

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF SOCIAL SCIENCES AND HUMANITIES
FACULTY OF SOCIAL SCIENCES

ASSESSMENT OF THE PRACTICES AND ASPECTS OF FARMLAND
MANAGEMENT IN GOZAMEN DISTRICT, EAST GOJJAM ZONE,
ETHIOPIA

BY

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By

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Table of contents

Contents	pages
List of Tables	v
List of Figures	vi
Acronyms	vii
Abstract	viii
Chapter one	
Introduction	1
1.1. Background of the Study	1
1.2. Statement of the Problem	3
1.3. Objectives	4
1.4. Research Questions	5
1.5. Methods and Procedures of the Study	5
1.5.1. Sampling Techniques	5
1.5.2. Data Collection Instruments and Data Sources	7
1.5.3. Data Analysis and Interpretation	8
1.6. Description of Variables Used in the Statistical Analysis of Determinants of Adoption and Implementation of Improved Farmland Management Practice	9
1.7. Significance of the Study	10
1.8. Scope and Limitations of the Study	10
1.9. Thesis organization	11
CHAPTER TWO	
Review of Related Literatures	12
2.1. Sustainable Land Management	12
2.1.1. The concept of Sustainability and Sustainable Land Management	12

2.2. Farmland Management	14
2.3. Farmland management practices and their Importance	15
2.4. Land Degradation in Africa	18
2.5. Land Degradation in Ethiopia.....	20
2.6. Major Determinants for Adoption and Implementation of Improved Farmland management practices	21
2.6.1. Government Policies and Programs.....	21
2.6.2. Farmers’ Decisions, Socio-economic and institutional factors.....	21
2.6.3. Education, Farmers’ local knowledge and active participation	22
2.6.4. Endowments of Physical and Human capital.....	24
2.6.5. Topography and climate	24
2.7. Conceptual framework of the study.....	25
Chapter Three	
Descriptions of the Study Area	27
3.1. Location and size	27
3. 2. Relief, climate and Drainage.....	28
3.3. Vegetation	29
3.4. Soils and Land Use/ Land Cover	29
3.5. Socio economic characteristics	30
Chapter Four	
Results and Discussions	34
4.1. Attributes of Sample Households	34
4.2. Farmland Management Practices.....	36
4.2.1. Soil Fertility Maintaining Practices	36
4.2.1.1. Indigenous Management practices	37
4.2.1.2. Modern management practices	40
4.2.2 Soil and Water Conservation Measures.....	43
4.2.2.1. Indigenous Methods	44

4.2.2.2. Modern management Methods	47
4.2.3. Weed and Insect Controlling Practices	51
4.2.4. Crop Productivity Increasing Practices.....	53
4.3. Determining Factors of the Adoption and Implementation of Improved Farmland Management Practices	57

Chapter Five

Conclusion and Recommendations	67
5.1. Conclusion	67
5.2. Recommendations.....	69
References.....	72
Appendixes.....	77

List of Tables

Table pages	No
Table3.1. Division of relief types in Gozamen woreda	28
Table3.2. Land use/land cover in Gozamen woreda.....	30
Table4.1. Attributes of sample hose holds	35
Table4.2. Indigenous soil fertility maintaining farmland management practices.....	40
Table4.3. Modern farmland management practices used to maintain soil fertility	43
Table4.4. Soil and Water Conservation Measures.....	50
Table4.5. Weed and Insect Controlling Practices	52
Table4.6. Crop Productivity Increasing Practices.....	55
Table4.7. Determinants of Adoption and Implementation of Improved Fertilizers	59
Table4.8. Determinants of Adoption and Implementation of Vegetation and Terracing	60
Table4.9. Constraining Factors of Benefiting from Extension Services	65

List of Figures

Figure No	pages
Figure1. Conceptual Frame Work of the Study	26
Figure2. Location of Gozamen Woreda	27
Figure3. The Practice of Ehura	38
Figure4. Diversion Ditches and Waterways	44
Figure5. Waterway Changed into Gullies.....	45
Figure6. The Impact of Waterways on Grazing Lands.....	46
Figure7. Part of Shuka Wetland Covered with Fila	47
Figure8. Parts of Shuka Wetland Changed into Grazing Lands	47
Figure9. The Practice of Terracing.....	49
Figure10. The Progress of Terracing in Gozamen 2003-2010	50
Figure11. The Practice Intercropping	53
Figure12. The Practice of Diversified Cropping`	54
Figure13. Collected Crop Residues and Dung- cakes in Gozamen	61
Figure14. Farmers' Participation on DAs Advices, and Community Forums and Panel Discussions.....	64
Figure15. Participants on Community Forums and Panel Discussions	66

Acronyms

ADLI- Agriculture Development Led Industrialization

AM - Amarit Subkebele

ANRS -Amhara National Regional State

CH - Chertekel Kebele

EEPFE- Environmental Economics Policy Forum for Ethiopia

ETB- Ethiopian Birr

Fr - Frequency

GA - Gabecha Subkebele

GDP- Gross Domestic Product

GWAO - Gozamen Woreda Administration office

WARDO - Gozamen Woreda Agriculture and Rural Development Office

GWEB - Gozamen Woreda Education Bureau

GWEPLAU - Gozamen Woreda Environmental Protection and Land Administration and Use office

GWHO - Gozamen Woreda Health Office

Ha- Hectare

ILRI - International Livestock Research Institute

IPM -Integrated pest management

MA - May Angetam kebele

MASL- meters above sea level (masl)

