ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE ADOPTION OF SOIL CONSERVATION STRUCTURES IN THE WESTERN CATCHMENT OF CHERAKE RIVER, SOUTHERN ETHIOPIA

MULUGETA NEKA

JUNE 1992

THE ADOPTION OF SOIL CONSERVATION STRUCTURES IN THE WESTERN CATCHMENT OF CHERAKE RIVER, SOUTHERN ETHIOPIA

A Thesis
Presented to
The School of Graduate Studies
of the
Addis Ababa University

In Partial Fulfillment
of the Requirements for the Degree of
Master of Arts in Geography

By
MULUGETA NEKA

JUNE, 1992

ADDUS ABABA UNIVERSITY

School of Graduate Studies

The Adoption of Social Conservation Structures in the Western Catchment of Cherake River, Southern Ethiopia

by

Mulugeta Neka

College of Social Sciences

Approved by Board of Examiners:

Belay Tegene
Advisor

Kebede Tato
Examiner

Kailash Nath Singh (Dr.)
Examiner

Kailash Nath Singh

CONTENTS

Page

ACKNOWLEDGEMENTS iv
LIST OF TABLES v
LIST OF FIGURES vii
LIST OF APPENDICES viii
ABBREVIATIONS ix
ABSTRACT x

CHAPTER

1. INTRODUCTION

1.1 Definition of terms 1
1.2 The problem: An appraisal . . . 2
1.3 Objectives of the Study 7
1.4 Literature review 8
1.4.1 The adoption process . . . 8
1.4.2 Adoption studies in Ethiopia 9
1.4.3 Degradation and Conservation of soils in Ethiopia 11
1.5 Significance of the Study 16
1.6 Selection of the Study Site . . . 16
1.7 Nature of Data 18
1.8 Methodology 19
1.8.1 Methods of analyses . . . 19
1.8.2 Measurement of Variables . 20
1.8.3 Hypothesis 33
1.8.4 Methodology for collecting primary data 34
1.8.4.1 Sampling procedure to collect primary data 35

PAGE

2. INTRODUCTORY DESCRIPTION OF THE STUDY AREA 41

2.1 The physical environment 41
2.1.1 Location 41
2.1.2 Geology and geomorphology 41
2.1.3 Climate 43
2.1.4 Soil 44
2.1.5 Vegetation 45

2.2 Population and economic activities 45
2.2.1 Sex and age composition of the population 45
2.2.2 Size of farm 47
2.2.3 Crop production 49
2.2.4 Livestock production . . . 51
2.2.5 Marketing of agricultural products 53

3. THE PROBLEMS OF SOIL DEGRADATION AND CONSERVATION 56

3.1 Farmers' perception of the causes of soil degradation 56
3.2 Soil Conservation 57
3.2.1 Farmers' awareness of the soil conservation measures 57
3.2.2 Construction of the level 'fanya juu' 58
3.2.3 Management of the level 'fanya juu' 62
3.2.4 Factors responsible for erosion damage in the study site 65

PAGE

4. ADOPTION OF THE SOIL CONSERVATION STRUCTURE 73

4.1 Adoption of the soil conservation structure (level 'fanya juu') . . 73

4.2 Factors that explain adoption of the level 'fanya juu' 76

5. RESULTS 85

5.1 Hypothesis testing 85

5.1.1 Bivariate regression analysis 86

5.1.2 Stepwise multiple regression analysis 90

6. CONCLUSIONS AND RECOMMENDATIONS . . . 94

6.1 Conclusions 94

6.2 Recommendations 97

FOOTNOTES 101

BIBLIOGRAPHY 105

APPENDICES 116

ACKNOWLEDGEMENTS

I would like to express my indebtedness to all persons for their unreserved encouragement. My heartfelt gratitude goes to Dr. Belay Tegene, current chairman of the Department of Geography and my thesis advisor. His valuable advice has helped me realize the thesis. He spared considerable time to go through and correct the draft copy of the thesis and make constructive criticism which resulted in substantial improvements in the research.

My great debt goes to the School of Graduate Studies which provided me with financial support. I also extend my thanks to the Geography Department for providing me with measuring instruments, and Ato Esayas Sahlu for drawing the maps and diagrams.

I am grateful to Ato Melakneh Mengistu for editing the draft of the thesis. In addition, I am greatly indebted to the following individuals who provided me with various advices.

- Dr. Karl Herweg
- Dr. K.N. Singh
- Ato Alemu Mekonen
- " Habtamu Belete
- " Yibeltal Gebayehu
- " Alemneh Wondimageny
- Ato Bitew Mihenyat
- " Yohanese Gebre Michael
- W/t Tigist Yetbarek
- W/o Asnaketch Abebe
- " Almaz Mekonen

LIST OF TABLES

TABLE PAGE

1. Index of adoption of conservation structures 23
2. Scaling of attitude towards conservation structures 26
3. Levels of water erosion before and after the introduction of the structures 28
4. Instruments utilized to collect data in the treated plots 35
5. Sample peasants associations and farmers . . 39
6. Size of subsamples from sample plots which have different level of destruction of the structures 40
7. Mean monthly temperature and rainfall data for Boditi from 1981 to 1991 44
8. Distribution of farm size 47
9. Crop calendar of the 5 major types of crops 49
10. Volume of crop production in 1990/91 51
11. Number of livestock in 1990/91 52
12. Farmers who marketed different portion of their produce in 1990/91 54
13. Percentage of farmers who obtained cash from the sale of livestock 55
14. Farmers' identification of the causes of soil degradation 56
15. Farmers' realization of soil conservation measures 58
16. The states of the level 'fanya juu' 62
17. The width and height of the level 'fanya juu' 64
18. Sources of run off that affected croplands . 66
19. Slope reduction due to the treatment of plots 69
20. Average inter-structure slope length in the treated plots 70

TABLE PAGE

21. Intensity of ploughing for various crops in the summer of 1991 71
22. Index of adoption of the level 'fanya juu' . 74
23. Reasons for the farmers' partial or whole destruction of the level 'fanya juu' 75
24. Attitude of farmers towards the level 'fanya juu' 77
25. Farmers' perception of soil erosion 81
26. Frequency of contact of farmers with the soil and water conservation agents in 1990/91 . . 82
27. Farmers' perception of yield increase . . . 83
28. Correlation matrix 87

LIST OF FIGURES

Figure Page

1. Land degradation in the Western Catchment of Cherake River 4

2. Relationship between topsoil depth and soil productivity (average of three plots) 14

3. Areas prone to erosion in the Western Catchment of Cherake River 17

4. The adoption model 21

5. Sample peasant associations 38

6. Geographical location of the study site . . 42

7. The farmhouse and its surroundings 46

8. Age and sex structure of the population in 1991/92 48

9. Layout of the level 'fanya juu' 59

10. the level 'fanya juu' crossing depressions . 61

11. Breaching of structures and erosion damage on croplands 68

LIST OF APPENDICES

Appendix		Page
1.	Achievements of the Community Forest and soil Conservation Development Department	116
2.	Conservation works in the peasant association of the study site	117
3.	Questionnaire	118
4.	Erosion damage and state of the level 'fanya juu' recording from	141
5.	Rills, gullies, and area of erosion damage in the treated plots	144
6.	Slope reduction and average inter structure slope length in the treated plots	145
7.	ANOVA tables	146

ABBREVIATIONS

CFSCDD	Community Forests and Soil Conservation Development Department
CSA	Central Statistical Authority
CSO	Central Statistical Office
EMA	Ethiopian Mapping Agency
EHRS	Ethiopian Highlands Reclamation Study
FAO	Food and Agricultural Organization
FFW	Food For Work
GDP	Gross Domestic Product
IAR	Institute of Agricultural Research
IDR	Institute of Development Research
LUPRD	Land Use Planning and Regulatory Department
m.a.s.l.	metres above sea level
MOA	Ministry of Agriculture
PA	Peasant Association
SCRP	Soil Conservation Research Project
SFCDD	State Forest Conservation Development Department
UN	United Nations
UNDP	United Nations Development Programme
WFP	World Food Programme

ABSTRACT

The Western Catchment of Cherake River is one of the erosion prone areas in Ethiopia. Natural and human factors in combination have caused considerable erosion damage to the soil resource in the area. In order to mitigate the severity of this problem, structural conservation measures have been introduced since 1985. To examine the adoption of the conservation structures, a sample of 200 plots were randomly selected and the owners of these plots were interviewed with reference to their respective sample plots.

Of the nine independent variables considered for the explanation of the adoption of the conservation structures, the stepwise multiple regression analysis revealed that the attitude of farmers towards the conservation structures, perception of soil erosion, and size of farm are the most significant.

The other factors that influenced majority of farmers to accept the conservation structure are its efficiency at controlling run off, reducing loss of soil and fertilizers, and increase of yield in lower altitudinal zones. On the contrary, inconveniences to the crosswise ploughing in steeper slopes, habitation of moles in the conservation structures, and loss of cropland have caused some of the farmers to reject the conservation structures. These shortcomings of the conservation structures are the major causes for lack of maintenance of structures, development of terraces, and efficient control of erosion.

CHAPTER ONE

INTRODUCTION

1.1 Definition of Terms

1. Acceptance is an act of approval of the worth of a thing, for example an innovation.

2. Adoption is an acceptance and use of an innovation (Misiko, 1976:40), such as structural conservation measure. Here, it involves maintenance of structures, stabilizing by growing of vegetation below the structures, etc. in order to keep them in good condition.

3. 'Fanya juu' is a 'Swahili' word which means 'throw up hill slope'. In this context, level 'fanya juu' is defined as an embankment along the contour made of soil and/or stone with a basin at its lower side (Hurni, 1986:44).

4. Innovation is an idea or practice, or object perceived as new by an individual.

5. Perception is a way of awareness of the physical and social environment, for example perception of soil erosion on one's cropland.

6. Rill is an ephemeral feature which has small channel made by erosion (Morgan, 1980:10). Fifty cms is considered as the maximum depth of a rill. It is a temporary feature as it is usually destroyed by ploughing.

7. Gully is a relatively permanent steepsided water course which experiences ephemeral flows during rainstorm (Morgan, 1980:10).

8. Cropland (also called cultivated land) is land under cultivation or under temporary fallow (Hurni, 1986:37). In this case it mainly refers to the land under cultivation where conservation structures had been constructed. The structural conservation measures were not constructed in the gardens which usually grow perennial crops such as coffee, thus they were not included in the croplands.

9. Soil conservation structures refers to the movement of earth and may be grouped into five main categories: bench (including terracing and bunding), drainage channels, waterways, checkdams and tillage practices (FAO, vol.1, 1986a:267). Level 'fanya juu' is one of the types of structures that eventually enables terrace formation.

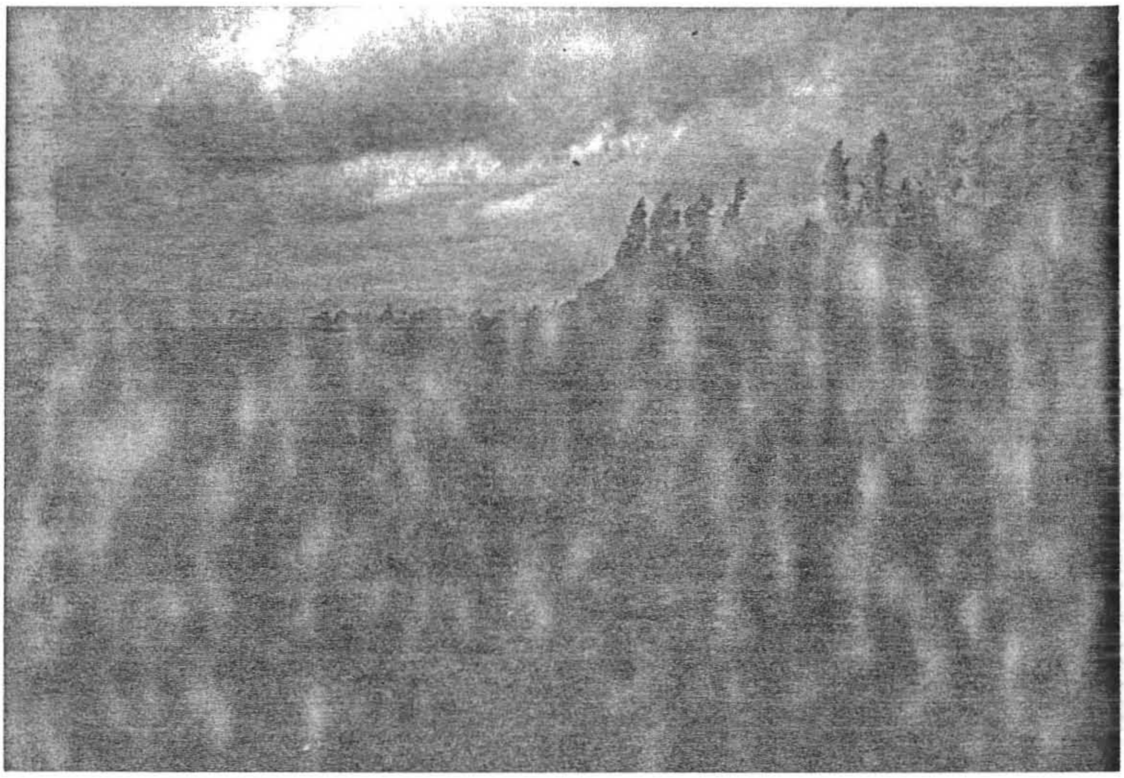
1.2 The Problem: An Appraisal

Agriculture is the backbone of the Ethiopian economy. It contributes about 45 per cent to the GDP, 90 per cent to export earnings and 85 per cent to the total employment and livelihood (FAO, Vol.1, 1986a:76). Rain-fed cultivation of crops is mainly confined to the highlands[1]. According to the Ethiopian Highlands Reclamation Study (EHRS), the Ethiopian high lands contributing only about 50 per cent of the total area of the country, accommodate approximately 88 per cent of the total population of the country, and account for over 95 per cent of its regularly cropped lands, about two-third of its livestock, and over 90 per cent of the national economic activity (FAO, Vol. 1, 1986a: XVII).

The soil resource of the Ethiopian highlands are seriously affected by erosion. The Western Catchment of the Cherake River which is part of the Ethiopian highlands is not an exception (See Figure 1). The nature of topography (slope, slope shape, and slope length) is the major factor for this problem. Erosion increases with increase in slope steepness, and slope length as a result of increases in velocity and volume of surface run off (Morgan, 1980:24; Thomas, 1984:19). Fault scarps, banks of several streams, and steep hillsides are the major contributing factors to soil erosion in the study area.

The other major cause of erosion is the improper farming practice. Up and downhill ploughing open the way for run off. As the run off flows, there will be high energy available to transport soil particles downslope. Moreover, the high intensity of ploughing destroys soil aggregate and prepares it for transport.

Fig. 1. Land degradation in the Western Catchment of Cherake River



Source: Photo August, 1991.

The reckless cutting down of trees for firewood, for construction of houses, and for having extra farmlands have also contributed to accelerated erosion. Croplands are not sufficiently covered during the most erosive rainfall in June and July. As a result, heavy soil loss occurs during these months.

High density of livestock also causes damage to the vegetation cover by excessive grazing. Furthermore, high density of livestock disturbs the soil structure by trampling and exposing the soil to erosion.

The increase in population has extended farming practices to more vulnerable land and reduced fallow periods. Welayita 'awraja'[2], in which the study site is found, has one of the highest population densities (223 persons/km^2) in Ethiopia (CSO, 1986:23). The high density of population and the consequent demand for land has forced the farmers to plough marginal lands which are very vulnerable to erosion. Continuous ploughing without sufficient period of fallowing (in order to feed the dense population) has worsened the condition.

Erosion brings about loss of soil fertility, decreased infiltration, and diminished workability of soils (Frye, 1987:152). The loss of soil whether in quantitative or qualitative terms results in degradation of the land resource and long-term decline in biological productivity (Velozo, 1987:10). Land degradation makes more severe the consequences of drought on agricultural production and agricultural productivity (Hurni, 1988:124).

Currently, the Ethiopian government and international organizations are making considerable efforts to conserve the natural resources. But the recently introduced conservation measures by these authorities are mainly of structural type (FAO, Vol.1, 1986a: 236).

The research focuses on the identification of socio-cultural factors that influence the adoption and management of one of the structural conservation measures, i.e the level 'fanya juu' in the Western Catchment of Cherake River (North Omo Administrative Region). The level 'fanya juu' is the only soil conservation structure introduced into the croplands of the study area. The other types of conservation measures were undertaken off-farm (see Appendix 2).

The construction of the conservation structures were executed under Food For Work (FFW) programmes. Farmers were paid (food and oil) per km. of bunding. This has resulted in the achievements of quantitative rather than qualitative targets (FAO, Vol.1 1986a: 272). Thus, poorly constructed conservation structures are apparent in the area.

The farmers were advised to maintain their individual conservation structures on the croplands. But lack of willingness of the farmers in maintaining the soil conservation structures on the farmlands was observed by the researcher. FAO (Vol.1. 1986a: 272) and Amare (1988:87) state the farmers resistance and lack of willingness to maintain conservation structures is due to large area of land taken out of production, problem of rodents and difficulty of turning round the plough and oxen.

1.3 Objectives of the Study

The purpose of the research is to examine the adoption of the level `fanya juu'. The problem encountered by each farmer in adopting the level `fanya juu' will be explored. In addition, the reasons that explain the causes of lack of interest in the maintenance of the level `fanya juu' will be examined.

The research has the following specific objectives:

1. To assess the factors that have motivated or deterred the farmers in the adoption of the level `fanya juu'.

2. To examine the management and state of the level `fanya juu' where it is adopted.

3. To identify solutions to the constraints on the adoption of the level `fanya juu'.

1.4 Literature Review

1.4.1 The adoption process

Decision to adopt and innovation takes time. Through the passage of time, people appear to go through a series of distinguishable stages in the adoption process. The stages in the adoption process are awareness, interest, evaluation, trial, and adoption (Rogers and Shoemaker, 1971:25; Lionberger, 1966:3-4; Bisrat, 1980:20). It is fruitful to follow the existing patterns of the adoption process than to try to cut or change them (Lionberger, 1966:8).

Quoting Couch (1964, cited in Jones 1967), Zemenfese (1985:30) points out that the decisions to adopt are classified into four, i.e. voluntary or optional adoption, adoption by directives, adoption by coercion, and group adoption. When the decision-maker and adopter is not the same person, the adopter of the innovation may not get sufficient time to evaluate and accept the innovation. That means there is a short-cut of the adoption process.

Governments may be involved either at the beginning or later stages in the course of the adoption process. The role of the government could be dissemination of information (informant), assuming of responsibility (sponsor) or enforcement by law or could also be non-intervention in the adoption process (Alves and Morill, 1975:299-300).

In Ethiopia, conservation is largely a programme that has been implemented by the government through the Community Forest and Soil Conservation Development Department (CFSCDD) extension agents, State Forest Conservation Development Department (SFCDD) and PAs (FAO, Vol.1 1986a:280). Hence, soil conservation structures were constructed on cropland without giving the needed time for the farmers' decision-making in the adoption process.

1.4.2 Adoption Studies in Ethiopia

Awetahegne (1975:45) investigated the role of several independent variables to explain the adoption of agricultural improvement. Agricultural communication, personal possession, knowledge of extension agent, formal group membership, and radio exposure are found to be highly positively correlated with the adoption of agricultural innovation.

Bisrat (1980:130) considered 18 independent variables to elucidate the variability of fertilizer use in Jima and Bako 'awrajas'. He found that man-land ratio, ox-to-land ratio, and borrowings are highly and positively correlated with fertilizer use.

Aregay (1975) also studied the role of 23 independent variables to explain the adoption of agricultural innovations (improved varieties of crops, soil management, and implements) in Chilalo 'awraja'. Ten independent variables (debt avoidance, traditionalism, attendance at meetings, attendance at demonstrations, farmers visit at model farmers, number of wives, number of female children, number of other dependents, age of farmer, and farmers visit to extension centre) explained 56 per cent of the variance in the adoption of agricultural innovation (Aregay, 1975:182).

Itana (1985:4) investigated several variables to explain the adoption patterns of improved seed and fertilizer in Chebo and Gurage, and Jibat and Mecha 'awrajas' of Ethiopia. He found that as the values of livestock, price of farm input, and non-farm income increase the adoption of improved seed and fertilizer also increases.

Some of the factors that deter the adoption of structural conservation measures are loss of cropland, inconveniences for crosswise ploughing, encroachment of weeds, and rodents habitation in the structures (Thomas, 1984:27-28; Ibarra, 1984:21).

Yohanese (1989:114) also points out that very slow adoption of the conservation technique could be due to the absence of discussion with the farmers, failure to educate the farmers, and the slow response of conservation structures in terms of crop yield improvement. The insecurity of land tenure and the cost incurred by the present land user have also created reluctancy to undertake either construction or maintenance of conservation structures (FAO, Vol.1, 1986a: 235;

Krauer, 1989:56; Aggrey-Mensah, 1984:23-42). Lack of winning the confidence of the rural community also contributes to the failure of conservation development programme (Kohler and Jemal, 1989:8).

1.4.3 Degradation and Conservation of Soils in Ethiopia

Climate (erosivity of rainfall), vegetation cover, topography (slope and slope length), soil property (erodibility), and land use determine the extent and magnitude of water erosion (Larson et al 1987:9). The Soil Conservation Research Project (SCRP, 1988:V and Mesfin, 1988:264) indicate that the inappropriate land management practices (reduction of fallow years, ploughing of marginal lands, excessive tillage particularly for 'teff', removal of dung and crop residues, overgrazing, livestock trampling, etc.) have increased the vulnerability of the soil resource of Ethiopia to accelerated erosion (see Section 1.2).

