et al.,* 2009).

In response to the extensive degradation of its resource base, Ethiopia has made some efforts to mitigate soil erosion and enhance or maintain agricultural land production. New soil conservation technologies were introduced in some degraded and food deficit areas of the highlands, mainly through food for work incentives since the early1980s. However, even though soil conservation technologies were promoted through the Ministry of Agriculture in Ethiopian highlands and other parts of the country where successive food-deficit recorded, including the study area, the farmers' perception of the problem of soil erosion and their responses to soil and water conservation practices have not been well studied. Moreover, the factors influencing Soil and Water Conservation measures were not identified (Shiferaw and Holden 1998).

Given this state of conditions, analysis of the issue of what specifically affects the adoption of Soil management practices by smallholder farmers to invest in soil conservation measures to maintain sustainable agricultural production and conserve the natural resource base of the country is not only an essential and realistic option but also a means for rural poor to get out of the vicious circle of poverty. Hence, the present research study tries to fill the Soil and Water Conservation practices gap in Kindo Koysha Woreda. The research result findings become the policy recommendations to the Woreda Officials in Ethiopia.

1.3 Objective of the Study

1.3.1 General Objective

The study's general objective was to determine Factors Affecting the Adoption of Physical Soil and Water Conservation Practices in Kindo Koysha Woreda, Wolaita zone.

1.3.2. The Specific Objectives of the study are

- to identify the Physical Soil and Water Conservation practices adopted by farmers in the study area,
- to examine the perception of farmers on Soil and Water Conservation practices and
- to determine the factors affecting farmers' adoption of Soil and Water Conservation practices.

1.4. Research Question

- What Farmers adopted physical Soil and Water Conservation activities in the study area?
- What is the perception of farmers on Soil and Water Conservation practices?
- What factors affect the adoption of Soil and Water Conservation practices by farmers?

1.5. Significance of the Study

Currently, erosion control measures/Soil and Water Conservation practices have been undertaken in a campaign, often without the involvement of the land users. As a result, those constructed physical structures were not sustained due to farmers' widespread dismantling of structures entirely or selectively. To ensure the sustainability of those structures, the participation of land users is critical, starting from planning to implementing the structures. From an economic point of view, those positively correlated factors with soil management practices have a significant advantage in stabilising the structures that would have a high impact on the productivity of the land. Click here **(https://www.youtube.com/watch?v=ntJouJhLM48)**

Accordingly, identification of the factors that were affecting the adoption of farmers' Soil and Water Conservation practices in long-term conservation activities can help policymakers, Non-Governmental Organizations (NGOs), international organizations, etc.

to take appropriate action in formulating projects/plans that curb the problem of land degradation with the active participation of farmers.

1.6. Scope and Limitation of the Study

This study aims to identify the factors that affect the adoption of physical Soil and Water Conservation activities, especially bunds (stone bund, soil bund, soil bund, and fanayajuu bund), to recommend practically accepted Soil and Water Conservation measures for farmers. Furthermore, the study will differentiate the farmers who stabilize the structure in the study area.

Regarding its limitation, this study is limited to one district in SNNPR, Wolaita Zone, Kindo Koysha Woreda of 108 HH selected from Dega and Woyna Dega agroecology in 5 kebele. Even though the area to be covered and sample size chosen is limited due to time and money scarcity, the expected result could be generalized to more expansive areas with similar geographical settings.

1.7. Organization of the Thesis

This thesis is organized into five chapters. Chapter one is the Introduction, followed by chapter two: a review of literature that comprises definitions, history of soil and water conservation practices, existing soil and water conservation practices, and factors influencing the adoption of soil and water conservation activities, etc. The third part includes an intensive description of the study area, research type and design, data collection, and analysis method. The fourth chapter describes the results and discussions, and finally, chapter five presents a research summary and recommendations based on the study's findings.

CHAPTER II

2. REVIEW OF PERTINENT LITERATURE

2. REVIEW OF PERTINENT LITERATURE

2.1. Concept of Land Degradation

Soil is a natural resource that generates yearly through the natural process. Soil erosion is interchangeably used with land degradation; however, soil erosion is only one form of land degradation. Land degradation can be defined in various ways concerning soil erosion to describe its negative impacts on land productivity (Hudson, 1995).

Land degradation can be defined as a process that lowers the current and future capacity of the land to support human life (Demeke, 1998). Allan (1949) described land degradation as a process that results in a radical change in the complete character of the land due to the loss of mineral plant nutrition, the oxidation and disappearance of organic matter, the breakdown of soil structures, the degeneration of vegetation and setting up of a new terrain of land and water relationship.

Land degradation is also defined as the temporary or permanent lowering of a land's productive capacity (FAO, 1994). Soil erosion accounts for the significant forms of land degradation in developing countries. Simultaneously, it is difficult to isolate and measure its impact on productivity even when available means and resources (Ayalneh, 2002). Soil conservation includes all human actions to prevent and treat soil degradation (Demeke, 1998). The amount of soil erosion, which occurs under a given condition, is influenced not only by the nature of the soil itself but also by the treatment or management it receives. The difference in erosion caused by different soil management is more significant than the difference in erosion from different soils given the same management (Hudson, 1995). Click here (**https://www.youtube.com/watch?v=y7uDAA_3VHk**)

According to Hudson (1995), the best land management might be defined as the most intensive and productive use of which the land is capable without causing any degradation. The application of sustainable Soil and Water Conservation (SWC) management is determined mainly by the economic status, public awareness, and educational level of the stakeholders, and the main prerequisite for attaining sustainable agricultural development is the formulation of appropriate resource management policies, which are supported by the farming community to which they are willing and able to respond

In many agricultural-based developing countries, environmental degradation takes soil nutrient depletion and loss of food production potential. Reversal erosion-induced productivity decline and ensuring adequate food supplies to the fast-growing population in these countries is a formidable challenge. Sustainable economic growth depends on a stable and resilient agricultural sector. Continued land degradation means lower rural income and economic decline. Controlling soil erosion and improving soil fertility are the keys to this economic growth. Today, soil degradation is almost universally recognized as a severe threat to the well-being of human beings. This is shown by the fact that most governments actively support soil conservation programs.

2.2. Problems of Land Degradation

Ethiopia is one of the Sub-Saharan African countries where soil degradation has reached a severe stage. Land degradation, mainly due to soil erosion and nutrient depletion, has become the most critical environmental problem in the country; coupled with poverty, a fast-growing population, policy failures, and social unrest, land degradation poses a severe threat to national and household food security (Shiferaw and Holden, 1998). A significant survey undertaken around the early 1980s concluded that 50% of the highland region, roughly 270,000 Km^2 had already lost its productive capacity (Hurni, 1983). Constable (1984) has indicated that in addition to soil degradation, which is extensive, current soil erosion rates are very high, and the estimates of soil loss from the highlands vary widely from less than a billion tons up to three billion tonnes per year.

Moreover, the Land Use and Regulatory Department of MoA estimated the gross soil loss from the highlands to be up to 1,900 million tons per year, of which 80% (1520 million tons) is from croplands, only 22% of the highland areas. The country's soil loss rate is estimated to be extremely high, where its soil loss varies by land cover type (Hurni, 1983). Click here (**https://www.youtube.com/watch?v=DmPLGBy14CM)**

According to Hurni (1983), soil formation rates in Ethiopia vary between 2 and 22 tons/hectare/year, much lower than the rate of soil erosion. The average soil loss rate is six times greater than the rate of soil formation, and it causes an annual reduction of 4 mm in soil depth.

According to Ayalneh (2002), extensive land degradation in the highlands of Ethiopia is often a direct outcome of the individuals’ and governments’ failure not fully recognize and integrate environmental values into the decision-making process. The problem is only identified after the situation has already become severe. Usually, much of the topsoil has been lost, and the productivity of the land is seriously impaired. Even then, plans are prepared with an emphasis on physically keeping the soil in place. With planners seldom giving attention to faulty land use and management problems, excessive run-off and soil loss are only the symptoms. Often contact between planners and stakeholders used to be minimal.

Finally, framers are directly or indirectly persuaded, even sometimes forced to implement the plans. Such strategies have seriously undermined the incentives for land users to involve themselves in implementing procedures, and the conservation programs have generally been far from successful.

According to Ayalneh (2002), resource users often have been blamed for the failure of the plans without any attempt to analyze their circumstances. Nevertheless, various soil and water conservation strategies have been known and practised in different places for hundreds of years. Therefore, the unsuccessful introduction of soil and water conservation should be traced to faulty approaches adopted.

Currently, there is a growing commences that soil conservation strategies need to be based on an approach that will ensure the participation of rural people in conservation because of the benefits that conservation brings. However, for soil and water conservation to occur and remain sustainable, the land users must carry out and maintain the necessary measures. Therefore, the government and NGOs' role should change from implementers of conservation projects to facilitators, who help identify the problem, develop suitable conservation measures, and encourage and assist the land users.

Therefore, it can be concluded that soil degradation is one of the major bottlenecks of agricultural development in Ethiopia. If proper measures are not taken, the present extent and soil erosion rates will continue to be even more severe in the future.

2.3. Consequences of Land Degradation

The degradation of soils has become an alarming global environmental problem threatening sustainable development in most developing countries. Barrett (1996) stated that the depletion of oil reserves, and its effect on world oil prices, is the most immediate threat to world economic stability. Still, the depletion of soil resources by erosion might be the most serious long-term threat. Over the last generation, the unprecedented doubling of world food supplies was achieved by adopting agricultural practices that led to excessive soil erosion, draining land productivity. Click here **(https://www.youtube.com/watch?v=sfE_pDUpgAs)**

Developing countries have lower incomes, and the agricultural share of income is much greater. For example, about 44% of the gross output in Ethiopia is generated from Agriculture (National Bank of Ethiopia, NBE, 2003).

The degradation of agricultural soil resources in Ethiopia is seriously limiting production. In economic terms, the annual rate of land degradation results in reduced agricultural output by about 2% per year (Hurni, 1983). According to FAO (1987), available estimates on the economic impact of soil conservation for three agro-ecological zones in Ethiopia indicated an annual on-site productivity loss of 2.2% from the 1985 yield level.

Constable (1984) also indicated that if proper measures are not taken. The present (1983/84) rates of soil erosion are allowed to continue; the national cost of soil degradation in the highlands alone would amount to about 15,261 million Ethiopian birr by 2010, of which 77.8% would be due to a decrease in crop production and 22.2% to decreased livestock production. Similarly, Wood (1990) argues that unless land-use changes are made to slow erosion, 10 million hectares (10% of the croplands) will be taken out of cultivation by 2010, affecting the lives of about 10 million people.

2.4. Soil Conservation Methods

Soil erosion causes considerable and, in most cases, irreversible soil fertility and productivity loss. The erosion of soil productivity is especially severe in the southern, southeast, and southwestern highlands, where Nitosols are the predominant soil type. Most soil fertility is concentrated in the topsoil (Belay, 1992).

To control soil fertility decline and sustainable agricultural development, soil erosion has to be arrested or reduced to a tolerable level, that is, to a level below the soil formation rate. There are several techniques for controlling erosion, and these are broadly grouped under (1) agronomic methods, which aim at controlling erosion by improving the vegetative cover of the soil; (2) soil management techniques, which try to control erosion by improving the aggregation of the soil particles; and (3) structural soil conservation methods, which control erosion by shortening the length and minimizing the gradient of the ground slope (Belay, 1992). The conservation methods recently introduced in Ethiopia are of the structural type, and the most common ones are the 'fanyajuu' bunds and the normal bunds. These structures consist of narrow ridges and channels constructed parallel or slightly to the contour to control erosion and facilitate terrace development. Click here **(https://www.youtube.com/watch?v=3MlceK6tLpw)**

In the case of the normal bunds, the ridge or the bund is constructed by digging a ditch and throwing the soil downhill, while in the case of fanyajuu, the bund has been built by throwing the soil uphill. Hundreds of thousands of kilometres of fanyajuu and normal bunds have been constructed over croplands in Ethiopia. However, reports indicate that these conservation structures have not been as successful as possible because the users (the farmers) were not keen enough to accept and maintain the technology (Wood, 1990). The failure of conservation programs partly emerges from the fact that planners and implementing agencies ignore or fail to consider socio-cultural factors as critical determinants of the success or failure of conservation programs.

Effective and sustainable conservation programs can be designed and implemented only if (1) the causes of land degradation are appropriately identified; (2) the right conservation technologies are selected; (3) the farmers are effectively involved in the planning and implementation of the conservation technology. Though socio-cultural factors are central in all of these, they are far more crucial in deciding the involvement and participation of farmers in conservation programs.

2.5. Soil and Water Conservation efforts

According to the Bureau of Planning and Economic Development (BOPED, 1999), the major problems regarding soil structures in SNNPR include severe soil erosion due to steep cultivation, overgrazing in midland and high lands, deforestation, and planting eucalyptus causing high moisture stress. The primary cause of low soil fertility in the watershed is soil erosion due to runoff. As a result, crop productivity remains very low, and some farmers were registered even for migration. Click here **(https://www.youtube.com/watch?v=3MlceK6tLpw)**

Soil erosion is also one of the significant constraints in agricultural production in the highlands of Ethiopia. Even though it shows improvement, Ethiopia's loss of forest cover in the last centuries (from 75% to 4%) caused rapid runoff and soil loss. The highlands, particularly the Amhara plateaus, are severely eroded (Fredric *et al*., 1999). Because of the steep slopes cultivated in Ethiopia, high lands, and high, often intensive rainfall, it is evident that runoff control is essential in soil conservation. Thus Community Forest and Soil Conservation Development Department (CFSCDD) implemented primarily engineered soil conservation structures, and Soil Conservation Research Projects (SCRP) conducted experiments to identify the best conservation structures. The experimental results revealed that soil loss could be reduced by as much as 80% (Grunder, 1992); experimental results on cover crops around the Holeta area showed that grass cover minimized soil loss to 1tone/ha per year while the loss on bare fallowed plots was 28tonnes/ha per year (Asrat, 1992). Tripathi and Singh (1993) also reported that natural cover and dub grass (cynodondactylon) effectively controlled soil erosion. Studies on graded banding constructed at Kota centre on sloping cultivated lands (slope up to 4%) showed that graded bands of $1m^2$ cross-section with 0.5 to 1.0m vertical intervals were for checking soil erosion (Tripathi and Singh, 1993). Graded banding or terracing has been helpful in areas receiving more than 800mm yearly rainfall. Runoff and soil conservation studies based on 8% sloping land showed that up and down cultivation of Maize in the Doon valley caused about 28.5tonnes/ha soil loss, which was reduced by 30% when maize was grown with cowpea across the slope (Anonymous, 1979). The runoff was reduced from 52 to 29m and soil loss from 39 to 14.9tones/ha by adopting contour cultivation in the same book. Click here **(https://www.youtube.com/watch?v=SluAePqROc8)**

Public policy plays a significant role in soil conservation for public and private lands (Terrence *et al*., 2002). Although the principal responsibility for soil conservation lies with those who use the land, the public has assumed joint responsibility with landowners and users. Soil conservation practices vary in cost, return, and effectiveness (Fredric *et al*., 1999). The most accessible practices to promote are those like a good fertilizer program that conserve soil and return a profit within a short period. The benefit of larger-term practices like terracing may not be recognized within a short period. The economic value of many conservation practices is further complicated by benefits that accrue to persons other than those who install the practices. According to Stonehouse and Profz (1993), Consideration of externalities shows that many conservation practices are economically desirable for societies even though their costs exceed the on-farm benefits. The farmer should not be the only one involved in paying for practices. These situations may be solved by governmental involvement in in-laws and cost-sharing for conservation practices. Click here **(https://www.youtube.com/watch?v=1HHYVYdlS10)**

2.6. Attributes of Innovations

It is generally accepted that five characteristics of innovations have influence over adoption decisions and include; relative advantage, compatibility, complexity, trialability, and observability, as described below (Rogers, 2003):

Relative advantage – This is "the degree to which an innovation is perceived as being better than the idea (or practice) that it supersedes" (Rogers, 2003). The relative advantage of an innovation depends on the context of the adopter and the circumstance in which it will be used. It can be influenced by various biophysical, economic, social, and governmental factors. Some factors influencing relative advantage include social status (Tarde, 1993), short-term cost-benefit to the adopter (Marsh *et al*., 2000; Abidi Ghadim *et al*., 2005), and impacts of the innovation on other parts of the adopter's operation or lifestyle (Cary, 1986; Kingwell *et al*., 1993), long-term profits (Wilkinson and, Cary 1992), risk of use of the innovation (Marra *et al*., 2003; Abidi Ghadim *et al.*, 2005), and policies affecting the use of the innovation (Helms *et al*., 1987).

Compatibility – Evaluation of the apparent consistency with the adopter's current operation, values, beliefs, past experiences, peer influence and perceived needs of potential adopters. Ideas that are more compatible fit more closely with the situation or circumstance and have more meaning to the potential adopter (Rogers, 2003). For instance, innovation is considered more compatible if it can be readily assimilated into the operation and utilized by the machinery and management of practices already in use. The adopter's skill level and abilities are also critical determinant factors in determining whether an innovation is compatible or not (Pannell *et al*., 2006).

Complexity – Similarly, the adopter determines the degree of complexity or the extent to which an innovation can be understood and relatively easily implemented (Wilkinson, 1989; Rogers, 2003). If the effort needed to implement increases the risk of an innovation failing, the relative advantage of adopting that innovation is proportionately reduced. Suppose an innovation is not complex but adds to the overall complexity of managing existing practices or an existing operation. In that case, the innovation may be too complex to adopt (Pannell *et al.,* 2006). Complexity can also be measured by other seemingly unrelated consequences of adoption, such as the increased effort to implement and maintain increased stress on adopters' or adopters' families and negative impressions of the innovation by members of the social system adopter lives.

Trialability – This refers to the degree to which an innovation can be tested on a small scale to reduce the uncertainty associated with adoption; the greater the level of trialability, the tremendous potential for adoption to occur (Tonks, 1983 Ohlmer *et al.*, 1998). Trialling the innovation allows the potential adopter to learn about the nuances of the innovation and provides an opportunity to learn new skills necessary to implement the innovation.

Observability – The degree to which the measurable effects of an innovation are visible to adopters and other individuals in the community (Pannell, 2001; Rogers, 2003). A high level of observability provides a more incredible opportunity to evaluate the relative advantage and complexity of potential adopters and others "over the shoulder" – in the social system.

In theory, if innovations are compatible with the decision maker's current operation and demonstrate high degrees of relative advantage, less complexity, trialability, and observability, they tend to be adopted more quickly (Pannell, 2001; Rogers, 2003). However, other factors may play an essential role in stakeholders' decision to adopt or not adopt innovation, such as economic pressure (Boserup, 1965), operational/technological life cycle change (Marchetti, 1980), and individual development.

2.7 Adopters' Personal Characteristics

Innovativeness is the "degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system" (Rogers, 2003). Individuals are not all created equally, nor do they adopt innovations at the same time or rate. Therefore, adoption research has identified five categories of ideal adopter types to describe the "innovativeness" of individuals. A normally distributed bell-shaped curve can describe these five ideal adopters without distinct discontinuities between categories. This classification continuum facilitates adopting the adoption-diffusion theory to human behaviour and improves our understanding (Rogers, 2003). These five adopter categories are described as follows:

• **Innovators** – This group can be described as venturesome and unafraid of trying new ideas, regardless of peer-social perceptions of their behaviour. They are typically not risk-averse, willing to accept occasional disappointment with the innovation. They are leaders whose skill set allows them to understand and apply more complex technologies and modify and experiment before abandoning the innovation. They are more willing to seek information outside the local social system, but other stakeholders in the local system often distrust them. The innovators' role in the diffusion process is to introduce innovation into the local system.

• **Early Adopters** – These adopters are more integral to the social systems in which they belong and typically accept innovations quickly, after the consequences of innovation adoption are made more evident by the experiences of innovators'. They are considered opinion leaders by many in the system. They are seen as role models for most of the community and, for this reason, are sought out by change agents to speed diffusion.

Peers respect them for making prudent decisions when choosing innovations; therefore, they reduce uncertainty via subjective evaluation. They are ahead of the majority.

• **Early Majority** – They are situated just ahead of most of the system and typically do not hold positions as opinion leaders. They are more conservative in their willingness to adopt and serve as the communication link between the early adopters and the remainder of the social network. This category encompasses the majority of persons in the social system.

• **Late Majority** – This group adopts innovation after the majority due to caution and skepticism. Their decision to adopt may be due to limited economic resources and/or peer pressure, which may influence their sense of social standing. They require the most reassurance of the value of the innovation before they feel safe.

• **Laggards** – This group is typically described as socially isolated and the last to adopt innovations. They are generally suspicious of change and change agents instead of relying on their experience to guide their adoption decisions.

Generally, innovators and early adopters have higher levels of education, are younger, more actively seek information, have higher social status, and have more significant income than late or non-adopters. Innovators and early adopters have large interpersonal networks and possess a less “pessimistic” attitude than late or non-adopters.

Understanding the adoption process among innovators and early adopters is essential because they influence the other social system members. They typically seek out these peers (opinion leaders) to gain information rather than technical data about the innovation.

2.8 Adoption and Agricultural Conservation Practices

In agricultural systems, producers experience high levels of uncertainty due to economic, institutional, social, and environmental factors. High competition, product price instability, and low returns to investment are typical characteristics of the agricultural market and contribute to these feelings of uncertainty (Workman *et al*., 1972; Kearl, 1975; Buttel and Swanson, 1986; Workman and Evans, 1993). When producers adopt conservation practices, they must commonly decide between improving and protecting environmental quality versus maintaining the profitability of their farms. By and large, the decision to survive economically is made (Swanson *et al.*, 1986; Saltiel *et al*., 1994), whereas adoption of conservation practices is discouraged because "returns to investment in conservation are [typically] low and usually not realized for years" (Swanson *et al*., 1986).