MOA- Ministry of Agriculture

NRM- natural resource management

SARD- sustainable agricultural and rural development

Shh - Sample households

SK2- Sub-kebele2

SK3 - Sub-kebele3

SPSS- Statistical Packages for Social Sciences

SSA- Sub Saharan Africa

Abstract

Farmland is so matchless precious natural resource which is vital for gainful agricultural production that calls for improved and efficient management practices. Thus, in order to utilize it in a sustainable manner, numerous management practices can be involved at a given farmland. The intention can be to control soil erosion, insects and weeds and /or to maintain its fertility which is vital to maximize productivity. There are various time-honored indigenous farmland management practices in Gozamen Woreda (District) which serve as a base to carry out improved land management systems. There are some newly introduced methods in practice as well. Nevertheless, the Woreda is still characterized by poor farmland management practices. Accordingly, this research was aimed to assess the practical indigenous and modern farmland management practices and aspects, to examine positive and negative impacts of each of the land management practices in terms of agricultural productivity and environmental protection and to assess the major determining factors of adoption and implementation of improved farmland management practices in the study area with special reference to two sample Kebeles (Chertekel and May Angetam). Through employing questionnaires, key informant interviews, field observation and case studies, it was found that although different introduced farmland management methods are put in practice in Gozamen, traditional management practices take the dominant share with respect to their intensive implementation, and some of environmentally adapted and less costly indigenous management methods have not gotten attention. Organic fertilizers help to maintain long run soil fertility with less cost on farmlands and the surrounding environment, but require long processes. On the contrary, inorganic fertilizers help to achieve crop productivity within a short period of time but maintain short term soil fertility (usually for a single cropping season). Likewise, insecticides and pesticides have tremendous impacts on the environment and health of animals, plants and human beings. Age, sex, number of labor forces, number of livestock, number of farm plots, contact with DAs and farmers' participation on community forums and panel discussions with regard to farmland management are the main determinants of the adoption and implementation of improved farmland management practices. Government policies, sources of fuel energy, problem of properly integrating indigenous and introduced management practices, absence of other alternative engagements, animal feeding systems, grazing and plowing systems and farmers' reluctance for carrying responsibility are the other constraining factorsS

Chapter One

Introduction

1.1. Background of the Study

The natural environment consists of various valuable natural resources such as air, water, soil, land, forest, flora and fauna which are basic for human life and development. Any change brought about in one of these components is counter balanced by some other changes in another component of the environment (Dave and Ketewa, 2008). In order to withstand such changes a wide range of techniques of natural resources management (NRM) have been used. Nonetheless, degradation of soils and other natural resources proceeds at a high rate in much of Africa, reflecting low rates of adoption of sustainable NRM strategies, especially among the poorer subpopulation of smallholder producers (Barrett *et al.*, 2002). Thus, in the rural area of Africa, in which most people today are employed in agriculture with acute poverty maintaining sustainable agricultural intensification to address the universal objective of reducing poverty and vulnerability is so challenging (Barrett *et al.*, 2002).

In the current international debate it is voiced that studying of small-scale farms of developing countries is most relevant for the design of sustainable agriculture and rural development (SARD) because most of world's food crop is from small farms of Africa, Asia, and Central America (Innis, 1997). Furthermore; it is argued that increasing sustainable agricultural outputs in third world countries implies improving the welfare of rural families and then poverty reduction (FAO, 1986). Improving the productivity of assets- labor, soil, vegetation, water and livestock- used in agricultural production is therefore central to the objective of improving African livelihoods and wellbeing in the next few decades (FAO, 1986). Nevertheless, the urgency to restore soil fertility in Africa stems from the fact that more than three quarters of the farmland in SSA has been so depleted of the basic nutrients, and hence leading to reduce crop yields. Today there are 95 million hectares of degraded land in SSA leading to greatly reduced productivity. During the 2002-2004 farming seasons in East Africa, especially Mali, Burkina

Faso, Nigeria, Ethiopia, Somalia and Kenya, annual loss of soil fertility on farmlands can be as high as 100 kg per hectare mainly due to poor farmland management (Ayieko, 2008).

As a result, agricultural production is down by more than 16% from what it was in the early 1970s in SSA. This is both a cause and consequence of deterioration in the natural resources like soil on which agriculture depends (Barette *et al.*, 2002). Ayieko (2008) warns that unless these conditions are reversed, food production in Africa will remain depressed. Improved land management that ensures better resource use and promotes long-term sustainability is basic to future food production and economic welfare of rural communities (USDA, 1994).

Farmlands are the components and homelands of the basic natural resources of the globe and in which the various ecosystems interact with their environment. Thus, farmland management significantly determines the sustainability of NRM, and agricultural practices and productivities of a country, mainly where agriculture is the leading economic activity like in Africa in general and Ethiopia in particular.

The soil is the soul of a farm. Proper soil management will maximize forage and crop production. However, this precious resource, mainly in the developing world, has been deteriorated and lost in an alarming rate as a result of poor farmland management (John and Merrell, 2010).

In light of this, it is important to assess the practical indigenous and modern farmland management practices and aspects, and their impacts on the farmlands' sustainability and productivity coupled with environmental protection in Gozamen woreda (District) which is one of the victims of the problem.

1.2. Statement of the Problem

Agriculture is the mainstay of the Ethiopian economy since more than 80% of the country's labor forces are farmers, 90% of the exports are agricultural commodities and one half of the GDP is generated from this sector (Teshome, 2010).

Ethiopia has adopted Agricultural Development Led Industrialization (ADLI) Policy. It gives heavy emphasis to sustainable agricultural development, food security and the improvement of life in the rural areas. The policy recognizes that sustainable agricultural production depends on appropriate natural resource management, and support for peasant agriculture is taken as the center price of this policy (Aregay, 1999). Conservation and sustainable land management was not, in fact, a highlight of the original policy, but has received more attention recently (Benin *et al.*, 2002).