Erosion results in soil degradation. Soil degradation can be defined as the deterioration in the quantity and quality of the soil resource and implies partial or total loss of productivity due to water erosion (Velozo, 1987:10).

Effects of erosion include reduced permeability and water retention in soils, increased run off which leads to flooding and changes in depth of river beds and erosion of banks of rivers and streams (Kassas, 1984:13; FAO, 1986c: 57). The misuse and loss of the protective cover of the soil, aggravated by drought, will lead the region to assume the characteristic of the desert (Mabbutt, 1985:1; FAO, 1986c: 64; Kassas, 1984:14; Secretariat of UN, 1977:7).

The decline of civilizations such as the Aksumite kingdom, Lalibella, Gonder, and Menz are believed to be caused by the degradation of the soil resource (Butzer, 1982:33). Emperor Minilik was on the verge of changing his capital (Addis Ababa) to Addis Alem because of the exhaustion of wood for fuel and building. But the introduction of eucalyptus tree made the Emperor abandon his idea (Pankhurst, 1964:250-251).

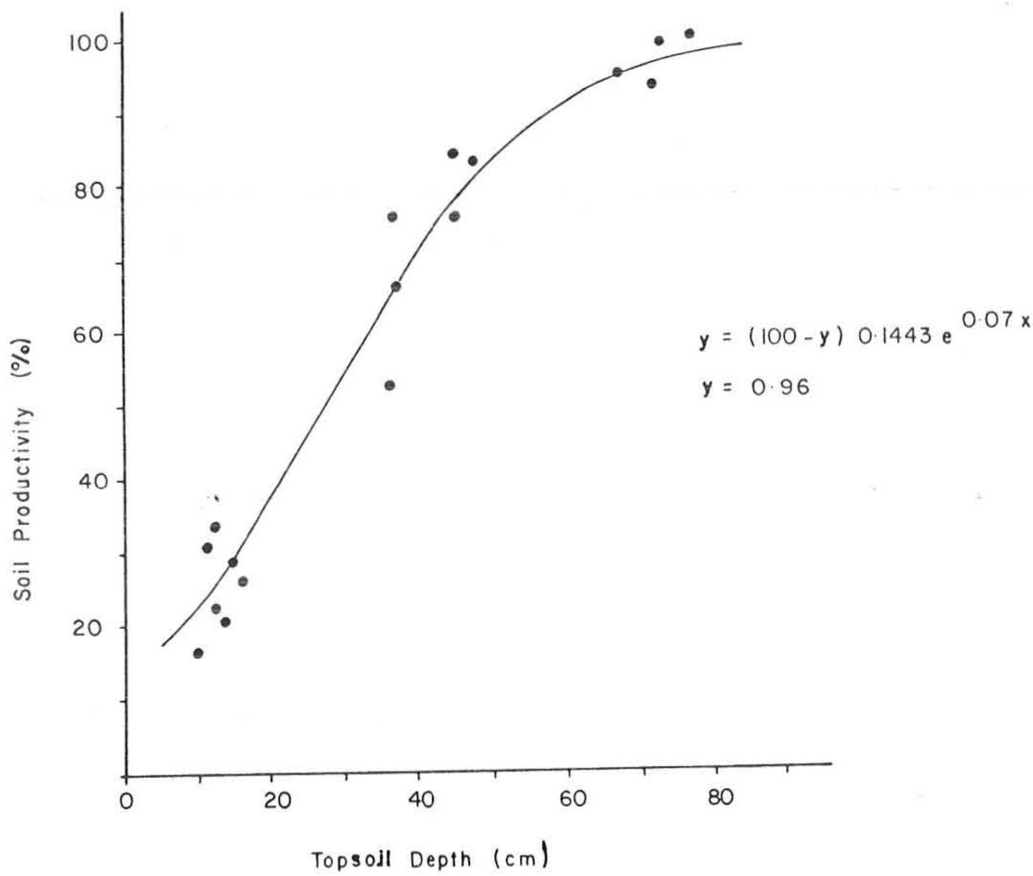
SCRP (1988:V) estimated that 1.6 billion tons of soil per year is removed from slopes in Ethiopia. Measurement of soil loss recorded by SCRP (1988:17) and Belay (1990:28) from plots in Gununo, (Northern Omo Administrative Region) vary from 0 on grasslands to 385.7 tons/ha/yr on continuously hacked bare fallow plots. Belay (1990:128) estimated a net soil loss rate of 75 tons/ha/yr for Gununo area. The findings of Belay also indicate that the total losses of organic matter, sodium, potassium, calcium, magnesium from bare fallow run off plots as a result of erosion were 20111, 903, 166.43, 896.92, 94.28 kgs/ha/yr respectively.

The ultimate effect of erosion is a decline and loss of soil productivity.[4] Belay (1990:124-126) employed yield to estimate productivity changes in slightly, moderately, and severely eroded soils in Gununo area. He converted the grain and seed yield data into percentage productivity values, by expressing the yield values as per cent of the maximum yield on the slightly eroded soils. This is performed to compare productivity of soils that were planted in different crops. The raltionship between topsoil depth, and percentage of soil productivity values is illustrated in Figure 2. Belay elaborates that severely and moderately eroded soils have soil productivity of less than 33 per cent, and 33 to 91 per cent respectively. These indicate reduction in productivity from the initial level by more than 67 per cent on the severely eroded soils and 9 to 67 per cent on the moderately eroded soils.

It is estimated that the cost of degradation from land going out of production and lower crop yields, and grazing land (in grass yields) in Ethiopia is 11873 millions and 3388 millions Birr respectively from the year 1985-2010 (FAO, Vol.1, 1986a:227). FAO further states that per capita income would fall from the present level of Ethiopian Birr 102 to 65 for the crop farmer and Ethiopian Birr 72 to 58 for the livestock farmer in the year 2010.

To counter the erosion problem the Ethiopian farmers have traditionally practised a number of water control and soil conservation techniques (Yeraswork et al., 1985:5). The traditional field terracing of the Konso people and the farmers

Fig.2 Relationships between topsoil depth and soil productivity (averages of three plots)



Source : Belay (1990: 125)

of the Abay gorge and Hararghe highlands can be cited as good examples. Ministry of Agriculture (MOA,1988:1-5) reports that main traditional conservation practices in Ethiopia include contour ploughing, ridging (for tuber crops), manuring, crop rotation, fallowing, ratooning, relay cropping, intercropping, alley cropping, mulching, cut and carry, drainage furrowing, graded diagonal cut off and path, cambered beds, level bunds, and bench terraces. But these conservation works are not universally practised by all rural community.

International agencies such as FAO, and world Food Programme (WFP) have supported conservation activities since 1972 (Yeraswork et.al., 1985:1). CONCERN and Care-Ethiopia are also participating in direct implementation of conservation programmes. The Ethiopian agencies that facilitate conservation works currently are CFSCDD and SFCDD under MOA (see Appendix 1), the Ethiopian Red Cross Society, and the Relief and Rehabilitation Commission. The Damot Gale 'Awaraja' Agricultural Department soil and water conservation agents and CONCERN have been involved in carrying out conservation works in the study site (see Appendix 2).

Institute of Agricultural Research (IAR), Alemay Agricultural University, CFSCDD and SCRP are undertaking conservation research (FAO, Vol.1, 1986: 261). SCRP has established 7 research sites in different agroecological regions since 1981 (SCRP, 1986:10).

1.5 Significance of the Study

Studies relating to the adoption of agriculture innovations in Ethiopia are very few. Even those few concentrated only on the adoption of modern inputs and selected seeds. No research was done on the adoption of soil conservation measures in Ethiopia. The acceptability of the soil conservation technologies by the rural community are not given due attention.

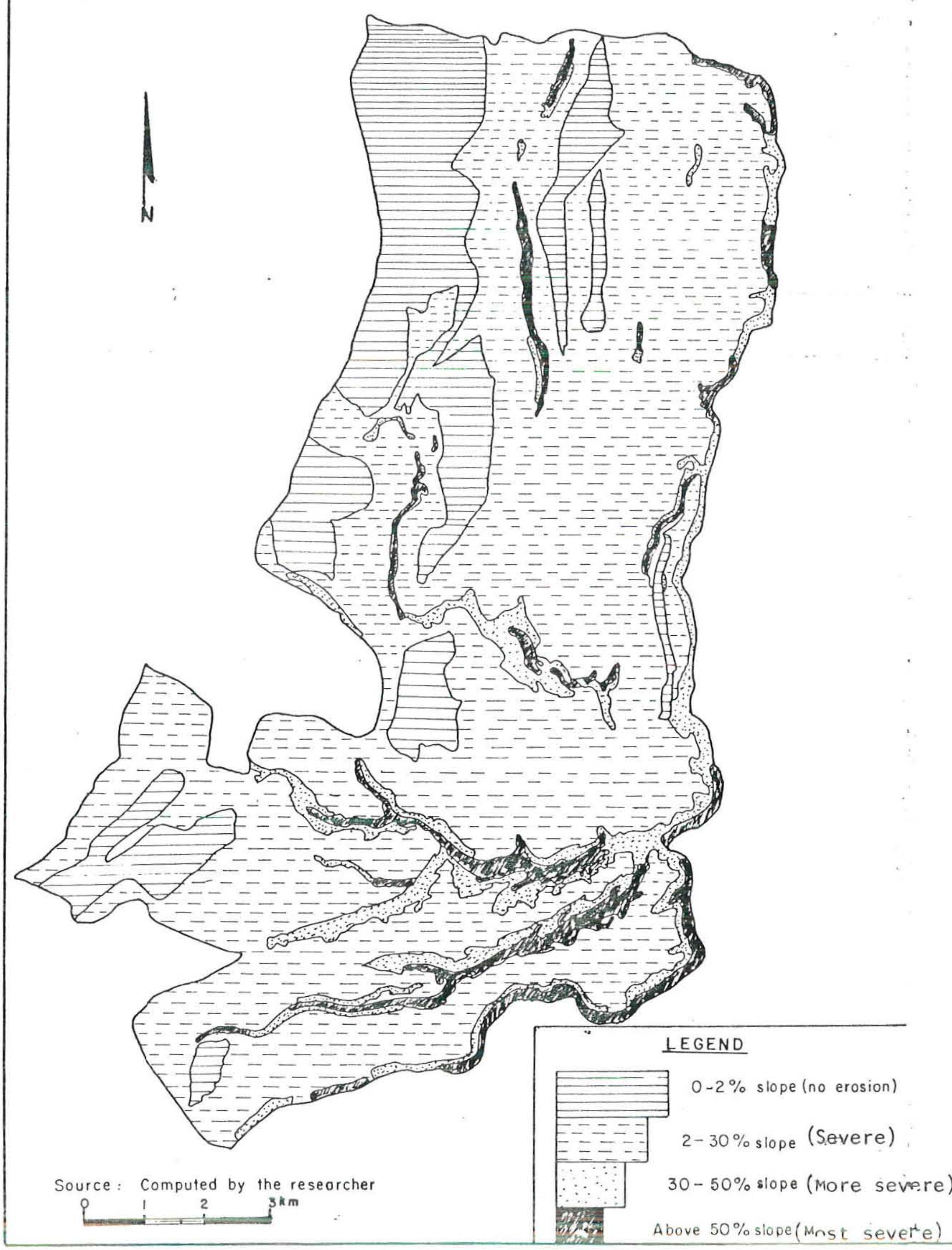
The serious problem of land degradation in Western Catchment of Cherake River reveals the need for conservation. And there will be no improvement in agricultural productivity and sustained development without conservation of the land resource. Study of this kind may contribute to the development of better conservation programmes to fit into the social environment of the study site. In addition, it may give relevant information to the adoption of conservation measures, and formulation of effective soil conservation policy.

1.6 Selection of the Study Site

The rationale for the selection of the study site are as follows:

1. There is severity of land degradation and its threatening effect on the livelihood of the community. The areas which are prone to severe erosion are indicated in Figure 3.

Fig.3 Areas prone to erosion in Western catchment of Cherake River.



(After FAO, 1984)

2. Introduction of soil conservation structure has been carried out since 1985. And research was not carried out to investigate its acceptability by the community of the study area.

3. The accessibility of the area due to the presence of a highway, and feeder roads makes it less difficult to conduct field survey.

1.7 Nature of Data

Primary and secondary data are utilized in this research. The primary data include socio-cultural and economic data, erosion damage on croplands, and the state of the level `fanya juu'. The data about the income of farmers is liable to errors because actual measurement of the farmers' crop production was not possible due to shortage of time and scope of the study. The farmers are suspicious about this matter when they are asked by interviewers. They do not properly answer questions related to income due to their fears of taxation according to their actual amount of income. In addition, the farmers start to consume, little by little, crops such as maize and potato while it is still in the field. These crops have the possibility of total consumption before harvest time. As a result, the farmers may not actually know the exact amount of production of some of the types of crops.

The field survey also enabled to record visible erosion damage and the state of the level `fanya juu'. There were difficulties in identifying the proper size of the rills in downslope ploughed croplands while the rills were recorded. Besides, there was the same difficulty in manioc cropped fields due to now and then digging up weeds.

Personal observation and casual exchange of views with the extension workers and farmers are utilized to enrich the primary data.

The secondary data sources include literature, and different maps (Land Use and Land Cover, Geomorphology and Soil, Land Resource and Topographical Maps) of the study site.

1.8 Methodology

1.8.1 Methods of Analyses

Both qualitative and quantitative techniques were employed in the research. The objective of examining the management and state of the level 'fanya juu' was analyzed making use of photographs, and percentages.

In recent years, many researchers prefer the multivariate analysis to the bivariate analysis to evaluate the adoption of innovations. In multivariate analysis, several independent variables are considered to explain a dependent variable. This is because "the world is a complex place" and very few of its patterns can be described or accounted for by a single independent variable" (Johnston, 1986:60).

The adoption model in Figure 4 was made use of to highlight the effect of multivariables on adoption. Hence the stepwise multiple regression analysis was utilized for the purpose of identifying and analyzing the factors that have initiated the adoption of the level 'fanya juu' by each farmer.

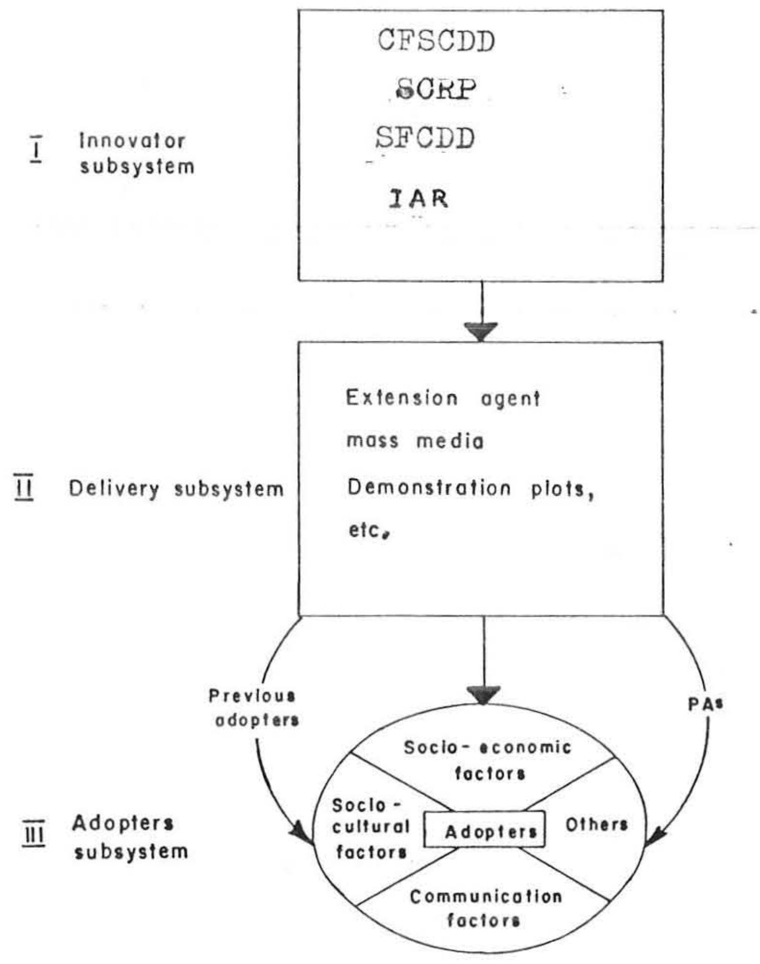
For the aim of identifying the areas prone to erosion, the spatial distribution of slopes was prepared based on topographical maps of Sodo (EMA, 1979a) and Shone (EMA, 1979b). The Reisz and Henry's method was used to demarcate the regions into subunits with almost the same contour spacing (Monkhouse and WilKson, 1964). Then the distance between the two consecutive lines was measured to find out the horizontal distances. The vertical intervals between contour lines were taken for the height differences. Then, the ratio of the height difference to its equivalent horizontal distance gave the slope of the area between the contour lines.

1.8.2 Measurement of Variables

A) Dependent Variable

Adoption of conservation structure. It is defined as the acceptance and making use of conservation structures by applying and keeping it up in good condition by the farmer. The adoption of the structures by farmers enables to arrest the loss of soil from croplands. Investigation of whether the structures are adopted or not helps to know about the success or failure of the conservation structure.

Fig.4 The adoption model



Source: Adapted from Bisrat Aklilu (1980:20)

<u>Measurement</u>. This variable was measured by the adoption scale (see Table 1). The scores for each item were given by the researcher based on the following rationale.

a) Acceptance of the existence of structures on one's cropland was given 25 points. The farmer may accept and maintain the structures either when he understands the usefulness of the structures or when he fears that breaching of a bund may cause severe erosion on lower sites.

b) Maintenance of the structures is the keeping up of the structures that are broken as a result of erosion, cattle movements, etc. Maintenance could involve only some of the broken parts (i.e. one time partial maintenance) or all of the broken parts in a year (i.e. one time complete maintenance).

Maintenance of the structures with the understanding of its importance was assigned higher scores than its maintenance in fear of a bund may cause severe erosion in lower sites. Depending on the intensity of maintenance activities additional 5 points were added to the previous scores.

c) According to the level of acceptance of the level 'fanya juu' by farmers, scores were allotted. Acceptance of the whole structures on all plots without any part being

Table 1. Index of adoption of conservation structures

Roll No.	Items	Score
1	Acceptance of the existing structures on one's farmland at present.	25
2	One time partial maintenance of the structures per year in fear of breaking of a bund may cause severe erosion in lower sites.	10
3	One time partial maintenance of the structures per year as a result of acceptance of the structures.	15
4	One time complete maintenance of the structures per year in fear of breaking of a bund may cause severe erosion in lower sites.	15
5	One time complete maintenance of the structures per year as a result of acceptance of the structures.	20
6	Two or more partial maintenances of the structures per year in fear of breaking of a bund may cause severe erosion in lower sites.	20
7	Two or more partial maintenances of the structures per year as a result of acceptance of the structures.	25
8	Two or more complete maintenances of the structures per year in fear of breaking of a bund may cause severe erosion in lower sites.	25
9	Two or more complete maintenance of the structures per year as a result of acceptance of the structure.	30
10	Not destroying any part of the structures in a single or all plots.	15
11	Destroying only one of the lines of consecutive structures to allow turning of plough and oxen in some plots and not destroying in other plots.	10
12	Destroying only one of the lines of consecutive structures to allow turning of plough and oxen in all plots.	5
13	Destroying the whole structures in some plots and not destroying in other plots.	5
14	Destroying all the structures from a single or all plots.	0
15	Growing of sugar-cane, banana, etc. at the end of the backslope of the structures.	20
16	Cut and carry of grass from structures when crops are grown on the farmland.	10
17	Cut and carry of fodder from structures throughout the year.	20
	Total scores	270

destroyed was given 15 points, but destroying of the whole structures was assigned 0 points. In addition, depending on the level of acceptance of the structures (accepting some lines of structures and rejecting other, etc.) points were given from 5 to 10.

d) Growing of sugar-cane, banana, etc. below the conservation structures, and cut and carry of grass grown on bunds throughout the year, were assigned 20 points each because both of them equally help stabilize the structures. But cut and carry of grass only when crops are grown was assigned 20 points. Finally grazing of livestock on the structures after crop harvest destabilizes the structures and it was allotted 0 point. The total scores of indicators of adoption of conservation structures was 270 points.

B) Independent Variables

After going through related literature (see section 1.4) and having a critical observation of the study site, 9 independent variables were selected to explain the adoption of the level 'fanya juu'.

1. **Attitude.** It is the feeling or emotion towards the conservation structures. Depending on several socio-cultural and economic reasons, each farmer develops

attitudes that influence his acceptance and maintenance of the structures. This variable is expected to have great impact on the adoption of the level `fanya juu'.

Measurement. Likert scale, also known as summated scale, was adopted to measure the attitudes of the farmers towards the conservation structures. It has been one of the most widely and successfully used techniques to measure attitude (Ary et al., 1985:195).

In Likert scaling the respondent is asked to choose between several response categories, indicating various strengths of agreement and disagreement (Moser, 1972:362). In this study only two categories - agree and disagree - were used. This was because of the low educational level of the farmers, and their lack of familiarity to scale observations that indicate intensity of agreements (Aregay, 1975:130).