The traditional diffusion model assumes that the individual's potential increased profitability is an adequate incentive to adopt new technologies. However, adopting resource conservation practices more often benefits society, leaving individual interests secondary to societal goals (Pampel and van Es, 1977; Fliegel and van Es, 1983). Increased societal concern for potential environmental impairments due to agricultural production has led to demands for more conservation-minded and sustainable agricultural practices (Saltiel *et al.*, 1994). The expectation of members of the more fabulous social unit becomes problematic if they believe or insist on farmers assuming a stewardship obligation. However, farmers cannot be expected to voluntarily bear the entire burden of investing in and implementing conservation practices, especially when faced with the fundamental uncertainties discussed above (Buttel and Swanson, 1986) or when the cost of implementation conflicts with societal demands for inexpensive foods coming from a highly productive farm industry (Swanson *et al*., 1986).

In other research, factors other than economic issues have influenced the decisions to adopt conservation practices. For instance, (Nowak and Korsching 1983) found that when a strong attachment to traditional farming methods exists, farmers are unlikely to implement best management practices and considered innovations, even if economic incentives were offered to cost-share the initial costs of implementation. Their findings also indicated that many farmers did not have the managerial skills, additional capital, or knowledge required to implement and sustain the new practices (Nowak and Korsching, 1983).

To substantiate this position, a study of Iowa farmers revealed that farmers with more extensive operations had more money to invest and better managerial skills and were more likely to adopt and use conservation tillage technologies (Bultena and Hoiberg, 1983). They were also younger, more educated, more familiar with newer practices, and more likely to accept the risk associated with innovation adoption.

However, the operator's perception of what others would think (responses) about the innovation was the factor having the single most significant effect on adoption decisions. Conservation tillage is an obvious modification to the farm. Neighbours' and friends' responses to the innovation appeared to be an essential determinant of adoption decisions and exemplify the powerful influence of the social system and local social norms. Click here (**https://www.youtube.com/watch?v=0J0GVAmsvTs**)

2.9. Approaches and Techniques of Analysis of Soil Conservation Studies

A farm-level approach in the study of soil conservation is more appropriate for incorporating site-specific events than society-level approaches requiring aggregation of heterogeneous variables to examine the value of soil conservation in maintaining and enhancing agricultural productivity. First, since the farmer is the primary soil conservation decision-maker, only a totalitarian state or a massive subsidy program could induce soil conservation without substantial economic benefits. Second, land-use problems generally depend on site-specific biophysical characteristics that vary significantly even in small areas (Kim *et al*., 2001).

On-site benefits to farmers may not be the immense benefit of soil conservation (Brooks *et al*., 1991). However, given the central role of the farmers in conserving soil, on-site benefits are likely to be the most crucial, especially in the least developed countries. In any case, the market value of the preserved agricultural productivity provides a lower bound for the value of soil conservation. Estimates of this value help policymakers determine the appropriate level of support for different soil conservation measures. Unfortunately, economic analysis of soil conservation from different land uses is not shared. Few empirical studies have estimated the value of soil conservation. One of the empirical studies employed to analyze the adoption of soil conservation practices is studying the farmers' decision-making behaviour.

In analyzing the farmers' decision-making behaviour, different researchers have been using different techniques to relate the decision to use and level of use to factors affecting it. These techniques range from descriptive statistics such as mean, percentage, frequency, and Chi-square test to probit, logit, and Tobit models, giving more excellent reliability and sophisticated statistical techniques.

The disadvantage of using descriptive statistics is that they fail to predict the combined effect of explanatory variables on the dependent variables. Moreover, these techniques do not separate the influence of other variables (Feder *et al*., 1985).

Analytical models widely used to assess the probability of using soil conservation technologies include logit or probit models (Shiferaw and Holden, 1998; Lapar and Pandey, 1999; Wegayehu, 2003).

However, Lynne *et al*. (1988), as cited in Baidu-Forson, (1999), pointed out that possible loss of information may occur if a binary variable is used as the dependent variable. For example, whether a farmer uses a given soil conservation technology may not provide sufficient information about the farmer's behaviour. He/she may apply fully or partly the technologies on his farm. Therefore, a strictly dichotomous variable is often insufficient for examining the extent and intensity of the use of technologies (Feder, *et al*., 1985).

2.10 Empirical Studies on the Determinants of Soil Conservation

Studies on the determinants of soil and water conservation decision behaviour of farmers in Ethiopia have been limited. Generally, the past approach to soil conservation study emphasized technical solutions to soil erosion problems to neglecting socioeconomic constraints (Shiferaw and Holden, (1998).

Technological innovations and scientific methods were the answers to soil erosion problems for decades. However, regardless of advances in the development and promotion of technologies, the soil erosion problem persisted, forcing changes in attitudes toward the way to tackle the problem. This led to the realization that soil conservation is a technical and socio-economic problem, which directed attention to socioeconomic and behavioural factors influencing soil conservation decision-making. This is evident from the ever-increasing literature on this area (Wegayehu, 2003).

Some literature was reviewed to develop general ideas concerning agro-climatic and socio-economic factors influencing farmers' soil conservation decision-making and related topics.

In the study of resource degradation and adoption of land conservation technologies by smallholders in the Ethiopian highlands, (Shiferaw and Holden 1998) found the importance of perception of soil erosion problems, household, and farm characteristics, farmers' perception of technology-specific attributes, and land quality differentials in shaping conservation decisions.

2.11 Conceptual Framework of the Study

The conceptual framework of the research study is based on the principles of the innovation-decision process described by Rogers (1995). The farmers go through a stage of being aware or knowledgeable of new technology, forming a positive or negative attitude towards it, and ultimately deciding whether to adopt it. According to Roger (1995), the technology is passed from its source to end-users through a medium (e.g., news, media, opinion leaders, on-farm or station demonstration, farmer's field days), and its distribution to potential users is dependent on extension, the personal attributes of the individual users. This adoption behavioural framework has frequently been used to examine the adoption of various technologies by farmers and was also adopted for this study. Figure 1 provides a simple schematic framework adopted for studying adoption decisions by farmers involved in this study.

Although the technology's profitability is a prerequisite for technology adoption, several other factors affect adoption. These include socioeconomic, technological, biophysical, and land-related factors. For example, when farmers fail to adopt soil management technologies, their farms become degraded through soil erosion and nutrient depletion. Consequently, the productivity of their land is jeopardized, and crop yields decline considerably. The result is food insecurity, lack of marketable surplus at the household level, and reduced agriculture sector contribution to GDP at the national level. In the long run, these impacts reinforce each other to keep farmers and the entire economy trapped in the vicious cycle of poverty. When they adopt, the vice versa of the above situation will occur.

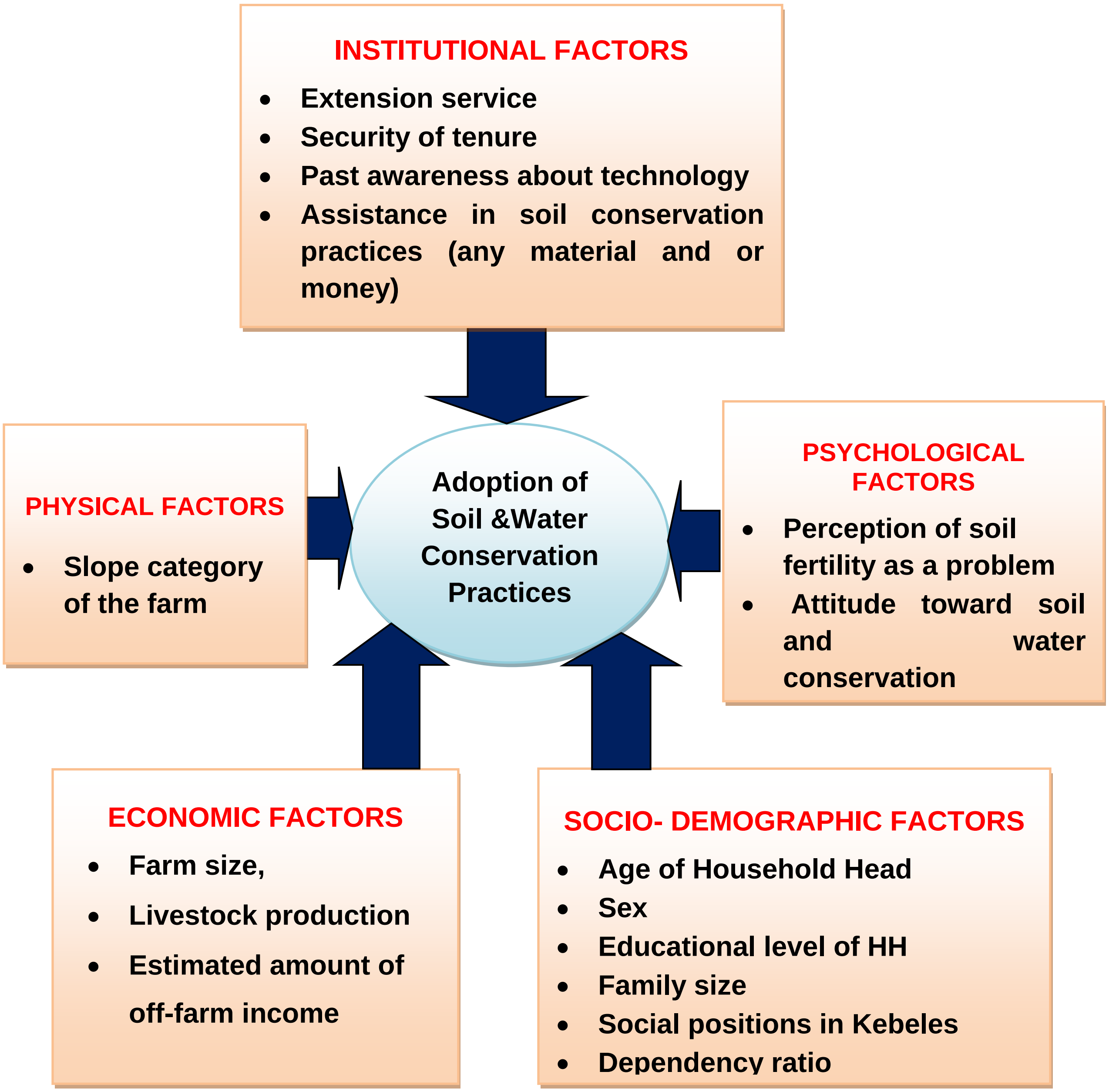

Figure 1: Conceptual Framework of the Study

***Source**: Rogers, (2003): Diffusion of Innovations (5th ed.)*

CHAPTER III

3. METHODOLOGY

3. METHODOLOGY

3.1. Description of the Study Area

3.1.1 Description of Wolaita Zone

Wolaita Zone is 13 Zones located in the southern central part of the Southern Nations, Nationalities, and Peoples' Regional State (SNNPRS). Astronomically, it is located within 6.51°-7.37° north latitude and 37.23°-38.14° East longitude.

The Zone has a population of 1,796,436, of which 886,591 are male and 909,845 are female. When these populations categorize into children, working, and old age groups, it became 839,726 (0-14 age group), 869,550 (15-64 age group), and 34,124 (65 and above age group), respectively. The zone's total area is 4,511.7 km² which categorizes the zone as one of the most densely populated areas in the country, with a density of 398.18 p/km^2. Its altitude ranges from 501-3000masl; the mean annual temperature of the zone ranges from 15.1°c to 27.5°c, and the mean annual rainfall ranges from 801mm to 1600mm. Therefore, the weather condition is categorized as low-land at 35%, mid-land at 56%, and high-land at 9% (Bureau of Finance and Economic Development, SNNPR, 2013).

The landholding of the farmers as indicated in the socio-economic profile 2003, the landless are 35,674, below 0.1ha are 166,202, 0.1-0.5ha are 53,810, 0.51-1ha are 20,293, 1-2ha are 10,490, and 2 ha and above are 5,585. (WZSEP, 2011).

Due to different factors such as land shortage, adverse climatic conditions, modern inputs and technology problems, and population density, the zone represents one of Ethiopia's primary food deficit and famine-prone parts and suffers from severe and chronic poverty and food insecurity. The rural households in Wolaita Zone faced a critical food shortage for more than six months, and overall dependence on the safety net program is very high. For instance, the safety net beneficiaries categorized as poor and poorest in 2012 in the Zone were 319 006 (WZSEP, 2012).

3.1.2 Description of Kindo Koysha Woreda

Kindo Koysha Woreda is one of 12 Woredas in the Wolaita Zone, located in the west of Soddo town at a distance of 36km and bounded by Damot Sore at North and North West, Soddo Zuria at the East South East, Offa and Kindo Didaye woreda South and Dawuro Zone the western part(See Figure 3). Geographically, it is located within 6.79° to 7.06° north latitude and 37.39° to 37.63° East longitude. The Woreda (District) includes 23 Kebeles (Villages) and two towns' kebeles. According to Zonal Socio-Economic Profile 2003, When the Woreda is agro-ecologically divided into square kilometres, Kola 284.2km^2, Woina Dega 205.26km^2 and Dega 36.84km^2 which sum up the total area of the Woreda to be 526.3km^2.

Figure 2: Administrative Map of Kindo Koysha District, Wolaita Zone
Source: Bureau of Finance and Economic Development, SNNPR, 2011.

Furthermore, the average altitude above sea level for Kolla is 600m, for WoinaDega is 1440m and for Dega is 2280. Therefore, its elevation above sea level ranges from 501meter at Omo River valley to 2500meter at Tepa (WZSEP, 2011).

3.1.2.1 Population

The total population of Woreda is 124,361 (60,984 male and 63,377 female). Almost all people except civil servants directly depend on subsistence agriculture, and side by side, depending on animal rearing. Of the total population of Woreda, the population under the children (0-14) years category is 60,534, the populations under the working category (15-64) years old are 61,955, and the population under the old age category (65 years and above) are 1872. Regarding rural and urban populations, 115,630 and 8731 are rural and urban populations, respectively. The total household rural population is 20,726. Socio-Qemer WZFED, 2012).

3.1.3. Climatic and Geo-Topographical Nature of the Area

Most of the target area is sloppy and mountainous, around 82% of the total area. Without the conservation of natural resources in this area, the production of crops is impossible. This is because of the erratic nature of rain, poor soil fertility, and shortage of land (>35% slope area used for crop production).

The topographic nature of the area is almost hilly, and besides, the erratic nature of rain facilitates the erosion capacity of the farmland. During the sowing of crops by farmers, it washed away the improved seed and fertilizers so that the farmers were forced to sow again. This nature of rain has also damaged crops' flowering and fruiting time. During harvesting time, unexpected rain damages the harvested crops. Unfortunately, no available data at Woreda indicates the damage due to the erratic nature of rain.

The target area comprises three agro-climatic zones: Highland, Midland, and Lowland. Most of the area is Midland (59.16% of the total agro-climatic zone), which is more suitable for crop production, 12.83% Highland, and 28% is a low land hard life and to work agricultural production. The Highland and Midland area is suitable for Highland and Midland crops and fruits for small land-holding households to improve farmers' income. In the case of low land parts, Borkoshe, Hanaze, and Zabeto produce vegetables and fruits with the help of small-scale irrigation. Regarding its climatic condition, the mean annual temperature of the area is 12.6°c-25°c and the mean annual rainfall of 1401mm-1600mm.

3.1.4. Crop production

Crop production has two agricultural seasons that coincide with the two rainy seasons and play a significant role in rain-fed agriculture, Belg and Meher. Meher season is the short rainy season, usually from July to September. The Belg season is the long rainy season, typically from February to June. Belg production contributed to most of the household consumption in the area. Farmers use the most cultivated land to produce maize, followed by root crops, and the minor crop to cover the land is vegetables which need intensive extension service.

Table 1 presents significant crops in terms of land coverage area and contribution to the community: Maize, Teff, Haricot been, Sweet potato, cassava, Sorghum, Wheat, Barley vegetables, and fruits. They are produced using rainfall as a source of water supply.

Table 1: Cultivated land, crop production, and productivity for 2011.

Types of Crops	Hectares	Quintals Produced	Productivity (Que/ha)
Maize	4793	239,866	50
Sorghum	351	6318	18
Teff	2558	35577	14
Wheat	514	17423	34
Barly	287	6024.7	21
Haricot bean	108	2048	19
Root crop	*4283*	763508	178
Enset	*450*	76351	170
Vegetable	*24*	3719	155
Total	**14,953**	**1,163388**	**78**

Source: **Kindo Koysha Woreda Agriculture Office, 2012.**

3.1.5. Soil and Water Conservation Practices in Kindo Koysha Woreda

Considering land degradation as a significant environmental and socio-economic problem as it was in other parts of the country, the Woreda has made remarkable efforts to reduce the negative impact of erosion by mobilizing the whole communities for free contribution and in the form of money in the PSNP program for the last 10 to 15 years. As the area is categorized as food insecure, different Non- governmental organizations in Woreda was engaged in Soil and Water Conservation activities in different forms. As a result, large areas have been converted into terraces, covered by soil bunds, closed by area closures, and planted with thousands of trees and multi-purpose tree seedlings. Nevertheless, the achievements have fallen far below expectations. The area still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly. Rural communities living in highly degraded and drought-prone highland areas, such as the highlands of the Fachana, Bade Woyde, Doge Laroso, etc., are involved in SWC (Soil and Water Conservation) activities and food for work under the PSNP.

The Kindo Koysha Woreda lies in the Omo River Basin. Currently, Gilgel Gibe 3 Hydro-electric power station is under construction and consists of land drained by the Baliya and Gamuwa Rivers from above. The Omo River flows northwest to the south to Lake Turkana; its tributaries effectively drain large catchment areas of Hadiya, Wolaita, Dawuro, Gamo Goffa, and South Omo zones.

Soil erosion in this area is severe and accompanied by mountainous and hilly topography; the area experiences a low degree of vegetation cover and gully erosion. As a result, soil erosion has made cultivation infeasible in several parts of the watershed. In addition, increasing population pressure has forced farmers to cultivate new and more marginal areas, including steep slopes.

3.2. Research Design

3.2.1 Type and Sources of Data

Both relevant qualitative and quantitative data were collected from primary and secondary sources. The primary data were collected from 108 individual farm households selected from five purposefully selected rural kebeles in the Kindo Koysha district using a formal sample survey. The general information collected from this source includes household characteristics, landholding and farm characteristics, farmers' awareness and perception of soil erosion problems, soil conservation technologies and attitudes, tenure arrangement, institutional support, demographic characteristics, and income status of the sample households. The secondary data were collected from published and unpublished documents from different sectors and organizations. Furthermore, five FGD sessions were arranged in each Kebele, comprising 6 to 10 members in each group. The group members comprised Kebele representatives, Development Agents, and community elders. Some relevant sectors, such as Woreda Agricultural Office and Finance and Economic Development Offices, were secondary data sources to triangulate the qualitative and quantitative data collected from primary and secondary sources.

3.2.2. Sampling Procedure

The Multi-Stage Sampling was employed to draw samples primarily based on Zone, Woreda, and Kebele (See Figure 2). The first three-stage involved the purposive selection of Zone, Woreda, and Kebele at different stages. In the First Stage, the Zone was selected. The second Stage, the Woreda, was selected based on the susceptibility of Woreda to erosion risks (% of undulated terrain), the presence of SWC structures, and personal knowledge about the Woreda as a researcher currently in this Woreda. In the Third Stage, Kebele's selection was based on the agro-ecological nature. In this case, Fachana and Bade Woyde were selected as Highland Kebeles, and Borkoshe, Chereche, and Doge Laroso were selected as MidlandKebeles. Finally, in the Fourth Stage, those agro-ecologically selected kebeles were categorized into villages based on agroecology.

Regarding the Highland Kebele, only those villages that belong to the Highland agroecology setting were selected. Those villages belonging to Midland and Lowland agroecology were left out as the conservation structure is rare in the Lowland area. Midland agro ecology-based villages for Highland Kebeles were left to make the sample representative. In Midland Kebeles, those villages belonging to Midland agroecology were selected, and for the same reason, those villages belonging to Lowland agroecology were left out. The fifth stage involved a simple random sampling of households from the list of villages. To facilitate this final stage, lists of household names in each selected village were obtained from the chiefs and village headmen in the study areas. Finally, farming households were selected using a table of random numbers to be interviewed. To make the respondents' female-headed households sensitive, more than 20% of the total interviewers were from female-headed households.