As evidences indicate, remarkable changes have not been taken in terms of sustainable agricultural production and development. For example, Teshome (2010) states, the performance of Ethiopian agriculture has been poor over the last three decades. One of the root causes of this problem is poor and unsustainable land management practices. On top of this, Berry (2003), pointed out that the direct costs of loss of soil and essential nutrients due to unsustainable land management is estimated to be about three percent of agricultural GDP or \$106 million and the loss of agricultural value between 2000-2010 could be \$7 billion, even without taking into account of the indirect impacts of land degradation in Ethiopia.

Land management problems like soil erosion, overgrazing and deforestation have steadily increased in Ethiopia despite there are numerous interventions (SARDP, 2010). The nutrient loss from lost soils in terms of phosphorus and nitrogen was 1.1 million metric tons in 1995 and 1.3 million metric tons in 2005. The monetary value of productivity loss is estimated at about 639 million ETB, in 1995 and 766 million in 2005 (Backteman, 2010). Therefore, unless the present land management practices are reversed (Kumela, 2007), large areas of the nation's farmland will deteriorate and it will become increasingly difficult to maintain even the present low level of production.

Traditional conservation measures are well-known in some parts of Ethiopia. For example, the people of Konso in Southern Nations, Nationalities and Peoples of Ethiopia applied terracing in their cultivated land last long ago. Some terraces are also seen in the northern regions and in lowland areas where water conservation is necessary (MOA, 1986). Other areas like Gojjam have developed systems of ditches to drain surplus run off. These measures, however, are not sufficient to control land degradation (MOA, 1986). Since Ethiopia has a wide variety of climate, from dry to wet, and also many different topographic features one can not apply the same conservation measures everywhere, and therefore, it is necessary to know what the characteristics of an area are where soil conservation has to be implemented (MOA, 1986).

In Amhara region, the rate of erosion is estimated between 16 and 50 tons per hectare per year (ILRI, 2000). The report also mentioned that as the result of high rate of erosion, the region accounts for more than 50% of the estimated annual soil loss in Ethiopia.

In Gozamen Woreda there is a wide range of indigenous soil and water conservation practices which farmers have developed over many generations which can often provide the basis to conduct improved systems of land husbandry. Some introduced methods are also practiced (Kiflemariam, 2008). Nowadays, the government has given emphasis for experiencing to implement modern and effective farmland management practices. Nevertheless, the Woreda is

still characterized by poor farmland management practices by which the researcher was inspired to conduct this study.

1.3. Objectives

The main purpose of this study is to assess the practical indigenous and modern farmland management practices and aspects, their impacts on the farmlands' sustainable productivity coupled with environmental protection as well as the major determining factors of adoption and implementation of improved farmland management practices.

The specific objectives are:

- To assess the indigenous and modern farmland management techniques farmers use to manage their farmlands
- To examine the positive and negative impacts of each of the farmland management practices in terms of agricultural productivity and environmental protection
- To assess the major determining factors of adoption and implementation of improved farmland management practices in the study area.

1.4. Research Questions

On the basis of the above formulated objectives, the following research questions are outlined:

- What types of indigenous and modern techniques of management practices are used on the farmlands?
- What are the positive and negative impacts of the farmland management techniques for agricultural productivity and environmental protection?
- What are the major determinants of adoption and implementation of improved farmland management practices in the study area?

1.5. Methods and Procedures of the Study

1.5.1. Sampling Techniques

Gozamen Woreda has 26 Kebeles having different agroclimatic characteristics. Taking this agroclimatic variation into consideration, the kebeles were preliminarily clustered into three categories with respect to their agroclimatic zone (Dega, Woyna Dega and Kola agroclimatic zones). Then, with the aid of lottery base random sampling method the Dega agroclimatic zone was discarded. Finally, out of the 26 kebeles, 2 sample kebeles (Chertekel and May Angetam) were randomly selected from the Woyna Dega and Kola agroclimatic zones respectively.

As it is obtained from the kebele Administration Bureaus, Chertekel Kebele is subdivided into Gabecha, Yedebona and Amarit sub- kebeles. Similarly, May Angetam kebele is subdivided into Sub-kebele1, Sub-kebele 2 and Sub-kebele 3. These different sub-kebeles are found in different parts of the kebeles with varying topographic features. For example, the southern and south eastern parts of Chertekel kebele have rugged topography while the remaining parts are mostly characterized by plateau and plain topographic features. In the same manner, the southern, north eastern and eastern parts of May Angetam kebele are dominated by up and down topography, where as most of the central and western parts have plateau and plain topography.

Accordingly, four sub-kebeles were purposively selected on the basis of their topographic characteristics including Gabecha and sub-kebele 3 from plateau and plain areas. Besides, Amarit and sub-kebele 2 were taken from bumpy areas of the two kebeles. In order to select household samples from similar topographic features, a lottery based random sampling was used.

All in all, 130 sample households were randomly selected from these sample sub-kebeles including both male and female headed households. So as to generate relevant information, the sample households were proportionally selected with respect to the number of total households of each sub-kebele through the following formula:

$$n = \frac{N(S)}{\sum N}$$

Where, n= the number of required samples of each sub-kebele

N= Total households of each sub-kebele

S= Total sample households to be treated

$\sum N =$ Total households of the four sample sub-kebeles

S is determined to be 5% of the total households of all sample subkebeles ($\sum N$) =130.

According to the Land Administration and Use Bureaus of the sample kebeles, the total households are:

1. Gabecha Sub- kebele = 900 = N_1
2. Amarit Sub- kebele = 846 = N_2
3. Sub- kebele 2 = 577 = N_3
4. Sub- kebele 3 = 281 = N_4

Total = 2604 = $\sum (N_1, N_2, N_3 \text{ and } N_4)$

Hence, based on the above formula and population data, the required sample households (n_1, n_2, n_3 and n_4) are drawn from each sub kebele (Gabecha sub- kebele, Amarit sub- kebele, Sub-kebele 2 and Sub- kebele 3) resulting 45, 42, 29 and 14 sample households respectively.