The item pool in Table 2 was developed depending on the preliminary survey of the study site. The items are composed of equal number of positive and negative statements. Agreement with a positive statement was given positive scores and disagreement with a positive statement was given negative scores. The scoring was reversed for negative statements. The range of numerical values for disagreement and agreement categories is from - 1 to +1.

attitudes that influence his acceptance and maintenance of the structures. This variable is expected to have great impact on the adoption of the level `fanya juu'.

Measurement. Likert scale, also known as summated scale, was adopted to measure the attitudes of the farmers towards the conservation structures. It has been one of the most widely and successfully used techniques to measure attitude (Ary et al., 1985:195).

In Likert scaling the respondent is asked to choose between several response categories, indicating various strengths of agreement and disagreement (Moser, 1972:362). In this study only two categories - agree and disagree - were used. This was because of the low educational level of the farmers, and their lack of familiarity to scale observations that indicate intensity of agreements (Aregay, 1975:130).

The item pool in Table 2 was developed depending on the preliminary survey of the study site. The items are composed of equal number of positive and negative statements. Agreement with a positive statement was given positive scores and disagreement with a positive statement was given negative scores. The scoring was reversed for negative statements. The range of numerical values for disagreement and agreement categories is from - 1 to +1.

Table 2. Scaling of attitude towards conservation structures

Roll No.	Items	Agree	Dis-agree
1	Maintenance of structures is a farmer's responsibility.	/ /	/ /
2	Personally, I feel competent to have technical know-how of maintaining the structures.	/ /	/ /
3	The extension agents imposed a greater strain upon the farmers way of cultivating.	/ /	/ /
4	The structures have created some inconveniences (difficulty of turning plough and oxen).	/ /	/ /
5	The structures help arrest run off and soil loss.	/ /	/ /
6	The structures have increased the volume of production on the sample plot.	/ /	/ /
7	The structures have increased the number of cultivations to prepare the seedbed.	/ /	/ /
8	The loss of cropland due to structures have decreased the income of the farmer.	/ /	/ /
9	The raised part and the ditch of the structures help control porcupine from cropland.	/ /	/ /
10	The structures arrest the washing away of fertilizers.	/ /	/ /
11	The structures on my cropland exist without my approval.	/ /	/ /
12	The traditional way of managing the land is better than the new one.	/ /	/ /
13	It is possible to prevent erosion.	/ /	/ /
14	Many farmers do not want to follow their separate and individual way without regard to the society's norms.	/ /	/ /
15	The structures take land out of production which is very much needed to satisfy the food requirements of the family.	/ /	/ /
16	The structures have not brought significant benefits to the farmer.	/ /	/ /
17	I do not feel insecurity of landholding.	/ /	/ /
18	I allow the existence of the structures on my cropland because of fear of government authority (the 'Awraja' Agricultural Department) and PAs.	/ /	/ /

To get a positive scale, the scores were transformed by adding 1 to each value and the range of values becomes 0 to 2. Then, the sum of total scores of the 18 items was taken for each interviewee. If the scores are high, it shows that the farmer has favourable attitude towards conservation structures. This is expected to lead to the acceptance of the structures. If the scores are low, it indicates that the farmer has unfavourable attitude towards the conservation structures. In this case the farmer may be reluctant to maintain the structures and may even destroy them.

2. <u>Perception of water erosion on croplands</u>. This refers to the farmer's awareness of the existence of soil erosion problem on his cropland. If the farmer had perceived soil erosion as a problem on his cropland before the introduction of the structures, he may be willing to maintain the structures. If the cropland was affected by run off (i.e. washing away of topsoil, fertilizer, and sown seed) before the construction of the structures, it is likely that the farmer adopts them (FAO, Vol. 2, 1986b:5). In addition, if the farmer believes that breaches on the upper slope structures cause greater erosion of soil in the lower part of the cropland, he may accept the structures.

<u>Measurement</u>. This variable was measured by asking the farmer to identify the level of water erosion on his cropland before and after the introduction of conservation structures. Points were allotted to alternatives in ascending order as indicated in Table 3. Each respondent was given the corresponding point to the alternative he answered.

Table 3. Levels of water erosion before and after the introduction of structures.

Levels of Water erosion	Before the introduction of structures	After the introduction of the structures
	Points allotted	Points allotted
No erosion	0	0
Slight erosion	1	1
Moderate erosion	2	2
Severe erosion	3	3

3. Perception of yield increase. This refers to the perceived increment of production of different crops grown by the farmer per unit area of land due to the introduction of the structures as perceived by the farmer. The unit of measurement used was half 'timad'.[5] Several researchers recorded crop yield increments following treatments with conservation structures. For instance, Belay (1990:168) reported that there was 85 kgs/ha mean annual crop yield increments on whole plots in Gununo area. It is not only the actual crop yield increment that is important but also the awareness of crop yield increment by the farmer which leads to the adoption of the conservation measure. If the farmer feels that the introduction of the structures have increased crop yield, he accepts and maintains the structures.

Measurement. This variable was quantified by asking the following questions.

a) How many quintals of maize were you producing each year before the introduction of the level 'fanya juu' in half 'timad' of the sample field?

b) How many quintals of maize are you producing each year after the introduction of the level 'fanya juu' in half 'timad' of the sample field? The above two questions were asked for the other four major crop types.

4. Contact of farmers with the soil and water conservation agents. This variable can be defined as the coming together of the farmer and the soil and water conservation extension agent of MOA to exchange views. Usually the farmer who has more contact is better in accepting innovations (Bisrat, 1980:141; Aregay, 1975:182). This is because the contact of the extension agent with the farmer enables him to inculcate the idea of soil conservation into the mind of the farmer and may result in increase in the adoption of conservation structures.

Measurement This variable was quantified by asking the farmer the number of contacts he made with the soil and water conservation extension agent in a year.

5. Educational level. This is the grade completed by the farmer. Education is one of the factors that affect the adoption behavior of the farmers (Singh and Sahay, 1972:26; Shaner et.al., 1982:65).

Measurement. This variable was measured by asking the farmer the following two questions.

a) Can you read and write?

b) If the farmer says yes, what is the grade you completed? If the farmer attended only the literacy campaign, he was considered as a grade 2 complete.

6. Size of farm. It is an area of cropland owned by the farmer. Itana (1985:104), and Singh and Sahay (1972: 24-25) point out farm size as an important influencing factor in the adoption of agricultural innovations. since the structures take land out of production, the small farm holders may face difficulty in meeting their families food requirements. With the increase of farm size, the effect of loss of cropland on the farmer's food requirements decreases. And it was expected that the adoption of the structures increases with the increase in farm size.

Measurement. Size of farm was quantified by asking the farmer the number of 'timads' of cropland he owns. The number of 'timads' was converted into hectares (see Footnote number 5).

7. <u>Compatibility of the conservation structure</u>. This is the consistency of the conservation structure with the past experience of the farmer. A farmer, who finds the structure to be useful and in agreement with his past experience, is more likely to adopt the structure. The farmer's past experience may predict how he reacts to the introduction of agricultural technologies (Shaner et.al., 1982:65).

<u>Measurement</u>. It was measured by asking the farmer whether the conservation structure is compatible with the past experience of the farmer or not. If the farmer says yes 1 point was assigned and 0 otherwise.

8. <u>Number of participations in social organizations</u>. This can be expressed as the involvement of the farmer in social organizations such as religious meetings, 'edir'[6],'debo'[7], and 'ekub'[8]. The number of participation in these organizations is assumed to increase the farmer's opportunity to discuss about the conservation structures. Hence, it was thought that the farmer will be more aware of the short and long-term benefits of the conservation structure for his cropland and may result in its adoption.

<u>Measurement</u>. It was quantified by asking the farmer the following questions.

a) Do you participate in social organization?

b) If the farmer says yes, in which of the following did you participate in 1990/91?

1. `Ekub'
2. `Debo'
3. `Edir'
4. Religious meetings
5. Others

Then the number of participation in these organizations per year by the farmer was recorded.

9. <u>Number of participation in soil conservation activities</u>. It can be defined as taking part of a farmer in the construction of the structures. The farmer, who participated in the construction of the structures and learned about its design, may not face difficulty in the maintenance of the structures. He also got opportunity to make contact with the soil and water conservation extension agents and realize the advantages of the conservation structures. Moreover, he was supplied with food and oil according to the number of days he spent in the construction of the structures. This might have served as an incentive to accept the structures. Thus, this variable was considered to be influencing factor to the adoption of the structures.

<u>Measurement</u>. It was measured as follows:

a) Did you participate in the construction of the structures?

b) If the farmer says yes, for how many days did you work till the end of 1990/91?

1.8.3 Hypothesis

Y_0 (the adoption of conservation structures, in scores) is positively correlated with:

X_1 (perception of soil erosion problem on cropland, in points),

X_2 (perception of yield increase, kg/ha),

X_3 (positive attitude towards conservation structures, in scores),

X_4 (frequency of contact with soil and water conservation extension agents, in number in a year),

X_5 (education level, in grades),

X_6 (size of farm, in hectares),

X_7 (compatibility of the structures, 1 for the consistency of the structures with the past experience of the farmer, 0 otherwise),

X_8 (participation in social organizations, in numbers in a year) and

X_9 (participation in soil conservation activities, in number of days till the end of 1990/91),

1.8.4 <u>Methodology for collecting primary data</u>

Questionnaire was formulated to gather primary data (see Appendix 3). The majority of the questions are objective type. There were also some open-ended questions. The final copy of the questionnaire was translated into `Amharic'[9] and `welayitinya'[10]. The `Amharic' translation was used to record the responses of the farmers. The `Welayitinya' version served as a reference when interviewing the farmers.

Criteria employed to select interviewers were as follows:

1. Students who completed twelfth grade,
2. Participation in soil conservation works,
3. Fluency in `Amharic' and `Welayitinya' and
4. Honesty.

Orientation was conducted for two weeks. This included giving introduction about the aim of the research, and nature of interviewing. The interviewers were also allowed to practice by interviewing 5 farmers each prior to the actual survey. These interviews were also used to pretest the questionnaire. Discussion was held with each interviewer in order to identify poor wording, sequence and format in the questionnaire. After changes were made in the questionnaire, the final copy was prepared. Then the actual survey was conducted in the field.

Field survey was also carried out to collect data about visible erosion damage on croplands and the state of the level 'fanya juu' after heavy rain-storms on August 16 and 24, 1991. The SCRP (1991:80-90) guide-line and recording form was adapted for this purpose (see Appendix 4). In addition, supplementary data was collected with the help of instruments (see Table 4).

Table 4. Instruments utilized to collect data in the treated plots.

	Type of data	Instruments to be utilized
1.	Length, depth, and width of rills	metre
2.	Inter-structure slope	clinometre
3.	Whole cropland slope	"
4.	Height of the ridge of the structure	metre
5.	Width of the structure	metre

1.8.4.1 Sampling procedure to collect primary data

From the 55 PAs in the Damot Gale 'Awraja', 13 PAs which have soil conservation structures on croplands were purposely selected. The selection of sample PAs, and plots was performed as follows:

1. Sample size. Backstrom and Hursh (1963:25-35) state six determinants of sample size and these were: (1) homogeneity of the population, (2) kind of sampling method being used, (3) time and money, (4) number of categories of data to be analyzed, (5) precision of sample estimates, and (6) degree of confidence. Considering homogeneity of the population, shortage of time, the cost of survey, the stratified sampling method to be employed, and large number of categories of data to be analyzed, a sample of 200 plots were thought to be adequate. The owners of the sample plots constituted 4 per cent of the total population (i.e. 5654 farmers in the 13 PAs which are and were having conservation structures, cited in Damot Gale Awraja Agricultural Department, 1991).

A subsample size of 30 plots was selected from the main sample plots in order to make assessments about erosion damage, and the state of the level `fanya juu'. Only 30 sample plots were selected in this case because of the following reasons.

a) The collection of these data needs skilled manpower. Besides, it was tiresome and time consuming.

b) There were large categories of data to be.recorded from each sample plot.

2. Sampling Method. Stratified, four-stages random sampling was utilized.

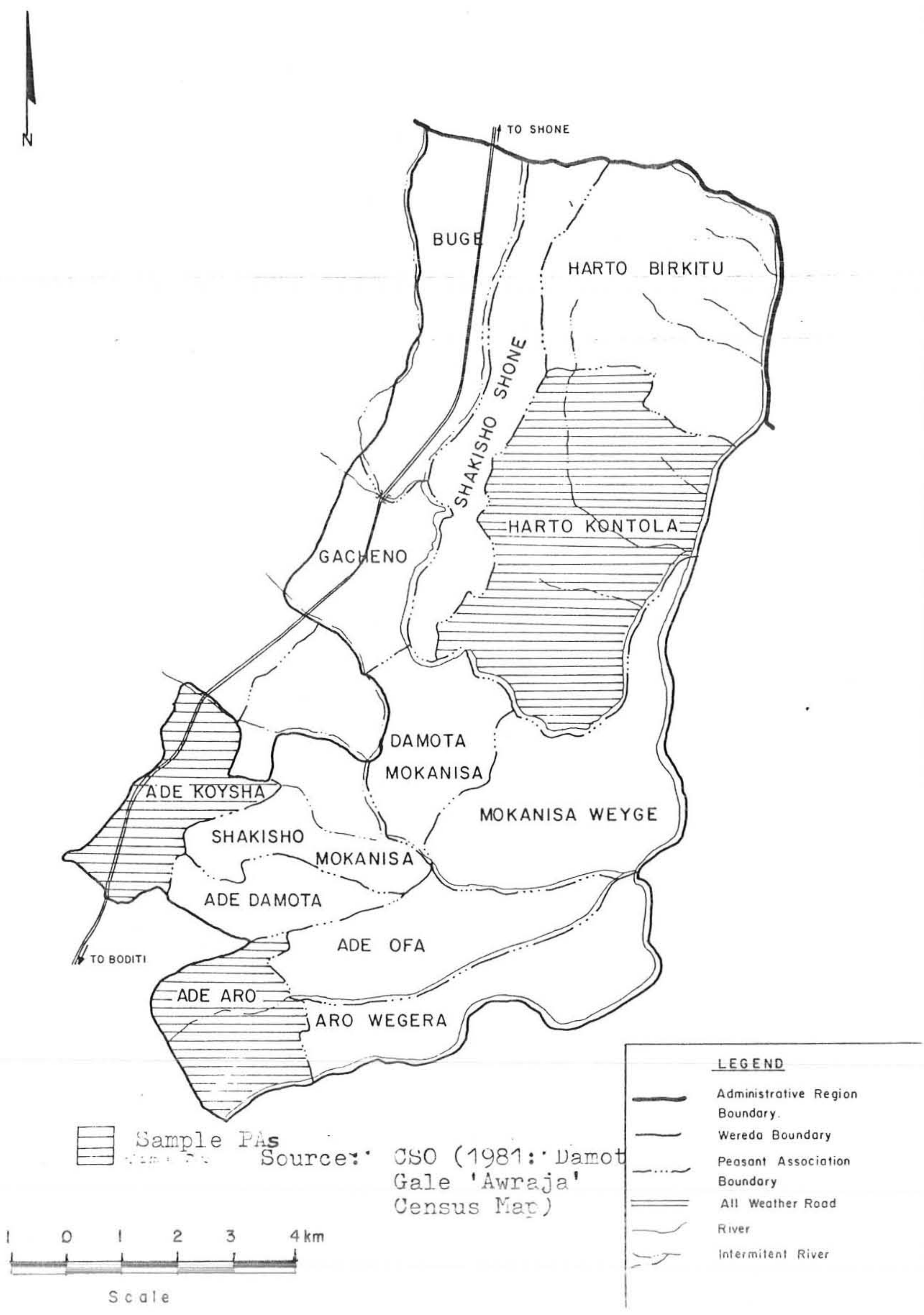
3. Sampling frame and sampling unit. In the first stage, a list of 13 PAs was the sample frame and each PA was the sampling unit. From the list of 13 PAs, 3 of them (23.3 per cent) were selected by systematic sampling (see Figure 5). In the Second stage, the list of farmers which were stratified based on the level of destruction of the structures[11] constituted the sample frame, and each farmer was the sampling unit. Preparation of the list of plots in order to have a sample frame was not possible. This was because:

   a) There was no large scale map which shows plots with different levels of destruction of the conservation structures of the study site.

   b) Preparation of large scale map of the study site, which shows farm plots, needs high cost and much time.

   c) It was thought that the list of farmers grouped based on the level of the destruction of the structures can serve as adequate alternative procedure for the selection of the sample plots.

Figure 5. Sample Peasant Associations.



Source: CSO (1981: Damot Gale 'Awraja' Census Map)

In view of these, 200 sample farmers were selected from the list of 3 groups of farmers as pointed out in Table 5. In the third stage, the list of sample farmers' plots was considered as a sampling frame, and the farmer's plot as a sampling unit. This was done in order to avoid confusion which may arise at the time of interviewing if the farmer has more than one plot. At this stage, a sample of 200 plots was selected randomly. The owner of these sample plots were interviewed by referring to the

Table 5. Sample PAs and farmers

Sample PAs	Farmers who did not destroy any part of structures in a plot or plots		Farmers who destroyed one line of consecutive structures in a plot or plots intentionally		Farmers who destroyed th whole structure from a plot or plot intentionally	
	Number of farmers	Number of samples	Number of farmers	Number of samples	Number of farmers	Number of samples
Ade Aro	28	4	52	8	148	22
Ade Koysha	61	10	104	15	36	5
Harto Kontola	452	66	361	52	127	18
Total	541	80	517	75	311	45

Source: Field Survey, 1991

sample plots. In the fourth stage, a subsample of 30 plots were randomly selected from the 200 sample plots in order to assess erosion damage and state of the level 'fanya juu' (see Table 6).

Table 6. Size of subsamples from sample plots which have different level of destruction of the structures.

Sample PAs	Plots which have the whole structures not destroyed		Plots which have one line of consecutive structures destroyed		Plots which have the whole structures destroyed	
	Number of samples	Number of subsamples	Number of samples	Number of subsamples	Number of samples	Number of subsample
Ade Aro	4	1	8	1	22	3
Ade Koysha	10	1	15	2	5	1
Harto Kontola	66	10	52	8	18	3
Total	80	12	75	11	45	7

Source: Field Survey, 1991

CHAPTER TWO

INTRODUCTORY DESCRIPTION OF THE STUDY AREA

2.1 The Physical Environment

2.1.1 Location

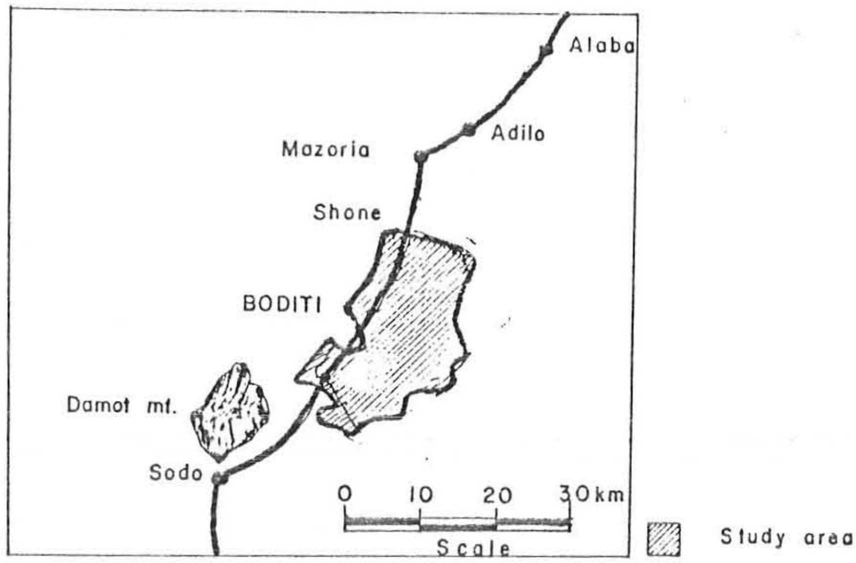
Western Catchment of Cherake River is located on the eastern part of Damot Gale 'Awraja', North Omo Administrative Region. It lies about 373 kms south of Addis Ababa, between Boditi and Shone towns on either side of the highway (see Figure 6).

2.1.2 Geology and Geomorphology

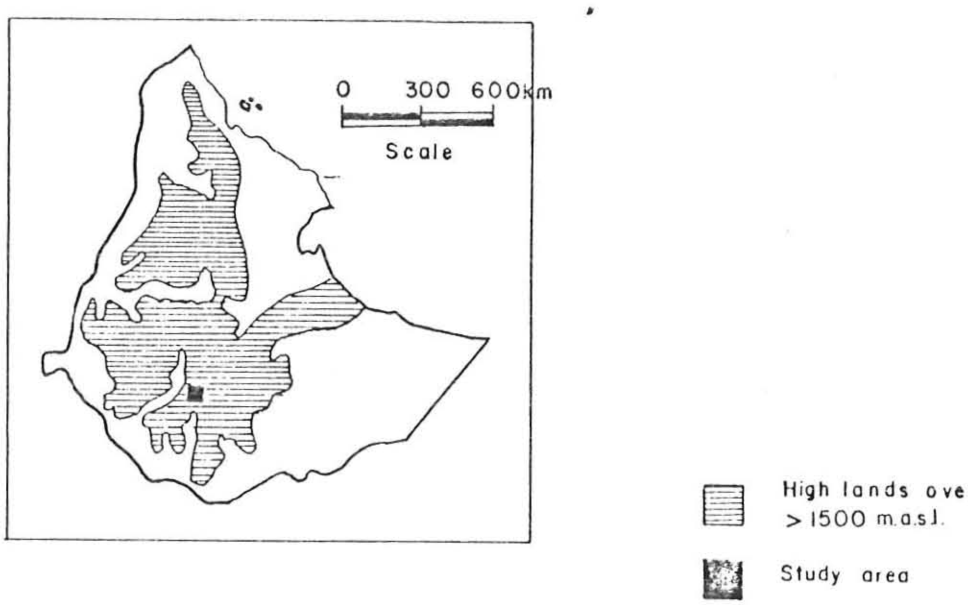
The rock types in the Western Catchment of Cherake River are identified as volcanic rocks of the Magdala group (Kazmin, 1973: Geological Map of Ethiopia). These volcanic rocks which consist of tuffs, trachytes, etc. are overlain by shallow colluvium in the basins (LUPRD, 1983: Geomorphology and Soils Map; Kazmin, 1973: Geological Map of Ethiopia). And the age of the formation varies from Upper Miocene to Pleistocene.