Pictorial form of Sampling Procedure

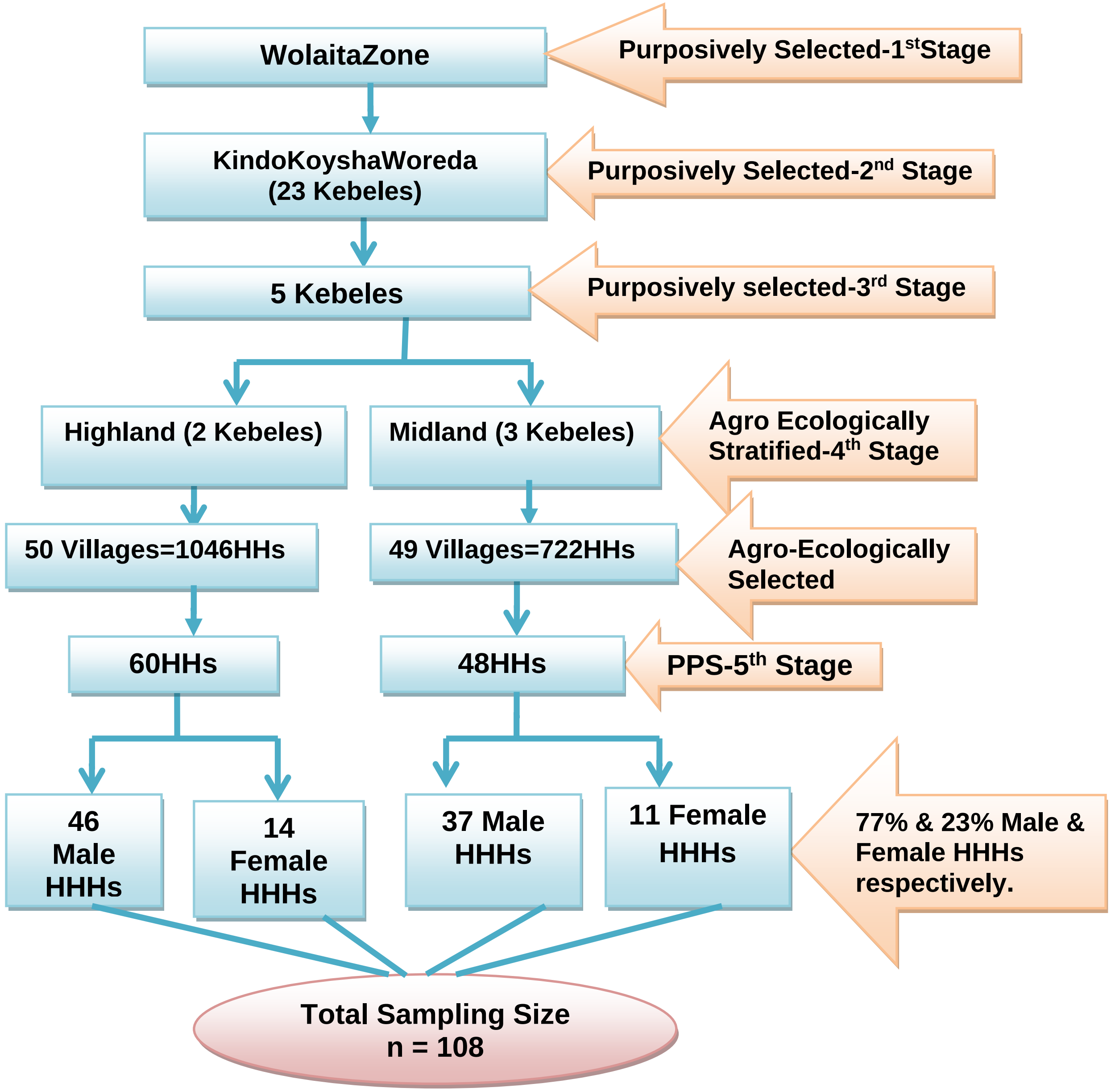

Figure 3: Sampling Procedure

3.2.3 Methods of Data Collection and Sampling Techniques

This study's primary data was generated from the sample households by conducting a formal survey using a structured interview schedule in March 2014. Five enumerators were selected based on educational background, experience in the stated field, and personal talent.

Having finished the selection process, a one-day orientation was given on the contents of the interview schedule, ways of capturing informal information, data collection methods, and related topics. Then structured interview schedule was developed, and before conducting the formal survey, a pre-test was conducted with three respondents. Findings identified during the pre-test were incorporated before completing the preparation of the question. Data were collected at the household level. Enumerators gathered data on identified variables from sample farm households under the researcher's supervision. Considering the presence (diffusion) of Soil and Water Conservation Technologies, 5 Kebeles were selected from the total number of 23 rural Kebeles in Woreda.

Because the diffusion and implementation of soil conservation technologies have been undertaken only in Dega and Woyna Dega climatic zone, each Kebele was categorized into three agroecology to exclude those households which belong to Kolla agroecology so that the selected households in these five Kebeles are found in one the two agro ecologic zones. Based on the number of households in these two agro-ecologies, 48 households from Dega Villages and 60 from Woyna Dega Villages were selected. Considering the total number of households in each Kebele, 108 sample farm households were selected proportionately and randomly employing Yemane's (1967) formula. Table 2 presents a summary of the sampling technique and sample size.

Table 2: Sample households from each Kebele.

Name of Kebeles	**Agro-Ecological Setting**				**Total HHs**	**Sample HHs**
	Dega		**WoynaDega**			
	Villages	HHs	Village	HH		
Fachana	20	380	-	-	380	26
Bade Woyde	29	342	-	-	342	22
Borkoshe	-	-	23	482	482	28
Chereche	-	-	12	260	260	15
Doge Laroso	-	-	15	304	304	17
Total	**49**	**722**	**50**	**1046**	**1768**	**108**

3.3 Analyses of Data

3.3.1 Descriptive Statistics

Analysis was made using inductive reasoning to describe the collected data and the integration, generalization, and classification of the data into categories. First, the data set was coded and categorized. The data was entered and cleared using Microsoft Excel software and imported into SPSS 16. Counting the frequency of occurrences was employed, and simple descriptive statistical procedures like average, percentage, and other tests of significance such as X^2, and t-test were employed using SPSS software. The results obtained from different categories of respondents have been interpreted accordingly.

3.3.2 Specification of Model

The multi-nominal logit regression model was applied to analyse the data. Farmer's use of physical soil and water conservation practices was dependent, while different hypothesized/conceptualized variables were considered independent variables.

To identify the determining factors behind the farming household's decision to engage in various physical soil and water conservation practices, the assumption is that a rational farming household head chooses among the three mutually exclusive physical soil and water conservation practice alternatives in a given period the maximum benefit. Following (Gujarati, 1995), suppose for the i^{th} respondent faced with j^{th} choices, we specify the utility choice **j** as:

$$U_{ij} = Z_{ij}\beta + \varepsilon_{ij} \quad \text{.......(1)}$$

If the respondent makes choice j in particular, we assume that **Uij**is the maximum among the j utilities. So the statistical model is derived by the probability that choice j is made, which is:

$$\text{Prob}\ (U_{ij} > U_{ik}) \text{ for all other } K \neq j \quad \text{.......(2)}$$

Where **Uij** is the utility to the i^{th} respondent from physical soil and water conservation activity **j**

Uik the utility to the i^{th} respondent from physical soil and water conservation activity **k**

Suppose the household maximizes its utility defined over income realizations. In that case, the household's choice is simply an optimal allocation of its asset endowment to choose physical soil and water conservation activity that maximizes its utility. Thus, the **i^{th}** household's decision can, therefore, be modelled as maximizing the expected utility by choosing the **j^{th}** conservation structure among J physical soil and water conservation activities, i.e.,

$$\max_j = E(U_{ij}) = f_j(x_i) + \varepsilon_{ij};\ j = 0...J \quad \text{...(3)}$$

In general, for an outcome variable with J categories, let the j^{th} soil and water conservation activity that the i^{th} household chooses to maximize its utility could take the value 1 if the i^{th} household chooses j^{th} soil and water conservation activity 0 otherwise. Then, the probability that a household with characteristics x chooses soil and water conservation activity j, P_{ij} is modelled as:

$$P_{ij} = \frac{\exp(X_i^{'}\beta_j)}{\sum_{j=0}^{J}\exp(X_i^{'}\beta_j)}, \quad \textbf{J=0} \text{...(4)}$$

With the requirement that $\sum_{j=0}^{J} P_{ij} = 1$ for any ***i***

Where: $\boldsymbol{P_{ij}}$= probability representing the $\boldsymbol{i^{th}}$ respondent's chance of falling into category ***j***

X= Predictors of response probabilities

$\beta_j =$ Covariate effects are specific to the **j^{th}** response category, with the first category as the reference.

Appropriate normalization that removes an indeterminacy in the model is to assume that $\beta_1 = 0$ (this arises because probabilities sum to 1, so only J parameter vectors are needed to determine the **J + 1** probabilities) (Gujarati, 1995) so that $\exp(X_i\beta_1) = 1$, implying that the generalized equation (4) above is equivalent to

$$\Pr(y_i = j / X_i) = P_{ij} = \frac{\exp(X_i\beta_j)}{1 + \sum_{j=1}^{J}\exp(X_i^{'}\beta_j)},$$ for j = 0, 2…J and

$$\Pr(y_i = 1 / X_i) = P_{i1} = \frac{1}{1 + \sum_{j=1}^{J}\exp(X_i^{'}\beta_j)}, \quad \text{...(5)}$$

Where: **y** = A polychromous outcome variable with categories coded from 0… **J.**

Note: The probability of P_{i1} is derived from the constraint that the *J* probabilities sum to 1. That is, $p_{i1} = 1 - \sum p_{ij}$. Similar to the binary logit model, it implies that we can compute J log-odds ratios, which are specified as;

$$\ln\left[\frac{p_{ij}}{p_{iJ}}\right] = x'\left(\beta_j - \beta_J\right) = x'\beta_j, if, J = 0 \qquad \text{..(6)}$$

3.3.3 The Dependent Variable of the Study

According to adoption studies, various factors are responsible for farmers' decisions to adopt or reject new agricultural technologies. These factors include socio-demographic, economic, psychological, institutional, and physical factors. Therefore, this study's intended dependent variable is farmers' adoption of physical Soil and Water Conservation practices, especially bunds (Soil bunds =$\mathbf{Y_0}$, Stone bunds=$\mathbf{Y_1}$**,** Soil faced Stone bund=$\mathbf{Y_2}$) Fanyajuu bund=$\mathbf{Y_3}$) are to be influenced by independent variables specified below.

3.3.4 The Independent Variables of the Study

It is hypothesized that a set of explanatory variables influences the decision to participate in environmental schemes. Various authors have examined the role of different variables. Much research on the uptake of environmental schemes has investigated farmers' behaviour concerning policy objectives and farming context. Physical form factors (percentage of the total area under crops, grassland area, total labour available, slope, etc.) were considered necessary to uptake environmental schemes in agriculture Wynn *et al.*, (2001). Based on the findings of past studies on farmers' decisions on investment and participation in soil management practices, the following explanatory variables were hypothesized to determine the farmers' willingness to participate in soil conservation practices.

Age of the household head (AGEHH)

The effect of a farmer's age on investment decisions can be a composite of farming experience and planning horizon. While more extended experience has a positive effect, young farmers, on the other hand, may have a longer planning horizon and may be more likely to invest in conservation. A priori Lucila et al. (1999) could not determine the net effect. However, Featherstone and Goodwin (1993) reported that an older individual looking at a shorter time horizon might not recoup all of the benefits from conservation investment. Similarly, Tegegne (1999) found that age negatively affected conservation decisions because it decreased participation in environmental protection. Thus, in this study, it is hypothesized that age negatively influences participation in soil conservation activity.

Sex of the household head (SEXHH)

This is a dummy variable, which takes a value of 1 if the household head is male and 0 otherwise. The sex of the household head was included to differentiate between males and females in their valuation of environmental protection. Tegegne (1999) reported that females, instead of males, participate more in environmental protection during peak season while males participate more during the slack season. The net effect may not be determined before the analyses of the results.

Education level of the household head (EDUCHHH)

This is a dummy variable, which takes 1 if the household head is literate and 0 otherwise. Education increases farmers' ability to get, process, and use information. Education is positively correlated with farmers' adoption and soil conservation efforts Tegegne, (1999); Ervin and Ervin, (1982). Education is expected to reflect acquired knowledge of environmental amenities. Therefore, it is hypothesized to have a positive role in participating in soil conservation activities.

Family Size (FAMSIZ)

This refers to the total number of family members. Imperfections in labour markets imply that households with sizeable human capital may invest more in conservation. In addition, the larger the family, the higher the probability that future generations will farm the land and reap the benefits of conservation investments (Featherstone and Goodwin, 1993). Thus, family size is hypothesized to positively influence soil conservation activity in this study.

Social Position in the Kebele (SOCPOSN)

The social position is assumed to determine the adoption of new technology as communication increases for farmers with better social status than others. This has resulted in more access to information and, hence, a better understanding of a specific technology for adopting new technology. The study by Singh (1991) indicated that farmers with both leadership statuses in the community were likelier to adopt Soil and Water Conservation Practices. It refers to the involvement of farmers in different administrative, religious, and other matters in the community. Therefore, it is expected that farmers in different positions are more likely to use soil-conserving technologies to be exposed to different information and ideas.

Dependency Ratio (DPNCY)

An increase in the consumer-worker ratio (dependency ratio) reduces the ability to meet subsistence needs and increases the personal rate of time preference (Bekele*et. al.,* 1997). Therefore, this variable is expected to have a negative effect on farmers' willingness to participate in soil conservation activities.

Farm Size owned by the Household in hectares (FARMSZ)

As the farm size of a given household increases, the probability of a household investing in soil and water conservation practices will decrease, indicating a negative relationship.

Size of Livestock holding (TLU)

Where credit markets are imperfect, the size of livestock holding may ease capital/cash constraints. It also reduces the subjective rate of time preference (Shiferaw and Holden, 1998) and provides security (lower risk) to land users, enhancing conservation investments. On the other hand, more specialization in livestock, away from cropping, may reduce the economic impact of soil erosion and/or increase the availability of manure needed to counter nutrient depletion, thus lowering the need for soil conservation. Hence, the effect of the size of livestock holding on conservation decisions was challenging to hypothesize a priori.

Estimated amount of farm income in birr (FINCOM)

The farm income's net effect on investments in land quality is indeterminate on theoretical grounds (Gould *et al*., 1989). Increasing dependence on non-agricultural activities may lower the economic significance of soil erosion. On the other hand, off-farm income may ease the constraint on liquidity needed for conservation investments. Generally, farm income is hypothesized to have a positive effect on soil management.

Perception of Farmers as erosion is a problem (PERCP)

A dummy variable for the perception of soil erosion problem. The recognition of the soil erosion problem is considered to be vital for soil conservation decisions. In other words, farmers who have already perceived the problem of soil erosion are more likely to be willing to participate in soil conservation activities than those who have not perceived the problem. Thus, the perception variable was expected to strongly affect farmers' decision to participate in soil management practices (Lynee *et al*., 1988).

Attitude of the farmer (FAMERATID)

This variable takes a value of 1 if there is a desire to try a new technology at its own cost and 0 if the desire is to wait until other land users have adopted it. Economic incentives will increase efforts, but responsiveness will differ with conservation-related attitude strength (Lynee *et al*., 1988). Cary (1986) indicated that peasants with a generally positive attitude towards new technologies are keen on undertaking and keeping conservation structures. Hence, in this study, attitude is hypothesized to affect soil conservation practices positively.

Extension Service (EXTSRS)

The extension services were one of the institutional characteristics expected to influence farmers' decision to adopt new technology. The service could be rendered to the farm households through various means such as field days, visiting demonstration fields, and participation in training. It indicates whether the household head gets extension service from Development Agents (DAs). Extension service provides the necessary information to acquire new skills and knowledge to improve soil conservation efforts. Therefore, access to extension education for farmers and using soil conserving practices or technologies are expected to be positively correlated.

Security of Tenure (SECTEN)

A dummy variable would take a value of 1 if the peasant considered that he/she would be able to use the parcel at least during their lifetime and 0 otherwise. The incentive to land improvement decisions is partly based on secured future land access. In many studies, tenure insecurity is a limiting factor to conservation investment (Barret, 1996). In this study, the farmer's feeling about using a given parcel at least during his/her lifetime was hypothesized to positively affect his/her decision to participate in conservation activities.

Past Awareness about Technology (TECHAWARE)

A dummy variable takes a value of 1 if the farmer has taken part in the soil conservation activities in the past and 0 otherwise. Knowing available soil conservation options makes land users more receptive to conservation structures (Shiferaw and Holden, 1998). Therefore, in the past, conservation undertaking was hypothesised to positively affect participation in conservation works.

Assistance in Soil Conservation Practice (ASSCOSOIL)

It is a dummy variable, referring to any assistance rendered to the farmers in soil conservation practices. It would take a value of 1 if the respondent received assistance from any source and 0 otherwise. Conservation investment costs a lot, and it is difficult to see the benefit in the short-term planning horizon. In addition to this, physical conservation practices require more labour and materials, which the farmer cannot afford (Neupane, R.P., Shamara, K.R., Thapa, G.B. 2002). The propensity to invest in land conservation practices is expected to increase in areas where Governmental and Non-Governmental Organizations are involved in agricultural development activities. Hence, any source's assistance (material, technical, and other incentives) encourages the farmers to decide on conservation practices, and a positive effect was hypothesized.

Slope category of the farm (SLOP)

This is a dummy variable for the slope category of a parcel, which takes a value of 1 if the slope is steep or very steep and 0 otherwise. The slope category of the parcel has been found to positively affect the farmer's decision to invest in conservation technology (Ervin and Ervin, 1982; Gould *et al.*, 1989). The slope variable is thus expected to positively affect farmers' decision to participate in soil conservation practices. Table three presents the name of the variables used, variable types, their measurements, and effects.

3.3.5 Hypothesized Variables

Table 3: Hypothesized variable and their relationship.

S. No.	Name of Variables	Measurement	Variable Type	Expected Effect
1	Age of the household head	Years	Continuous	-
2	Sex of the household		Dummy	-
3	Education level of the household head	-	Dummy	Positive
4	Family size	Number	Continuous	Positive
5	Dependency ratio	Number	Continuous	Negative
6	Social position in the kebele	-	Dummy	Positive
7	Farm size owned by the household in hectares	Hectare	Continuous	Negative
8	Size of Livestock holding	TLU	Continuous	Negative
9	Estimated amount of farm income	Birr	Continuous	Positive
10	Extension service	Rate of visit	Dummy	Positive
11	Security of tenure	-	Dummy	Positive
12	Past awareness about technology	-	Dummy	Positive
13	Assistance in soil conservation practice	-	Dummy	Positive
14	Farmers' Perception of erosion hazard	-	Dummy	Positive
15	Attitude of the farmers	-	Dummy	Positive
16	Slope category of the farm	Per cent	Dummy	Positive

CHAPTER IV

4. DATA ANALYSIS AND RESULTS

4. DATA ANALYSIS AND RESULTS

This section deals with the description and interpretation of the findings of this study. It also compares the present research findings of this study with previous research studies.

4.1 Descriptive Analysis of the study

4.1.1 Socio-Demographic Factors concerning Adoption of SWC practices

4.1.1.1 Age

The age of the farmer was hypothesized to influence in two directions. That is farming experience and planning horizon. While more ample farming experience has a positive effect, young farmers, on the other hand, may have a longer planning horizon and hence, may be more likely to invest in conservation, showing also it has a positive effect on soil and water conservation decision. On the other hand, Featherstone and Goodwin B.K. (1993) reported that an older individual looking at a shorter time horizon might not be able to get back all of the benefits from conservation investment, implying that the result would be negative.

Based on sampled households, 37.96% (41) used stone bunds to conserve their land with a mean age of 49.02 years, and 47.22% (51) used both structures (stone bund with soil bund) with a mean age of 45.04 years, 14.81% (16) were used soil bund only with the mean age of 42.62 years. The result shows that more than 33% are under, with a longer planning horizon. The remaining 67% of respondents were in older age groups with more ample farming experience. Farmers in this working age group are assumed to better access soil and water conservation information.

One sample t-test value shows that the mean age is 45.69, standard deviation 10.824, standard error 1.003, and t-value 19.86, significant at a 1% probability level. See table 4, which shows the mean age for three types of structures with their t-value and SD.

Table 4: Age of the sample household respondents

Soil conservation structures	Mean age
Stone bund	49.02
Soil bund	42.62
Both	45.05
Total mean	**45.56**
Maximum	**72**
Minimum	**25**
SD	**10.824**
t-value	**19.86**
P-value	**0.000*****

Note: *** at less than 1% probability level.

***Source:* Own survey, 2014**

4.1.1.2. Sex of the Household

Studies conducted on Sex to differentiate between Males and Females in their valuation of environmental protection show that females instead of males tend to participate more in environmental protection during peak season while males participate more during slack season Tegegne (1999). Sex of the household in the sampled household was cross-tabulated with physical soil and water conservation structures to know the association between sex and the conservation structures; the result shows that there is no association between sex and conservation structure with a chi-square of 2.24 and a p-value of 0.32 (See Table 5).

Table 5: Physical SWC activities implemented by farmers * Sex of respondent.

Type of SWC Conservation Activities.	Sex of the Household		Total
	Male	Female	
Stone bund	35	6	41
Soil bund	12	4	16
Both	37	14	51
Total	**84**	**24**	**108**
Chi-square			**2.24**
P-value			**0.32**

Note: Not significant

***Source:* Own survey, 2014**

4.1.1.3 Educational Level of household

Education has a significant role in processing and interpreting the information received from any source. Similarly, it is impossible to communicate with relevant professionals without educational backgrounds and interpret any received information. Of 108 sampled households, 64.8% (70) are literate, which means they can read and write, and the remaining 35.2% (38) are illiterate. This, in turn, shows that 64.8% of the respondents can utilize the information on soil and water conservation practices supplied by their counterparts and professionals. The result depicts that better-educated households have a more realistic understanding of soil erosion problems and more knowledge of soil water conservation practices and can more easily be involved in conservation activities, indicating a positive relationship.

The chi-square and p-value result shows significance at a 5% probability level with a chi-square of 17.54 and a p-value of 0.025. This result is in line with the findings of Ervin and Ervin (1982). They found that education was significantly related to conservation efforts. More educated farmers are more likely to use contouring, minimum tillage, and hay or pasture rotation to control soil loss and found a positive relationship (See Table 6).