1.5.2. Data Collection Instruments and Data Sources

1.5.2.1. Data Collection Instruments

The most important instruments employed to generate relevant information were questionnaire, key informant interview, field observation and formal and informal discussions with farmers.

Questionnaires: Structured questions have been prepared and administered to household samples so as to gather primary information from farmers through household survey. The questions were formulated in both open ended and close ended forms and administered through face to face interview.

To make simple for understanding, all the questions were translated into Amharic. In the data collection process enumerators were employed. Before starting the data gathering, brief orientations were offered to enumerators by the researcher regarding how to approach, handle the

interview and discuss on each question. The researcher was also supervising, adjusting and consulting the enumerators from the beginning up to the end of the data gathering work.

Key Informant Interviews: they were carried out with Agriculture and Rural Development experts, Environmental Protection and Land Administration and Use experts of the Woreda, and Environmental Protection and Land Administration and Use Committee, and DAS of the sample kebeles.

Field Observation: It was necessarily used to gather primary information with regard to the current conditions of cultivated lands, the observable management practices and the surrounding environmental conditions relating to the management practices through transect walking across the farmlands of the study area with the aid of visual photographs.

Case Study: the case studies were conducted through detail discussions with individual farmers regarding the farmland management practices to be undertaken, the positive and negative impacts of the management practices to be implemented relating to proper farmland management and environmental protection as well as the determining factors of adapting and implementing of improved farmland management techniques.

In order to make the discussion fruitful, model farmers were considered to be appropriate to participate, because they are expected to have better experiences and information with regard to improved farmland management. As a result, before conducting the discussion, preliminarily, top 10 model farmers (5 from each sample kebele), were selected based on their score provided by the kebele DAs. According to the DAs, the provision of the score is taken place on the basis of the farmer's over all farming experiences like adapting of improved technology, their participation in community discussions about natural resource management, their contact and discussions with DAs and their effectiveness. Next, through lottery based random sampling, 2 participants from Gabecha and Amarit subkebeles of Chertekel and 1 participant from Subkebele 2 of May Angetam were selected. The reason for the variation of the number of participants between the two kebeles was the difference of the number of households. In addition, Sub-kebele

2 was selected by using lottery method discarding Sub-kebele 3. Finally, the discussions were taken place with each participant individually.

1.5.2.2. Data Sources

Data were collected from primary and secondary sources.

Primary Sources: the primary inputs were collected from farmers, DAs, Agriculture and Rural Development experts, Environmental Protection and Land Administration and Use experts of the Woreda, Environmental Protection and Land Administration and Use Committee of both kebeles as well as the physical and man made features of farmlands and their surroundings.

Secondary Sources: they include GWAO, GWARDO, GWEPLAU, GWHO and GWEB reports as well as other published and unpublished documents and books.

1.5. 3. Data Analysis and Interpretation

The data generated from primary and secondary sources through questionnaires, key informant interview, observation and formal and informal discussions were analyzed and interpreted qualitatively and quantitatively. Simple statistical descriptions like percentage, graphs and β coefficient were employed with the aid of Statistical Packages for Social Studies (SPSS). The remaining data are discussed, described and narrated qualitatively. The analysis is supplemented with visual photographs recorded during field observation.

1.6. Description of Variables Used in the Statistical Analysis of Determinants of Adoption and Implementation of Improved Farmland Management Practices

Though there are several factors constraining the adoption and implementation of improved farmland management practices, the most apparent determinants which are which are statistically analyzed through SPSS to calculate the coefficients of β .

- Age (AGE) in years; sex (SEX), male= 1, female= 0;
- Literacy (LITERACY), literate= 1, illiterate= 0;
- Labor forces available in a household (LABFOR) in number;

- Number of livestock (NULIVE), in number;
- Number of plots (NUPLOT), in number;
- DAs advices (DAADVICE), yes= 1, no= 0;
- Participation of the households on community forums and panel discussions with regard to farmland management (PARCOMFO), yes= 1, no= 0 and
- Distance of the farm plots away from the households' homesteads (KMD).

The distances are represented with respect to how many kilometers the farm plots far away from farmers' dwellings, from 0 to 0.5 km distance (KMD 0-0.5) up to a distance of more than 2.5kms (KMD >2.5). These were described as yes= 1 and no= 0 with respect to the application of the management practices required. What more, the other determinants obtained from observations, key informant interviews and discussions are also described in this part.

The weight and the type of influences (positive or negative) of the independent variables (explanatory variables) over the dependent variables (application of organic fertilizers, chemical fertilizers, vegetation and terracing) are determined on the basis of the signs (- or +) and the largeness or smallness of the coefficients of β . When the coefficients of β have negative signs (-), the relationship among the dependent and independent variables is said to be inverse relationship, the reverse is true for positive (+) signs. Coefficients of β refers the extent of units by which the dependent variables increase or decrease as a result of one unit increasing or decreasing of the independent variables. Accordingly, if coefficients of β is greater or equal to - or + 0.5, the dependent variables are strongly influenced by the independents.

1.7. Significance of the Study

Farmland management plays a vital role to maintain sustainable natural resource management, to keep the natural environment safe, to achieve sustainable agricultural development and to ensure the livelihood of the people. In the study area, as such significant studies have not been conducted regarding farmland management practices and their implication on the farmlands and

environmental conditions. Therefore, this study is expected to be informative for all concerned bodies of the agricultural sector, either governmental or non governmental, and policy makers.