The geomorphology of the study site varies from undulating high plateaux formed predominantly on pyroclastic deposits in the west to moderately dissected sideslopes of an extinct central volcanos and other relic volcanic forms, often with small cone and vent remnants in the east (LUPRD, 1983:

Fig. 6 Geographical location of the study area.



Source - LUPRD of MOA, (1984), Landuse & Land cover map



Source - SCRP (1986 : 10)

Geomorphology and Soils Map). Fault Scarps that run from north-east to south-west form prominent features in the eastern part. The land falls in steps from the north-eastern foot of Damota Mountain towards the Rift Valley. The altitude ranges from 2900 m.a.s.l. in the south-west to 1600 m.a.s.l. in the north-east (EMA, 1979a: Topographical Map of Sodo; EMA, 1979b: Topographical Map of Shone). The eastern part is highly dissected by small streams which join Cherake River.

2.1.3 Climate

The climate of the study site was assessed on the basis of data collected at the Boditi meteorological station, 0.5 kms south-west of the study site (see Table 7). The area has a mean annual temperature of 17.0° C and annual range of 3.3° C. The lowest temperature is recorded for July (15.3°C) and the highest temperature for March (18.6°C).

The annual rainfall is 1200.6 mms. The method of 'rainfall coefficient'[12] (FAO, 1965:20) was employed to differentiate between a rainy month and dry months. As indicated in Table 7, there are 8 rainy months for Boditi, with two maxima in May and August. The Land Resource Map (LUPRD, 1984) indicates that this area has an average growing period of 270 days.

Table 7: Mean monthly temperature and rainfall data for Boditi from 1981 to 1991.

Month	Min. Temp. (°C)	Max. Temp. (°C)	Temp. Av. (°C)	Rainfall (mm)	Rainfall Coefficient
Jan.	10.6	25.5	18.1	26.7	0.3
Feb.	11.2	25.5	18.4	54.2	0.5
March	11.6	25.5	18.6	125.6	1.3
April	11.4	24.3	17.9	158.1	1.6
May	11.0	23.6	17.3	170.7	1.7
June	10.3	22.0	16.2	135.0	1.3
July	10.0	20.6	15.3	124.9	1.2
August	9.8	20.9	15.4	140.2	1.4
Sept.	10.0	22.5	16.3	124.5	1.2
Oct.	10.0	23.7	16.9	63.5	0.6
Nov.	9.0	24.6	16.8	43.8	0.4
Dec.	8.9	24.9	16.9	33.4	0.3
Annual	10.3	23.6	17.0	1200.6	

Source: National Meteorological service Agency, 1991: Time series Meteorological data.

2.1.4 Soil

The main soil type in Western Catchment of Cherake River is pellic vertisol interspersed by chromic cambisols which occupy small remnants of volcanic vents and cones.

2.1.5 Vegetation

The undulating plateau is mostly occupied by settlements and farmlands. Hedges, trees, and grasslands divide the farmlands. Remanants of trees of the original forests are seen in the croplands. Along the rivers and streams, there are bushlands interspersed by grasslands. Important trees consist of Osyris abyssinica, Podocarpus gracilior, Croton macrostachys, syzygrum guineense, and Albizia gummifera (LUPRD, 1984: Land Use and Land Cover Map). In addition, there are also trees such as Eucalyptus globulus, Erythrian brucei and Ficus dahro.

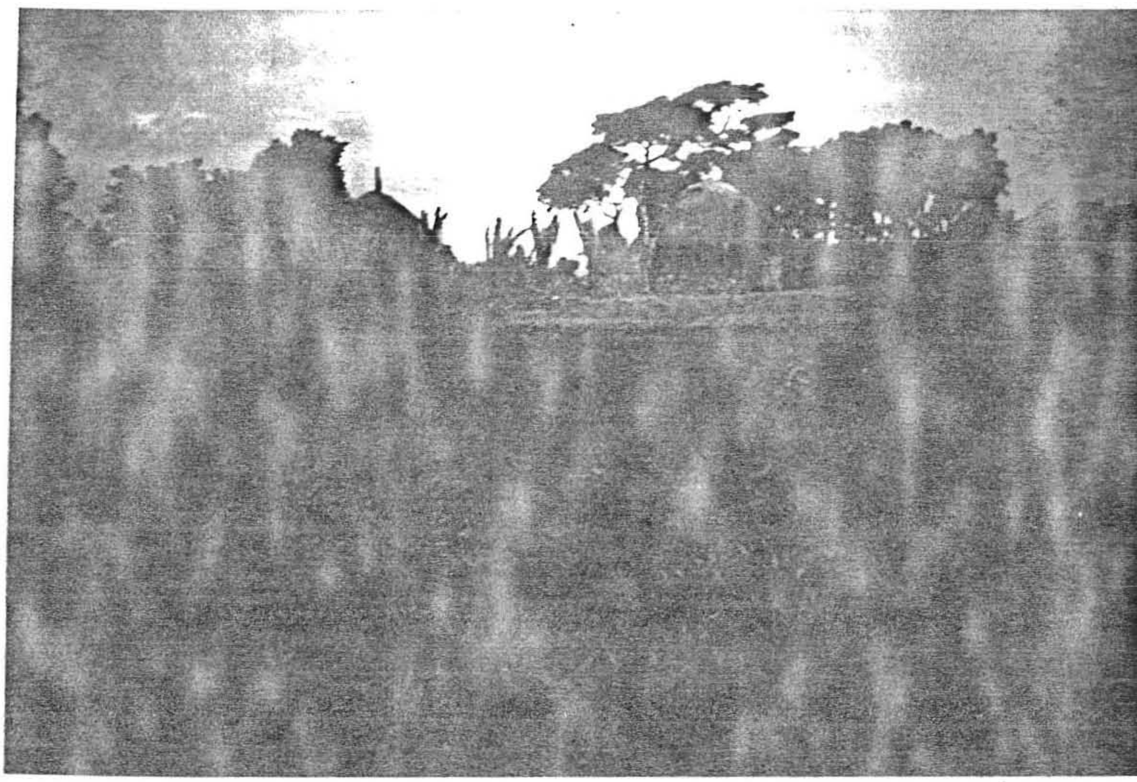
Eventhough there is shortage of arable land, the Welayita people have a good practice of growing trees. In front of each farmhouse, there is open field surrounded by big trees (see Figure 7). Mostly the sides of roads and footpaths are covered with the growth of different species of trees. The perennial crops of 'enset' (Ensete ventricosum), coffee (Coffea arabica) also add green scenery to the surroundings throughout the year.

2.2 Population and Economic Activities

2.2.1 Sex and age composition of the population

The total population of the 200 sample households is 1408. The family members of these households range from 3 to 15 and this makes an average of 7 family members. This is much higher

Fig. 7. The farmhouse and its surroundings.



Source: Photo August, 1991.

than the nation's rural population average household size of 4.4 (Office of Population and Housing Commission, 1984:68-69).

The age and sex structure of the population is shown in Figure 8. The population under 15 years of age constitutes about 45.1 per cent of the population. This proportion of the youthful population is typical of the developing countries. About 53 per cent of the population are between the ages of 15 and 64, and 1.3 per cent have reached the age of 65 and over. The proportion of males to females in the population is 52 per cent to 48 per cent respectively.

2.2.2 Size of farms

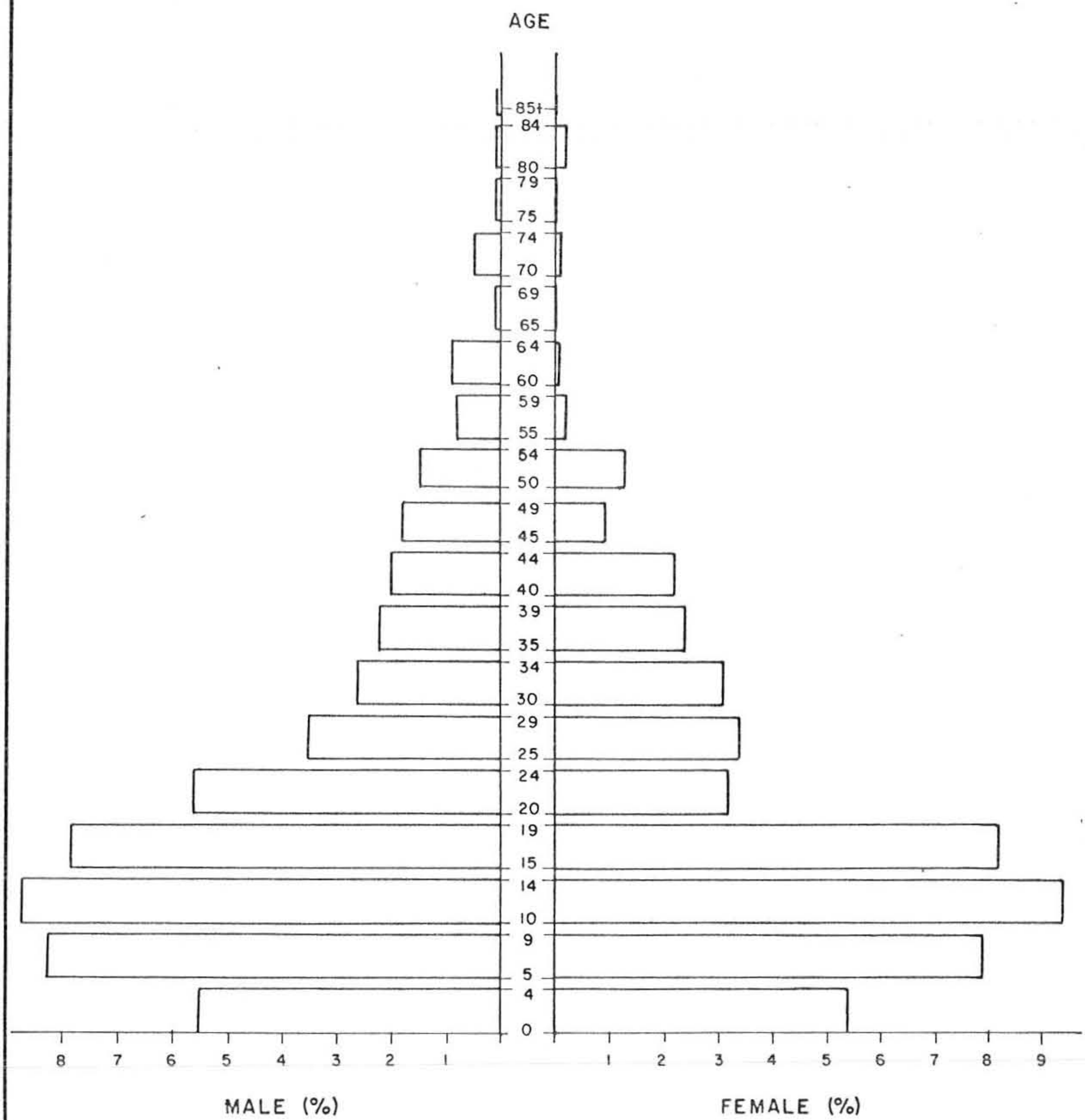
The size of farms of an individual farmer in the Western Catchment of Cherake River is one of the smallest in the country. The average farm size is 0.37 hectare (see Table 8). The size of farms range from 0.06 hectares to 2.38 hectares. Twenty-six per cent of the farms are from 0.17 to .034 hectares. The majority of the farms (55.5 per cent) are between 0.35 and 0.52 hectares.

Table 8. Distribution of farm size

Size of farm (ha)	Number of farmers (%)
Less than 0.17	6.0
0.17 - 0.34	26.0
0.35 - 0.52	55.5
0.53 - 0.70	9.0
Greater than 0.70	3.5
Total	100.0

Source: Field survey, 1991.

Fig. 8   Age and sex structure of the population in 1991/92



Source - Field Survey, 1991.

2.2.3 Crop production

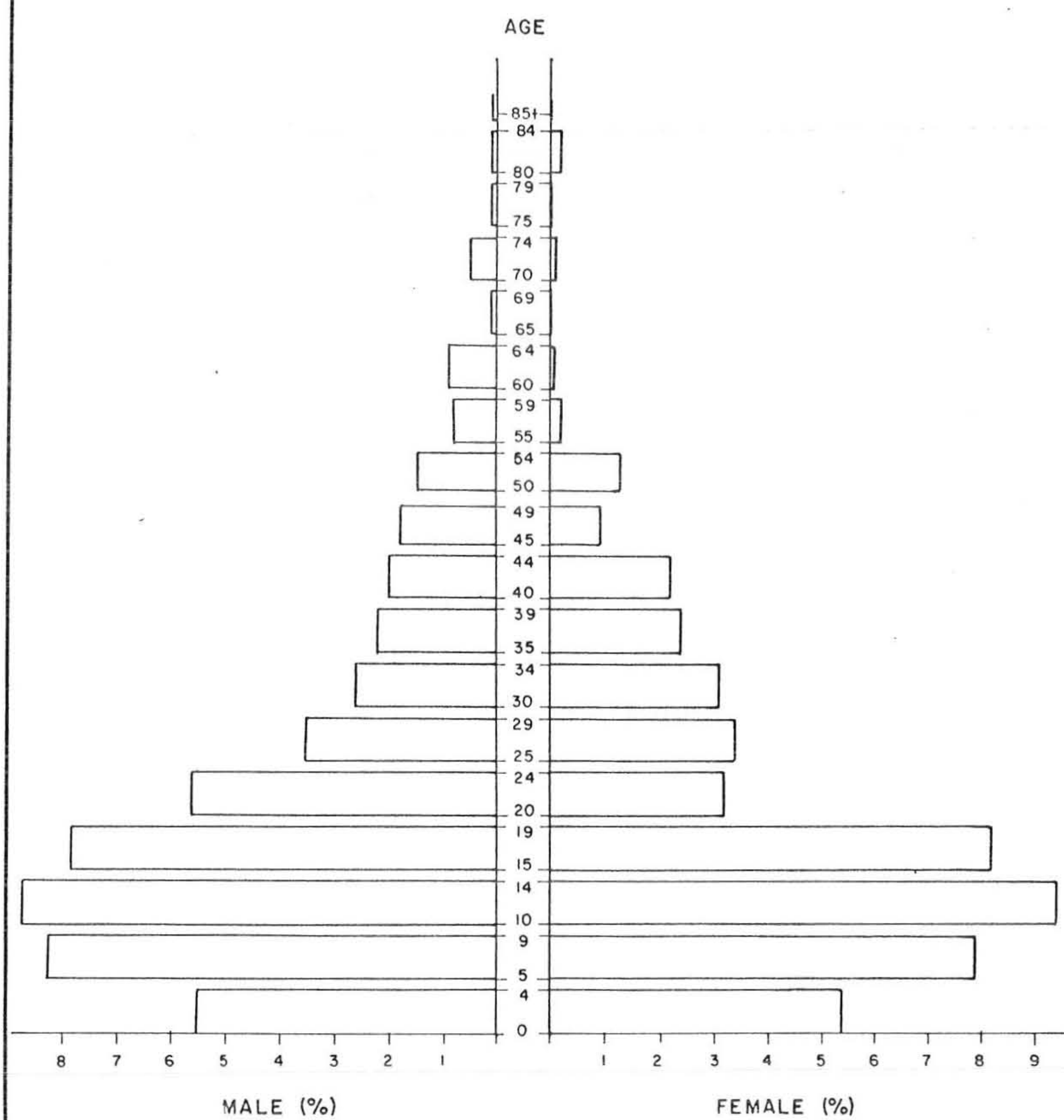
The crops grown in the study area include coffee, 'enset', 'chat' (Catha edulis)[14], banana (Musa sapientum), sugar-cane (Saccharam officinarum), and avocado (Persea gratissima). Various annual crops such as maize (Zea mays), 'teff' (Eragrostis tef), barley (Hordeum vulgare), Sorghum (Sorghum vulgare), haricot bean (Phaseolus vulgaris), potato (Solanum tuberosum), sweet potato (Ipomoea batatas), manioc (Manihot esculanta) are also grown. These crops are cultivated in different seasons of the year. As explained in section 2.1.3, the area has an average growing period of 270 days and as a result double cropping is practised. The cropping calendar of the 5 major types of crops is shown in Table 9.

Table 9. Crop calendar of the 5 major types of crops.

Types of Crops	Months			
	Ploughing	Sowing	Weeding	Harvesting
Maize	Oct.-Dec.	Jan.-March	Feb.-May	August-Oct.
Teff	Oct.-Feb. May-July	Feb.-April July-August	April-May August-Sept.	May-June Sept.-Nov.
Haricot bean	Oct.-Feb. May-July	Feb.-April July-August	March-May August-Sept.	May-July Sept.-Nov.
Barley	Oct.-Feb. May-June	Feb.-April July-August	April-June August-Sept.	May-August Sept.-Nov.
Sorghum	Oct.-Feb.	Feb.-April	March-June	Nov.-Dec.

Source: Field survey, 1991.

Fig. 8 Age and sex structure of the population in 1991/92



Source - Field Survey, 1991.

The total crop production by the sample households in 1990/91 is shown in Table 10. Sweet potato, manioc, and maize which are the staple food items of the Welayita people account for the major production. The next largest production comes from 'teff', sugar-cane, and haricot bean.

The volume of crop production is mainly limited by shortage of cropland. But the possibility of growing crops twice in a year has supported increasing the crop production. Moreover, 37 per cent of the farmers reported that they apply artificial fertilizers to increase crop production. There are several reasons for lack of more widespread practice of artificial fertilizers. Among the reasons, in order of their importances, are high cost and poor supply of artificial fertilizer. More than half (57.5 per cent) of the farmers utilize animal manure. Low availability of animal manure (due to the small number of livestock and use for fuel) has limited its application to the farmland. Apart from this, utilization of residues of crops such as maize and sorghum for fuel has reduced what is left on the cropland.

Table 10. Volume of crop production in 1990/91.

Types of crops	Crop production (quintals)
1. Stimulants	
a) Coffee	19.0
b) 'Chat'	26.0
Total	45.0
2. Fruits	
a) Banana	12.0
b) Avocado	0.9
Total	12.9
3. Cereals	
a) Maize	134.3
b) 'Teff'	89.0
c) Barley	16.0
d) Sorghum	29.8
Total	269.1
4. Root crops	
a) Potato	30.9
b) Sweet potato	175.8
c) Manioc	150.9
d) 'Enset'	40.1
Total	417.7
5. Vegetable	
Haricot bean	62.0
6. Sugar-cane	78.6

Source: Field survey, 1991.

2.2.4 Livestock production

The types of livestock that are being reared include cattle, sheep, goat, horse, mule, donkey and poultry (see Table 11). Most of the households (82 per cent) responded that the number of livestock they own has diminished in the past 17 years. The farmers explained that this is due to shortage of grazing grounds, disease of animals, and selling of animals to pay off taxes and buy crops at the times of famine.

Table 11. Number of livestock in 1990/91

Types of livestock	Number of livestock
Cattle	550
Sheep	127
Goat	57
Horse	11
Mule	2
Donkey	30
Poultry	289

Source: Field survey, 1991.

Most of the land is used to cultivate crops. Only areas of very steep slopes are left to grow grass. Fifty per cent of the households own privately owned grazing ground, and 21 per cent of the households share grazing grounds with their relatives. There are also 6 per cent of the households which make use of government controlled degraded land for grazing. The remaining households, which do not have pasture land, feed mainly crop residues to their livestock. Forty-three per cent of the households responded that there have been decrease of grazing ground as a result of encroachment of the farmlands, and the government control of degraded lands in the past 17 years.

2.2.5 Marketing of agricultural products

In developing countries, such as Ethiopia, farmers mainly produce crops for consumption. They only convey some portion of their crops to market in order to get cash to buy industrial commodities (see Table 12). Highest percentage of farmers marketed more than half of the total produce of coffee, and `teff'. This indicates that they are the most important cash crops. One-third or less than one-third of the total produce of maize, haricot bean, `enset', sweet potato, and manioc are sold.

Table 12. Farmers who marketed different portion of their produce in 1990/91.

Types of Crops	Farmers who marketed less than one-third of their produce (%)	Farmers who marketed one-third to half of their produce (%)	Farmers who marketed more than half of their produce (%)
Coffee	7.0	8.5	9.5
'Chat'	1.5	0.5	3.0
'Enset'	9.0	0.5	0.5
Banana	3.0	4.0	4.0
Sugar-cane	6.0	2.5	4.0
Avocado	1.0	0.0	0.0
Maize	14.5	1.5	1.0
'Teff'	4.0	16.5	33.0
Haricot bean	12.5	3.0	1.5
Barley	3.0	2.0	1.5
Sorghum	8.0	0.0	0.0
Potato	2.5	1.5	1.0
Sweet potato	8.5	0.5	0.5
Manioc	15.5	5.0	10.5

Source: Field Survey, 1991.