Table 6: Educational level of household Vs. Soil and water conservation structures

Education level	Structure carried out by households			
	Stone bund	Soil bund	Both	Total
Illiterate	22	1	15	38
Literate	19	15	36	70
Total	**41**	**16**	**51**	**108**
Chi-square		17.54		
p-value		0.025**		

Note: ** at less than 5% probability level.

***Source:* Own Survey, 2014**

4.1.1.4 Social Position in the Kebele (SOCPOSN):

It refers to the involvement of farmers in different administrative, religious, and other matters in the community or their respective Kebele. According to the result identified in the sample survey, of 108 respondents, 44 (38.9%) were members of at least one social position in their respective Kebele. Likewise, as depicted in Table 7, there was no recognized association between social position and soil and water conservation structures. This finding opposes Singh's previous finding (1991), which recognized a positive association between social position and soil and water conservation practices. This result was strengthened by the value of X^2 =0.884 and a probability level of 0.933

Table 7: Farmers' participation in Social organization in their respective Kebele Vs physical soil and water conservation structures implementation

Participation in Social Organizations	Physical Structures			Total
	Stone bund	Soil bund	Both	
Member of Council	3	1	7	11
KebeleCadre	4	3	7	14
Cooperative Member	3	2	2	7
Village Leader	5	0	0	5
Two and above	3	2	2	7
Total	**18**	**8**	**18**	**44**
Chi-square	0.88			
p-value	0.933			

Source: Own survey, 2014

Not Significant

4.1.1.5 Family Size (FAMSIZ):

It was hypothesized that households with sizeable human capital might invest more in conservation (Shiferaw and Holden, 1998). In addition, the larger the family, the higher the probability that future generations will farm the land and reap the benefits of conservation investments (Featherstone and Goodwin, 1993).

Based on Table 8 below, the family size varies from 2 to 10 with a minimum of 2, and the maximum 10 average family size is 5.23 with a standard deviation of 1.705. The t-value=3.83 and p-value of 0.000*** show a strong relationship between family size and soil and water conservation practices. The result is in line with the findings of Shiferaw and Holden (1998) and Featherstone and Goodwin (1993)

Table 8: Descriptive Statistics for a family size of sample households Vs. Conservation measures

Conservation measures	Mean Family size	Total
Stone bund	5.6	41
Soil bund	4.8	16
Both	5.29	51
Total mean	**5.23**	**108**
Minimum	2	Std. Deviation=1.75
Maximum	10	t-test =3.83
Sum	608	p-value=000***

Note: *** Significant at less than 1% probability level

***Source:* Own survey, 2014**

4.1.1.6 Dependency Ratio

An increase in the consumer–worker ratio (dependency ratio) reduces the ability to meet subsistence needs and increases the personal rate of time preference (Shiferaw and Holden, 1998). Therefore, this variable is expected to have a negative effect on farmers' willingness to participate in soil conservation activities.

As predicted, the dependency ratio has a negative effect on soil and water conservation application decisions. The survey result shows that the maximum dependency ratio for sample households was 4, and the minimum was 0.1, totalling 130.98. The mean value of the dependency ratio for surveyed households was 1.21. For stone bund construction, the mean value was 1.08, for soil bund 1.34, and for both stone and soil bund, 1.23 with SD=0.83, t-value= -24.02, and p-value =0.000***, which shows a robust negative relationship (See table 9 below).

Table 9: Dependency Ratio and the survey Households

Physical structures	Mean value for structures
Stone bund	1.08
Soil bund	1.34
Both	1.23
Maximum= 4	**SD=0.83**
Minimum =0.1	**t-test -24.02**
Sum =130.98	**0.000*** **

Note: *** significant at less than 1% probability level.

Source: Own survey, 2014

4.1.2 Economic Factors of the adoption of soil and water conservation practices

4.1.2.1 Area of farmland (Farm Size):

Soil and water conservation structures may take some area that would have been used for the farm (growing of crops). Therefore, farmers who operate on larger farms can allocate some part of the land more than on small farms. On the other hand, farmers with a more apparent farmland size seem to be less interested in investing more time in soil and water conservation practices; instead, they like to increase their production by extending their farm size.

The researcher faced difficulty in hypothesizing whether it influenced positively or negatively analysis. However, the analysis shows that the mean land size for stone bund construction was 0.63, for soil bund construction was 1.196 and both, 0.69. As shown in Table 10, this result shows that those farm households with larger farmland sizes were relatively interested in soil bunds to protect their land from soil erosion, and the rest used stone bunds and both to stabilize their land. Regarding the land size of sample households, the minimum landholding was 0.0125Hectare; the maximum was 2.25Hectare with a total sum of 80.06hectare, and its SD and t-value were 0.53 and 9.63, respectively, which shows that it has a strong relationship with soil and water conservation practices positively with less than 1% probability level. The following table shows the mean value of landholding with its t-test.

Table 10: Mean of Land Size distribution under surveyed households

Physical structures implemented by survey Household Head	Mean of Land size
Stone bund	0.63
Soil bund	1.196
Both	0.69
Total Mean	**0.74**
t-test,	**9.63**
SD,	**0.53**
Significance	**0.000*****

Note: significant at less than 1% probability level.

***Source:* Own survey, 2014**

4.1.2.2. Livestock holding:

This variable represents the livestock holding of the household in a tropical livestock unit. It is used as an indicator of wealth and a source of farmyard manure. Livestock in the study area is more of a mixed farming system based on the complementarities effect to increase crop productivity and animal productivity and, on the other hand, a source of income. Therefore, when livestock increases in farm households away from cropping may reduce the economic impact of soil erosion and lower the need for soil conservation; on the other hand, those farmers who have a large number of livestock may have more capital to invest in soil conservation practices. This affects the use of soil conservation measures positively. However, conservation technologies are more labour-intensive in the study area and require less capital. Therefore, livestock holding size is hypothesised to affect conservation investment negatively.

The type and the total number of livestock owned across all sample households are given in Table 11. Sample farmers rear livestock for various purposes, including draft power, milk, meat, eggs, transport, and other purposes. The survey result shows that for 48% of sampled households, the source of feed for livestock is grazing by cut and carry system, and 52% of the respondents fed their livestock by different sources such as straw, crop residues, farmyard vegetations and sometimes on grazing. Regarding pasture land ownership, 60.2% use it individually, 28.7% use it communally, and the remaining 10.2% use it individually and communally.

The data analyzed descriptively shows that the size of livestock influenced soil and water conservation structures negatively at less than 1% probability level with a t-test is -5.11and significant level of 000***. The mean size of livestock is 2.3, and SD is 1.41. Table 12 shows the mean value and t-value of the sample households.

Table 11: Livestock holding of surveyed households

Categories of Livestock	Number of animals	TLU
Ox	57	57
Cow	92	92
Calve	73	18.25
Heifer	31	23.25
Horse	1	1.1
Donkey	8	5.6
Goat	139	18.07
Sheep	47	6.11
Mule	-	-
Chicken	156	2.028
Total		**248.705**

Source: **Own survey, 2014.**

Table 12: The mean value of TLU with their soil conservation structure

Physical structures implemented by HH	Mean of TLU
Stone bund	2.14
Soil bund	3.13
Both	2.07
Total Mean	**2.3**
t-test,	**-5.11**
SD,	**1.41**
Significance	**0.000*****

Note: 000 at a probability level less than 1%.***

Source: Own survey, 2014.

4.1.2.3 Household income

The net effect of farm household income on investments in land quality is indeterminate on theoretical grounds (Gould *et al*., 1989). However, increasing dependence on agricultural activities may increase the economic significance of soil erosion. On the same notion, farm income may ease the constraint on liquidity needed for conservation investments, positively affecting soil and water conservation activity. Generally, farm income is hypothesized to affect soil and water conservation practices. On the other hand, off-farm might have an adverse effect on soil management. The net effect of combining off-farm income and other farm sources would not be determined before analysis.

The data analysis reveals that total farm income has positively and strongly affected farmers' soil and water conservation practices, with the mean value for stone bund 2495.86 birrs for soil bund 4061.25 birrs and both 3191.97 birrs. This result shows that farmers with relatively higher income choose soil bunds to protect their land and those with less mean income showed their interest in using stone bunds. This may be due to the scarcity of farmland and the sloppiness of their farm, which forced them to use a more intensive type of conservation structure(stone bund) as it takes less area to construct other forms of conservation structure. As seen in table 13, the t-test and p-value are 5.92 and 0.000***, respectively, which shows that income positively and strongly influences farmers' soil and water conservation decisions in the study area.

Table 13: Shows the mean value of farm household income of sample households based on each structure implemented and its t-value.

Soil Conservation Structures	Mean income
Stone bund	2495.86
Soil bund	4061.25
Both	3191.97
Total mean	**3249.69**
Maximum	**17800**
Minimum	**100**
SD	**3138.04**
t-value	**5.92**
P-value	**0.000*****

Note: Significant at less than 1%.

Source: Own survey, 2014

4.1.3. Psychological Factors

4.1.3.1.Perception of farmers on Soil and Water Conservation Practices(PERCP):

Recognizing Soil and Water Conservation practices' effectiveness is vital for soil conservation decisions. In other words, farmers who have already perceived Soil and Water Conservation practices are more likely to be willing to participate in soil conservation activities than those who have not perceived the measures. For example, the Likert scale measured farmers' perception of physical soil and water conservation structures showing that 36.11% agreed and, 59.25% strongly agreed, up to 95.37% claimed the effectiveness of the structure. In comparison, the remaining 4.63% were neutral. (See Table 14 below).

The cross-tabulation result reveals no significant association with soil and water conservation practices, with a chi-square of 0.71 and a p-value of 0.95. Click here (**https://www.youtube.com/watch?v=7j06mC9FvLk)**

Table 14: Shows Cross-tabulation of Farmers' Perceptions of Physical SWC activities.

Physical soil and water conservation activities	Farmer's perception of the effectiveness of structures in protecting against soil erosion					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Stone bund	0	0	2	15	24	41
Soil bund	0	0	0	8	8	16
Both	0	0	3	16	32	51
Total	0	0	5	39	64	108
Chi-square						**0.71**
p-value						**0.95**

Not significant

***Source:* own survey, 2014**

4.1.3.2 Attitude of the farmer (FAMERATID):

Past studies on farmers' attitudes toward soil and water conservation indicated that peasants with a generally positive attitude towards new technologies are keen on undertaking and keeping conservation structures. Based on this, farmers were asked how they perceived soil fertility since they started farming compared to the past and were cross-tabulated to know how many of them undertook soil conservation works on their farms. The cross-tabulation result shows that, of those who perceived their farms' soil fertility increased, 89% were undertaken soil conservation activities on their farm plot. On the other hand, of those who answered that their farm's soil fertility was declining, 55% were undertaken soil conservation activities.

Similarly, cross-tabulation was carried out (table 15) to know the perception of farmers who dismantled existing soil and water conservation structures; of those who claimed to decrease soil fertility on their farm plot (76.8% or 83) of 108 respondents, 89% or 73 were agreed that they had partially dismantled previously constructed soil and water conservation structures by their descendants due to scarcity of cropland.

Here their partial dismantling is not because of a lack of knowledge on conservation structures but because of the scarcity of cropland due to the re-division of the existing for their descendants. (Source:ownKey Informants and Focus Group Discussion). The cross-tabulation result carried out to know farmers' attitude reveals that there is no strong relationship between attitude and implementation of conservation structures with chi-square 3.955 and p-value0.412

Table 15: Shows a cross-tabulation of farmers' attitudes toward Physical SWC activities.

Physical SWC activities	**Farmers attitude**			
	Neutral	**Agree**	**Strongly agree**	**Total**
Stone bund	2	25	14	41
Soil bund	0	11	5	16
Both	4	29	18	51
Total	6	65	37	108
Chi-square				**3.955**
P-value				**0.412**

Not significant(NS)

***Source:* Own survey, 2014**

4.1.4. Institutional Factors with Adoption Soil and Water Conservation Practices.

4.1.4.1. Extension Service (EXTSRS):

It indicates whether the household head gets extension service from development agents (DAs). Extension service provides the necessary information to acquire new skills and knowledge for farmers to improve soil conservation efforts.

Access to extension services and sources of agricultural information by sample households reveals that of 108 sample farmers, those farmers who contacted Kebele extension agent once per are 37.96percent, twice a month were 15.74%, three times per month were 21.3%, and 25% were got extension service not more than four times per year. This result shows that extension service and SWC practices have no linkage with chi-square 7.18 and p-value 0.31. Table 16 and 17 represents access to extension service and source of agricultural information by sample farmers.

Table 16: Access to Extension Service by sample households

Physical soil and water conservation activities	How often have you obtained extension advice on soil conservation practices?				Total
	Once per Month	Twice per Month	Three times per Month	Not more than four times per Year	
Stone band	16	6	5	14	41
Soil band	7	4	3	2	16
Both	18	7	15	11	51
Total	**41**	**17**	**23**	**27**	**108**

Table 17: Response on the source of agricultural information by sample households

Physical soil and water conservation activities	Source of Agricultural information for farmers			Total
	Other Farmer	Mass media	Extension Agent	
Stone band	1	0	40	41
Soil band	1	1	14	16
Both	3	1	47	51
Total	**5**	**2**	**101**	**108**
chi-square		**7.18**		
p-value		**0.31**		

Not Significant (NS)

Source: Own survey, 2014

4.1.4.2 Security of tenure (SECTEN)

Security of tenure indicates the scope the right farmer has to use his land for long-term development. Therefore, security gives the farmers confidence to invest in the land, bringing maximum benefits. On the other hand, farmers are expected to be reluctant to improve theirs and have no full rights on their land. Therefore, it is hypothesized that tenure security and soil conservation efforts are positively correlated.

Based on the survey to know whether they feel the land belongs to them, the result shows that more than 90% of the respondents asked in three different ways replayed that they are confident enough to use their land in the long run. The remaining 10% claimed they have no confidence in using their land in the long run. Furthermore, when they were asked whether they had the right to inherit the land from their children or not, 87.03% claimed that they had the right to inherit their land from their children. Statistically, land security does not affect the use of soil and water conservation practices with a chi-square of 0.85 and p-value of 0.65. Table 18 represents physical soil and water conservation activities vs farmers' right to inherit their land to their children, their privacy to use their land throughout their lifetime and the ownership of their land to the government or not.

Table 18: Response on land tenure security by sample households.

Physical soil and water conservation activities	Do you think you have the right to inherit the land for your children?		Total
	Yes	No	
Stone band	34	7	41
Soil band	13	3	16
Both	47	4	51
Total	**94**	**14**	**108**
Physical soil and water conservation activities	**Do you expect that you will use the land throughout your lifetime?**		**Total**
	Yes	No	
Stone band	34	7	41
Soil band	13	3	16
Both	47	4	51
Total	94	14	108
Physical soil and water conservation activities	**To whom do you think that the land belongs?**		**Total**
	to my Own	to Government	
Stone band	35	6	41
Soil band	12	4	16
Both	42	9	51
Total	**89**	**19**	**108**

Not Significant(NS)

***Source:* Own survey result/2015**

4.1.4.3 Assistance in soil conservation practices (ASSCOSOIL):

This variable refers to any assistance in the form of food for work or money rendered to the farmers in soil conservation practices. Conservation investment costs a lot, and it is difficult to see the benefit in the short-term planning horizon. In addition to this, physical conservation practices require more labour and materials, which the farmer cannot afford Neupane *et al.,* (2002). It is expected that in areas where governmental and Non-

Governmental Organizations are involved in agricultural development activities, the propensity to invest in land conservation practices increases. Hence, any source's assistance (material, technical, and other incentives) encourages the farmers to decide on conservation practices, and a positive effect was hypothesized.

Sample farmers were asked to respond whether they received any assistance in the form of cash or kind and the survey result depicts that 75% (81) respondents have participated in soil and conservation works for money contribution in the form of safety-net or any other, 3.7% (4) were participated for food for work contribution and the remaining 21.3% (23) were participated for free contribution. Regarding its significance, the chi-square and p-value (14.43 and 0.1) reveal that it is not significant (see table 19)

Table 19: shows the cross-tabulation of Physical soil and water conservation activities with assistance given to those farmers in the form of food for work or money.

Physical soil and water conservation activities		In what kind of soil and water conservation practices have been participated?			
		Food for work	**money for work**	**free contribution**	**Total**
	Stone bund	0	33	8	40
	Soil bund	2	11	3	29
	Both	2	37	12	5
Total		4	81	23	108
Chi-square				**14.43**	
p-value				**0.1**	

Not significant (NS)

Source: **Own survey result/2014**

4.1.4.4 Past awareness about technology (TECHAWARE):

This is intended to know whether the farmer has taken part in soil conservation activities in the past or not. Knowing available soil and water conservation options makes land users more receptive to conservation structures (Shiferaw and Holden, 1998). Therefore, in the past, conservation undertaking was hypothesised to positively affect participation in conservation works. The survey result obtained from sample farmers reveals that past awareness of soil conservation structure has no relation to influencing farmers’ decision in undertaking conservation activity with a chi-square1.81 and a p-value of 0.4, which is not significant (See Table 20). Click here (**https://www.youtube.com/watch?v=-BXQntQBgA0**)

Table 20: Cross-tabulation of physical SWC activities with the participation of farmers in SWC related training and field demonstration.

Physical soil and water conservation activities	Have you participated in soil conservation training for the last five years?			Total
		Yes	No	
	Stone bund	26	15	41
	Soil bund	13	3	16
	Both	33	18	51
Total		**72**	**36**	**108**
Physical soil and water conservation activities	**Have you ever attended any field demonstration day arranged by the extension program?**			**Total**
	Stone bund	12	29	**41**
	Soil bund	5	11	16
	Both	15	36	51
Total		32	76	108
Chi-square				**1.81**
p-value				**0.4**

Not significant(NS)

***Source:* Own survey, 2014**

4.1.5 Physical factors concerning the adoption of soil and water conservation practices.

4.1.5.1 Slope category of the farm

This is a variable for the slope category (SLOP) of a parcel, which is categorized as flat (0-5%), gentle (6-15%), and steep or very steep (>15%). Previous studies reveal that the slope category of the parcel has been found to positively affect the farmer's decision to invest in conservation technology (Ervin and Ervin, 1982; Gould *et al.,* 1989). As prior expected, the slope variable has a strong positive effect on farmers' decision to participate in soil conservation practices. It significantly affects farmers' decisions on soil and water conservation practices.

Based on sample farmers' respondent results, those farmers (21.3%) with flat category of their land have applied soil bunds to protect their soil from erosion while those farmers with gentle slopes chose both soil and stone bunds to protect their land, which was about 49.07% of total 108 respondents have their land with a gentle slope, about 29.6% respondents with steep slope who claimed to only stone bunds and both each with half numbers with chi-square 23.22 and p-value 000***. This chi-square and p-value result shows a positive and strong association between slope and soil and water conservation structures (See Table 21).

Table 21: shows the cross-tabulation of physical SWC practice and the slope of his farm's category

		In what category of slope do your farms categorize?			
Physical SWC activities implemented by farmers		**Flat (0-6%)**	**Gentle (6-15%)**	**Steep(>15%)**	**Total**
	Stone bund	6	20	15	41
	Soil bund	11	4	1	16
	Both	8	29	14	51
Total		**23**	**53**	**32**	**108**
Chi-Square				**23.22**	
P-value				**0.000*** **	

Note: *** Significant at less than 1% probability level

***Source:* Own survey, 2014**

4.2 Physical Soil and Water Conservation practices adopted by farmers in the study area

Figure 4: Stone Bund Construction

Based on the qualitative survey result, farmers have adopted the following Soil and Water Conservation activities:

Stone Bund and Soil Bund Construction

Some farmers use stone bunds or stone terraces regardless of the agro-climatic zone differences. According to the respondents, stone bund construction is labour-intensive and limited to areas with stone on the farm plot. Regardless of its labour intensiveness, it is strong enough to capture the soil washed down by floods from steep and mountainous slopes. Other types of soil conservation technologies are not effective if constructed well by indigenous specialists. Even though soil bund is rarely used as a soil conservation method in the study area, some farmers whose farmland is relatively flat use it with poor design.

Strip Cultivation

Farmers with relatively larger cultivated land deliberately leave unploughed strips within the farmland following the horizontal contour or at the boundary of their farmland to decrease flood hazards from uplands. In addition, the trapped soil developed on the strip will make the soil more fertile over time. This is suitable for growing grass for their cattle. After some time, farmers plough some or all parts of the strips and leave another strip below the old one.

The parameters, lengths, widths, and distances between two strips vary from one farm plot to another. Obliviously, this practice demands no labour input except that the farmers keep some part of the land out of cultivation. However, according to the farmers, this practice will not be possible because of land shortage.

Cut off drains

These structures are the physical structures constructed by digging deep soil to divert the runoff before reaching the farmland. The farmer constructed such structures to prevent the loss of seeds, fertilizer, and soil due to excessive running from uplands and dispose of the excess water for the field. However, farmers responded that these structures accelerate soil erosion if their pavement is not aligned with the safe waterway. During a transect walk with the Development Agent's gullies associated with constructing these structures, especially between the boundaries of plots, they were commonly observed.