1.8. Scope and Limitations of the Study

Taking the time limitation into account, the scope of the study is delimited in two Kebeles of the Woreda with special emphasis on crop producers (cultivated land), and it is mainly confined to the management practices and their implications on agricultural productivity and the surrounding environment as well as the determining factors for adopting and implementing modern management practices.

Due to time and financial limitations, soil test was not carried out which was important to analyze soil character differences of farm plots which are under different management practices. Moreover, due to seasonal variations, farmland management practices are variable in the study area. But these variations of the management practices were not sufficiently described because of lack of sufficient data mainly due to time constraint. So as to minimize the influences of these limitations, the researcher has tried to undertake intensive field observations coupled with farmers' brief descriptions related to the variations of the management practices within different seasons, and their impacts.

The other constraint was the unavailability of recorded data with regard to how and when the farmland management practices being practiced in the study area are introduced. This had made difficult to categorize into newly introduced or indigenous management methods. As a result, the categories were undertaken on the basis of the information that researcher had gathered from farmers.

1.9. Thesis Organization

The paper is organized under four chapters. The first chapter deals with the introductory part (the background, statement of the problem, objectives, significance, delimitation and limitation as well as methods and procedures). This is followed by chapter two which deals with the review of

related literatures. Chapter three focuses on descriptions of the study area. The main findings are analyzed and discussed under chapter four. The final chapter, chapter five, deals with the conclusion and recommendations of the study.

Chapter Two

Review of Related Literatures

2.1. Sustainable Land Management

2.1.1. The Concept of Sustainability and Sustainable Land Management

The term sustainability was introduced relatively recently, although it has long been a basic concept in land resource management (Young, 1998). Because of differences in individual perceptions, spatial considerations, and temporal scales and perspectives, there is no standard definition for sustainability (Kiflemariam, 2008).

A sustainable practice is one that can continue indefinitely. Sustainability essentially means that production and economic gain will flourish over a very long, essentially infinite period of time (Loon *et al.*, 2005). Hindmarch and Pienkowski (1997) argue that sustainable use means using landscapes, ecosystems, species and genes in a way that meets both present and future needs. Whatever it has no a standard definition because of its broader concept considers sustainability

with the combination of production and conservation, as a central concept in land resource management (Young, 1998).

Because of argumentativeness of the term sustainability, there is no also generally agreed definition for sustainable land management, so that scholars explain it in different ways. Sustainable land management encompasses the need for long term preservation of the resource base to allow adequate future crop production in a manner that is socially acceptable, economically viable and environmentally sound (Loon *et al.*, 2005).

Sustainable land use is that which meets the needs for production of present land users, whilst conserving the basic resources for future generations on which that production depends, or it is the use of land resources such as soils, water, animals and plants for the production of goods to meet changing human needs while assuring their long term productive potential and the maintenance of their environmental functions (Young, 1998)

World Bank (2006) stated that, for rain fed farming systems, good land management requires an integrated and synergistic resource management approach that embraces locally appropriate combinations of the following technical options:

- Buildup of soil organic matter and related biological activity to optimum sustainable levels for improved moisture, infiltration and storage, nutrient supply, and soil structure through the use of compost, farmyard manure, green manures, surface mulch, enriched fallows, agro-forestry, cover crops, and crop residue management.
- Integrated plant nutrition management with locally appropriate and cost-effective combinations of organic or inorganic and on-farm or off-farm sources of plant nutrients (such as use of organic manures, crop residues, and rhizoidal nitrogen fixation; transfer of nutrients released by weathering in the deeper soil layers to the surface by way of tree roots and leaf litter; and use of rock phosphate, lime, and mineral fertilizer) to the plant. Plant varieties that are adapted to specific production environments and sustainable agricultural practices and that are resistant to specific pests and diseases will become increasingly important.
- Conservation farming practices can reduce unnecessary input use. Minimum tillage or no-till crop production reduces labor and equipment costs, enhances soil fertility, reduces erosion, and

improves water infiltration, thereby reducing unit costs and conserving land resources. Improved crop residue management, including mulching, is often a necessary component of these systems.

- Organic farming eliminates use of chemical inputs and can be sustainable as long as practices maintain productivity at a reasonable level

- Integrated pest management (IPM) systems have been developed for many crops to control pests, weeds, and diseases while reducing potential environmental damage from excessive use of chemicals. Scaling up IPM technologies is a challenge, as these management systems rely on farmers' understanding of complex pest ecologies and crop-pest relationships.

2.2. Farmland Management

A single definition has not been provided for farmland management. Land resource management is the actual practice of the use (s) of the land by the local human population, which should be sustainable (FAO, 1991). Farmland is arable land which used for crop agriculture (<http://www.thefreedictionary.com/farmland>). Management is the act or art of managing; or judicious use of means to accomplish an end; or skillful treatment of resources (<http://www.answers.com/topic/management>). Farmland management, in general, can be defined simply as the act of judicially and skillfully managing arable lands. This study also seems to take it as a working definition.

Land is the first pre-requisite natural resource for farming. It is greater than all other resources because it is all inclusive and provides food, clothing and materials for shelter (Boss and Pond, 2005). But it has been necessarily affected by natural and human oriented activities. Inherently, fertile land is more enduring than a less fertile one. On account of this capacity and better

productivity, the best farmland is crucial for healthy environment and profitable production (Boss and Pond, 2005).

In many agrarian settings a significant portion of the income of the rural poor still comes from farming, despite far-reaching livelihood diversification processes that occurred in different places (Akram-Lodhi *et al.*, 2007). Hence, for attainment of the goal formulated on agriculture, sustainable agricultural development is a pre-requisite, which in turn requires development of appropriate farm management (Assefa, 2005).

Farmland is a relevant, well performed and poorly understood asset that has been increased interest, discussion and activity in recent times. It is also a quite unique and highly specialized resource which in turn requires an equally unique and highly specialized manager with appropriate level of experience, knowledge and expertise (Rogers, 2009).