Farmers also obtain cash by selling livestock (see Table 13). This is in order to buy food items for the family members when there is shortage.

Table 13. Percentage of farmers who obtained cash from the sale of livestock.

Amount of Cash (Ethiopian Birr)	0-100	101-200	201-300	More than 300
Percentage of farmers	11.5	6.0	4.5	9.0

Source: Field Survey, 1991.

CHAPTER THREE

THE PROBLEMS OF SOIL DEGRADATION AND CONSERVATION

3.1 Farmers' Perception of the Causes of Soil Degradation

Perception refers to the farmers' awareness of the factors that result in soil degradation. The factors listed in Table 14 were employed to evaluate their identification of the causes

Table 14. Farmers' identification of the causes of soil degradation.

	Causes of soil degradation on cropland	Number of farmers (%)
1.	Up and downhill ploughing	52.5
2.	Not applying animal manure	29.5
3.	Roads as an agent of concentrating water	11.5
4.	Footpaths that cross croplands as an agent of concentrating water	34.5
5.	High density of livestock	10.5
6.	Not applying crop rotation	16.5
7.	Not applying mixture of organic matter	28.0
8.	Not practicing fallow	28.0
9.	Steep slope	83.5
10.	Heavy rains	60.0
11.	Running water	81.0
12.	Others	1.5

Source: Field Survey, 1991.

of soil degradation. The majority of the farmers identified steep slopes, running water, and heavy rains as the causes of soil degradation on cropland. Significant number of farmers (about 50 per cent) also perceived up and downhill ploughing as a cause of soil degradation. In addition, about one-third of the farmers recognized footpaths that cross croplands to bring about soil degradation.

3.2 Soil Conservation

3.2.1 Farmers' awareness of the soil conservation measures

This can be defined as the realization of the different conservation measures as solutions to the problems of soil degradation. Among the means pointed out by the majority of the farmers to overcome the soil degradation are level 'fanya juu' and drainage ditches (See Table 15). Level 'fanya juu' was suggested by 79.0 per cent of the farmers. A little over one-third of the farmers (38.0 per cent) also believed that drainage ditches are effective means of controlling soil loss. Application of animal manure and fallowing were also identified by 32.0 and 21.5 per cent of the farmers respectively. The rest of the measures were identified by insignificant number of farmers.

Of the measures employed to control soil loss, drainage ditches and level 'fanya juu' were applied by 29.0 and 69.0 per cent of the farmers respectively. About 27 per cent of the farmers also apply animal manure to their croplands.

Table 15. Farmers' realization of the soil conservation measures.

	Soil conservation measures	Number of farmers who think that the measure controls erosion (%)	Number of farmers who apply the measure (%)
1.	Appling animal manure	32.0	27.5
2.	Fallowing	21.5	14.5
3.	Drainage ditches	38.0	29.0
4.	Level `fanya juu'	79.0	69.0
5.	Stone bund	12.0	2.0
6.	Growing of banana on bunds	14.5	12.5
7.	Growing of sugar-cane on bunds	16.0	12.0
8.	Others	4.0	0.0

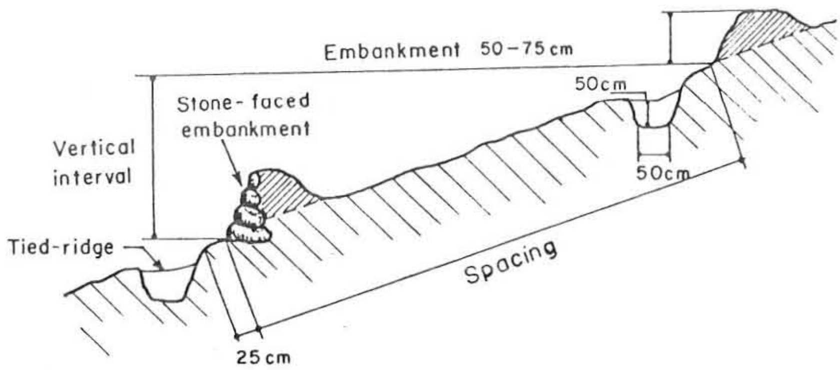
Source: Field survey, 1991.

3.2.2 Construction of the level `fanya juu'

The construction of the level `fanya juu' in the study site was carried out by Damot Gale `Awraja' Agricultural Department and CONCERN. At present CONCERN has shifted its area of work to the neighbouring Damot Weydi `Awraja'. The lay out of the level `fanya juu' is given in Figure 9.

In the construction of the level `fanya juu', the Damot Gale `Awraja' Agricultural Department made use of the guide-lines drafted in 1977 E.C. by Southern Regions of Ethiopia Agricultural Department, and Natural Resources Conservation and

Fig.9 Lay out of the level 'fanya juu'



Source: Hurni (1986 : 44)

Development Department (1977:66). Currently, they are employing the guide-lines prepared by Hurni (1986: 44-45). Both guide-lines indicate almost the same dimension of the level 'fanya juu', but have different ways of determining the spacing of the conservation structures. The old guide-line determines the spacing of the level 'fanya juu' by the formula:

$$\frac{168-7x\%\ slope}{3}$$

According to Hurni's procedure, the spacing between the level 'fanya juu' is fixed at vertical interval of one metre for slopes of less than 15 per cent and a vertical interval of two and a half times the depth of reworkable soil for slopes greater than 15 per cent (Hurni, 1986:44-45).

Eventhough different vertical intervals were recommended for the spacing of the structures in different slopes, the technical assistants[15] of the soil and water conservation extension agents (Damot Gale 'Awraja' Agricultural Department) applied only the one metre vertical interval (personal communication with the technical assistants). Furthermore, the level 'fanya juu' was constructed without proper care and design, for example the level 'fanya juu' mostly crosses depressions without due consideration to the contour (see Figure 10).

Fig. 10. The level 'fanya juu' crossing depressions

Source: Photo August, 1991.

3.2.3 Management of the level 'fanya juu'

Proper management and maintenance of the level 'fanya juu' is needed to facilitate and speed up terrace formation. Poor management and absence of maintenance can only result in damaged,[16] and filled up[17] structures. In addition, poor design and unattentive construction across depressions may only result in concentration and ponding of water above the bunds, and cause breaching and damage of the structures. The states of the level 'fanya juu' in the 30 sample plots can give us a hint in this regard (See Table 16).

Table 16. The states of the level 'fanya juu'

States of the level 'fanya juu'	Number of plots (%)
Stabilized	26.6
Damaged only	3.4
Filled up and damaged	50.0
Totally destroyed	20.0
Total	100.0

Source: Field Survey, 1991.

Of the 30 sample plots, only 26.6 per cent had stabilized structures. On the contrary, 3.4 and 50.0 per cent of the plots had damaged, and filled up and damaged structures respectively. The plots whose level 'fanya juu' were destroyed constitute 20.0 per cent of the plots.

The damages to the structures were brought about by ploughing, run off, and habitation of moles in the structures. The conservation structures in about half of the plots were inhabited by moles. These burrowing animals make hollows for their underground habitation in the structures. The moles get easy access to the cropland in order to feed on the cultivated crops. For the purpose of protecting the crops, farmers either destroy the whole structures or put traps by digging a pit into the structures.

Farmers also cause damage to the structures by intentionally narrowing the width of the structures[18] from year to year[19] (See Table 17). Besides, farmers deliberately destroy every other structures to enable easy crosswise ploughing (See Section 4.1). This clearly suggests that there is a need for the conservation structures to effectively fit into the prevailing farming system (Sanders, 1988a:277). Absence of this measure in the study site has significantly reduced the acceptability and effectiveness of the conservation structures.

Farmers had intentionally destroyed the conservation structures in 20 per cent of the plots. This is due to mainly inconveniences of ploughing created by the level 'fanya juu', habitation of moles in the structures, land taken out production and non-existence of soil loss on their croplands (See Section 4.1).

The width and height of the structures[20] were also measured to evaluate the present conditions of the level 'fanya juu' (See Table 17). Structures that had heights of more than 75 cms were observed in about one-fourth of the plots. A little lower than half of the plots had 51 to 75 cms heights of structures. One-tenth of the plots had heights of structures that range from 26 to 50 cms suggesting improper management of the structures in these plots.

Table 17. The width and height of the level 'fanya juu'

Width of the structures		Height of the structures	
Width (cm)	No. of plots (%)	Height (cm)	No. of plots (%)
Totally destroyed	20.0	Totally destroyed	20.0
1 - 25	0.0	1 - 25	0.0
26 - 50	16.8	26 - 50	10.0
51 - 75	23.3	51 - 75	43.3
76 - 100	13.3	76 - 100	16.7
101 - 125	10.0	101 - 125	3.3
126 - 150	10.0	126 - 150	6.7
151 - 175	3.3	-	-
176 - 200	0.0	-	-
201 - 225	0.0	-	-
226 - 250	3.3	-	-
Total	100.0	Total	100.0

Source: Field Survey, 1991.

The width of the structures also showed wide variations. Widths of structures varying from 26 to 50 cm were observed in 16.8 per cent of the plots. A considerable proportion of the plots had 51 to 75 cms width of structures and over one-tenth of the plots had widths of structures that range from 76 to 100 cms. One-tenth of the plots had widths of structures varying from 101 to 125 cms. In general widths of structures were very much narrowed due to improper management.

3.2.4 Factors responsible for erosion damage in the study site

Appreciable erosion damage was observed in 35.2 per cent of the treated plots. Some of the significant factors that bring about erosion damage are concentrated run off, improper management of the structures, and improper ploughing techniques.

1. Run off. This is a major cause of erosion. There are different sources of run off in the treated plots. As indicated in section 3.2.2, the poor construction of the structures has resulted in the structures to cross depressions without due consideration to the contours (See Figure 10). This creates concentration of water in the depressions and breaching of structures.

   Run off generated in villages accounted for the erosion damage in 10.0 per cent of the plots (See Table 18). Several sources in combination (depressions, roads, footpaths, and villages) generated and concentrated run off in 16.7 per cent of the plots. But the damaging

Table 18. Sources of run off that affected croplands

	Sources of run off	No. of plots affected (%)
1.	Villages only	10.0
2.	Villages and footpaths	36.7
3.	Villages and croplands	10.0
4.	Villages, footpaths, and croplands	6.7
5.	Villages, footpaths, and depressions	3.3
6.	Depressions, roads, footpaths, and villages	16.7
7.	None	16.7
	Total	100.0

Source: Field Survey, 1991.

effect of run off in these plots have been decreased by cut off drain, vegetation, and structures. Both villages and footpaths are significant sources of run off in 36.7 per cent of the plots. This is due to the compaction of the soil by the trampling effect of people and livestock. Of the 30 plots, rills developed in 25 of them. The number of rills in each plot varied from 1 to 25 (See Appendix 5). On the average there were 17.4 rills, and 1.1 gullies per hectare of land. As a result, 29.5 per cent of the total area of the plots (3.9 hectares) were severely affected by erosion.

Fig. 11. Breaching of structures and erosion damage on Croplands.

Source: Photo August, 1991.

the average inter-structure slope was deducted from the average slope of the cropland to calculate the reduction in the slope of the cropland(See Table 19 and Appendix 6).

Table 19. Slope reduction due to treatment of plots.

Slope reduction (%)	Number of plots (%)
0.0	23.3
0.1 - 4.0	46.7
4.1 - 8.0	26.7
8.1 - 12.0	0.0
12.1 - 16.0	3.3
Total	100.0

Source: Field Survey, 1991.

The construction of the level `fanya juu' has brought about .01 to 4 per cent slope reduction in 46.7 per cent of the plots. This is not a remarkable slope reduction. As explained in section 4.2, this was due to lack of maintenance in significant number of farms. As a result, the construction of the level `fanya juu' has not successfully prevented these plots from erosion damages by run off.

The concentration of run off is much higher in longer slopes than in shorter ones. The structures were designed and constructed in order to make break in slopes (See Table 20 and Appendix 6). There was slope length of under 25.1 metres in 56.7 per cent of the plots. But the

Table 20. Average inter-structure slope length in the treated plots.

Average inter-structure slope length (metres)	Number of plots (%)
0.0 - 25.0	56.7
25.1 - 50.0	26.7
50.1 - 75.0	10.0
75.1 - 100.0	3.3
Above 100.0	3.3
Total	100.0

Source: Field Survey, 1991.

structures in these plots were not developed to satisfactory height to control run off (See Section 3.2.3). The remaining plots, which have more than 25 metres of slope length, seem to have sufficient length for generating run off and initiating rills and gullies.

3. Improper ploughing techniques. After the introduction of the level 'fanya juu', the farmers were expected to change their ploughing techniques. The practice advised was contour ploughing. But the farmers did not accept the new practice and still continue to plough crosswise. The newly recommended ploughing technique is not effective in uprooting weeds and preparation of fine seed-bed (Personal communication with the farmers).

The intensity of ploughing, i.e. the average number of up and downhill ploughing for the seed-bed of manioc and 'teff' were the highest (see Table 21). As the intensity of ploughing increases, more soil aggregates are destroyed. This condition is worsened as the intensity of

Table 21. Intensity of ploughing for various crops in the summer of 1991.

	Intensity of ploughing		
Types of crops	Up and down	Horizontal	Average
Manioc	3	3	3.0
Sorghum	2	3	2.5
Sweet potato	2	2	2.0
Haricot bean	1	2	1.5
Maize	2	2	2.0
Barley	1	2	1.5
'Teff'	2	3	2.5

Source: Field Survey, 1991.

ploughing increases from year to year. This results in decrease of the pore spaces in the soil which in turn reduces the infiltration of water and speeds up run off generation.

As indicated in Section 1.2 and 2.2.1, the average household size and crude population density in the study site are much higher than the nation's average. The population density is high not only in relative but also in absolute terms. The high population density has put pressure on the land and subsequently forced the farmers to reduce fallow periods, and increase cultivation of marginal lands. The majority of the farmers (78.5 per cent) reported that they have discontinued to put their croplands under fallow. Several factors have also restricted the application of artificial fertilizers, and animal manure (See Section 2.2.3). Consequently, the physical structure and fertility of the soil has deteriorated since it does not get sufficient time for regaining.

CHAPTER FOUR

ADOPTION OF THE SOIL CONSERVATION STRUCTURE

4.1 Adoption of the soil conservation structure (level 'fanya juu')

The following items (See Table 22) are selected to quantify the adoption of the level 'fanya juu' by the farmers (See section 1.6.1). Here, the items are utilized to analyze the responses of farmers to each item. About 75 per cent of the farmers accepted the existence of the level 'fanya juu' on their farmlands (the reasons that contributed to the acceptance of the level 'fanya juu' are elaborated in section 4.2). About 56 per cent of the farmers have maintained the level 'fanya juu'. In addition, substantial number of farmers keep up the level 'fanya juu' in relatively better conditions by growing of sugar-cane (25.5 per cent of the respondents), and protecting from grazing of animals by cut and carry of grass from structures (50.5 per cent of the respondents). But the farmers demanded the provision of food for work (65.0 per cent of the respondents), followed by supply of pickaxe and shovel (40.5 per cent), provision of labour (19.5 per cent), and education (18.5 per cent) for the continuation of the maintenance of the level 'fanya juu'.

About 25 per cent of the farmers do not accept the structures. Several reasons were given for rejecting the structures (See Table 23). For these farmers, the

Table 22. Index of adoption of the level 'fanya juu'

Roll No.	Items	No. of farmers (%)
1.	Acceptance of the existing structures on one's farmland at present	75.5
2.	One time partial maintenance of the structures per year in fear of breaching of a bund may cause severe erosion in lower sites	5.0
3.	One time partial maintenance of the structures per year as a result of acceptance of the structures	11.5
4.	One time complete maintenance of the structures per year in fear of breaching of a bund may cause severe erosion in lower sites	1.5
5.	One time complete maintenance of the structures per year as a result of acceptance of the structures	6.0
6.	Two or more partial maintenance of the structures per year in fear of breaching of a bund may cause severe erosion in lower sites	3.5
7.	Two or more partial maintenance of the structures per year as a result of acceptance of the structures	14.0
8.	Two or more complete maintenance of the structures per year in fear of breaching of a bund may cause severe erosion in lower sites	9.0
9.	Two or more complete maintenance of the structures per year as a result of acceptance of the structures in a single or all plots	6.0
10.	Not destroying any part of the structures in a single or all plots	11.0
11.	Destroying only one of the lines of consecutive structures to allow turning of plough and oxen in some plots and not destroying in other plots	7.5
12.	Destroying only one of the lines of consecutive structures to allow turning of plough and oxen in all plots	54.0
13.	Destroying the whole structures in some plots and not destroying in other plots	2.5
14.	Destroying the whole structures from a single or all plots	25.0
15.	Growing of sugar-cane, bananas, etc. at the end of the backslope of the structures	25.5
16.	Cut and carry of grass from structure when crops are grown on the farmland	50.5
17	Cut and carry of grass from structures throughout the year	20.5

Source: Field survey, 1991.

Table 23. Reasons for the farmers lack of maintenance, partial, and whole destruction of the level 'fanya juu'.

	Reasons	No. of farmers who did not maintain (%)	Number of farmers who partially destroyed the structures (%)	Number of farmers who wholly destroyed the structures (%)
1	Habitation of moles in the level 'fanya juu'	27.5	39.0	17.0
2	Inconveniences of ploughing created by the level 'fanya juu'	2.5	44.0	18.5
3	Insecurity of land holding	0.0	2.5	1.0
4	Nonseverity of soil loss	9.0	11.5	4.5
5	Land taken out of production by level 'fanya juu'	24.5	23.5	15.0
6	Encroachment of grass to the cropland	25.1	3.0	1.0
7	Non-existence of soil loss	16.0	14.5	8.5
8	Shortage of labour	8.6	0.0	0.0
9	Others	2.5	3.5	1.5

Source: Field Survey, 1991.

disadvantages outweigh the advantages of the structures. The more important factors for the farmers lack of maintenance of the structures are habitation of moles in the structures, land taken out of production, encroachment of grass to the cropland and non-existence of soil loss. One or more reasons together are also considered by the farmers for destroying the structures. The major reasons forwarded for partial or total destruction of the level 'fanya juu' are inconvenience of ploughing created by the level 'fanya juu', habitation of moles in the structures, and loss of cropland. FAO (Vol.2. 1986b: 49) advises growing of grass on the land taken out of production. But about 62 per cent of the farmers did not consider grass grown on the land taken out of production to be of equal benefit to the crop production. Nonseverity and absence of soil loss also contributed significantly to the partial and total destruction of the level 'fanya juu'. Moreover, the enroachment of grass to the cropland has added to the inconveniences created by the structures which has led to the destruction of the conservation structures by the farmers.

4.2 Factors that explain adoption of the level 'fanya juu'.

Several factors can be mentioned in the explanation of the adoption behavior of farmers. Only those factors that are considered most important are treated here.

1. Attitude of farmers. The items in Table 24 elucidate the feelings or emotions of the farmers towards the conservation structures. The majority of the farmers agreed that the level 'fanya juu' help control run off, soil loss and loss of fertilizers. In line with this, 75 per cent of the farmers acknowledged that the structures

Table 24. Attitude of farmers towards the level 'fanya juu'

	Items	No. of farmers (%)		
		Agree	Disagree	No answer
1	Maintaining of the structures is a farmer's responsibility	77.5	22.5	0.0
2	Personally, I feel competent to have technical know-how of maintaining the structures	41.0	59.0	0.0
3	The extension agents imposed a greater strain upon the farmer's way of cultivating the land	47.0	52.5	0.5
4	The structures have created inconveniences (difficulty of turning plough and oxen)	47.0	53.0	0.0
5	The structures help arrest run off and soil loss	87.5	12.0	0.5
6	The structures have increased volume of production on sample plots	75.0	25.0	0.0
7	The structures have increased the number of cultivation to prepare the seed-bed	65.0	34.0	1.0
8	The loss of cropland due to the structures have decreased the income of the farmers	35.5	64.5	0.0
9	The raised part and the ditch of the structure help control porcupine from the cropland	72.0	28.0	0.0
10	The structures control the washing away of fertilizers	88.5	11.0	0.5
11	The structures on my cropland exist without my approval	38.0	62.0	0.0
12	The traditional way of managing the land is better than the new one	72.0	28.0	0.0
13	It is possible to prevent erosion	85.0	14.5	0.0
14	Many farmers do not want to follow their separate and individual ways without regard to the society's norms	74.0	26.0	0.0
15	The structures take land out of production which is very much needed to satisfy the food requirements of the family	50.5	49.0	0.5
16	The structures have not brought significant benefits to the farmer	30.0	70.0	0.0
17	I do not feel insecurity of landholding	87.0	13.0	0.0
18	I allow the existence of the structure on my cropland because of fear of the government and PA	47.5	52.5	0.0

Source: Field survey, 1991.

have increased crop production. And this has assisted in the acceptance of the structures. Many writers argue that short-term benefits to farmers are the most persuasive reasons for accepting soil conservation methods (Wenner, 1988:200 and Sanders, 1988 b:60). The farmers who gained marked benefits in this respect were those in drier lower altitudinal zones[21] of the study site as a result of water retention by the conservation structures. This has caused the adoption of the level 'fanya juu' by substantial number of farmers (75 per cent) in this region.

In general the farmers agree that maintenance of the structures should be their responsibility. Though about 77 per cent of farmers admitted that it is their responsibility to keep the state of the level 'fanya juu' in good condition, only 55.6 per cent of the farmers maintained their structures.