Soil bund (Fanyaju Terraces) **Click here (https://www.youtube.com/watch?v=80jirXONSpY)**

It improved soil conservation structures by digging a trench, throwing the soil downhill to form an embankment, and, over time, easing the deposition of fertile soil in front of the embankment to plant hedge crops. The survey results show that this structure was not used by the respondents apart from some areas where NGOs have undertaken Soil Conservation works. Respondents applying these structures explained the advantage of the structures as follows

Figure. 5: Soil Bund Construction

- Bunds hold water and allow it to soak into the ground, reducing runoff and causing gullies
- Fertile soil gradually deposits in front of the bunds producing a bench terrace
- This can be built by an individual or by a group
- The local name of the Soil Bund Construction is called **"Fanyajuu Terraces"** Bunds can be used to produce high yields and produce animal feed.

Crop residues

They were leaving crop residues on the field after harvest is another traditional practice used by the farmers in the area. The qualitative survey result shows that the farmers implement this measure to improve soil fertility and protect soil from erosion. During the Focus Group Discussion, it was observed that crop residues were left on the field at BorkosheKebele. However, during the discussion with the key informants, it was noted that most farmers used the crop residue for off-plot purposes because of a shortage of animal feed and fuelwood.

Figure 6:Farmland covered with Maize Crop Residue

Major causes of soil erosion in the study area

Sample farmers were asked to identify or rank pre-identified causes of soil erosion such as deforestation, overgrazing, over-cultivation, poor agricultural practices, cultivation on steep slopes, excess rainfall, and poor government policy. As it is depicted in the following table, 105 farmers agreed that deforestation is a significant cause; 108 respondents agreed that overgrazing is the primary cause; 106 agreed that poor agricultural practice is the primary cause; 103 respondents agreed that cultivation of steep slopes is the primary cause; 85 respondents agreed that over-cultivation and excess rainfall are significant causes and 33 respondents agreed that poor agricultural policy is responsible for soil erosion in the study area.

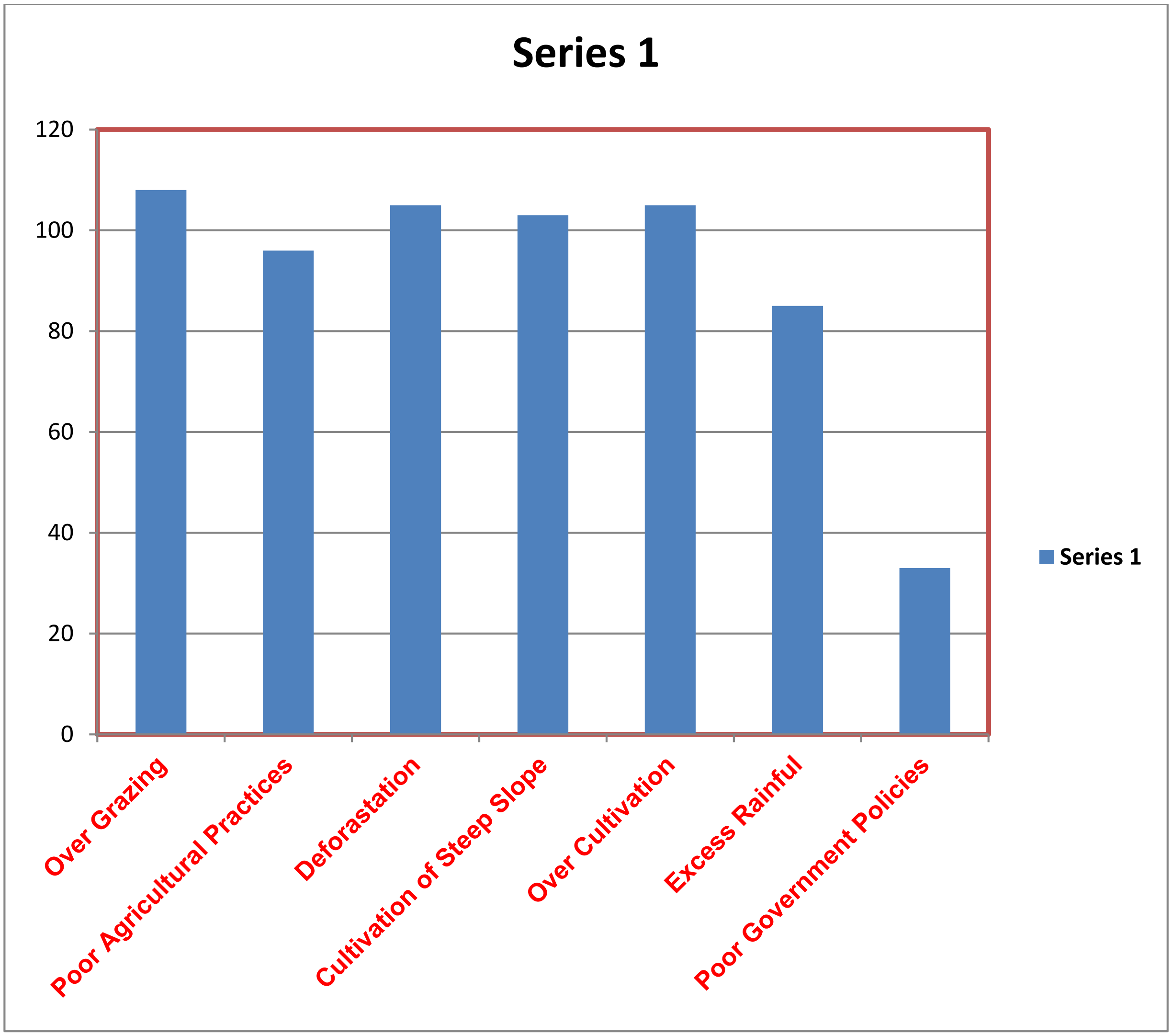

Figure 7: Major causes of soil erosion rated by sample respondents

4.3 Perception of farmers on Soil and Water Conservation practices

The importance of SWC measures in controlling soil erosion was not a new concept to the farmers in the study area, the effect of SWC measures on soil productivity and the expectations farmers had on installed SWC measures: especially bunds. Most farmers perceived that SWC measures increased crop yield, prevented soil erosion, and improved the soil-water retention capacity of the soils (Table 22). However, few farmers believed that SWC measures could assure the land's long-term productivity. This implies that farmers were likely to invest in cheap and straightforward short-term benefit measures rather than go for the recommended mechanical structures such as bench terraces and soil bunds. Furthermore, because top-down enforcement adopted mechanical SWC measures that were not correctly implemented, farmers believed conservation measures were less successful in soil erosion control. As such, 93 per cent of farmers perceived that conservation measures were incapable of preventing (or stopping) soil erosion phenomenon, based on the performance of the SWC on their fields, despite the positive perceptions they had for the SWC measures. This finding is similar to the study by (Featherstone and Goodwin, 1993), which showed that most farmers' primary cause of disinterest in SWC activities is their perceived ineffectiveness of these technologies.

Sample farmers were asked to understand their perception or awareness of Soil and Water Conservation practices by examining the seriousness of the decline in soil fertility of their main plot; his response to tackle those problems revealed that about 104 (96.3%) responded that their land was at the risk of minor serious to very serious and 4 (3.7%) responded that they have no problem with soil fertility decline. Meanwhile, when they asked to respond on what measure to be taken to tackle these problems, they responded that 48 (44%) were replayed to apply bunds construction (Stone and soil bunds), 43 (39.8%) were replied to use a combination of bunds with other types of measurements, 10 (9.25%) responded to apply strip cropping on contours, and the rest 7 (6.48%) confirmed to use tree or grass plantation. See Table 23, which presents the decline in soil fertility on the main plot of respondents’ farms vs farmers and recommends tackling the problem.

Similarly, sample farmers were asked to scale their perception of erosion as a problem for their farmland; the result depicts that 56.5% responded that they agree, 25% strongly agree, 17.6% disagree, and 1% strongly disagree. This result shows that the recognition of erosion as a problem was confirmed by more than 80% of respondents, revealing that erosion threatens their farmland if appropriate measures are not taken. See Table 24, which represents the proportion of farmers who responded that soil erosion is a problem for their farm.

Table 22: Farmers' Perception on Soil and Water Conservation response reclaiming their soil macronutrient and retaining soil fertility.

Physical soil and water conservation activities	Indigenous Soil and Water Conservation Practices reduce the soil erosion					Total
	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	
Stone band	0	0	3	27	11	41
Soil band	0	1	1	8	6	16
Both	0	1	6	31	13	51
Total	**0**	**2**	**10**	**66**	**30**	**108**
Physical Soil and Water Conservation activities	**Soil and Water Conservation measures retain the soil macro-nutrient**					**Total**
	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	
Stone band	0	0	11	16	14	41
Soil band	0	0	4	5	7	16
Both	0	0	10	18	23	51
Total	**0**	**0**	**25**	**39**	**44**	**108**
Physical Soil and Water Conservation activities	**Effective Soil Management will promote the yield of the farmers**					**Total**
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Stone band	0	0	1	35	5	41
Soil band	0	1	2	10	3	16
Both	0	0	6	38	7	51
Total	**0**	**1**	**9**	**83**	**15**	**108**

Source: Own survey result, 2014

Table 23: shows the cross-tabulation result of the perception of farmers on Soil Fertility decline with their recommendation to tackle the problem

How severe is the decline in Soil Fertility on the main plot of your farm	Measurements recommended by farmers				
	Tree or grass planting	Bunds construction	Strip cropping	Bunds with other types of measurements	Total
Very serious	0	9	0	0	**9**
Serious	2	37	4	13	**56**
Minor	5	2	6	28	**41**
No problem	0	0	0	2	**2**
Total	**7**	**48**	**10**	**43**	**108**

Source: **Own survey, 2014**

Table 24: Respondents scale as Soil erosion is a problem for his farm plot

Perception of farmers on erosion as a problem	Frequency	Per cent
Strongly disagree	1	0.9
Disagree	19	17.6
Neutral	0	0
Agree	61	56.5
Strongly agree	27	25

Source: **Own survey, 2014**

4.4 Results of the Econometric Model

In the previous section, we have described associations between the dependent and explanatory variables using statistical tests to identify the factors affecting the adoption of soil and water conservation activities. However, identifying these factors does not sufficiently stimulate policy actions unless the variables are entered into the econometric model. The multinomial logistic model was employed to know those factors affecting farmers' adoption specifically and collaboratively. Because those agro-ecological and socio-economic settings are different even in the same locality. Before conducting the econometric analysis, it is essential to define the variables to be entered into the econometric model and investigating

4.4.1 Definition of Variables used in Multinomial Logistic Regression Model

Table 25: Dependent and Independent/Explanatory Variables and their definitions applied in the Multinomial Logistic Model

Dependent variables are Physical Soil and Water Conservation Practices	
Dependent Variables: Y_0 = Stone Bund, Y_1 = Soil Bund, Y_2 = Stone Bund + Soil Bund	
Independent Variables	
AGEHH	Age of the household.
SEXHH	Sex of the respondent (1= Male, 0= Female)
EDUHHH	Education level of the respondent (1= Literate, 0= Illiterate)
DPNCY	Dependency ratio of the household.
FAMSIZ	Family size of the respondent.
FARMSZ	Farm size owned by the household.
SOCPOSN	Social position of the household (1= if he belongs to one organization, 0= otherwise)
TLU	Size of livestock holding measured in tropical livestock unit.
FINCOM	Estimated amount of farm income.
PERCP	Perception of farm households as erosion is a problem.
FAMERATID	Attitude of a farm household toward SWC practices.
EXTSRS	Extension service delivered to farm households.
SECTEN	Security of tenure (1=if he can use the land in his lifetime, 0= otherwise)
TECHAWARE	Past awareness about technology(1=if he is aware, 0= Otherwise)
ASSCOSOIL	Assistance rendered to the farmer in areas of soil conservation
SLOP	Slope category of the farm.

4.4.2 Variance Inflation Factor for Continues Variables

Multi-collinearity Test

Before running the Multinomial Logistic Model for analysis, it is imperative to check multicollinearity or association among the hypothesized independent variables. The existence of multi-collinearity is the situation where independent variables are correlated. Hence, separating the effect of each explanatory variable from predicting the parameters of interest was challenging. As most econometricians suggest, two types of measures are often suggested for checking for multi-co linearity. Variance Inflation Factor (VIF) for associations among the Continuous explanatory variables and contingency coefficients for dummy variables.

VIF can be defined as **VIF(x_i)=** $\mathbf{1/(1-R_i^2)}$

Where $\boldsymbol{R_i^2}$ is co-efficient of multiple determinations, and the variable x_i represents the explanatory variables? Each selected continuous explanatory variable and coefficient of determination are computed. VIF shows how the existence of multi-collinearity inflates the variance of the inflation factor. Suppose the VIF of a variable exceeds **10** (this will happen if $\mathbf{R^2}$exceeds **0.90**); that variable is said to be highly collinear. The remedy is omitting variables with a value of 10 and more from the model analysis (Gujarati, 2004). Accordingly, the Variance Inflation Factor (VIF) was employed to test the degree of multicollinearity among continuous variables (Tables 25 & 26). As a result, there was no multi-collinearity problem for the continuous drop from the model.

Table 26: Variance Inflation Factor (VIF) for ContinuousExplanatory Variable.

Variables	VIF	Tolerance level
AGEHH	8.06	0.124
EDUCHH	2.54	0.393
FAMSIZ	1.81	0.552
DPNCY	9.09	0.11
FARMSZ	1.46	0.681
FAMINCOM	1.35	0.74
TLU	6.53	0.153

Source: ***Own survey, 2014***

4.4.3 Contingency Coefficient for Dummy/Categorical Variable

Conversion coefficients were employed to test the degree of association among Dummy or Discrete variables. The contingency coefficient is a chi-square-based measure of association. The decision rule sets that when the result approaches 1, it indicates the existence of multi-collinearity, whereas values less than 0.75 indicate there is no problem

The contingency coefficients are computed as:

$$C=\sqrt{x^2}/N+x^2$$

Where, **C**= Coefficient of contingency, $\mathbf{X^2}$ = Chi-square random variable, **N** = total sample size

As indicated (Table 26), independent discrete variables have no high degree of association. Hence, all the variables were fitted into the logit model for further analysis. Contingency coefficient for dummy variables such as sex, social position, and land security.

Table 27: Contingency Coefficient for Dummy Variables

Variable	SEX	SOCP	PERC	ATTID	EXTSRS	SECTEN	TECHWAR	ASSIS	SLOP
SEXHH	1	0.15	0.03	0.25	0.23	0.07	0.03	0.012	0.146
SOCPOSN		1	0.244	0.104	0.307	0.093	0.141	0.091	0.155
PERCP			1	0.38	0.019	0.122	0.173	0.207	0.16
FARMERATID				1	0.144	0.126	0.187	0.273	0.55
EXTSRS					1	0.112	0.186	0.302	0.227
SECTEN						1	0.256	0.366	0.260
TECHAWARE							1	0.520	0.483
ASSCOSOIL								1	0.598
SLOP									1

Source: ***Own survey, 2014***

4.4.4 Model Result

Table 28: Econometric Model results on predictors of Stone Bunds base Category is both (Stone Bund and Soil Bund)

Independent Variables	Stone bund against Both					Soil bund against Both				
	B	SE	EXP (B)	Wald	Sig.	B	SE	EXP (B)	Wald	Sig.
Intercept	26.14	3.13		67.42	0.001**	66.36	1283.9		0.003	0.959(NS)
AGEHH	15.29	0.66	3.44	286.18	0.000***	15.06	0.58	4.8	272	0.000***
SEXHH	0.47	0.318	0.194	1.107	0.324(NS)	0.038	0.39	0.5	0.005	0.46(NS)
EDUCHH	17.122	1.211	2.57	199.8	0.031**	18.73	0.51	3.6	1.31	0.000***
FAMSIZ	10.20	0.34	3.36	45.9	0.000***	-0.93	1.31	0.22	0.73	0.41(NS)
SOCPOSN	0.25	1.24	0.83	0.44	0.2(NS)	0.056	0.28	0.56	0.027	0.419(NS)
DPNCY	-13.93	1.35	2.86	53.87	0.000***	-28.9	1.76	5.8	252.68	0.000***
FARMSZ	13.53	0.47	5.21	228.2	0.000***	0.48	2.04	1.62	0.115	0.56(NS)
TLU	7.08	1.09	7.95	1.63	0.14(NS)	0.69	1.15	2.67	0.72	0.4(NS)
FINCOM	13.86	0.34	3.4	176.8	0.000***	11.21	0.34	2.35	164.5	0.000***
PERCP	1.03	1.56	1.82	0.44	0.506(NS)	1.1	0.85	3.03	1.7	0.19(NS)
FAMERATID	0.29	0.80	1.34	0.14	0.706(NS)	-1.54	1.26	0.21	1.5	0.22(NS)
EXTSRS	12.8	0.37	1.6	94.9	0.36(NS)	7.08	0.68	0.12	0.32	0.1(NS)
SECTEN	0.21	0.35	0.76	0.19	0.26(NS)	0.145	0.33	0.67	0.09	0.35(NS)
TECHAWARE	0.26	0.28	0.84	0.44	0.17(NS)	0.24	0.28	1	0.37	0.195(NS)
ASSCOSOIL	6.48	0.59	9.89	86	0.79(NS)	6.84	0.59	9.89	86	0.79(NS)
SLOP	1.59	0.66	5.69	5.66	0.000***	0.7	0.45	2.02	3.29	0.09**

-2Loglikelihood= 217.05 ***df*** ***146***

Chi-square=205.24 ***Sig*** ***0.001***

Source: Own Survey, 2014

Summary of Quantitative Analysis of Stone Bund

Age

It was used as a variable to investigate the uptake of the Soil and Water Conservation scheme. Previously it was hypothesized that age would negatively affect using Soil and Water Conservation activity on his farmland. However, the econometric result depicts positively influenced Soil and Water Conservation activities when the household age increases or the older farmers tend to take conservation work increase; this may be due to prolonged experience with soil erosion. As indicated in the above table, there is a unit increase in farm household head’s age; there are 3.44 unit increments in stone and soil bund construction.

Sex

The sex of the household head was included to differentiate between male and female in undertaking the Soil and Water Conservation structure. The researcher was in a dilemma to hypothesize their contribution before conducting the research. The econometric model result (as indicated in the above Table) shows that sex negatively affected the Soil and Water Conservation structure, i.e., a unit change of being a female-headed household has resulted in a 0.2 unit decrease in both stone and soil bund construction.

Education Level

Education level increases farmers’ ability to get, process, and use information. Based on the literature reviewed and researchers' investigation, it is hypothesized to participate positively in soil conservation practices. The econometric result confirmed a pre-determined hypothesis. Furthermore, it influenced positively, which is a unit increase in education would increase soil and water conservation practice by 2.6 units.

Family Size

Family size is one socio-demographic variable that refers to the total number of family members. Imperfection in labour markets implies that households with sizeable human capital may invest more in conservation (Shiferaw and Holden 1998). As was supposed in the hypothesis, this variable positively influenced Soil and Water Conservation practices at the significant level of 0.000.[***] A unit increase in family size and a 3.36 unit increase in stone and soil bund construction.

Dependency ratio

The dependency ratio is also a socio-demographic factor referring to the consumer-worker ratio. This variable was hypothesized to influence Soil and Water Conservation practices negatively. An increase in the consumer-worker ratio reduces the availability to meet subsistence needs and increases the personal rate of time preference (Shiferaw and Holden 1998). The econometric result confirms the hypothesis by affecting SWC practices negatively at the 0.000 *** level. As the dependency ratio increased by 1 unit, stone and soil bund construction decreased by 2.9 units.

Farm Size

The farm is one economic variable that refers to the size of landholding the household head occupied by different crops. It was assumed that an increase in farmers' farmland would tend to allocate parcels of their land to conservation activity. As hypothesized, farm size positively affected physical soil and water conservation practices at the rate of 5.2 units at 0.000. ***

Farm income

It is one of the economic factors assumed to positively influence SWC practices that stimulate the liquidity constraint of household income. As hypothesized, a household's farm income positively influenced conservation activity at the significant level of 0.000. *** A unit increase in farm household income; there are 7.95 unit increments in stone and soil bund construction.

Slope of the farm

The slope of the farm was hypothesized to influence conservation activity positively. The above table shows that it influenced the activity positively at a significant level of 0.03**. As a unit change in slope gradient increases, there is a 0.28 unit change in stone bund construction.

Summary of Quantitative analysis for Soil Bund

Unlike stone bunds, five variables influenced soil bund construction when inserted into SPSS version 16. Most of the variables influenced were socio-demographic factors affected by stone bund constructions, such as age, education level, dependency ratio of the household head, and the household's farmland slope category.

Age

The econometric model result regressed on farmers' age for soil bund construction reveals that farmers' age has a positive effect on soil and stone bund (both) construction, which means an increase in the unit rate of farmers' age there is a change in 4.8 unit and positively influenced soil bund construction at the significant level of 0.000***.

Education level

The education level of the farm household also has a positive influence on Soil and Water Conservation Practices. As indicated in the above table, a unit change in education level would result in a 3.6 unit increment in stone and soil bund construction.

Dependency ratio

The dependency ratio is also a socio-demographic factor that significantly influenced both Stone and Soil bunds at 0.000***, showing a strong and negative influence. Regarding its influence rate, a unit change in dependency ratio decreased by 5.8 units of soil bund construction.

Farm income

As it is influenced by stone bund construction, farm income is also influenced by both Stone and Soil bund construction at a significant level. In a unit increment in farm income, there are 2.35 changes in Soil and Water Conservation practices.

Slope Category

The slope also influenced Soil and Water Conservation activities at a significant rate of 0.09 or 10%. With a unit increment in the slope of the given farmland, there is a 2.02 unit change in both Stone and Soil bund construction.