In the twenty first century food and production systems will need to meet adequately supply safe, nutritious, and sufficient food for the world's growing population, significantly reduce rural poverty by sustaining the farming delivered components of rural household incomes, reduce and reverse natural resource degradation, especially that of land but at the global level, large area of formerly productive land has been rendered unproductive (World Bank, 2006). The farmland manager is, therefore, responsible for the selection of prospective farmland management strategy for this resource (Rogers, 2009).

2.3. Farmland Management Practices and their Importance

In order to utilize land in a sustainable manner, numerous management practices can be involved at a given farmland. The intention can be to control soil erosion, weeds and insects and /or to maintain its fertility which leads to maximize productivity. Regarding this issue, Blaike (1995) stated that they are of two different types, mechanical protection works and agronomic methods, although they are usually used together in any soil conservation project.

Most conservation schemes combine both mechanical and agronomic techniques, and in many instances they are complementary. For example, gully erosion can be treated by mechanical means (e.g. a masonry drop structure), cutting back the gully head to stable ground and planting it to grass and/or trees, and following a variety of agronomic measures above gully to reverse practices which brought about sheet and then gully erosion in the first place (Blaike 1995).

Contour furrows serve the dual purpose of curbing erosion and increase the percentage water that infiltrate into the soil. The method simply entails plowing furrows along the contour, at interval down a slope (Whitmore, 2000). In addition, Whitmore stated that by interrupting overland flow, terracing helps to control erosion. However, the steeper the slope and the greater the likelihood of rain of high intensity, the greater the erosion hazard, and hence the closer together should the terraces be.

There are numerous number of agronomic farmland management techniques. For instance, if one is to use nature as a model for sustainable farming practices, then diversification is an obvious place to begin (Innis, 1997). Crop types, cropping systems, crop residues, and crop and vegetative covers, (Innis, 1997 and Mulugeta, 2007), are the other important practices for effective farmland management.

Conservation tillage, contour farming, cover cropping and agro-forestry are all practices that protect soil quality while promoting water flow in to the soil (John and Merrell, 2010). The crop cover is a major factor that reduces soil loss (under plot conditions) by protecting the soil from the erosive force of the falling rain drops thereby increasing infiltration and preventing runoff (Mulugeta, 1988). Reducing the cultivation of leguminous crops means depriving the soil of a natural fertilizing agent (Dave and Katewa, 2008). The strategy of reducing risks by planting several species and crop varieties can stabilize yields over a long term and maximize returns with low level of technology and limited resources. Besides, for effective nutrient management and sustainable cropping, minimize soil erosion and leaching, recycling organic nutrients, compensating nutrient loss and selecting adopted and efficient species are the most generic farmland management practices (World Bank, 2006). The composting of vegetables and the use

of crop residues and other organic fertilizers is the other efficient way to conserve farm nutrients and enable farmers to redistribute the nutrient-rich compost to fields (World Bank, 2006).

It is widely agreed that small farmers intercrop as a form of against total loss of their crop. Intercropping will probably be an essential part of future agriculture, because it uses environmental and other resources more efficiently than does mono-cropping. Mono-cropping, which often allows erosion to proceed more quickly than soil can be formed, and which allows many other kinds of environmental damage, has clearly a limited future (Innis, 1997). Legumes supply their own nitrogen when fertilizer is not used, which means that there is usually not more nitrogen taken from the soil by two crops by one if one crop is a legume. The explanation is that with only one root system, there is more nutrient loss through leaching and erosion than with two root systems (Innis, 1997).

Lime (to make the soil less acidic or to increase its PH level and to improve conditions to the growth of plants) (Sakala *et al.*, 2007), and chemical fertilizers with effective management are also likely be applied on farmlands for the sake of soil fertility management.

Moreover, farmland management practices can be categorized into indigenous and introduced management practices. The acceptance and implementation of these management practices depends on the desire and willingness of farmers which in turn request continuous and effective deeds from agricultural experts and researchers.

Indigenous technology is one of the inherited and transferred from generation to generation. As reality indicated, it is still continuously and widely practiced activity across different agro-ecological and socio-economic parts of Ethiopia. One of the silent features of indigenous technologies has provided short, medium and long term benefits to the farmers (Yohannes, 1999).

The indigenous technology by the eye of modernist is to be 'romantic' and 'static', i.e. as not solving the prevailing problems. This leads to discourage the farmers from using the practices of

local technology and was under estimated its activities (Yohannes, 1999). In Ethiopia the most perceived and preferred indigenous technologies by farmers are drainage ditches, animal manures, fallowing, crop rotation and contour ploughing (Bahru, 1993). The technologies are less requesting of labor for constructing and maintenance (Ludi, 2004).

Indeed, indigenous technology is not always contributing positively. It has its own short comings. The limited experience of farmers in appropriate crop rotation patterns, fallowing practices, inability of farmers to apply conservation based farming practices, inappropriate use of crop residues and the demand of manure changes to fuel wood are some of the problems associated with the technology (Shawal, 1989).

The introduced technologies, comparatively, have long run benefits and importance. But the hope and desire of the farmers was to get immediate benefits and to increase production from treated lands in order to continue the practical application of the new technology (Aklilu, 2000). Nevertheless, different studies at different times reached and pointed out those farmers have blamed the new technology. The majority of peasants have revolted against the acceptance of modern technology (Eyasu, 2007). The complains of the farmers are associated with the following drawbacks: its narrowness for ploughing, losses of the substantial lands (out of use), the breeding conditions of rodents and weeds within structure, its difficulty in designing, demands of much labor, encourage for formation of water logging at flat, land solidness at steep slope and artificial water way to form gullies (Eyasu, 2007).