Fields with the level 'fanya juu' also demand more labour at the time of ploughing. Forty-seven per cent of the farmers pointed out that the structures create difficulty in turning the plough and oxen. There is also a consent by about 35 per cent of them that the loss of cropland due to the structures has decreased their income. All these add to the development of negative attitude towards conservation structures.

Furthermore, the loss of cropland due to the structure (See section 4.1) has developed unfavourable attitude towards the level 'fanya juu'. Of the 24 sample plots, an average of 3.5 per cent loss of cropland due to the conservation structures was recorded. This is much lower than an average of 10 per cent reduction by structures as mentioned by Aggrey - Mensah (1984:39) and Belay (1990:142). The decrease of the average loss of cropland by the structures in the study site is because of the farmers narrowing of the width of the conservation structures. The width of the structures have been reduced to an average of 88.9 cms from about 1.5 metres at the time of construction (See Table 17). The destruction of one of the lines of consecutive level 'fanya juu' have also reduced the loss of cropland by the structures. Besides, 61 per cent of the farmers replied that the traditional ways of managing the land (drainage ditches, crop rotation, etc.) are better than the new ones (level 'fanya juu', level bunds, etc.).

The introduction of the level 'fanya juu' is alien to the farming system of the region. The farmers are used to crosswise ploughing, but the introduction of the conservation structure makes difficult turning of plough and oxen. This inconvenience is much pronounced with increasing slope. Conservation programmes fail because very little attention is given to the economic, social, and political environment in which farmers live (Douglas, 1988:215; Sheng and Meiman, 1988:26). All of the above mentioned short-comings of the level 'fanya juu' have played significant roles in the development of unfavourable attitude towards the structures. It was because of these that 25 per cent of the farmers completely destroyed the structures.

Insecurity of landholding is felt by a small number of farmers (13 per cent). This may be due to the lower frequency of reallocation of land in the study area. Change of landholding due to reallocation of plots affected only 2.5 per cent of the farmers. Relatively higher number of farmers (6.5 per cent) were affected by the villagisation programme. Thus, the insecurity of land ownership has not strongly contributed to the rejection of the conservation structures (See Table 23).

2. Perception of soil erosion. Record of the levels of soil erosion on the croplands according to the observations of the farmers is given in Table 25. About 13 per cent of the farmers confirmed that there was no erosion on their croplands before the introduction of the soil conservation structures. The farmers did not participate in the decisions whether their farms need the conservation structure or not. It was simply done to provide reasons for food for work programmes and distributions of food and oil to the farmers (Personal Communication with soil and water conservation agents of MOA, and CONCERN). Hence,

Table 25. Farmers' perception of soil erosion

	Levels of erosion	Number of farmers who have perceived different level of erosion (%)	
		Before the introduction of the structures	After the introduction of the structures
1.	No erosion	13.5	43.0
2.	Slight erosion	19.0	42.0
3.	Moderate erosion	16.5	10.5
4.	Severe erosion	51.0	4.5
	Total	100.0	100.0

Source: Field Survey, 1991.

the conservation structures were constructed not only on steep slopes but also on flat croplands. And there was no benefit in keeping the level 'fanya juu' on flat croplands, they were soon destroyed by the farmers.

The majority of the farmers (87 per cent) agreed that their fields were affected by erosion. The owners of these fields appreciate the advantages of the level 'fanya juu'. The introduction of the conservation structures has raised the number of farmers that reported no erosion to 43 per cent from 13.5 per cent before the introduction of the structures. The percentage of farmers who observed moderate and severe erosion on their croplands has decreased from 16.5 and 51.0 per cent before the introduction of the structures to 10.5 and 4.5 per cent, respectively, after the introduction of the structures.

This suggests that, according to the opinions of farmers, the structures are effective in arresting soil erosion. The success of the level 'fanya juu' in these respects has considerably motivated the farmers to adopt it.

3. Frequency of contact of farmers with the soil and water conservation agents. As clarified in section 1.5.2, it is believed that the contact of the soil and water conservation agent with the farmer increases the farmer's awareness of soil conservation practices and results in an increase in the adoption of the structures. There were 2 contacts in a year by 16.5 per cent of the farmers as shown in Table 26. The frequency of contacts of the extension agents with the farmers had reached its highest stage only when the conservation structures were

Table 26. Frequency of contact of farmers with the soil and water conservation agents in 1990/91.

Number of contacts	Number of farmers (%)
0	1.0
1	4.0
2	16.5
3	5.5
4	3.5
5	2.5
6	0.5
Above 6	7.5

Source: Field Survey, 1991.

constructed (personal communication with the extension agents of MOA). As the number of contacts declined, the farmers lost the benefits of education by the extension workers. In accordance with this opinion, about 19 per cent of the farmers demanded education to be given for themselves in order to continue the adoption of the soil conservation structures.

4. Perception of yield increase. More than 50 per cent of the farmers have reported yield increases in maize, 'teff' and sorghum after the introduction of the level 'fanya juu' (See Table 27). Twenty-nine and about 42 per cent of the farmers have also reported yield increase of haricot bean and barley respectively. These benefits have motivated a significant number of farmers to adopt the soil conservation structures.

Table 27. Farmers' perception of yield increase

Number of crops	Number of farmers who reported yield increase (%)
Maize	63.0
'Teff'	55.0
Haricot bean	29.0
Barley	42.5
Sorghum	53.5

Source: Field Survey, 1991.

Most of the farmers who reported yield increase are found in the lower altitudinal zones of the study site. As pointed out in section 4.1, the yield increase is the result of higher water retention of the soil which is brought about by the introduction of the level `fanya juu'. This is easily perceived by the farmers since there is shortage of rainfall in the lower altitudinal zones.

CHAPTER FIVE

RESULTS

5.1 Hypothesis testing

As indicated in section 1.6.2, variables hypothesized to explain the adoption of the level 'fanya juu' (Y_0) are as follows:

X_1 (perception of soil erosion on croplands, in points),

X_2 (perception of yield increases, kg/ha),

X_3 (attitude of farmers towards conservation structures, in scores),

X_4 (frequency of contact with extension agents, in numbers in a year),

X_5 (educational level, in grades),

X_6 (size of farm, in hectares),

X_7 (compatibility, dummy variable - 1 for the level 'fanya juu' consistency with the past experience of the farmer, 0 otherwise),

X_8 (participations in formal organizations, in numbers) and

X_9 (participations in soil conservation works, in number of days).

To test the validity of the hypothesis bivariate regression, and stepwise multiple regression analyses were made.

5.1.1 Bivariate regression analysis

This method serves to explain the variation of a dependent variable with an independent variable. Based on the correlation matrix in Table 28, variables that have only strong relationship with the dependent variable will be dealt with.

A. Positive attitude of farmers towards the level `fanya juu. This independent variable has a strong positive correlation ($r=0.7016$) with the adoption of the level `fanya juu'. The variation in the attitude of farmers towards soil conservation structures accounted for 49.2 per cent (r^2) of the variation in the adoption of the level `fanya juu'. The analysis of variance was employed to test the significance of the regression model ($Y_0 = 3.0384X_3 + 34.6380$) in the explanation of the adoption of the level `fanya juu' (see Appendix 7a). The model is statistically significant at 0.05 significance level.

The strong relationship between positive attitude towards the level 'fanya juu' and its adoption is because of the confidence of the majority of farmers in the efficiency of level 'fanya juu' in arresting run off, and loss of soil and fertilizers (see section 4.2). In addition, substantial number of farmers have perceived an increase in crop production after the introduction of the conservation structure as a result of water retention in the areas where there is shortage of rainfall.

Table 28. Correlation matrix

	Y_0	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Y_0	1.0000									
X_1	0.5173*	1.0000								
X_2	0.3639*	0.2761	1.0000							
X_3	0.7016*	0.4662	0.4179	1.0000						
X_4	-0.1838*	-0.1411	-0.1789	0.2236	1.0000					
X_5	0.1800*	0.1734	0.0913	-0.1469	-0.0878	1.0000				
X_6	0.1953*	0.0187	0.1440	0.0119	-0.0555	0.0495	1.0000			
X_7	0.2633*	0.0456	0.2267	0.2214	-0.0914	-0.0682	0.1513	1.0000		
X_8	0.0046	0.0299	0.0209	0.0063	0.1138	0.1405	0.0726	0.0391	1.0000	
X_9	0.1114	0.0997	0.0129	0.0255	0.0036	0.3480	0.0651	-0.0193	0.1845	1.000

* Significant at 0.05 significance level (critical F = 3.84)

B. Perception of water erosion on cropland. This explanatory variable has revealed a correlation coefficient of 0.5173 with the adoption of the level 'fanya juu'. Eventhough, the correlation coefficient is of low value, the direction of the relationship was as expected. The perception of severe water erosion on the cropland explained 26.76 per cent of the variation in the adoption of the level 'fanya juu'. The regression model (Y_6 = 13.7147X_1 + 22.2991) is significant in the explanation of the adoption of the level 'fanya juu' at 0.05 significance level (see Appendix 7b).

The causes of positive correlation between the two variables can be grasped from the following explanation. The introduction of the conservation structures has made the croplands of 29.5 per cent of the farmers free from erosion (see section 4.2). Moreover, there are substantial decreases in the severity of erosion in much number of croplands. The number of farmers who reported severe and moderate erosion on their croplands have declined from 51.0 and 16.5 per cent to 4.5 and 10.5 per cent respectively after its introduction.

C. Perception of yield increase. This variable has weak positive relationship (r = 0.3639) with the adoption of the level 'fanya juu'. But the direction of the association between them was found to be the same as the expectation of the researcher. The farmers' perception of yield increase accounted for 13.24 per cent of the variation in the adoption of the level 'fanya juu'. As shown in Appendix 7c, the regression model (Y_6 = $0.0714X_2 + 42.5552$) explanation of the variation in the adoption of the level 'fanya juu' is statistically significant at the 95 per cent confidence limit.

The association of farmers perception of yield increase with the adoption of the level 'fanya juu' is reasoned out in the following statement. As indicated in section 4.2, more than half of the farmers have identified yield increase in maize, 'teff', and sorghum. Besides, over one-quarter of the farmers reported yield increase of haricot bean and barley. This is due to water retention of the soil as a result of the introduction of the conservation structures. This has been realized by the farmers which live in the drier areas.

As pointed out in the correlation matrix in Table 28, the other independent variables have shown very low but positive correlation with the dependent variable as expected, except one variable (frequency of contact with the extension agents). The unexpected negative correlation of frequency of contact with the extension agents, and the adoption of the level 'fanya juu' may be due to the following reasons.

1/ Most of the farmers who live around Boditi destroyed the level 'fanya juu'. This is because the farmers have not perceived yield increase after the introduction of the level 'fanya juu'. These areas are wetter and the growth of crops is not affected by shortage of water in the soil. As a result, these areas have not gained the short-term benefits of yield increase like the lower altitudinal zones. But the farmers make more frequent visits to Boditi on market days and meet the extension agents. Hence, there is higher frequency of contacts with the extension agents by those farmers who destroyed the conservation structures.

2/ The higher frequency of contacts made by the farmers who live around Boditi with the extension agents seems to develop friendly relations with each other. Consequently, the farmers were not afraid of being penalized for destruction of the conservation structures.

5.1.2 Stepwise multiple regression analysis

The stepwise multiple regression analysis was also employed to identify the independent variables which are significant in the explanation of the dependent variable. The absence of sizeable collinearity between the independent variables allowed the application of stepwise regression analysis without any difficulty.

The variables were entered in the regression in their order of importance in relation to their partial correlation coefficients[22].

$R_{03.1256789} = 0.6074$

$R_{01.2356789} = 0.3101$

$R_{06.1235789} = 0.2644$

$R_{07.1235689} = 0.1495$

$R_{09.1235678} = 0.0981$

$R_{08.1235679} = -0.0553$

$R_{05.1236789} = 0.0530$

$R_{02.1356789} = 0.0197$

Step 1

X_3 (attitude of farmers towards the level 'fanya juu') is the best explanatory variable of the dependent variable (the adoption of the level 'fanya juu').

$$Y_0 = 3.0384X_3 + 34.638$$

$$R_{0.3} = 0.7016$$

$$R^2_{0.3} = 0.4922$$

It is the first in the stepwise multiple regression equation and accounted for 49.22 per cent of the variation in the adoption of the level 'fanya juu'. The importance of this variable is explained in section 5.1.1.

Step 2

X_1 (perception of soil erosion on croplands) was added in the regression equation at this step, since it has the next largest partial correlation coefficient.

$$Y_0 = 2.5478X_3 + 6.4423X_1 + 23.9152$$

$$R_{0.31} = 0.7338$$

$$R^2_{0.31} = 0.5385$$

The variation in the adoption of the level 'fanya juu' explained by the multiple regression equation increased to 53.39 per cent at this step.

Stép 3

X_6 (size of farm) is entered at this step.

$$Y_0 = 2.5704X_3 + 6.2794X_1 + 24.4230X_6 + 15.2488$$

$$R_{0.316} = 0.7600$$

$$R^2_{0.316} = 0.5776$$

By the addition of this variable, the variance described by the multiple regression equation is raised to 57.76 per cent. The addition of other variable hardly increased the explanation of the variation in the dependent variable significantly. All the other variables are excluded from analysis. Hence, the stepwise multiple regression analysis enabled to sort out, among the variables considered, the most important variables that explain the adoption of the level 'fanya juu'. These variables, in their order of importance, are attitude of farmers towards the level 'fanya juu', perception of soil erosion on croplands and size of farm.

The third best explanatory variable in the stepwise multiple regression analysis is farm size. This is different from the bivariate regression analysis which shows the farmers' perception of yield increase as the third best explanatory variable. This seems to be due to the collinearity of the latter explanatory variable with the first best explanatory variable (attitude of farmers towards conservation structures). The importance of size of farm in the explanation of the adoption of the conservation structures is because of the similarity in the variation of the acceptance of the level 'fanya juu' to the size of farm. Though conservation structures take land out of production, the farmers who own a large area of land are less affected. Consequently, these farmers are motivated by the benefits of conservation structures to adopt them.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The introduction of soil conservation measures in the erosion prone areas of Western Catchment of Cherake River is advisable. But lack of taking into account the physical (topography, climate, and soil) and social (Cultural and economic) factors has significantly retarded the adoption of the conservation measures. Besides, the conservation structures were poorly constructed, especially in the depressions. The conservation structures also take considerable land out of production. This is greatly felt especially by farmers who own small area of land. As a result, farmers have narrowed the width of the conservation structures and even destroyed them in some cases. Moreover, the habitation of moles in the conservation structures affected the farmers in either of the two ways.

1) The moles eat their cultivated crops.
2) The farmers dig into the conservation structures to put traps or wholly destroy the conservation structures. And these add to exposure of their land to erosion and difficulty in farm activities.

In addition, inconveniences of ploughing created by the structures, and encroachment of grass to the cropland are the apparent difficulties encountered by the farmers. All these shortcomings of the level 'fanya juu' have caused it to be improperly managed and even wholly destroyed by significant number of farmers. Even the ones that exist have not developed into sufficient height so that terraces can be formed. They are damaged and filled up in many of the treated plots. These states of the conservation structures further expose the cropland to servere erosion damages as the run-off gets outlet in broken structures.

On the other hand, there are also important benefits from the conservation structures which have influenced majority of farmers to adopt them. The bivariate regression analysis has revealed that the most important independent variables to explain the adoption of the level 'fanya juu' are the attitude of the farmers towards it, perception of water erosion, and perception of yield increase. The application of the stepwise multiple regression analysis has enabled us to single out the best independent variables to explain the adoption of the level 'fanya juu' with minor changes from the bivariate regression analysis. The independent variables identified with the help of the latter procedure are:

1) Attitude of farmers towards the level 'fanya juu'.
2) Perception of soil erosion and
3) Size of farm.

The factors that influenced farmers to develop favourable attitude towards the level 'fanya juu' are the efficiency of the structures at controlling run off, and control of loss of soil and fertilizers. These benefits are perceived more by farmers that have croplands on steep slopes. In addition, the perception of increased production on treated plots have added to the acceptance of the conservation structures on the lower altitudinal zones where there is shortage of rainfall. The production increase in these areas is because of the improvement in the infiltration and water retention of soils as a result of the conservation structures.

The adoption of the level 'fanya juu' has increased with the increase in farm size. Farmers who have small size of farms have difficulty of meeting their families food requirements and their rejection of the conservation structure which put land out of production is to be expected. On the other hand, those farmers who own relatively larger area are less threatened since their satisfaction of their families food requirements with the remaining cropland is better met. The benefits of the structures to these farmers have motivated them to accept the level 'fanya juu'.

Finally, one can say that the majority of the farmers have accepted the conservation structures on their croplands. But most of the conservation structures has not been properly maintained and the main objective of terrace development has not been realized. The farmers have requested the provision of

The factors that influenced farmers to develop favourable attitude towards the level 'fanya juu' are the efficiency of the structures at controlling run off, and control of loss of soil and fertilizers. These benefits are perceived more by farmers that have croplands on steep slopes. In addition, the perception of increased production on treated plots have added to the acceptance of the conservation structures on the lower altitudinal zones where there is shortage of rainfall. The production increase in these areas is because of the improvement in the infiltration and water retention of soils as a result of the conservation structures.

The adoption of the level 'fanya juu' has increased with the increase in farm size. Farmers who have small size of farms have difficulty of meeting their families food requirements and their rejection of the conservation structure which put land out of production is to be expected. On the other hand, those farmers who own relatively larger area are less threatened since their satisfaction of their families food requirements with the remaining cropland is better met. The benefits of the structures to these farmers have motivated them to accept the level 'fanya juu'.

Finally, one can say that the majority of the farmers have accepted the conservation structures on their croplands. But most of the conservation structures has not been properly maintained and the main objective of terrace development has not been realized. The farmers have requested the provision of food for work, supply of pickaxe and shovel, provision of labour, and education for the maintenance and proper management of the conservation structures.

6.2 Recommendations

The following recommendations are made for the better success of the adoption of the soil conservation measures.

1. Preliminary survey of the physical environment of the area is and was necessary for the introduction of the conservation measures that are suitable for the area with regard to its rainfall, soil type, and topography. The areas that are affected by erosion and therefore need conservation measures should be demarcated.

2. The following adjustments should be made for the level 'fanya juu' in order to make it fit for the farming techniques and needs of the community.

    a) The farmers should get an easier method of killing moles (such as provision of poisonous chemicals) to keep the conservation structures free from them.

    b) The inter-structure spacing requires to be sufficient enough in order to allow crosswise ploughing. Instead of narrowing the inter-structure spacing, vegetation may be used as supplementary conservation measure.

c) The level 'fanya juu' should be applied more widely in low altitudinal zones where farmers can register considerable crop yield increase.

d) Improvement in the construction of the conservation structure must be made so that concentration of water in some spots can be controlled.

e) Provision of pickaxe and shovel is necessary so that the farmers can maintain the conservation structures.

3. Large diversion ditches should be constructed in order to divert excess surface run off from steep slopes, and villages and footpaths to water courses so that the conservation structures and the cultivated land can be protected.

4. The soil and water conservation agents must discuss the problems of land degradation with the farmers so that the latter can be aware of its short and long-term effects on the livelihood of the farming community. In addition, they should try to convince the farmers in question that conservation measures are necessary for an increase in agricultural productivity, and sustained development in the countryside.

5. Farmers are usually suspicious of new technologies. Demonstration of the importance of the conservation measures gives them firsthand information about the

conservation measures. This can be done practically by selecting farmers from each PA who are willing to make their farms to be used for the purpose.

6. As far as possible the necessary support should be given to the soil and water conservation staff and extension agents. These include supply of sufficient transport service, training of employees, and upgrading of the best workers. These measures can stimulate them to teach the management of soil conservation structures to the farmers and perform similar activities.

7. Conservation programmes can be more successful if they are carried out in conjuction with other developmental programmes. These include education of family planning, and provision of sufficient amount of fertilizers, selected seeds and artificial insemination of local cows with reasonable cost. Priorities of these services and delivery of items may be given to those farmers who continuously maintain the conservation structures. These measures can increase the farmers capacity to meet their food requirements and compensate for the loss of cropland taken by the conservation structures. In addition, these may serve as an incentive to maintain the conservation structures. And this can help to raise the height of the conservation structures to sufficient level for the development of terraces.

8. The farmers need to be given environmental education so that they can properly manage their conservation structures. This cannot be overcome only by soil and water conservation agents. The mass media can be employed to disseminate environmental education. Apart from these, schools can play significant roles in training the farmers' children so that conservation measures can have continuity. It then follows that introduction of environmental education as a subject in the schools curricula is advisable. MOA should direct its effort towards the realization of these measures.

FOOTNOTES

1. According to FAO, the highland is the area between 1500 and 3000m.a.s.l.

2. 'Awraja' is the second higher administrative subdivision in Ethiopia. Wherever it is cited it refers to the former subdivisions, except that of Damot Gale 'Awraja'.

3. 'Teff' (*Eragrostis tef*) is one of the unique cereal crops that are domesticated in Ethiopia (Vavilov, 1957 cited in Westphal, 1975:73). It is used to prepare 'enjera' (fermented flat bread) and sometimes porridge. It is the staple food in north-central, north-western, and most towns and cities of Ethiopia.

4. Soil productivity is defined as the capacity of soil in its normal environment to produce a specified plant or a sequence of plants under specified management system (Belay, 1990:124).