4.5. Summary of Qualitative Analysis

Farmers in the study area used both improved and traditional soil conservation methods. Improved soil conservation practices include improved stone bund, soil bund and fanyajuu, and other physical and biological conservation methods. Indigenous soil conservation methods include traditional ditches, traditional stone bunds, making trash lines, leaving grass strips, etc.

As the Focus Group Discussion members and Key Informants Interviews have explained, both improved and traditional Soil and Water Conservation methods collaborate with improved and traditional biological conservation methods to protect against soil erosion. Most farmers use hand tools to prepare their lands rather than using oxen to plough. This method has helped control their soil from erosion without applying any physical or biological conservation mechanisms. Fanayaju bunds and improved terracing are very limited due for various reasons. They employ traditional systems with no technical specifications, and hence much variability in the application is observed; most types of measures are adapted to cultivated land. The most widely used traditional soil conservation measures in the study area include crop residue covering, traditional ditches or tie ridges, and trash lines. Some farmers also use traditional stone bunds wherever there are stones on their farmland. Unploughed strips on cultivated land are rarely used because of land shortages. Tie ridges are constructed every cropping season and run diagonally over the cultivated land. In some areas where farmers use Oxen, they make ditches using Ox ploughs.

CHAPTER V

5. CONCLUSION AND RECOMMENDATIONS

5. CONCLUSION AND RECOMMENDATIONS

In response to the extensive degradation of its resource base, Ethiopia has made some efforts to mitigate the problem of soil erosion and enhance or maintain the production potential of the agricultural land with promoted Water and Soil Conservation mechanisms through the Ministry of Agriculture in Ethiopian highlands and other parts of the country where successive food deficit was recorded including the study area.

Kindo Koysha Woreda has made remarkable efforts to reduce the negative impact of erosion and covered significant areas with different physical and biological measures by mobilizing the whole community for free contributions and money in the PSNP program for the last 10 to 15 years. As the area is categorized as food insecure, different NGOs in Woreda were engaged in Soil and Water Conservation activities in different forms. The area still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly.

Farmers' perception of soil erosion and their responses to soil conservation practices have not been well studied. Moreover, the factors influencing soil conservation measures were not identified.

Therefore, this study's objective was to identify what factors affect the adoption of physical soil and water conservation practices and examine farmers' perceptions of soil and water conservation practices.

Both primary and secondary data were collected for this purpose. The primary data were collected from 108 proportionately and randomly selected sample households from 5 Kebeles in Kindo Koysha Woreda, while secondary data was from group discussions of different sources.

The multinomial logit model was applied to identify socio-demographic, Economic, Institutional, Psychological, and Physical factors that affect the adoption of soil and water conservation practices.

This study indicated that farmers' adoption of soil and water conservation decision was influenced by socio-demographic, economic, institutional, and physical factors. Education levels, age of household head, family size, and dependency ratio have influenced factors from socio-demographic factors; Farm size and household income were economic factors influenced; Extension service was institutional, and slope category of the farm was of physical factor that influenced the adoption of soil and water conservation practices.

Of these significantly influenced variables, sex and dependency ratio were negatively influenced, and the rest were positively influenced.

Farmers in the study area used both improved and traditional soil conservation methods. Improved soil conservation practices include improved stone bund, soil bund, fanyajuu, and other physical and biological conservation methods. Indigenous soil conservation methods include traditional ditches, traditional stone bunds, making trash lines, leaving grass strips, etc.

Causes of erosion were also investigated. The result shows that open grazing was the 1st cause of soil erosion in the study area, followed by poor agricultural practice, deforestation, and cultivation of steep slopes.

Farmers were also confident enough to answer the conservation structures: stone bunds, soil bunds, and Fanyaju followed by a drain cut, waterway, and hillside terracing.

Based on the results found from the analysis, the following conclusion and recommendations were made.

5.1. Conclusion

Most socio-economic factors were the primary determinant for farmers to undertake soil and water conservation measures which designers and planners mainly neglected to carry out conservation activities. Most farmers experience a land shortage, forcing them to use steep slopes for crop production, which is technically and scientifically not recommended. Even though most farmers understand some of the physical soil and water conservation practices, partial dismantling is experienced in densely populated areas.

Most farmers choose to prepare their land with hand tools rather than tilling it with oxen which enables them to protect their farmland from soil erosion. Furthermore, it enhanced them to allocate their parcel of small land for crop production rather than leaving their land for bunds construction. Traditional soil and water conservation practices are directly related to improved soil and water conservation practices. It was identified that those farmers who have traditional stone bunds, soil bunds, and cut-off drains have likely shown their interest in implementing the structures in an improved manner.

Apart from the technical gap in selecting appropriate measurement that fits with sloppiness, farmland situation, and standardization, they have no problem perceiving soil and water conservation practices in the study area. This may be due to long-time experience with the consequences of soil erosion.

5.2. Recommendations

- Any soil and water conservation interventionist must understand a given locality's socio-economic conditions before undertaking any soil and water conservation activity.

- Most of the best land is already in use, with considerable sloping areas for crop production and erosion problems. It can be expected that land-use planners will be called upon to help decide how best to use this sloping land. In preparing plans for these sloping lands, increasing attention will need to be given to preventing and controlling erosion. A closer relationship between land-use planners and soil conservationists will need to be developed. At the same time, land-use planners will need to understand erosion and methods for its control better.

- Farmers' main problem with bund construction is the lack of enough spacing between bunds to intercept run-off before the flow becomes too large to create channels and form rills. So there should be enhanced extension service to clarify his farm land's sloppiness and the recommended spacing between bunds to be constructed.

- As significant causes of soil erosion in the study area are overgrazing, deforestation, and poor agricultural practice, extension interventionists need special attention to address those issues.

- To carry out soil and water conservation activities in a given locality, it is vital to investigate the community's farming culture. For example, in the area, farmers who farm their land by hand were not interested in using any soil and water conservation measures.
- In implementing soil and water conservation practices, investigating existing local resources and the availability of farmland is vital because most farmers who have stones available in their locality are replayed and choose stone bunds to protect their farms. In addition, they chose this structure because it consumes less area when compared to soil bunds and Fanayaju bunds.
- Community participation ineffective watershed management at the Kebele level in constructing Fanyaju Bund, Check dam, Diversion channels, etc., will reduce soil erosion and enhance the economical use of water among the farmers.
- People's participation and involvement in Watershed structures establishment in the hilly places where farmers require the watershed structures like check dams, farm ponds, etc., have to be considered. Click here (**https://www.youtube.com/watch?v=Z_xp9lJ0E7Q**)
- Encouraging the International and Local NGOs involves finding out the farmers' problems, mainly the soil and water conservation and Watershed Management practices, for a permanent solution to the prolonged SWC problems.
- Giving priority to indigenously adopted soil and water conservation practices with modifications to improve water holding capacity based on sloppiness and soil types.

6. REFERENCES

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7. APPENDICES

7. APPENDICES

APPENDIX I: Household Survey with Interview Schedule

ADOPTION OF PHYSICAL SOIL AND WATER CONSERVATION PRACTICES IN SOUTHERN ETHIOPIA

Preamble

The enumerator should greet the respondent and his family when he arrives at the respondent's home and appreciate finding him well. Furthermore, he should thank the respondent for his commitment and devotion to his precious time.

The objective of the survey is to collect information related to physical Soil and Water Conservation practices in KindoKoyshaWoreda. The study is conducted for academic purposes. The data collected will be kept confidential. Hence, we request your honest and fair response to fill up this questionnaire.

Name of the Enumerator________________________Date:________________

I) General information

1.1 Name of respondent______________________

1.2 Sex: 1) Male 2) Female

1.3 Marital status: 1) Single 2) Married 3) Divorced 4) Widowed

1.4 Religious: 1) Orthodox 2) Protestant 3) Catholic 4) Muslim 5) Others, specify

1.5 Kebele ______________________ village_________________

1.6 Household head's age __________________years

II) Socio-Demographic Factors

1. Social Position in Kebele

1.1) Have you participated in leadership in some formal social organizations (positions) in kebele? 1 =Yes 2 = No

1.2) If ´Yes´, what is the household status in kebele?

1) Member of Council 2) Religious leader 3) Kebele Cadre 4) Cooperative members 5. Others, specify_______ 6. None

1.3) Have you participated in some Informal Organizations in the community?

1= Yes 2= No

1.4) If ´Yes´, in which one of the following were you participating? 1. Idir 2. Mahiber 3. Other (specify)

1.5) Education level 1) Illiterate 2) Elementary (1st-4th) 2) Primary (5th-6th) 4) Junior (7th-8th) 5) Secondary and above (> 9th)

1.6) Household characteristics

a. Household family member's information

S. No.	Name	Sex	Age	Education	Relation
	Total number				

2. Dependency ratio=children under 15 + household > 65 years divided by the number of households within 16 to 64 is _____(to be calculated by the researcher)

1. Number of children under 15 years _________________
2. Number of household within 16 to 64 years _____________
3. Number of household above 65 year_________________

III) Economic Factors

1. Farm Size owned by the Household

1.1) Do households own farmland? 1=Yes 2=No

1.2) If you answer the question above ´Yes´, fill in the following table.

S.No.	Type of Land Use	Area in Hectare
1	Cultivated land	
	• Own	
	• Rented in	
2	Fallow land	
3	Grazing land	
4	Tree (Bush) land	
5	Homestead area	
6	Others	

1.3) Which types of traditional soil conservation structures do you like more?

1) Planting different grass types on contour

2) Preparing tie ridges 3) Crop residues 4) Zero tillage 5) Dry mulching or green mulching 6) Intercropping and or Strip cropping……. (Please blank one or more traditional soil and water conservation practices the farmer responds to).

1.4) Why?

1. Labor intensive 2. Consume less area 3. Preserves soil fertility 4. Has/have complementary effect 5. Others, Specify______________

1.5) What type of farming practice is common on your land?

1) Tillage by oxen 2) Zero tillage 3) Digging by hand tool 4) Others, Specify;_________

1.6) Trend of rainfall in your area through time. 1) Increasing 2) Decreasing 3) The same

1.7) What type of soil commonly belongs to your farm? 1) Clay 2) Clay loam 3) Black/ hard black 4) Red 5) Sandy/Sandy loam 6) Others, Specify;_______________

2 Size of Livestock holding

2.1) Number of livestock

S. No.	Types of Livestock	No. of Units
1	Ox	
2	Cow	
3	Calve	
4	Heifer	
5	Horse	
6	Mule	
7	Donkey	
8	Goat	
9	Sheep	
10	Chicken	
	Total	

2.2) What are the primary sources of feed?

1) Grazing 2) Hay 3) Straw 4) Maize and Sorghum 5) Atella 6) others, Specify;-------------

2.3) How are pasture lands owned in your area?

1) Individually 2) Communally 3) Others, Specify;______________________________.

3. Household Income

3.1) What is your primary source of income? 1, Crop sale 2, Livestock sale 3, Off-farm income 4, Other (Specify)____________

3.2) Income earned from livestock products during the last season?

S.No.	Type of Livestock Product Marketed	Unit	Amount	Value
1	Cattle			
2	Sheep			
3	Goat			
4	Milk			
5	Butter			
6	Hides and skin			
7	Chicken			
8	Egg			
9	Bee			
10	Other(Specify)			
	Total			

3.3) Income earned from crop production in the last season?

S.No.	Type of crop product marketed	Unit	Amount	Value
1	Maize			
2	Teff			
3	Haricot bean			
4	Sweet potato			
5	Potato			
6	Horticulture crop			
7	Other(Specify)			
	Total			

3.4) Do your family members work on off-farm activities? 1 =Yes   2 = No

3.5) If your answer to question 3.2 above is ´Yes,´ fill in the following table for the season.

S.No.	Types of Off-farm Activity	Family member working 1. Men 2. Women 3.Children	Total income in Birr in One year
1	Petty trade		
2	Weaving		
3	Leather making		
4	Selling of firewood		
5	Pottery		
6	Labour hired out		
7	Remittances		
	Total		

IV) Psychological Factors

1. Farmer's Perception of Soil erosion is a problem

1) Is your farmland prone to erosion? 1= Yes 2= No

2) If 'Yes', how much of your farmland is affected by erosion in (ha) --------------------

3) How do you perceive the level of the parcel's exposure to soil erosion?

1. No risk 2. Medium 3. High exposure to erosion

4) Has your farmland been severely affected by soil erosion before? 1 =Yes 2 =No

5) If 'Yes,' the severity of erosion on your farming plots since you started farming 1. Very severe 2. Severe 3. Minor

6) When did the soil erosion problem start on your farm? 1. Before birth (heard from parents) 2. Since childhood 3. In recent years (before ----- years) 4. Others (specify) ------

7) How does the household perceive the soil depth/ fertility since starting farming compared to the past? 1. Increasing 2. Decreasing 3. No change 4. Do not know

8) If the answer decreases to 8, What measures did the household take to rehabilitate the conditions? 1. Apply Manure 2. Apply Chemical fertilizer 3. Practice Terracing 4. Planted Trees or grass 5. Fallow System 6. Strip Cropping along the contour 7. Bunds Construction (soil bunds, stone, fanyaju) 8. Check dams 9. Others (specify) ------------------

9) How severe is the decline in soil fertility on the main plot of your farm since you started farming concerning average year/adequate rainfall? 1. Very Serious 2. Serious 3. Minor 4. No problem

10) Do you think soil erosion will affect your farmland in the future if situations remain unchecked? 1. Yes=1 2. No=2

11) If ´Yes, what would you recommend to tackle this problem? 1, Practice Terracing (hillside) 2, Planted Trees or grass 3. Fallow System 4. Strip Cropping along the contour 5. Bunds Construction (soil band, stone band, fanyaju…) 6. Check dams 9. Others (specify)

12) Physical Soil and Water Conservation activities implemented by farmers on his farm.
1. Stone bund 2. Soil bund 3. Fanyaju 4. Terracing 5. Combination

15. Perception of farmers towards soil erosion as a problem

S. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Supply of enough water is good for plant growth					
2	Less water supply deteriorates plant growth					
3	Frequent tillage of land by oxen will promote the quality of the soil					
4	Frequent ploughing incurs a higher cost for the poor farmers					
5	Indigenous soil water conservation practices reduce the soil erosion					
6	Indigenous soil and water conservation practices may not be appropriate for sloppy areas.					
7	Soil and water conservation practices make the land productive					
8	Poor soil and water conservation practices lead to land degradation.					
9	Effective land management practices protect the damage to structures					
10	Heavy rain creates a loss of the land management structure					

16. The following are significant causes of soil erosion

S. No.	Causes of Soil erosion	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Deforestation					
2	Overgrazing					
3	Over cultivation					
4	Poor agricultural practices					
5	Cultivation of steep slopes					
6	Excess rainfall					
7	Poor government policies					

17. The consequences of soil erosion

S. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Land productivity (yield) decline					
2	Change in type of crops grown					
3	Reduces farm plot size					
4	Silt deposition					
5	Road dissection					

18. Attitudes toward Soil and Water Conservation

S. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Soil and water conservation measures retain the soil macro-nutrient					
2	Depletion of soil macro-nutrients from the land occurs due to mismanagement of the farmland					

3	Proper soil management practices will increase the income of the farmers					
4	Sound soil and water conservation management requires huge expenditure					
5	Effective soil management will promote the yield of the farmers.					
6	Lack of farmers' knowledge of soil and water conservation will reduce the yield					

The following types of soil conservation measures are efficient in reducing the problem of soil erosion in your farmland

S.No.	Types of Soil Conservation Measures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Stone bund					
2	Soil band					
3	Fanyajuu					
4	Cut off drain					
5	Hillside terrace					
6	Waterway					

What are the problems related to each soil conservation structure?

S.No.	Categories of Problem	Soil bund	Stone bund	Fanyajuu	Terrace
1	Source of wild grass invasion				
2	Reduce farmland size				
3	Difficult to turn oxen				
4	Difficult to implement				
5	Labour intensive				
6	Others, (Specify)				

V) Institutional Factors

1. Security of Tenure

1.1) To whom do you think that the land belongs?

1) To my own 2) To the government 3) Other____________

1.2) Do you think you have the right to inherit the land for your children?

1= Yes 2= No

1.3) Do you expect that you will use the land throughout your lifetime? 1= Yes, 2= No

1.4) Do you agree that the government allows farmers to sell their land?

1) Agree 2) Disagree 3) Difficult to decide

1.5) Have you rented the land before? 1= Yes 2= No

1.6) If ´Yes´, who is responsible for keeping the rented land quality?

1) The owner 2) Myself 3) Both of us

2. Extension Service

2.1) What is your most important source of Agricultural information for the last two years?

1. Other farmers 2, Mass media 3, Development Agent 4, Other sources

2.2) From whom do you most frequently get farm advice?

1) Development agents (DAs) 2) NGOs 3) Others, specify _________________

2.3) How often have you been visited by DAs last year? 1) Once per month, 2) Twice per month, 3) Three times per month, 4) Others, specify-

2.4) How often have you obtained extension advice on soil conservation practices

1) Once in a month 2) Twice in a month 3) Thrice in a month 4) Once in three months 5) Twice in three months 6) Others, specify_______________________

2.5) Did you receive any Credit service during the last 12 months? 1= Yes 2= No

2.6) If ´Yes´, did you repay your loan? 1= Yes 2= No

3. Past Awareness of Technology

3.1) Have you participated in Training on Soil Conservation for the last five years?

1= Yes 2= No

3.2) If ´Yes´ for how many times? ___________

3.3) Have you ever attended any Field Demonstration day arranged by the extension program? 1=Yes 2= No

3.4) Do you own a radio/television? 1= Yes 2= No

3.5) If ´Yes,´ have you ever heard or listened to Radio/TV programs programmed on Soil and Water Conservation? 1=Yes 2= No

3.6) Have you ever read about soil and water conservation matters in Pamphlets? 1= Yes 2= No

4. Assistances in Soil Conservation Practice

4.1 In what kind of Soil and Water Conservation practices have been participated?

1) Food for work 2) Money for work 3) Free 4) Other

4.2 Are any Non-Governmental or governmental organisations participating in Soil and Water Conservation activity in your area? 1=Yes 2=No

4.3 If yes, what are they? 1) Concern WW Ethiopia 2) Catholic Mission 3) TerepezaKeleHiwot Development 4) Mercy Corps International 5) Others, (Specify)______________

VI) Physical Factors

1. Slope category of the farm

1.1 What is the topographic nature of the slope of your farm?

1) Flat (0-6%)

2) gentle (6-15%)

3) Steep slope and mountainous (>15%)

APPENDIX II: Checklist for Key Informants Interview

1. Do you agree that existing Soil and Water Conservation practices support Kebele farmers?
2. How can the land management strategies be improved in your Kebele?
3. What factors affect the adoption of Physical Soil and Water Conservation Practices in Woreda?
4. What are Physical Soil & Water Conservation practices adopted by farmers in the study area?
5. What is the Development Agent's contribution to saving the Kebele farmers in Soil and Water Conservation practices?
6. What is the role of government in Physical Soil and Water Conservation practices?
7. How is the extension structure and support to farmers?
8. What is the land degradation problem in the Woreda, and what prevention mechanisms did the Woreda practice?
9. Why do people dismantle most constructed Physical Soil and Water Conservation structures in KindoKoyshaWoreda?
10. What is the rainfall condition in the woreda?

APPENDIX III: Tropical Livestock Unit equivalencies for different domestic animals.

Animals	TLU equivalent
Calf	0.25
Heifer	0.75
Cow and ox	1.0
Horse	1.10
Donkey	0.70
Sheep and Goat	0.13
Chicken	0.013

Source Strock, *et al.*, 1991

8. ETHIOPIA–KEY TECHNICAL TERMS

8. ETHIOPIA - KEY TECHNICAL TERMS

We include a list of Key technical terms that are generally used by Ethiopians practically and culturally. These Key terms will help know the meaning of the words of other nationalities, readers, or users who will read this E-Book. In addition, Ethiopian researchers have generally used these technical terms in their Thesis and other research documents. That is why; we have prepared to understand the international scholars accessing this research document.

Belg: Long Rainy Season starts from February to June every year.

Birr: Ethiopian Currency

Dega: Highland altitude, which is one of the topographies of the agro-ecological zones

Development Agent is disseminating the new technology and innovations to the model farmer and fellow farmers in the villages. The Development Agents are for Agriculture, Health, Livestock and Natural Resource Management for every Village (Kebele) in Ethiopia.

Fanyajuu: the farmers in a local indigenous method usually do soil Bund construction. An erosion-controlling structure could be made by digging a ditch and throwing the soil uphill.

Idir/Edir: The social customary Informal Financial Institutions in the Village help the people in emergencies like death ceremonies and natural catastrophes like drought, famine, and flood situations.

Iqub/Equb: It is a traditional Informal economic Institution existing in both the Urban and the Village that saves cash. Equb will help the poor people who cannot buy clothing, food, household equipment, etc. The small group consists of 30 to 40 members of the society who used to contribute 2 to 5 Birr weekly, and each member collected a maximum of 300 Birr. It is one of the popular mutual finance benefit schemes, often formed by people affiliated.

In other words, the number of members depends on the availability of like-minded people in the locality. Besides, the amount of money each member can contribute also depends on the healthiness of all members. Collection time can also be determined based on mutual agreements weekly, every 15 days, or monthly.

Kebele: means “Village” in the Ethiopian language. The Kebele is the basic administrative unit of the Ethiopia Government. A type of administrative division at a lower level is higher than the village. It is one of the small administrative units of the District (Woreda).

Kert: A small plot size of land equivalent to 0.5 hectares.

Kiremt: Rainy season

Kolla: Low land is mainly lower than 500m above sea level. It is one of the topographies of the agro-ecological zones.