2.4. Land Degradation in Africa

Since agriculture, environment and farmland management are interlinked, the performance of agricultural productivity and environmental health of a country, mainly where agriculture is the main stay of the national economy, depend on the appropriateness of the management techniques to be practiced on farm plots. The management practices to be implemented have negative and positive effects. Land degradation is the most serious problem which results inappropriate application of farmland management practices.

Dave and Katewa (2008) stated that fertility of land supports the growth and development of natural vegetation and agricultural crops. But a number of natural and man-made factors like management practices lower the quality and productivity of land which is commonly referred to as land degradation.

Land degradation covers the various forms of soil degradation, including erosion and fertility decline. Soil erosion has been regarded as the most serious and wide-spread forms of land degradation, and itself a cause of fertility decline, through removal of organic matter and nutrients (Young, 1998). Evidence is accumulated that fertility decline which is the summary of changes in soil physical (structure and water holding capacity), chemical (loss of plant nutrients and acidification), and biological (lowering of soil organic matter, with associated decline in the activity of fauna), is extremely widespread in areas that have been under annual cropping and consequently opens the way for serious environmental deterioration (Young, 1998),.

Land degradation problem is a global issue and almost it affected the whole earth though variation exists in intensity, and it is more severe in developing countries (Kiflemariam, 2008). Moderate and severe land degradation are defined as a reduction in potential yield of 10-50% and more than 50 %, respectively affects 40% of agricultural land in Africa and 44% in Asia (Mrstrand, 1991).

Africa, particularly, has experienced a mean crop yield loss of 8.2 percent due to past soil erosion, while in some countries land productivity has declined by over 40 percent. Today, 95 million hectares of land particularly in SSA are at risk of irreversible land degradation if non-sustainable land use practices continue (GECC, 2009). The densely populated highlands of East Africa is the other vulnerable region of sever land degradation (Braun, 2006).

The spread and extent of soil degradation depends on different factors, such as soil, relief, climate and farming systems (intensity of use). Annual depletion of soil fertility in SSA was estimated at 22kg N, 3kg P and 15kg K per hectare (Mitiku, *et al.*, 2006). Although there are few

long-term experimental studies of land degradation in Sub-Saharan Africa those that are available show that under continuous cultivation using low external inputs, soil fertility rapidly decreases, yields decline, and a combination of inorganic and organic source of soil fertility is necessary to sustain crop production (Bationo *et al.*, 1998). Generally, this severe land degradation in Africa has threatened the agricultural productivity and livelihood of the poor (Nkonya *et al.*, 2008).

Hence, with the rise in population placing over increasing pressure on scarce land, governments of developing countries should give high priority to rational land use, improved land management, and avoidance of degradation (Young, 1998).

2.5. Land Degradation in Ethiopia

About 66% of the soil in Ethiopia is suitable for cultivation (112mha), while only 12% are utilized (FAO, 2004). Nevertheless, all physical and economics evidence show that loss of land resource productivity is an important problem in Ethiopia and that with continued population growth the problem is likely to be even more important in the future (Berry, 2003). Therefore, Land degradation has been long recognized as a major impediment to economic growth and famine occurrences in Ethiopia, and efforts have been made to address the problem especially in the last quarter of the 20th century. For instance, many areas, mostly in the northern Ethiopia fertility loss needs urgently to be compensated by new external impacts and/or soil conservation measures need to be implemented (Benin *et al.*, 2002).

In Amhara region, coupled with the effects of the long history of settlement, prevailing farming methods and increasing population pressure which forces people to cultivate even steeper slopes has exacerbated the devastating land and degradation (Askale, 2005). The interrelated problems of soil erosion, soil nutrient depletion and limited soil moisture are the most critical land management problems in the Amhara region, and are inflicting substantial costs in the region (ILRI, 2000).

Most of the soil and water conservation activities in the region are undertaken from the perspective of individual and the communities and not from a watershed perspective. Soil conservation measures that are currently being promoted (e.g. Soil bunds) have been emphasized to the neglect of indigenous practices and biological ones, and without conservation of the variability of soil, rainfall and slope conditions. The degradation is aggravated by the cropping of cereals, particularly teff as farmland requires repeated plowing (heavy pulverization before sowing and it remains bare at the onset of the rains (ILRI, 2000). Generally, the fundamental causes of land degradation in Amhara region and Gozamen Woreda particularly, is inappropriate farmland management practices (Teshome, 2010).

2.6. Major Determinants for Adoption and Implementation of Improved Farmland Management Practices

Scholars explain that in the real world there are numerous challenging factors determining the adoption and implementation of better farmland management practices to prevent land degradation and/or to rehabilitate degraded land. Of these, government policies and programs, socio-economic and institutional factors, education, farmers' local knowledge and active participation, Endowments of Physical and Human capital as well as topography and climate are the most determinant factors.

2.6.1. Government Policies and Programs

There is a general consensus that it is far less expensive to prevent land degradation via the application of good management based on both cultural and scientific knowledge than to rehabilitate degraded land. Because several natural (such as climate change) and man made factors like misaligned policies and incentives as well as weak enforcement capabilities of policies put hindrances on activities to be practiced to assure sustainable land management World Bank (2006). In many places researchers and farmers are finding that traditional methods resurface effectively when policy and science give them the space to do so (Barrett *et al.*, 2002). Government policies and programs at many levels may influence income strategies and land management and their implications for production, resource conditions, and household income ,

agricultural extension, conservation technical assistance programs, land tenure policies, and rural credit and savings programs affect awareness, opportunities, and constraints at the village or household level (Pender *et al.*, 2006). Programs may attempt to address land management approaches directly, for example, by promoting particular soil fertility management practices (Pender *et al.*, 2006).