5. 'Timad' is an area of land that can be ploughed by a pair of oxen in a day. In order to know the number of 'timads' that make a hectare in the study site, the dimensions of 30 sample plots were measured. The actual dimensions of each sample plot was compared with the number of 'timads' estimated by each owner of the field. Then, the average size of one 'timad' is calculated. One 'timad' has come to be 0.17 hectare. In other words, about 6 'timads'

constitute one hectare. The 'timad' includes the cultivated land and the land occupied by the structures. This is because the farmer thinks the advantage of the conservation structures when his produce increases in his total farm size.

6. 'Edir' is an association formed by people living nearby. Its members contribute small amount of money in order to conduct funeral ceremonies.

7. 'Debo' is a communal labour used to perform its members tasks turn by turn.

8. 'Ekub' is money collected and distributed to its members every regular period of time.

9. 'Amharic' is one of the major languages spoken in Ethiopia. It is the medium of communication in the government institutions.

10. 'Welayitinya' is the language spoken by Welayita people in the south-central part of Ethiopia.

11. Level of destruction of the structures is the relative damage caused on the structures of different farmers' croplands. This include from no damage at all through destruction of one line of consecutive structures to the whole destruction of the structures.

12. Rainfall coefficient is the ratio between the mean monthly rainfall and one-twelfth of the annual mean. A month is said to be rainy when the rainfall coefficient is 0.6 and above, and dry when the rainfall coefficient is less than 0.6. FAO (1965:20) has utilized the 'rainfall coefficient' to distinguish between rainy and dry months.

13. 'Enset' (Enset ventricosum) is one of the endemic cultivated plants in Ethiopia. 'Enset', sometimes called false banana by foreigners, is a harbaceous plant related to banana (Westphal, 1975:123). The pulp of the psuedostem and corms are fermented and changed into dough-like substance. Various kinds of bread and porridge can be prepared from it. It is a staple food in south-western highlands of Ethiopia.

14. 'Chat' (Catha edulis) is indigenous perennial crop to Ethiopia (Sylvain 1958, cited in Westphal, 1975:73). The fresh leaves and twigs of 'chat' are used to be chewed (and usually swallowed) for their stimulating effect. It has been associated with religious activities of Muslims. At present it has been practiced by significant number of students (including Christians) who attribute it with giving strength for studying.

15. Technical assistants are twelfth grade complete students who were employed to carry out the plan of the level 'fanya juu' on the cropland, and supervise its construction.

16. Damaged structures are structures in which some parts of it are breached or destroyed due to improper management (narrowing by ploughing, digging up the structures to destroy the habitation of moles, etc.) and poor construction of the structures.

17. Filled up structures are structures which have become full of sediments transported from above the structures. This usually happens due to lack of maintenance in order to raise the height of the structures.

18. Width of the structure is the horizontal distance between the upslope of the ridge and the downslope end of the ditch of the structure.

19. Narrowing the width of the structures by the farmers is due to the loss of cropland which has reduced the production of crops required to satisfy their basic needs.

20. Height of the structure is the vertical distance between the top and bottom of the ridge of the structure.

21. Lower altitudinal zones in the study site are the areas which have an altitude of about 1600 m.a.s.l.

22. X_4 was excluded from the analyses of partial correlation coefficient and multiple stepwise regression because it was discovered that it had negative correlation with the dependent variable different from the expectation of the researcher.

BIBLIOGRAPHY

Aggrey-Mensah, W. (1984), Ethiopian Highlands Reclamation Study, degradation of the Ethiopian Highlands and actions to Combat It: Social and Economic implications: Costs and Benefits, Working Paper 12, LUPRD, MOA, FAO, Addis Ababa.

Alves, W.R. and R.L. Morill (1975), "Diffusion Theory and Planning", Economic Geography, Vol. 15, No.3.

Amare Gebre Egziabher (1988), Socio-Economic and Ecological Analysis of Soil Conservation in Ethiopia: Cases from Gununo Twin Catchment, Addis Ababa, Ethiopia.

Argay Waktola (1975), Assessment of the Development, Diffusion and Adoption of Package of Agricultural Innovations in Chilalo, Ethiopia, Ph. D. Dissertation, Ohio State University Xerox University Microfilms.

Ary, D. et al. (1985), Introduction to Research in Education (3rd ed.), Holt Rinehart and Winston, New York.

Awetahegne Alemayehu (1975), Identification and Description of Opinion Leader for the Diffusion of Agricultural Innovations in Two Northern Regions of Ethiopia, Ph.D. Dissertation, University of Maryland, University Microfilms International.

Backstrom, C.H. and G.D. Hursh (1963), Survey Research, Northwestern University Press, U.S.A.

Belay Tegene (1990), Erosion: Its Effect on Properties and Productivity of Eutric Nitosols in Gununo Area, Southern Ethiopia, and some Techniques of Its Control, (Unpub.), Ph.D. Dissertation, Geography Department, University of Berne.

Bistrat Aklilu (1980), Technical Change in Subsistence Agriculture:The Adoption and Diffusion of Fertilizers in Ethiopia's Minimum Package Programme, Ph.D. Dissertation, Boston University, University Micro-films International.

Butzer, K.W. (1982), "Empires, Capitals and Landscapes of Ancient Ethiopia", Archaeology, Vol. 35, No.5.

CSO (1986), Statistical Abstract, Addis Ababa, Ethiopia.

___ (1981), Damot Gale 'Awraja' Census Map (1:50,000), Addis Ababa, Ethiopia.

CONCERN (1992), Conservation Works in Damot Gale 'Awrajas', (Unpub).

Damot Gale 'Awraja' Agricultural Department (1991), Conservation Works in the 13 Peasant Associations of Damot Gale 'Awraja', (Unpub).

Douglas, M.G. (1988), "Integrating Conservation into Farming System: The Malawi Experience", in W.C. Moldenhauer and N.W. Hudson (eds.) Soil and Water Conservation, Ankey, Iowa.

Dragovich, D. (1976), "Adoption and Diffusion of Kikuyu, An Improved Pasture Grass", Professional Geographer, Vol. 28, No.28.

EMA (1979a), Topographical Map: Sodo (1:50,000), Addis Ababa, Ethiopia.

___ (1976b), Topographical Map: Shone (1:50,000), Addis Ababa, Ethiopia.

FAO (1965), Report on Survey of the Awash River Basin: Climatology and Hydrology, Vol.3, Rome.

___ (1984), Assistance to Land Use Planning, Ethiopia: Land Evaluation, Part one: Introduction and Procedure, UN Development programme, Rome.

___ (1985), Assistance to Land Use Planning, Ethiopia: Guidelines for Land Use Planning, UN Development Programme, Rome.

___ (1986a), Ethiopian Highlands Reclamation Study, Final Report, Vol.1. Report Prepared for Government of Ethiopia, LUPRD, MOA, FAO, Rome.

___ (1986b), Ethiopian Highlands Reclamation Study, Final Report, Vol. 2. Report Prepared for Government of Ethiopia, LUPRD, MOA, FAO, Rome.

___ (1986c), "Natural Resources and the Human Environment for For Food and Agriculture in Africa", FAO Environment and Energy Paper 6, Rome.

Fraye, W.W. (1987), "The Effect of Soil Erosion on Crop Productivity", in J.M. Harlin (ed.), Soil Loss, Process, Policies and Prospects, West View Press, London.

Hurni, H. (1983), Ethiopian Highlands Reclamation Study, Soil Formation Rates in Ethiopia, Working Paper 2, LUPRD, MOA, FAO, Addis Ababa.

_____ (1986), Guide-lines for Development Agents on Soil Conservation in Ethiopia, Community Forest and Soil Conservation Development Department, MOA, Ethiopia.

_____ (1987), "Erosion, Productivity, Conservation Systems in Ethiopia", in P. Sentis (ed.), Soil Conservation and Productivity, Universidad De Venezuela, Proceeding IV, Internal Conference on Soil Conservation, Marcay.

_____ (1988), "Degradation and Conservation of the Resources in the Ethiopian Highlands" Mountain Research and Development, Vol. 8, No. 2 and 3, Poineer Impression, USA.

Ibarra, R. (1984), Ethiopian Highlands Reclamation Study: Soil Conservation in Ario, Wollega Region, Working Paper 22, LUPRD, MOA, FAO, Addis Ababa.

Itana Ayna (1985), An Analysis of Factors Affecting the Adoption and Diffusion Patterns of Package of Agricultural Techniques in Subsistence Agriculture: A Case Study in Two Extension Districts of Ethiopia, M.A. Thesis, Department of Economics, Addis Ababa University.

Johnston, R.J. (1986), Multivariate Statistical Analysis in Geography, Longman Scientific Copublished in the United States with John Willy and Sons, Inc. New York.

Kassas, M. (1984), "Deforestation, Desertification and Soil Loss", Deforestation Control Bulletin, UN Environment Programme, A Bulletin of World Events in the Control of Deserts, Restoration of Degraded Lands and Reforestation, No.2.

Kazmin., V. (1973), Geological Map of Ethiopia, (1:2,000,000, Geological survey of Ethiopia, Ministry of Mines, Addis Ababa, Ethiopia.

Kohler, J. and Jemal Abdella (1989), Farmers in Merhabete, Farmers Circumstances in the Two Service Cooperatives of Gideb and Lij Agba, Merhabete Studies Report, No.1.

Krauer, J. (1988), "Rainfall, Erosivity, Isoerodont Map of Ethiopia", SCRP Research Report 15, Addis Ababa Ethiopia.

Larson, W.E. et.al.(1987), "The Threat of Soil Erosion to Long-term Productivity", in J.M. Harlin (ed.) Soil Loss, Process, Policies and Prospects, Westview Press, London.

Lionberger, H.F. (1966), Adoption of New Ideas and Practices, The Iowa State University Press, Annes, Iowa.

LUPRD (1983), Geomorphology and Soils Map: Awassa, Ethiopia (1:1,000,000, Assistance to Land Use Planning Project FAO/UNDP-ETH/78/003, Ethiopian Mapping Agency, Addis Ababa, Ethiopia.

_____ (1984), Land Resource Map: Awassa, Ethiopia (1:1,000,000) Assistance to Land Use Planning Project FAO/UNDP-ETH/78/003, Ethiopian Mapping Agency, Addis Ababa, Ethiopia.

_____ (1984), Land Use and Land Cover Map: Awassa, Ethiopia (1:1,000,000), Ethiopian Mapping Agency, Addis Ababa, Ethiopia.

Mabbutt, J.A. (1985), "Desertification of the World's Rangelands", UN Environment Programme", Desertification Control Bulletin, A Bulletin of World Events on the Control of Deserts, Restoration of Degraded Lands and Restoration, No.2.

Mesfine Wolde Mariam (1988), "An Assessment of Strain and Distress on the Ethiopian Highlands", Mountain Research and Development, UN University International Mountain Society, Vol.8, No.4, Poineer Impressions, U.S.A.

Misiko, A.M.P. (1976), Incentives and Disincentives Influencing Farmers in the Adoption of Agricultural Innovations, The Case of Bungom District, Kenya, Ph.D. Dissertation, Cornell University, University Microfilms International.

MOA (1988), Conservation Based Farming System Trials Programme Preparation Study, Johal Consulting Agency Ltd., in Association with Shawel Consulting International.

Monkhouse, F.J. and H.R. Wilkson (1964), Maps and Diagrams, Methuen and Company Ltd, London.

Morgan, R.P.C. (1980), Soil Erosion, Longman, Inc. New York.

Moser, C.A. and G. Kalton (1972), Survey Methods in Social Investigations (2nd ed.), Basic Books, Inc., New York.

National Meteorological Service Agency (1990), Time Series Meteorological Data, (Unpub.) Addis Ababa, Ethiopia.

Office of the Population and Housing Commission (1984), Population and Housing Census Preliminary Report, Vol.1, No.1, Addis Ababa, Ethiopia.

Pankhurst, R. (1964), "Wildlife and Forests in Ethiopia", Ethiopian Observer, Vol. 7, No.3.

Planning and Programming Department of MOA (1984), 1985-1988 Evaluation and 1989 Financial Activities Report, Vol.1, Addis Ababa, Ethiopia.

Rogers, E.M. and F.F. Shoemaker (1971), Communication of Innovations: A Cross-Cultural Approach, (2nd ed.) Free Press.

Sanders, D.W. (1988a), "Soil and Water Conservation on Steep Lands: A summary of Workshop Discussion", in W.C. Moldenhauer and N.W. Hudson (eds.), Soil and Water Conservation Society World Association of Soil and Water Conservation, Ankeny Iowa.

_______, (1988b), "Food and Agricultural Organizations Activities in Soil Conservation", in W.C. Moldenhauer and N.W. Hudson (eds), Soil and Water Conservation Society World Association of Soil and Water Conservation, Ankeny, Iowa.

SCRP (1986), "Fourth Progress Report (Year 1984)", Soil Conservation Research Project, Vol.5, University of Berne, Switzerland in Association with the UN University, Tokyo.

____ (1988), "Fifth Progress Report (Year 1985)" Soil Conservation Project, Vol.6, University of Berne, Switzerland in Association with the UN University, Tokyo.

____ (1991), "Eighth Progress Report (Year 1988)" Soil Conservation Research Project, Vol.9, University of Berne, Switzerland, in association with the UN University, Tokyo.

Secretariat of UN (1977), Desertification: Its Causes and Consequences, Pergamon Press.

Shaner, W.W., et.al. (1982), Farming Systems Research and Development Guide-lines for Developing Countries, West View Press, Colorado.

Shaxon, T.F. (1987), "Changing Approaches to Soil Conservation" in P. Sentis (ed.), Soil Conservation and Productivity, Universidad Central De Venezuela, Proceeding IV, International Conference on Soil Conservation, Maracay.

Sheng, T.C. and J.R. Meiman (1988), "Planning and Implementing Soil Conservation Projects", in W.C. Moldenhauer and N.W. Hudson (eds.), Soil and Water Conservation Society World Association of Soil and Water Conservation, Ankeny, Iowa.

Singh, I.B. and B.N. Sahay (1972), Communication Behaviour and Social Change, Bookhive 26/18, East Partel Nagar, New Delhi-8, India.

Southern Regions of Ethiopia Agricultural Department, Natural Resources and Development Department (1977), Natural Resources (Forest, Wild Animals, and Soil) Development, [Amharic], (Unpub.) Addis Ababa, Ethiopia.

Thomas, D.B. (1984), Ethiopian Highlands Reclamation Study, Soil and Water Conservation in the Ethiopian Highlands: An Assessment of Requirements and Evaluation of Activities, Working Paper 13, LUPRD, MOA, FAO, Addis Ababa, Ethiopia.

Velozo, R.D.C. (1987), "Incentive for Communities Involvement in Conservation Programmes", FAO Conservation Guide 12, Rome.

Wenner, C.G. (1988), "The Kenyan Model of Soil Conservation", in W.C. Moldenhauer and N.W. Hudson (eds.), Soil and Water Conservation Society World Association of Soil and Water Conservation, Ankeny, Iowa.

Westphal, E. (1975), Agricultural Systems in Ethiopia, Centre for Agricultural Publishing and Documentation, Wageningen.

Yeraswork Admassie et.al. (1983), Ethiopian Highlands Reclamation Study, Report on the Sociological Survey and Sociological Consideration in Preparing a Development Strategy, Working paper 4, LUPRD, MOA, FAO, Addis Ababa, Ethiopia.

Yohanese Gebre Michael (1989), "Land Use, Agricultural Production, and Soil Conservation Methods in the Andit Tid Area, Showa Region", SCRP Research Report 17, M.A. Thesis, Geography Department, Addis Ababa University.

Zemenfese Tsighe (1985), A Study in the Pattern and Determinants of Diffusion in An Urban Setting: The Case of Postal Establishments in Ethiopia, M.A. Thesis, Geography Department, Addis Ababa University.

Appendix 1

Achievements of the Community Forest and Soil Conservation Development Department.

Roll No.	Activities	YEAR 1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
1	Terracing ('000 ha)	53.8	30.9	47.7	65.7	37.01	14.5
2	Terracing maintenance (ha)	7783.3	5622.0	3555.0	8956.0	5676.6	7000.0
3	Checkdam (km)	3094.0	1751.0	900.0	1066.0	661.0	256.0
4	Checkdam maintenance (km)	--	399.0	9760.0	1019.0	279.5	146.0
5	Seedling production (million)	164.0	383.0	362.5	320.3	212.77	--
6	Seedling planting ('000 ha)	60.0	59.7	122.0	95.8	103.97	83.27
7	Land under closure ('000 ha)	19.6	28.2	63.6	41.7	37.32	12.5
8	Forest area closure ('000 ha)	--	3.1	19.5	0.2	314.4	--
9	Planting grass on bund (kms)	--	--	--	--	6109.1	--
10	Run off ditch (kms)	--	--	--	--	108.3	--
11	Extension workers given training	--	561.0	437	53.0	180.0	--
12	Representatives of public associations given training	13545.0	8337.0	3681.0	8177.0	3849.0	1953.0

a. Includes activities of 23 projects under the Government of Ethiopia Conservation programme

b. Only the activities of 23 projects under the Government of Ethiopia Conservation Programme

Source: Planning and Programming Department of MOA (1984)

Appendix 2

Conservation Works in the Peasant Association of the study Sites.

	Peasant Associations	Hillside Terracing (km)	Micro-basin (000)	Check-dam (km)	Soil bund (km)	Stone bund (km)	Level `fanya juu'(km)	Cut Off drain (km)
1.	Harto Burkito	--	140	0.2	5.0	--	165.0	0.2
2.	Harto Kontola	--	1300	2.0	51.0	--	380.0	8.0
3.	Shakisho Shone	--	100	--	1.2	--	10.0	0.1
4.	Buge	--	52	--	1.0	--	30.0	0.5
5.	Gacheno	--	165	0.2	2.0	--	62.0	0.12
6.	Damota Mokanisa	46.0	422	0.25	6.5	10.48	145.0	.025
7.	Mokanis Weyge	110.0	495	0.3	16.4	--	56.0	0.4
8.	Shakisho Mokanisa	--	30	0.4	1.2	--	46.0	0.25
9.	Ade Koysha	--	25	0.2	2.5	--	25.0	0.1
10.	Ade Damota	--	30	0.1	0.7	--	60.0	0.15
11.	Ade Aro	--	--	--	0.3	--	80.0	0.05
12.	Ade Ofa	--	80	0.3	3.0	--	90.0	--
13.	Aro Wegera	--	--	--	--	--	50.0	--
14.	Not classified in Peasant Associations	66.0	--	1.1	--	--	301.9	--
	Total	222.0	2839	5.06	90.8	10.48	1500.0	10.12

Source: Damot Gale `Awraja' Agricultural Department (1991) and CONCERN (1992).

Appendix 3.

Addis Ababa University

Geography Department

Questionnaire to be Completed by farmers

Interviewer ______________________________

Informant code __________________________

Address of informant: PA 1. Harto Kontola / /

2. Ade Aro / /

3. Ade Koysha / /

Awraja __________________________

Administrative Region ____________

Number of minutes taken for the interview ________

Instruction

Answer the questions marking 'x' in the box where the informant's response corresponds or filling in the blanks.

3.1 Family characteristics

The following questions are prepared to know the family characteristics of the informants.

1. Age of the head of the family __________________
2. Sex 1. Male / / 2. Female / /
3. Educational level 1. Can read and write / /
   2. Cannot read and write / /

4. If the informant says literate, what grade did you complete?

____

5. Material status
   1. single / /
   2. married / /
   3. divorced / /
   4. separate / /
   5. widow / /

6. What is the number of family members?

____

7. Complete the following table.

Family member	Relations	Age	Sex	Occupation	Educational level
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

8. Which of the following languages do you speak?
   1. Welayitinya / /
   2. Amharic / /
   3. Orominya / /
   4. Others ______________

9. What is your religion?

   1. Orthodox Christian / / 4. Islam / /
   2. Catholic / / 5. Others ____________
   3. Protestant / /

10. Where is your birth place?

   1. Damot Gale 'Awraja' / /
   2. Another 'awraja' / /

11. If you came from another 'awraja', specify the reasons.

   ____

3.2 Farming systems.

The following questions enables to understand how the farmers carry out their farming activities.