Mahber: It refers to a support union, which is usually formed based on religious, ethnic, professional, etc. affiliation whereby members contribute some amount of money voluntarily, which they will latter use for individual, group, or community support programs.

Meher: Short Rainy Season starts from July to September every year.

Time Difference: Ethiopia Standard Time is 3 hours ahead of Greenwich Mean Time (GMT+3). Ethiopia is in East Africa Time Zone (EAT). European Time at 8 A.M., but in Ethiopia, it is 2 in the morning.

Woreda: Means District. The Woreda is a small administrative unit of the Zone. Local administrative above Kebele level, which is equivalent to District.

Woyne Dega: Mid Highland altitude.

Year Difference in Ethiopia: An Ethiopian year comprises 13 months and is seven years behind the Gregorian calendar. Ethiopians celebrated the new Millennium in September 2011 because the Ethiopians continued with the same calendar that the Roman church amended in 525 AD. The current Ethiopian year is 2012, and the European Year is 2020.

9. GLOSSARY

9. GLOSSARY

Adaptive Research: Research conducted to validate, modify and/or calibrate a new technology to specific soil, climate, socioeconomic or environmental characteristics of a given area.

Afforestation: Conversion of bare land into forestland by planting forest trees. Planting a forest crop on land has not previously or not recently carried in a forest crop.

After-Cultivation: Harrowing, rolling, tilling, and other cultivations carried out in a field after the crop has emerged

Agricultural system: The pattern of land distribution, ownership, management, and the agricultural economy's social and institutional structure.

Agriculture area: Land used primarily for producing or collecting farm commodities. The land distinguishes between arable land under protective cover, land under permanent crops in the open air, and land under permanent meadows and pastures, both naturally grown or cultivated.

Agriculture holding: Economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production, without regard to title, legal form, or size.

Agricultural Operation: The management and use of farming resources to produce crops, livestock, or poultry.

Agricultural Production: Measured in the total output of a crop.

Agriculture: A broad class of resources includes all forms of land use to produce biological (biotic) products –animal or plant. The fundamental basis for agriculture is the miraculous process of photosynthesis, the many valuable products synthesized by it, and plants and animals, including human beings. Nature has endowed soils with immense nutrients, which support much of the agricultural activity. Agriculture is now predominantly dependent on external nutrient support to supplement soil fertility.

Agro-climatic Regions: The grouping of different physical areas into broadly homogenous zones based on climatic and edaphic factors.

Agro-ecological Zone: A land resource mapping unit, defined in terms of climate, landform, soils, and land cover, and having a specific range of potentials and constraints for land use. Essential elements in defining an agroecological zone are the growing period, the temperature regime, and the soil units. A significant area of land is broadly homogenous in climatic and edaphic factors but not necessarily contiguous, where a specific crop exhibits roughly the same biological expression. Zones of similar agricultural performance are defined by soil and climate.

Alkali Soil: Soils with exchangeable sodium percentage (ESP) above 15, electrical conductivity below 4 dS/m, and usual pH above 8.0-8.5. Also called sodic soils (high in Sodium). Deficiencies of nitrogen and zinc are the most important. All alkali soils are alkaline but not vice versa, as the soil can have an alkaline reaction but have an ESP below 15. Gypsum application and green manuring are essential components of the reclamation technology of these soils.

Altitude: Vertical distance above sea level.

Analysis of Variance: Analysis of variance is a method for testing a hypothesis about means. It is the most widely used statistical inference method for analysing experimental data.

Annual Crops: Crop plants complete their life cycles within a season or year, such as rice, wheat, maize, coffee, and plantains. They produce a crop of seeds and die. Some of these crop plants may produce tillers. If such rooted tillers are separated from the main shoot and planted, each tiller will survive that season as a new plant but will not live until another disease.

Applied Research: Research in which the results can be used immediately by the farmer and applied to particular practical problems in the country or a region.

Arable Land: Land is ploughed, and crops are cultivated: agriculture is based on field crops such as Sorghum, millet, maize, and vegetables. Arable land includes all land used in most years for growing temporary crops and lying fallow or has not been sown due to unforeseen circumstances. Arable land does not include land under permanent crops or land under protective cover.

Attitudes: The states of mind or feelings of an individual, group, or society regarding issues such as material gain, hard work, saving for the future, and sharing the wealth.

Bedload (erosion): The sediment moves by sliding, rolling or salting on or near the streambed sediment, mainly by tractive or gravitational forces, but at velocities more minor than the surrounding flow.

Bed: Narrow flat-topped ridge on which crops are grown with a furrow on each side to facilitate irrigation and drainage of excess water or an area in which seedlings or sprouts are grown before transplanting.

Biodiversity: The variety of life forms within an ecosystem.

Broadcasting: The action of spreading seeds, fertilizer, or other agrochemicals on the soil surface. It is usually done before planting and is typically incorporated with tillage but may be unincorporated in no-till systems.

Bund: A low embankment, wider than a ridge, typically higher than 20cm but lower than 1m, used to control runoff on irrigated land. Bunds are characterized by the materials used (earth bund, stone bund, or mixed bund), their shape (triangular bund, trapezoidal bund, semi-circular bund), their dimension (large semi-circular bund), and their position across the slope (contour bund), graded water diversion bund, straight water diversion bund, and presence of ties if any (tie bund).

Case Study: The detailed study of an individual unit such as a household, farm, enterprise, or activity. It contrasts with the survey approach in which several units are studied. The case-study approach is helpful for familiarisation and teaching purposes, whereas the survey approach is more oriented toward gaining information about the population of the relevant unit.

Check Dam: Small dam builds across a gully or other small watercourse at suitable points to control water levels and regulate downstream discharges.

Check Row Planting: The planting process in which row-to-row and plant-to-plant distances are uniforms, and plants across the rows are also in line.

Check Basin Irrigation: Check-basin irrigation method is the most common method among surface irrigation methods. The field is divided into small plots surrounded by small bunds on all four sides in this method. Water from the head channel is supplied to the field channels one after the other. Each field channel supplies water to two rows of check basins, and water is applied when the field is quite large, and it is not easy to level the entire field. In such situations, the field is divided into small strips and each strip is into several plots by putting bunds, and these plots are called check basins. The advantage of this method is that the water can be applied uniformly and effectively. It is suitable for close-growing crops like groundnut, wheat, millet, etc. The disadvantages are that more labour is required, and more land is wasted under channels and bunds. Inter-cultivation is not possible due to bunds.

Central Tendency: There are many measures of the centre of a distribution. These are called measures of Central Tendency. The most common are the mean, median, and mode.

Climate change: Non-transient altering of underlying climates, such as increased average temperature, decreased annual precipitation, or greater average intensity of droughts or storms. They are used to the impact of the global warming phenomenon. Note the distinction between changes in weather (which varies within a climate) and change in climate that alter underlying probabilities of weather outcomes.

Class Interval: The class interval is a data division used in a histogram. For instance, it is possible to partition scores on a 100 point into class intervals of 1-25, 26-49, 50-74, and 75-100.

Commercial Farming: Specialized farming enterprise that is capital-intensive and aimed at profit maximization.

Community Forestry: Forestry developed in areas marginal to agriculture. Many community members are landless or small-scale farmers, often characterized by ecological and cultural diversity and the employment of traditional technologies. Communal land development is fundamental to this type of forestry.

Compost: Organic residues, or a mixture of organic residues and soil, that has been mixed, piled, and moistened with or without adding fertilizer and lime and are generally allowed to undergo thermophilic decomposition until the original organic materials have been substantially altered or decomposed. Sometimes it is called “artificial manure” or “synthetic manure.” Conventionally, it has been categorized as rural or urban compost according to the type and location of the composting waste. Composts are prepared through micro-organisms on wastes such as leaves, roots, stubbles, crop residues, straw, hedge clippings, weeds, sawdust, kitchen wastes, and human habitation wastes. The nutrient status of compost depends mainly on the nutrient content of the wastes and their preparation method.

Confidence Interval: A confidence interval is a range of scores likely to contain the parameters being estimated. Intervals can be more likely to contain the parameters: 95% of 95% confidence intervals contain the estimated parameter, whereas 99% of 99% confidence intervals contain the estimated parameter. The wider the confidence interval, the more uncertainty there is about the parameter's value.

Conservation of Natural Resources: The main principles of protecting natural resources are related to the improvement and use of natural resources that will assure their highest economic or social benefits for humans and their environment now and into the future. The management of human use of the biosphere may yield the most significant sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancing the natural environment.

Conservation Practice: Any technique or measure used to protect the soil and water resources for which standards and specifications for installation, operation, or maintenance have been developed.

Conservation Tillage: Any tillage and planting system leaves at least 30% of the soil surface covered by residue after planting. Conservation tillage maintains a ground cover with minor soil disturbance than traditional cultivation, reducing soil loss and energy use while maintaining crop yields and quality. Conservation techniques include minimum tillage, mulch tillage, ridge tillage, and no-till. Conservation tillage varies widely with crop and soil type.

Conservation: The management of natural resources to provide maximum benefits over a sustained period. In farming, conservation entails matching cropping patterns and agricultural lands' productive potential and physical limitations to ensure profitable production's long-term sustainability. Conservation practices focus on conserving soil, water, energy, and biological resources. Contour farming, no-till farming, and integrated pest management are standard conservation practices, divided into land management and structural practices.

Contiguous Drought: Drought resulting from irregular precipitation patterns cause a moisture deficit during the rainy season.

Contour: Linear boundaries of the land surface indicate places of equal elevation; the lines on a map connect these points.

Contour Bunding: This practice consists of making a comparatively narrow-based embankment at intervals across the land's slope on a level along the contour. It is an important measure that conserves soil and water in arid and semi-arid areas with high infiltration and permeability. It is commonly adopted on agricultural land up to a slope of about 6 per cent. These cross-sections of the bunds can be used as a guide in similar situations. It may be noted here that as no specifications for bunding in deep black soil are available so far, no large-scale bunding on them can be recommended, pending further research.

Contour cropping: Sowing a crop in rows or strips so that these follow along a contour.

Contour Crops: These crop plants are grown on or along the contour lines to protect the land from erosion, for instance, marvel grass, Dinanath grass, Setaria, and Anjan grass.

Contour Farming: Field operations such as ploughing, planting, cultivating, and harvesting on the contour or at right angles to the natural slope, reduce soil erosion, protect soil fertility, and use water more efficiently.

Contour Flooding: Method of irrigation by flooding from contour ditches.

Contour Furrow: A furrow ploughed on pasture or rangeland to prevent soil loss to allow water to penetrate the soil, sometimes used in planting trees and shrubs on the contour.

Contour Tillage: Culturing land with uniform elevation or contour lines reduces erosion.
Constant: A value that does not change values such as Ti or the mass of the Earth is constant

Continuous Variables: Variables can take on any value in a particular range. Time and distance are continuous; gender SAT score and “time rounded to the nearest second” are not. Variables that are not continuous are known as discrete variables. No measured variable is genuinely continuous. However, discrete variables measured with enough precision can often be considered continuous for practical purposes.

Crop Productivity: The quantitative production of a crop in terms of its primary production per unit of land area. Usually expressed as kg or tonnes per hectare. Same as crop yield. Example. Eight Tonnes grain/ha.

Crop residue management system: The operation and management of cropland to maintain stubble, stalks, and other crop residues on the surface to prevent wind and water erosion, conserve water, and decrease evaporation.

Crop Residues: These represent the bulk of the crop biomass left after removing the primary produce (grain, fruit, etc.) from the field. Most crops produce a voluminous amount of residues, e.g., stalk, stubble, trash, husk, etc., which can be used for mulching, ploughing back compost making industrial raw material, fuel, thatch, or feed to animals. It is often discarded or burnt, which must be avoided to conserve and recycle organic matter and nutrients. Crop residues contain a substantial proportion of plant nutrients. Their N content and C mainly control the mineralization of their N: N ratio. The critical N content of organic materials for net mineralization is between 170 and 1.80% N. Rice straw contains 0.58, 0.23, and 1.66% N, P_2O_5, and K_2o, respectively.

Crop Yield: The data reported under this element represent the harvested production per unit of harvested area for crop products. In most cases, yield data are not recorded but obtained by dividing the data stored under the production element by those recorded under the element; area harvested. Data are recorded in Kilograms or tons per hectare.

Cropping Pattern: The yearly sequence and spatial arrangement of the crops or crops and fallow in a given area. Includes sequential or multiple cropping, intercropping, mixed cropping, relay cropping, etc. Example: rice followed by wheat, maize followed by wheat followed by the green gram.

Cultivable Area: Area of land potentially fit for cultivation. This term may or may not include part or all of the forests and rangeland.

Cultivar: A variety of plant species produced by selected breeding.

Cultivation: A tillage operation used in preparing land for seeding or transplanting or later for weed control and loosening the soil. The growing field crops, vegetables, fruits, trees, flowers, and fish.

Cut-off time (irrigation): In surface irrigation, the time at which the supply of water is cut off at the top end, leaving the water already supplied to flow down the slope.

Cutback irrigation: Water is applied in-furrow irrigation faster at the beginning of the irrigation period and then reduced or cut back to a lesser rate, usually one-half the initial rate or that amount to balance with the intake rate.

Cut-off drain: A drainage system for draining seepy hillsides. Tiles are placed along the hillside to intercept the seepage water and prevent it from reaching the bottomland, or an open channel is dug along the hillside to achieve the same effect.

Deforestation: Those practices or processes that result in the change of forested lands to non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1. The burning or decomposition of the wood releases carbon dioxide; 2. Trees that once removed carbon dioxide from the atmosphere in photosynthesis are no longer present and contribute to carbon storage.

Disaster: An occurrence of a natural catastrophe, technological accident, or effect of climate change or drought, then rural farmer households become a poorer or human-caused event that has resulted in severe property damage, deaths, and/or multiple injuries.

Drought: An insufficient moisture supply from precipitation or soil for optimum plant growth. A period of abnormally dry weather is sufficiently prolonged for the lack of water to cause a severe hydrologic imbalance (i.e., crop damage) in the affected area. Drought severity depends upon the degree of moisture deficiency, the duration, and the size of the affected area. It is months or years when a region notes a deficiency in its water supply. Generally, a region receives below-average precipitation over an extended period. It is usually ranging from several months to several years. Although droughts can cause significant damage, drought is a regular, recurrent feature of the climate for most regions. Having adequate drought mitigation strategies in place can significantly reduce the impact. In the worst-case scenario, recurring drought can also bring about desertification. As a drought persists, its conditions worsen, and its impact on the local population gradually increases.

Dry Farming: The practice of crop production in low-rainfall areas without irrigation. Crop production without supplementary irrigation in semi-arid regions is dependent on precipitation. Dryland farming requires the capture and efficient use of precipitation. Therefore, farming activities should be focused on retaining precipitation, reducing evaporation, and utilizing drought-tolerant crops. Rainfed farming includes dryland farming, though these terms are not interchangeable. Both systems exclude irrigation, but rainfed agriculture can emphasize, i.e. the safe disposal of excess water.

Deforestation was clearing forested land for agricultural purposes or logging and using it as firewood.

Dependent Variable: A variable that is explained or affected by another variable. A variable that measures the experimental outcome. In most experiments, the effects of the independent variable on the dependent variables are observed.

Developing Countries: Asia, Africa, the Middle East, Latin America, Eastern Europe, and the former Soviet Union are presently characterized by low living and other developmental deficits. Used in the development literature as a synonym for less developed countries.

Development: The process of improving the quality of all human lives and capabilities by raising people's levels of living, self-esteem, and freedom.

Discrete Variable: Variables that can only take on a definite number of values are called "discrete variables." All qualitative variables are discrete.

Dummy Variable: An artificial variable

Earth Dam: An embankment dam in which more than 50 Percent of the total volume is formed of compacted fine-grained material obtained from a borrow area (i.e., excavation area). Earth dams retain water in a small valley or depression where water flows regularly.

Environment: The combined external condition affecting the life, development, and survival of an organism or an ecosystem.

Family farm: A farm plot owned and operated by a single household.

Farm Enterprise: An individual crop or animal production function within a farming system is the smallest unit for which resource use and cost return analysis is usually carried out.

Farmer: The principal decision-maker involved in the management of a farm. Usually, but not always, will be head of the household. Sometimes the choice of principal decision-maker will be somewhat arbitrary since the decision-making may sometimes be segregated for different farm activities.

Farming System: Unit of analysis of agricultural production, defined by the components and boundaries and the types of interactions among the components and environments outside the boundaries. Farming systems include all agricultural and non-agricultural, under the control of farm household units. For example, a decision-making unit comprises a farm household, cropping, livestock systems, and fish production systems that produce crop and animal products for consumption and sale.

Farm System Analysis: Investigating farm-level constraints, translating this knowledge into improved technologies, and testing this technology.

Farming Systems Types: Shifting cultivation, fallow systems, ley and dairy systems, systems with permanent upland cultivation, systems with arable irrigation farming, systems with perennial crops and grazing systems, etc.

Fixed Assets: Durable assets represent long-term investments for more than one production cycle. Examples are breeding livestock, plant and machinery, land and building, etc.

Food Insecurity: A situation exists when people lack secure access to sufficient amounts of safe and nutritious food for average growth and development and active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal, or transitory.

Food Security: Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. A situation exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Forest Plantation: Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They have introduced species (all planted stands) or intensively managed indigenous species.

Focus Group Discussion: A Qualitative method of data collection in which the information is collected in the context of a group through relevant discussion

Forest land: Land on which the vegetation is dominated by forest or, if trees are lacking, the land bears evidence of former forest and has not been converted to other vegetation.

Forestry: The science of establishing, cultivating, and managing forests and their attendant resources. The science, art, and practice of managing and using for human benefit the natural resources that occur on and in association with forest lands.

Fragile land: Land sensitive to degradation when disturbed, such as with highly erodible soils, soils where salts can and do accumulate, and soils at high elevations.

Furrow Irrigation: A method similar to corrugation irrigation used in permeable soils. It consists of feeding narrow furrows very close to one another with small discharges to quickly wet all the soil between two rows of crops (often orchards). Furrows parallel to the rows may be laid mechanically and reduce erosion.

Furrow: A trench or extended narrow cut in the soil after a plough passes through it, a trench or ditch dug by hand. An opening left in the soil after a plough or disc has opened a shallow channel at the soil surface. A shallow channel cut in the soil surface, usually between planted rows, controls surface water and soil loss or conveys irrigation water.

Groundwater run-off: Water from a catchment area that moves freely under the influence of gravity and enters the soil.

Groundwater: Water in the soil beneath the surface, usually under conditions where the pressure in the water is greater than the atmospheric pressure, and the soil voids are substantially filled with the water. That portion of the water below the ground's surface, whose pressure is more significant than atmospheric pressure.

Growing Season: Used generally, not as a technical term, to refer to the period of the year when most crops are grown, e.g., the rainy season. The period of a year when the environment enables farmers to produce a crop of economic value.

Gully Erosion: A channel resulting from erosion caused by the concentrated but intermittent water flow, usually during and immediately following heavy rains. It is deep enough (usually >0.5 m) to interfere with and not be obliterated by normal tillage operations.

Green revolution: The boost in grain production associated with the scientific discovery of new hybrid seed varieties of wheat, rice, and corn has resulted in high farm yields in many developing countries.

Habitat: The place or type of site where species and communities typically live or grow is usually characterized by a relatively uniform portion of the physical features or consistent plant form. Deserts, Lakes, and forests are all habitats.

Heterogeneous: Non-uniform, variable, coming from outside. Their heterogeneous nature causes their outside. Their heterogeneous nature causes their constituents to segregate. Example: physical fertilizer mixtures.

Household: A household in the Ethiopian case is understood similarly as FAO (2005:4) defines “a household is an economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes, without regard to title, legal form or size.” Households represent rural societies' primary production and consumption unit and are agents of economic change. ii. Composed of the farmer and his family and is considered both the production and consumption unit of the social organization. The household can be managed by one person or operation collectively. Family members live, sleep, eat, share the same place, and divide household duties, general farm management, and work.

Independent Variable: A variable that does not need to be explained by or is not affected by another variable. The variable is manipulated by the experimenter, as opposed to dependent variables. Most experiments observe the effect of the independent variable(s) on the dependent variable.

Indicator: A directly observable trait used to define a variable empirically.

Inferential Statistics: The type of statistics that makes conclusions from data derived through sampling and projects them onto the population

Infrastructure: Facilities enable economic activity and markets, such as transportation, communication and distribution networks, utilities, water, sewer, and energy supply systems.

In situ: One of the Soil and water conservation measures is essential for in-situ conservation of soil and water. The main objective of these practices is to reduce or prevent either water erosion or wind erosion while achieving the desired moisture for sustainable production. It should be constructed to conserve *in situ* moisture and reduce soil loss. The one-meter diameter circular basin for level lands depends upon infiltration and rainfall. ‘V’ ditches of size 5m x 5m with trees planted Centre and height according to the rainfall and slope of sloppy lands. Saucer basins/ semi-circular bunds with 2m diameter to 15-20cm across the slope.

Integrated Drainage: A general term for a drainage pattern in which stream systems have developed to where all parts of the landscape drain into some part of a stream system. The initial or original surfaces have disappeared, and the region drains to a standard base level.

Integrated Farming System: Integration of various agricultural enterprises, viz., cropping, animal husbandry, fishery, forestry, etc. A judicious mix of any one or more with cropping complements the cropping enterprise.