12. Which of the following are not working days in a week?

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
/ /	/ /	/ /	/ /	/ /	/ /

Sunday
/ /

13. Which of the followings are not working dates in a month? (underline).

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30						

14. Ownership of livestock in 1990/91

Livestock	Ownership (in numbers)	Amount of money collected from the sale of livestock (birr)
Heifers	_____	_____
Young male bulls	_____	_____
Bulls	_____	_____
cows	_____	_____
Lambs	_____	_____
Female adult sheep	_____	_____
Male " "	_____	_____
Kids	_____	_____
Female matured goat	_____	_____
Male matured goat	_____	_____
Colts	_____	_____
Young female horse	_____	_____
Mares	_____	_____
Male adult horse	_____	_____
Young male mule	_____	_____
Young female mule	_____	_____
Adult male "	_____	_____
Adult female "	_____	_____
Young donkey	_____	_____
Female adult donkey	_____	_____
Male " "	_____	_____
Poultry	_____	_____

15. If the farmer has livestock, for what purpose do you utilize the animal dung?

1. For fuel / /
2. For fertilizing the backyard / /
3. For fertilizing the farms / /
4. " " the backyard and the farms / /
5. For all of the above / /
6. Others ________________________________

16. Specify the amount of milk and eggs you got in 1990/91

Amount of milk (litres)	Income (Birr)
______	From milk ____________
______	From cheese ____________
______	From butter ____________
______	From eggs ____________

17. How is the grazing land owned?

1. By the government / / 3. Collectively / /

2. Privately / / 4. Others ___________

18. If the grazing land is owned privately, how many 'timads' is it? ____

19. How many minutes does it take on foot from your house to your grazing land? ________________________________

20. How many minutes does it take on foot from your house to the animals watering place?

____

21. Do you think the area of the grazing land has decreased in the past 17 years?

1. Yes / / 2. No. / /

22. If the informant says yes for Q. 21, why has it decreased?

1. Because of ploughing of grazing land / /

2. Because of closure of grazing grounds by the government **(PAs)** / /

3. Others ______________________________

23. Has the number of your livestock decreased for the past 17 years?

1. Yes / / 2. No. / /

24. If the informant says yes for Q. 23, why have they decreased?

    1. Because of shortage of grazing ground / /
    2. " " diseases of animals / /
    3. Others ______________________________

25. How many minutes does it take on foot from your house to each of the followings?

    1. To grain-mill ___________________
    2. To elementary school ____________
    3. To road _________________________
    4. To health centre ________________

26. Specify the items which you utilize as fuel?

    ______ ________ _________ __________ __________

27. How many 'timads' of land do you own?

    ____

28. Specify the size of your farms and its distance from your house.

Farm number	Size of farm	Distance from home to farm
1.	______ 'timads'	____________ minutes
2.	______ 'timads'	____________ minutes
3	______ 'timads'	____________ minutes
2.	______ 'timads'	____________ minutes
4.	______ 'timads'	____________ minutes

29. If your landholding has changed since 1974, how many times did it happen? ______________________________________

30. If your landholding has changed since 1974, what were the reasons for its change?

    1. Population pressure / /

    2. Villagisation programme / /

    3. Others ____________________

31. Identify the specific months of agricultural activity.

Types of Crops	Ploughing months	Sowing months	Weeding months	Harvesting months
Maize				
'Teff'				
Haricot bean				
Barley				
Sorghum				

32. Did you utilize artificial fertilizer in 1990/91?

    1. Yes / /   2. No / /

33. If the informant says yes, for which crops does it result in yield increase? ____________ ___________ ____________

34. If the informant says no for Q. 32, Why?

    1. Because of no availability of artical fertilizer/ /

    2. Because the type of the artificial fertilizer is not appropriate for the soil / /

    3. Because the artificial fertilizer is expensive for me / /

    4. Others ______________________________________

35. Did you utilize selected seed in 1990/91?

1. Yes / / 2. No / /

36. If the informant says no for Q. 35, why?

___________, ______________, ______________,

____

37. If the selected seed has resulted in yield increase, which crops have shown the yield increase?

___________, ______________, ______________,

____

38. Complete the following table.

Types of Crops	Production in 1990/91	
A. Perennial crops	____________	kgs
Coffee	____________	"
'Chat"	____________	"
'Enset"	____________	"
Banana	____________	"
Sugar-cane	____________	"
Avocado	____________	"
B. Annual crops	____________	"
Maize	____________	"
'Teff"	____________	"
Haricot bean	____________	"
Barley	____________	"
Sorghum	____________	"
Potato	____________	"
Sweet potato	____________	"
Manioc	____________	"

39. In which season was it good for crops in 1990/91?

1. Spring only / / 3. Both / /

2. Summer only / / 4. It was not good in both seasons / /

40. Indicate the amount of each crop you sold in 1990/91.

		From the total annual production		
	Type of Crops	One-third or under	More than one-third to half	More than half
A.	Perennial crops	/ /	/ /	/ /
	Coffee	/ /	/ /	/ /
	.`Chat"	/ /	/ /	/ /
	`Enset"	/ /	/ /	/ /
	Banana	/ /	/ /	/ /
	Sugar-cane	/ /	/ /	/ /
	Avocado	/ /	/ /	/ /
B.	Annual crops			
	Maize	/ /	/ /	/ /
	"Teff"	/ /	/ /	/ /
	Haricot bean	/ /	/ /	/ /
	Barley	/ /	/ /	/ /
	Sorghum	/ /	/ /	/ /
	Potato	/ /	/ /	/ /
	Sweet potato	/ /	/ /	/ /
	Manioc	/ /	/ /	/ /

41. If the informant has occupation other than farming, what is your income in 1990/91?

	Occupation	Income (Birr)
1.	Potter	_______
2.	Jeweller	_______
3.	Carpenter	_______
4.	Tanner	_______
5.	Weaver	_______
6.	Other	_____________________________________

42. Which of the following do you have?

1. Radio / /
2. Wrist watch / /
3. A house with corrugated roof / /
4. Modern bed / /
5. Leather shoe / /
6. Wollen cloth / /

3.3 Soil Conservation

The following questions are prepared to understand the farmers' perception of soil erosion and conservation. Whatever answer the farmer gives, it is confidential. What we want is the right answer according to the opinion of the farmers.

43. How was the soil erosion on this (sample) plot before the introduction of the level `fanya juu'?

1. No soil erosion / /
2. Slight soil erosion / /
3. Moderate soil erosion / /
4. Severe " " / /

44. After the introduction of the level `fanya juu', how is the soil erosion?

1. No soil erosion / /
2. Slight soil erosion / /
3. Moderate soil erosion / /
4. Severe soil erosion / /

45. Which of the followings are the causes of soil erosion on cultivated fields according to your perception?

1. Up and down ploughing / /
2. Not applying of animal manure / /
3. Roads as an agent of concentrating water / /
4. Footpaths that cross croplands as an agent of concentrating water / /
5. High density of livestock / /
6. Not practising crop rotation / /
7. Not applying organic matter / /
8. Not practising fallow / /
9. Steep slope / /
10. Heavy rain / /
11. Run off. / /
12. Others ____________________________________

46. Is it possible to control soil erosion?

1. Yes / / 2. No / /

47. If the information says yes, which of the followings can control soil erosion?

Soil conservation measure	The measure you think that controls erosion	The measure you apply on your cropland
1. Applying animal dung	/ /	/ /
2. Fallowing	/ /	/ /
3. Drainage ditches	/ /	/ /
4. Level 'fanya juu'	/ /	/ /
5. Soil bund	/ /	/ /
6. Stone bund	/ /	/ /
7. Growing of banana on	/ /	/ /
conservation structures	/ /	/ /
8. Growing of sugar-cane		
on conservation structures	/ /	/ /
9. Others	/ /	/ /

48. Was there level 'fanya juu' on your cropland?

    1. Yes / / 2. No / /

49. Is there level 'fanya juu' on your cropland?

    1. Yes / / 2. No / /

50. Is the level 'fanya juu' consistent with your past experience?

    1. Yes / / 2. No / /

51. Are you interested in the level 'fanya juu'?

    1. Yes / / 2. No / /

52. Is the level 'fanya juu' efficient in arresting soil erosion?

    1. Yes / / 2. No / /

53. According to your opinion, does the level 'fanya juu' have acceptance?

    1. Yes / / 2. No / /

54. Do you want to continue the adoption of the level 'fanya juu"?

    1. Yes / / 2. No / /

55. Did you maintain the conservation structures?

1. Yes / /   2. No / /

56. If the informant says yes for Q. 55, how many times did you maintain?

1. One time partial maintenance of the conservation structures per year in fear of breaching of a bund may cause severe erosion in lower sites. / /
2. One time partial maintenance of the conservation structures per year as a result of its acceptance./ /
3. One time complete maintenance of the conservation structures per year in fear of breaching of a bund may cause severe erosion in lower sites. / /
4. One time complete maintenance of the conservation structures per year as a result of its acceptance./ /
5. Two or more partial maintenance of the conservation structures per year in fear of breaching of a bund may cause severe erosion in lower sites. / /
6. Two or more partial maintenance of the conservation structures per year as a result of its acceptance./ /
7. Two or more complete maintenance of the conservation structures per year in fear of breaching of bund may cause severe erosion in lower sites. / /
8. Two or more complete maintenance of the conservation structures per year as a result of its acceptance./ /

57. If the informant says no for Q. 55, why did you not maintain the conservation structures?

1. Because of habitation of moles in conservation structures / /

2. Because of encroachment of grass on the cropland / /

3. Because of loss of cropland / /

4. " " only slight erosion / /

5. " " non-existence of erosion / /

6. " " " labour / /

7. Because of difficulty of up and down ploughing / /

8. Others ____

58. Who should maintain the conservation structure in your opinion?

1. Privately

2. Collectively

3 Others ____________ , __________ , ___________

59. If help is needed to continue maintenance of the level 'fanya juu', what kind of help do you need?

1. Labour

2. Education

3. Food for work

4. Shovel and pickaxe

5. Others____________

<u>Instruction.</u> If the informant has conservation structures on a single plot, ask Q. 60 to 63. But if he has structures on more than one plot go to Q. 64 to 67.

60. Did you destroy one of the lines or more of the conservation structures?

1. Yes / / 2. No / /

61. If the informant says yes, why did you destroy?

1. Because of habitation of moles in conservation structures / /

2. Because of encroachment of grass on the cropland / /
3. Because of loss of cropland / /
4. Because of only slight erosion / /
5. Because of non-existence of erosion / /
6. Because of difficulty of up and down ploughing / /
7. Because of change of landholding / /
8. Others ____

62. Did you destroy the whole conservation structures?

1. Yes / / 2. No / /

63. If the informant says yes for Q. 62, why did you totally destroy the conservation structures?

1. Because of habitation of moles in the conservation structures / /
2. Because of encroachment of grass on the cropland / /
3. Because of loss of cropland / /
4. Because of only slight erosion / /
5. " " non-existence of erosion / /
6. " " difficulty of up and down ploughing / /
7. Because of change of landholding / /
8. Others ____

64. Did you destroy one of the lines or more of the conservation structures?

1. Yes / / 2. No. / /

65. If the informant says yes for Q.64, in which of the plots did you destroy the structures ?

1. In some of the plots / / 2. In all of the plots / /

66. If the informant says that he destroyed the structures in some of the plots, why did you destroy the structures in some of the plots?

1. Because of habitation of moles in the conservation structures / /
2. Because of difficulty of up and down ploughing / /
3. Because of change of landholding / /
4. " " only slight erosion on these plots / /
5. " " higher loss of cropland in these plots/ /
6. Because of non-existence of erosion in these plots/ /
7. Because of encroachment of grass on these croplands / /
8. Others ___________________________________

67. If the informant says he destroyed the conservation structures in all plots, why did you destroy in all plots?
1. Because of habitation of moles in conservation structures / /
2. Because of difficulty of up and down ploughing / /
3. " " change of landholding / /
4. " " only slight erosion in all plots / /
5. " " non-existence of erosion in all plots / /
6. Because of much loss of cropland in all plots / /
7. Because of encroachment of grass in all plots / /
8. Others ___________________________________

68. If you destroyed the whole structures in a plot or plots, when did you destroy them? ______________________

69. If you destroyed the whole structures in a plot or plots, why did you do it?
1. Because of habitation of moles in the conservation structures / /
2. Because of difficulty of up and down ploughing / /
3. " " change of landholding / /

4. " " only-slight erosion / /

5. Because of non-existence of erosion / /

6. Because of loss of cropland / /

7. Because of encroachment of grass / /

8. Others ____

<u>Instruction</u>. If there is level 'fanya juu' on your cropland at present answer Q.70 to 72.

70. Did you plant sugar-cane, banana, etc on the conservation structure?

1. Yes / / 2. No / /

71. If there is grass on the conservation structure, what type is it?

1. Local grass / / 2. New type / /

3. There is no grass

72. Have you practised cut and carry of grass from conservation structures?

1. Yes / / 2. No / /

73. If the informant says yes for Q. 72 at what time of the year do you do it?

1. Only when crops are grown / /

2. Throughout the year / /

74. Do you allow livestock to graze on the conservation structures after crop harvest?

1. Yes / / 2. No / /

75. Is (was) there difficulty created after the introduction of the conservation structures?

1. Yes / / 2. No / /

76. If the informant says yes for Q. 75, what are the difficulties?

1. Habitation of moles in the conservation structures / /
2. Difficulty of up and down ploughing / /
3. Change of landholding / /
4. Only slight erosion / /
5. Non-existence of erosion / /
6. Loss of cropland / /
7. Encroachment of grass from structures / /
8. Others ___________________________________

77. Do you plough up and down in the treated plots?

1. Yes / / 2. No / /

78. What was the size of the plot (i.e. sample plot) in 'timads' before the introduction of the conservation structures?

____

79. If the size of the plot decreased after its treatment, by how many 'timads' did it decrease?

1. One-quarter of a 'timad' / /
2. One-third " " " / /
3. Half 'timad' / /
4. Three-quarter of a 'timad' / /
5. Others _____________________________

80. Complete the following table.

Types of crops	Average production before the construction of the level 'fanya juu'	Average production after the construction of the level 'fanya juu'
1. Maize in half timad	___________ kg.	__________ kg.
2. 'Teff' in half timad	___________ kg.	__________ kg.
3. Haricto bean in half timad	___________ kg.	__________ kg.
4. Barley in half timad	___________ kg.	__________ kg.
5. Sorghum in half timad	___________ kg.	__________ kg.

81. According to your opinion, if grass is grown on the conservation structure, will it be equally beneficial to the crop production?

1. Yes / /   2. No / /

82. When was the conservation structure constructed on your cropland? ______________________

<u>Instruction</u>. Answer the statements that follow by saying agree or disagree. We are equally interested whether you agree or disagree to the statements.

	Item	Agree	Disagree
83.	Maintenance of the conservation structure is a farmer's responsibility.	/ /	/ /
84.	Personally, I feel competent to have technical capacity of maintaining the conservation structure.	/ /	/ /
85.	The extension agents impose a greater strain upon the farmer's way of cultivating the land.	/ /	/ /
86.	The conservation structures have created inconveniences.	/ /	/ /
87.	The conservation structures help control soil loss and run off.	/ /	/ /
88.	The introduction of the structures have increased the volume of agricultural production on the sample plot.	/ /	/ /
89.	The structures have increased the number of cultivations to prepare the seed-bed.	/ /	/ /
90.	The loss of cropland due to structures has decreased the income of the farmer.	/ /	/ /
91.	The raised part and ditch of the structures help control procupine from cropland.	/ /	/ /
92.	The structures control the washing away of fertilizer from cropland.	/ /	/ /
93.	The structures on my cropland exist without my approval.	/ /	/ /
94.	Traditional way of managing the land is better than the new one.	/ /	/ /
95.	It is possible to prevent water erosion.	/ /	/ /

cont'd

96.	Many farmers do not want to follow their separate and individual ways without regard to the society's norms.	/ /	/ /
97.	The structure takes land out of production which is very much needed to satisfy the food requirements of the family.	/ /	/ /
98.	The structures have not brought significant benefits to the farmer.	/ /	/ /
99.	I do not feel insecurity of land holding	/ /	/ /
100.	I allow the existence of the structures on my cropland because of fear of the government and PA.	/ /	/ /

3.6 Communication

These questions help understand how the farmers exchange views with each other and with agricultural extension agents.

101. Do you participate in social organization?

    1. Yes / /   2. No / /

102. If the informant says yes for Q. 101, in which social organizations did you participate in 1990/91?

    1. 'Debo / /   4. Religious meetings / /
    2. 'Edir' / /   5. Others ______________
    3. 'Ekub' / /   ______________

103. If you go on foot to the Damot Gale 'Awraja' Agricultural Department how much time do you take? _______ minutes.

104. How many times did you meet the soil and water conservation agent in 1990/91? ___________ times.

105. Do you have a radio?

    1. Yes / /   2. No / /

106. If the informant says yes for Q. 105, to which radio programme do you listen to?

   1. To the agricultural radio programme broadcast in Amharic / /
   2. To the educational radio programme broadcast in Welayitnya / /
   3. Others ______________________________________

107. If the informant says the educational radio programme broadcast in Welayitinya, how many time do you listen in a week? ____ times.

108. If the informant says the agricultural radio programme broadcast in Amharic, how many times do you listen in a week? __________________________________ times.

109. From whom do you listen about innovation?

   1. From merchants / /
   2. From friends / /
   3. From travellers / /
   4. From soil and water conservation agents / /
   5. From relatives / /
   6. Others ______________________________________

110. Were there meetings about conservation of natural resources in 1990/91?

   1. Yes / / 2. No / /

111. If the farmer says yes for Q. 100, how many times did you participate in the meetings? _________________ times.

112. If you participated in the soil conservation works, how many days did you work till the end of 1990/91?

_________________________ days.

113. How many times do you go to market in a week?

____________________ times.

Appendix 4

Erosion damage and state of the level 'fanya juu' recording form.

Date of Exam	Owner of the plot	Location	Elevation	Erosion features: No. of rills & gullies	Dimension of rills & gullies: Length	Width	Depth	Area of damage

Source: Adapted from SCRP (1991: 83-92)

Continued

General		Conservation				
Shape		Traditional drainage ditch		Land management		
Angle	Shape	Type	Gradient	No. of tillages	Type of managements	State of the structure

Source: Adapted from SCRP (1991: 83-92)

Continued

Conservation				Adjacent area	
Inter-Structure slope	Inter-Structure slope length	Height of the structure	Width of the structure	Run off coming from upslope	Damage caused by run off from cropland down slope

Source: Adapted from SCRP (1991: 83-92)

Appendix 5

Rills, gullies, and area of erosion damage in the treated plots.

Plot No.	Total Area (m^2)	No. of rills (in numbers)	No. of gullies (in numbers)	Area of damage (m^2)
1	3000.00	1	0	1200.0
2	4658.04	3	0	0.0
3	6764.00	10	3	6764.0
4	8415.00	20	3	510.0
5	3094.50	17	0	3094.5
6	2517.20	20	2	89.90
7	5778.75	10	0	510.0
8	1729.75	24	0	24.0
9	4176.00	0	0	2088.0
10	7832.25	4	0	796.5
11	4680.00	2	0	2000.0
12	1020.50	0	0	0.0
13	1612.00	0	0	0.0
14	2368.00	13	0	492.0
15	3060.80	11	0	1010.0
16	4500.00	20	0	675.0
17	3256.60	1	0	3256.6
18	12960.10	1	0	6022.9
19	2053.90	8	0	34.0
20	3100.00	3	1	620.0
21	7037.80	25	0	1599.5
22	8046.00	1	0	0.0
23	2703.68	13	0	0.0
24	3120.00	1	0	1560.0
25	4200.00	0	0	2000.0
26	9384.90	12	1	2350.0
27	1020.00	5	2	510.0
28	5282.00	5	0	760.0
29	5226.00	2	2	1000.0
30	510.00	0	0	260.0
Total	133114.68	232	14	39226.9

Source: Field survey, 1991.

Appendix 6

Slope reduction and average inter-structure slope length in the treated plots.

Plot No.	Inter-structure slope (%)	Slope of cropland (%)	Slope reduction (%)	Slope length (m)
1	3.3	10.0	6.7	13.47
2	6.7	6.7	0.0	24.45
3	2.9	4.7	1.8	20.75
4	1.3	1.7	0.4	23.48
5	6.3	8.3	2.0	21.00
6	6.7	6.7	0.0	20.00
7	9.2	10.0	0.8	20.00
8	5.0	5.0	0.0	25.00
9	7.9	12.5	4.6	31.00
10	10.3	11.7	1.4	25.50
11	11.7	11.7	0.0	32.25
12	3.3	6.7	3.4	29.25
13	6.1	6.7	0.6	223.50
14	3.6	9.7	6.1	19.40
15	3.2	6.7	3.5	19.70
16	8.3	8.3	0.0	14.43
17	7.5	7.5	0.0	51.00
18	4.1	5.5	1.4	25.00
19	7.0	7.0	0.0	39.00
20	6.7	12.5	5.8	29.00
21	7.6	15.0	7.4	24.60
22	4.9	11.7	6.8	22.50
23	6.8	19.2	12.4	78.00
24	4.2	8.0	3.8	52.00
25	5.9	8.3	2.4	31.00
26	8.5	11.7	3.2	68.50
27	10.2	16.7	6.5	37.00
28	11.8	12.7	0.9	11.20
29	8.5	13.0	4.5	19.98
30	4.2	5.0	0.8	13.48

Source: Field survey, 1991.

APPENDIX 7

ANOVA Tables

7a. ANOVA table for significance testing of the regression model of positive attitude of farmers and adoption of the level 'fanya juu'

Source	Sum of Squares	Mean of squares	Degree of freedom	F Ratio
Regression	85177.847	85177.847	1	191.931
Residual	87871.273	443.794	198	
Adj.total	173049.120			

Critical F=3.84 (at 0.05 significance level).

7b. ANOVA table for significance testing of the regression model of perception of water erosion and adoption of the level 'fanya juu'

Source	Sum of Squares	Mean of squares	Degree of freedom	F Ratio
Regression	46299.977	46299.977	1	72.327
Residual	126749.150	640.147	198	
Adj.total	173049.120			

Critical F= 3.84 (at 0.05 significance level)

7c. ANOVA table for significance testing of the regression model of perception of yield increase and the adoption of the level 'fanya juu'

Source	Sum of Squares	Mean of squares	Degree of freedom	F Ratio
Regression	22912.950	22912.950	1	30.218
Residual	150136.170	758.263	198	
Adj.total	173049.120			

Critical F= 3.84 (at 0.05 significance level).

DECLARATION

I, the undersigned declare that this thesis is my original work, has not been presented for a degree in any other University, and that all sources of material used for the thesis have been duly acknowledged.

Name : Mulugeta Neka

Signature : ____________

Place and date of Submission: Addis Ababa.

June, 1992.