Intensive Cropping Systems: Such cropping systems make relatively continuous use of the land for crop production. These do not allow a fallow period, and two or more seasonal crops can be raised in a year on the same piece of land through sequence cropping, inter/mixed cropping, or both. Example: rice-wheat system, maize-wheat-green gram system, coconut-pineapple-black pepper multi-storeyed cropping systems in which 4 crops grow in a field at any given time.

Intensive Cropping: Maximum land use utilizing regular succession of harvested crops.

Intensive Farming: A farming system to produce the maximum number of crops in a year with a high yield from the land available and maintain a high livestock stocking rate.

Intercropping: The growing of two or more crops on the same field per year, simultaneously or in the case of relay intercropping with an overlapping period. Simultaneously, systems refer to cultivating two or more crops intermingled or with a distinct row or strip arrangement. Here there is one main crop while the others are subsidiary crops, for instance, sesame+groundnut+sorghum+wheat+rice+mustard. It refers to growing two or more generally different crops simultaneously on the same land, base crop necessarily in a distinct row arrangement. The recommended optimum plant population on the base crop is suitably combined with an appropriate additional plant density of the associated crop. There is crop intensification in both time and space dimensions.

Irrigable Area: Area capable of being irrigated, principally regarding availability of water, suitable soils, and land topography.

Irrigated Land: Areas artificially provided with water, other than rain, for improving pastures or crop production. Uncontrolled land flooding by overflowing rivers and streams is not considered irrigation.

Irrigation Canal: A permanent irrigation canal constructed to convey water from the source of supply to one or more farms.

Irrigation Methods: How water is controlled and applied to an area. One of four irrigation methods used to apply irrigation water; is surface sprinkling: Micro and sub-irrigation. One or more irrigation systems can be used to apply water to each irrigation method.

Irrigation Schemes: Areas of irrigation schemes where water is wholly or partially controlled. These schemes may be under individual or collective control. They are classified as significant (often public schemes), medium and small schemes.

Irrigation System: Physical components (pumps, pipelines, valves, nozzles, ditches, gates, siphon tubes, turnout structures) and management used to apply irrigation water by an irrigation method. All properly designed and managed irrigation systems have the potential to apply water across a field uniformly.

Irrigation Water Management: Managing irrigation applications based on the soil's water-holding capacity and the crop's need. The water is applied at a rate and in such a manner that the crop can use it efficiently, and resource losses are minimized. Irrigation efficiency is the ratio of water stored in the crop root zone compared to the amount of water applied.

Irrigation Water Requirement: The calculated amount of water needed to replace soil water used by the crop(soil water deficit) for leaching undesirable elements through and below the plant root zone, plus other needs, after consideration, is made for adequate precipitation.

Irrigation: Water is artificially applied to soil and confined in time and space, usually for crop production. It enables it to meet the water requirements at a given time of its vegetative cycle or bring the soil to the desired moisture level outside the vegetative cycle. The irrigation of a field includes one or more watering per season. Water distribution systems for irrigation at the field level may be broadly classified into the systems of the flowing kind that cause more or less uniform wetting of all the soil. Irrigation does not include precipitation. A distinction is made between surface irrigation (basin, border, furrow irrigation) and localized irrigation (an umbrella term for other irrigation systems such as trickle, drip, drop, daily flow, and micro and overhead irrigation (sprinkler irrigation).

Integrated Rural Development: The broad spectrum of rural development activities, including small-farmer agricultural progress, the provision of physical and social infrastructure, the development of rural nonfarm industries, and the capacity of the rural sector to sustain and accelerate the pace of these improvements over time.

Key Informants: These are community members who are exceptionally qualified to provide information about local conditions, usually due to their position within the community, e.g., local officials, community leaders, and other development workers. Key informants may provide background information or introductions to other community members or groups. The qualitative information will help to triangulate with quantitative data of the research.

Land Area: Total area excluding area under inland water bodies.

Land Capability: The suitability of land for use without permanent damage. As ordinarily used in the USA, land capability is an expression of the effect of physical land conditions, including climate, on the total suitability for use, without damage to crops that require regular tillage, for grazing, woodland, and wildlife. In addition, the land capability involves considering the risks of land damage from erosion and other causes and the difficulties in land use owning to physical land characteristics, including climate.

Land Cover is the observed (bio) physical cover on the earth's surface. When considering land cover, describe the vegetation and the manufactured features. Consequently, areas where the surface consists of bare rock or bare soil describe land itself rather than land cover. Also, water surfaces can be disputed as being genuine land cover. However, in practice, the scientific community describes those aspects under the term land cover. Land cover is not to be confused with land use. For example, woodland or forests are land covers, but the land use may be hunting or rubber tapping.

Land Degradation: Deterioration in land quality. Such land can no longer sustain an economic function appropriately and/or the original natural ecological function due to natural processes or human activity.

Land Levelling: Land preparation involves moving soil from high to low spots to achieve a flat horizontal surface so that irrigation water will be evenly distributed throughout the field.

Land Preparation: Preparing the soil for planting to provide a favourable soil environment for plant germination and/or growth.

Land Quality: A complex land attribute that distinctly affects its suitability for specific uses. For example, the land quality "availability of water" directly affects crop yields and land suitability for different crops. Most land qualities can only be assessed by modelling the interaction of several land characteristics. For example, water availability is modelled from data or rainfall, the available water capacity of the soil, and potential evapotranspiration.

Land System: A land unit with a relatively uniform climate and a repeating pattern of landforms, soils, and vegetation. A land system may be divided into land facets.

Land Tenure: Land tenure refers to arrangements or rights under which the holder holds or uses land. Land rented out is not considered to be part of the holding. A holding may be operated under one or more tenure forms, with each parcel normally operated under one tenure form. All data regarding land tenure should be collected for the same time reference. Many land tenure systems allow people to use the same property for different purposes. For example, farming rights can belong to one person, while the trees to another and the fruit of the trees to someone else. Leasing and renting are kinds of land tenure, just as is share-cropping.

Land forming: Tillage operations move soil to create desired soil configuration. Forming may be done on a large scale, such as gully filling or terracing, or a small scale, such as contouring, ridging, or bedding.

Landholdings: Land owned, occupied, or used by farmers or tenant farmers.

Landscape: The fundamental traits of a specific geographic area, including its biological composition, physical environment, and anthropogenic or social patterns. A collection of related landforms, usually the land surface, which the eye can comprehend in a single view. The landscape is a distinct association of landforms, as operated on by geological processes (exo-or endogenic) that can be seen in a single view.

Landslide: The term describes the downslope movement of soil, rock, and other weathered materials because of gravity. A general term for a mass movement landform and a process characterized by moderately rapid (greater than 30 cm per year) downslope transport, through gravitational stresses, of a mass of rock and regolith may or may not be water-saturated.

Land-use: Land-use is characterized by the arrangements and activities inputs people undertake in a particular land cover type to produce, change, or directly link land cover and people's actions in their environment. A crop is not land use. The recreation area is a land use term for different land cover types: sandy surfaces like a beach, a built-up area like a luna park, a forest, etc.

Land reform: A deliberate attempt to reorganize and transform agricultural systems to foster an equal distribution of agricultural incomes and facilitate rural development.

Least developed countries: A United Nations designation of countries with low income, low human capital, and high economic vulnerability.

Less developed countries: A synonym for developing countries.

Likert Scale: The respondent has to choose a scale introduced by Likert employing a set of response categories ranging from positive to very negative.

Linear Regression: A method of estimating the value of a Dependent Variable when the values of two-interval scaled and normally distributed variables are known.

Literacy: The ability to read and write.

Livestock Systems: A subset of farming systems, including cases in which livestock contribute more than 10 per cent to total farm output in value terms or where intermediate contribution such as animal traction or manure represents more than 10 per cent of the total value of purchased inputs.

Livestock Unit: A standard live weight unit for all grazing animals based on their respective live weight. A familiar LU is 500Kg, with adult cattle representing 1.0 LU and adult sheep representing 0.0 LU.

Livestock: Refers to all animals kept or reared, mainly for agricultural purposes. Includes aquaculture for fish production.

Low-income countries (LICs): In the World Bank classification, countries with a gross national income per capita of less than $976 in 2008.

Multiple Regression: Multiple regression is linear regression in which two or more predictor variables are used to predict the criterion

Non Governmental organizations (NGOs): Nonprofit organizations often provide financial and technical assistance in developing countries.

Off-farm Income involves working on other farms for wages or arrangements such as sharecropping or exchanging labour in-kind. Off-farm income is strictly defined as income generated from working outside one's farm through participating in ploughing, weeding, or harvesting on another farmer's land. Moreover, we also consider income from local environmental resource extraction, such as firewood collection, charcoal production, and gathering of wild fruits, as off-farm income.

On-farm Income: Income generated from farming, whether on owner-occupied or leased land, includes livestock and crop income. Income is derived from crop production and the rearing and selling of animals. This includes income earned from commercial woodlots and beekeeping.

Pilot Study: A complete replica of the leading research study employed in a fraction of the sample.

Positive Association: There is a Positive association between X and Y if smaller values of X are associated with smaller values of Y and larger values of X are associated with larger Y values.

Pre-test: A small-scale test administered before introducing a study aimed at measuring the efficacy of one or more main study elements. It helps to modify and update the Interview Schedule/Questionnaire.

Qualitative Data: The data collected should be from elderly people who are highly experienced in the research area.

Quantitative Data: The data to be collected from the concerned respondents or any published reports quantitatively.

Qualitative Variable: Also known as Categorical Variables, qualitative variables with no natural sense of order. They are, therefore, measured on a nominal scale.

Random Sampling: The process of selecting a population subset for statistical inference. Random sampling means that every member of the population is equally likely to be chosen.

Regression: Regression means “prediction.” The regression of Y on X is the prediction of Y by X.

Regression Analysis: A method employed to study the relationship between variables, especially the extent to which a dependent variable functions one or more independent variables.

Sample: A group of units chosen to be included in a study

Significance: A criterion related to the validity of data.

Significance Level: In significance testing, the significance level is the highest value of a probability value for which the null hypothesis is rejected. Expected significance levels are 0.05 and 0.01. If the 0.05 level is used, the null hypothesis is rejected if the probability value is less than or equal to 0.05.

Smallholder Farmer: In Ethiopia, the smallholder farmer meets the conventional meaning of small farms of less than 2 hectares per household. They are known for resource constraints like capital, inputs, and technology, heavy dependence on household labour; their subsistence orientation; and exposure to risks such as reduced yields, crop failure, and low prices.

SPSS: A statistical package for Social Sciences that the software could support with computer-assisted research data analysis.

Social system: The organizational and institutional structure of a society, including its values, attitudes, power structure, and traditions.

Soil Degradation: A process that describes human-induced phenomena that lower the soil's current or future capacity to support human life. Improper use by humans commonly causes a decline in soil quality. This includes physical, chemical, and/or biological deterioration. Its consequences are loss of organic matter, a decline in soil fertility, a decline in structural condition, enhancement in erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants, or excessive flooding.

Soil Fertility: The overall ability of a soil to support vigorous crop growth by ensuring adequate plant nutrients and suitable conditions for water uptake and providing favourable conditions for root growth and development. Fertility synthesises chemical, physical, and biological components and is influenced by climatic and management factors. Its assessment helps decide fertilizer application rates, which is the primary function of soil fertility, low and inadequate to support the desired level of plant production. Fertilizer application aims to increase soil fertility.

Soil Management: The total of all tillage operations; cropping practices; decisions; usage of inputs including fertilizers, amendments, bio-fertilizers, pesticides, herbicides; and other treatments such as irrigation and drainage or applied to soil for plant production and soil conservation.

Soil Productivity: The capacity of the soil, in its typical environment, to produce a specified plant or sequence of plants under a specified management system. It emphasizes the capacity of the soil to produce crops and is expressed in terms of yield.

Soil erosion: Loss of valuable top soils resulting from overuse of farmland, deforestation, and consequent flooding of farmland.

Staple food: A leading food consumed by a large portion of a country's population.

Stakeholders: A large group of individuals and groups of individuals (including governmental and non-governmental institutions, traditional communities, universities, research institutions, development agencies and banks, donors, etc.) with an interest or claim (whether stated or implied) which has the potential of having an impact on a given project and its objectives. Stakeholders with a direct or indirect "stake" can be at the household, community, local, regional, national, or international levels.

Stream: (watercourse, river) Body of water, generally flowing in a natural surface channel. Water flows in an open or closed conduit, a jet of water issuing from an orifice, or a body of flowing groundwater.

Stream-bank erosion: Torrents are defined as hill streams characterized by wide-spreading beds on emergence from the hills with ill-defined banks, flashy flows, and swift currents. Usually, they are dry watercourses, except during the rainy season. With every downpour in their catchment, they get very swollen with flood and subside almost to their average tiny size immediately after the storm is over. These sudden and violent flows are responsible for moving immense residues, comprising boulders, shingles, sand, and silt, depending upon the terrain's geology. This debris gets deposited in the torrent bed in the form of scattered islands due to the sudden widening of the torrent channel after it emerged from the hills or the gradient's flattening in the lower reaches or obstructions caused by wild vegetation and uprooted trees. These deposits raise the bed level of the torrent. These deposits, in turn, reduce the transporting capacity of the torrent, resulting in the transporting capacity of the torrent resulting in overflow, the meandering of the course, and the erosion of the banks.

Subsistence Crop: The crop grown under problematic conditions when no other crop can be grown, such as floating rice in flood-prone areas.

Subsistence farm: A low-income farm emphasising production for the farmer's use or the farmer’s family rather than for sale.

Subsistence Farming: Growing crops and, where appropriate, keeping animals to provide food (cereals, pulses, vegetables, and fruits), shelter materials, and possibly other products (fibres, medicinals) for family use.

Sub-surface Irrigation: Irrigation of crops by applying water below the surface of the ground through pipes.

Surface Irrigation: A method of irrigation when the water is applied to the land by allowing it to flow by simple gravity before infiltration. It includes various systems depending upon the relative magnitude of the surface flooding and infiltration phases after accumulation (submersion).

Surface runoff: Water from a catchment area is discharged or lost without entering the soil.

Surface Soil: The uppermost part of the soil, ordinarily moved in tillage, is equivalent to uncultivated soils and ranges in depth from 7 to 25 cm. Therefore, they were frequently designated as the surface layer plough layer.

Surface tillage: Cultivating or mixing the soil to a shallow depth.

Surface water: All waters on the earth's surface, including fresh and saltwater, ice, and snow, as distinguished from underground water, oceans, lakes, rivers, etc. The runoff from paved or unpaved land or buildings is distinct from sewage.

Sustainable Agriculture: An integrated system of farming that will, over the long term, satisfy food and fibre needs, enhance environmental quality, make the most efficient use of resources, sustain the economic viability of farm operations and enhance the quality of life. Overall, sustainable agriculture emphasizes management practices that take advantage of natural processes (such as nutrient cycles, nitrogen fixation, and pest-predator relationships), improve the match between cropping patterns and agronomic practices on the one hand, and the productive potential and physical characteristics of the land on the other. Commercial fertilizers and pesticides are used selectively to ensure production efficiency and conservation of soil, water, energy, and biological resources. Sustainable agricultural practices include crop conservation tillage systems, including no-till planting methods, integrated pest management, and genetically improved crops and animals.

Sustainable land use: Land use achieves production sufficient to meet present and future populations' needs while conserving or enhancing the land resources on which that production depends.

Sustainable Production Systems: Production systems are designed to remain viable indefinitely by not degrading the resource base, impeding continued production indefinitely. Sustainable implies continuous improvement based on the concept that we continue to learn about the results of our interaction with complex ecosystems. Therefore, we must remain in a constant mode of learning and documentation to hone our systems toward a perfect form.

Sustainable Use: The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations. The uses of the biological products and ecological services of ecosystems are in a manner and at a rate that does not reduce the system's ability to provide those products and services to future generations. Sustainable use of the environment and its living resources is used at a rate that does not exceed its capacity for renewal to ensure its availability for future generations. Sustainable management involves our current generation while conserving natural resources and protecting the environment for the benefit of future generations.

Sustainable: Production systems that can meet present needs without reducing the capability to meet future needs. FAO has defined sustainability as "Sustainable development is the management and conservation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable".

Temperature: The measure of molecular motion or the degree of heat of a substance. It is measured on an arbitrary scale from absolute zero, where the molecules theoretically stop moving. It is also the degree of hotness or coldness. Surface observations refer primarily to the free air or ambient temperature close to the earth's surface.

Terrace: A step-like surface bordering a stream or shoreline representing the former position of a floodplain, lake, or seashore. A raised, generally horizontal strip of earth and/or rock constructed along a hill on or nearby on a contour to make the land suitable for tillage and prevent accelerated erosion. An earth embankment is constructed across a slope for conducting water from above at a regulated flow to prevent accelerated erosion and conserve water.

Tillage: The mechanical manipulation of the soil profile for any purpose, but in agriculture, it is usually restricted to modifying soil conditions and/or managing crop residues and/or incorporating chemicals for crop production.

Tiller: A vegetative branch of the rice plant composed of roots, culm, and leaves, which may or may not develop a panicle. Shoot arising from the main culm (stem).

Topsoil: The upper part of the soil, with the lower limit set at 30cm or shallower. The soil depth may be limited by a root growth-inhibiting layer, a hard rock, a pedo-genetically indurated layer, a chemically unfavourable layer, or a strongly contrasting layer.

Topography: The relief exhibited by a surface. Refers to the differences in elevation of the land surface on a broad scale. It is derived from the site's most representative or characteristic slope gradient.

Watershed: (catchment, catchment area, drainage area, drainage basin, river basin): A physiographic unit in the landscape defined by the drainage dividers around the area drained by a particular body of water. If a lake, there is often one watershed with subunits for contributing streams. If a river, it may be defined for any point or all. The whole surface drainage area contributes to water or a lake. The total area above a given point on a stream contributes water to the flow at that point (syn: 'drainage basin,' 'river basin'). Regardless of size, the total area above a given point on a waterway contributes runoff water to the flow at the point. A major drain-area subdivision of a drainage basin is based on this concept.

Watershed Analysis: A systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. The watershed analysis is a stratum of ecosystem management planning applied to watersheds.

Watershed Degradation: A marked deterioration in the hydrological behaviour of a river system, which reduces the potential of land and water by causing a water flow of inferior quality, quantity, and timing.

Watershed Management: Planned use of watersheds (river basins) following predetermined objectives.

Yield: The aggregate of products from growth or cultivation, usually expressed in quantity per area. Amount of production per unit area over a given time. A measure of agricultural production. Crop yield can be total dry matter yield (grain+straw) or economic yield (grain only). They are usually expressed as Kg/ha, Mg/ha (Mg=Megagrams), or tonnes/ha. The expression “quintals (100/Kg) /ha” is getting out of use.

World Bank: An organization known as an “international financial institution” that provides development funds to developing countries in interest-bearing loans, grants, and technical assistance.

10. SUBJECT INDEX

10. SUBJECT INDEX

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Dr. Samantha Curle
Assistant Professor, Dept. of Education, University of Bath, UK

Ethiopia's biophysical potential is significant, land degradation and poverty continue to challenge sustainable agricultural development opportunities. This problem is further aggravated by high population pressure in rural areas - currently, 86 per cent of Ethiopia's 72 million inhabitants live in rural areas, climatic variability, limited use of sustainable land management practices, the widespread dismantling of constructed soil and water management structures, and a high dependence on rain-fed agriculture. Moreover, deforestation due to farmland expansion and energy needs, fragile soils, undulating terrain, and heavy seasonal rains make the rural family of Ethiopia highly vulnerable to soil erosion and gully formation. This book enlightens the knowledge of soil and water conservation practices among the rural farmers in Ethiopia.

Prof. Dr. Mohamed Rabie
President, Arab Thought Council in Washington

Ethiopia is one of the Sub-Saharan African countries where soil degradation has reached a severe stage. Due to soil erosion and nutrient depletion, land degradation has become the most critical environmental problem in the country, coupled with poverty, a fast-growing population, policy failures, and social unrest. Moreover, land degradation severely threatens national and household food security. Therefore, soil conservation strategies need to be based on an approach that ensures the participation of rural people in conservation because of the benefits that conservation brings. For soil and water conservation to occur and remain sustainable, land users should carry out and maintain the necessary measures; however, as the book shows, Ethiopian farmers have managed these land management structures to the economical use of irrigation water to maintain the agricultural activities.

Prof. Dr. Predrag Ilic
Director and Scientific Advisor of Institute for protection and ecology of the Republic of Srpska

The farmers in developing countries like Ethiopia follow the Indigenous method of Soil and Water Conservation Practices. However, due to the Institutional interventions, the modern scientific methods of soil and water conservation have been recommended because Ethiopian lands' landscape is mostly undulated. Two immediate pressures have forced the smallholder farmers to adopt modern technology to save the water and soil fertility when they have proper two practices. This book will be helpful for future researchers, development practitioners and NGOs to design the projects on Soil and Water Conservations.

Dr. Seda Yıldırım
Assoc. Prof., Tekirdag Namık Kemal University, Faculty of Economics and Administrative Sciences, Department of Business Administration, 59030, Tekirdag, Turkey

Ethiopia is an important country with higher numbers of refugees as a host country in the African Region. However, Ethiopia is categorized as the least developed country in the African region. Accordingly, Ethiopia should protect its water and food sources to keep their sustainability in the long term. As the agriculture sector supports Ethiopia's economy, the balance between farming activities and water sources is also an essential issue in the long term. This book provides evidence to determine factors influencing the adoption of physical soil and water conservation practices. In addition, this study investigates how farmers perceive Ethiopia's soil and water conservation practices. It is thought that this book will contribute to policymakers and future studies by giving a case of Ethiopia.

ISBN 979-888796792-9
9 798887 967929