2.6.2. Farmers' Decisions, Socio-economic and Institutional Factors

Agricultural production and land conditions are affected by land management practices, including both private decisions made by farm households and collective decisions made by groups of farmers and communities. For example, farm households make decisions about land use (whether, for example, cropland or grazing land), the crop types to plant, the amount of labor to use, and the types and amounts of inputs, investments, and agronomic practices to use to conserve soil and water, improve soil fertility, reduce pest losses, and so on (Pender *et al.*, 2006). Socio-economic and institutional factors in turn affect farmer's decisions with respect to land use and land management practices such as plowing fallow, use of manure, and other sources of organic matter, fertilizer use, and adoption of soil and water conservation measures (ILRI, 2000).

Ethiopia is characterized by rapidly growing population. Most of its population use wood as a source of energy which is comparatively cheaper than fuel energy (Berry, 2003). For example, in Ethiopia, a 1989-90 study suggests that nationwide, 18 percent of energy in rural areas is supplied by dung and crop residues and this percentage has probably grown since then. Specific studies in two upland villages showed maize and sorghum stalks providing 69 percent of total fuel and use in one, and dung providing 50 percent of energy use in the other (Berry, 2003). This reduces fertility and makes farmlands bare exposing for erosion. The more prevalent diagnosis of the causes of the technological application gap is also inadequate support systems for small-farm agriculture, such as extension, credit or input supplies (FAO, 1984). Reluctance to changes and high poverty levels that force people to over-exploit the natural resources so as to provide food to their families are perhaps the other constraints for land management (Michel, 2008).

With regard to institutional factors, Berry (2003) states that because of the weak infrastructure and the shortage of funding, in Ethiopia, extension services are weak and serve only a small part of rural areas. Allied with this problem is the poor historical record of local participation in finding approaches to dealing with the particular local problems of unsustainable land management.

2.6.3. Education, Farmers' Local Knowledge and Active Participation

Education may increase households' access to credit as well as their cash income, thus helping to finance purchases of physical capital and purchased inputs. This may help to promote production of high-value crops and as well as promoting greater use of such capital and inputs in producing traditional food crops (Feder, *et al.*, 1985). Education may also promote changes in income strategies and technologies by increasing households' access to information about alternative market opportunities and technologies, and hence households' ability to adapt to new opportunities. On the other hand, more educated households may be less likely to invest in inputs or labor-intensive land investments and management practices because the opportunity costs of their labor and capital may be increased by education. Thus, the net impacts of education on land management are significantly important (Feder, *et al.*, 1985).

Farmers' local knowledge and active participation are the other relevant issues in the field of farmland management. Incorporation of farmer local knowledge is essential to address data and information gaps, and in determining farm level sustainable land management indicators <http://wgbis.ces.iisc.ernet.in/energy/HC270799/LM/SUSLUP/Thema1/35/35.pdf>. The knowledge intensity of natural resource management reinforces the necessity of farmer centered development strategies, since different people and communities learn and communicate in different ways. The process must be farmer centered; fully involving intended beneficiaries from the early, problem identification stage onwards (Barrett *et al.*, 2002).

In other cases, traditional methods must be adapted to a current, changed context. Even receptive farmers need to learn about new methods in order to adopt them (Barrett *et al.*, 2002). Farmers form and update beliefs, i.e. learn about the current and prospective situation differently depending on their information transfer and the information shared among individuals appears to be the most significant (Barrett *et al.*, 2002).

Learning from others can create an incentive to delay adoption in order to let others incur the costs of experimentation while one observes the results relatively less costly (Foster and Rosenzweig, 1995). Farmers' field schools, which are based on experimental learning, and community groups can create and maintain social capital that complements human capital, particularly, education, in acquiring, interpreting and applying valuable information (Foster and Rosenzweig, 1995). Shiferaw and Holden (1998) indicates that although farmers tend to know their production environments better than the outsiders do, aptitude, experience, and training clearly matter.

In the case of awareness, for example, (Yohannes, 1998), assures that the adoption of a new techniques of soil conservation methods in Andit Tid, like terracing, particularly known as Fanya-juu, are influenced by farmers' awareness of the innovation, or lack of discussion with farmers regarding the implementation of the methods between farmers and Ministry of Agriculture, time lag between the introduction of the technique and the response in terms of crop yields, and the design of the technique related to the farming system.

2.6.4. Endowments of Physical and Human capital

Livestock ownership necessarily influences land management. Households that own more oxen use contour plowing and apply manure (Pender *et al.*, 2004). The benefit of the use of livestock manure in crop production is improvements in soil physical properties and the provision of nitrogen, phosphorous and potassium and other mineral nutrients (Hoffman, 2002). The application of livestock manure increases soil organic matter content, and this leads to improved water infiltration and water holding capacity as well as an increased cat ion exchange capacity.

Manure and urine raise the PH level and accelerates the decomposition of organic matter and termite activity (Hoffman, 2002). However, in this context, soil nutrient can not increase without increasing the number of animals (Joshi and Ghimire, 1996).

2.6.5. Topography and Climate

Topography and climate have direct and indirect impacts on farmland management. The types and intensity of the management practices to be implemented at a given farmland depends on the nature of the climate and topography where the farmland is located (Girmay *et al.*, 2008).

Climate and topography affect the types of crops to be produced at a given farmland. For example, in Ethiopia most arable land (70%) in the highland is in cereals, with wheat and barley in the higher ground and teff, sorghum and maize in the lower elevations (Berry, 2003).

Legumes are special kinds of plants. They have the ability to hide bacteria in their roots, which form nodules (numerous rounded masses in the roots) (Tacio, 2009). The bacteria present in these nodules catch nitrogen from the air and transform it into usable form and supply it to the soil to be used by the next crop. Thus leguminous crops are used as green manure for improving the productivity of the soil (Wongwiwatchai, 2000).

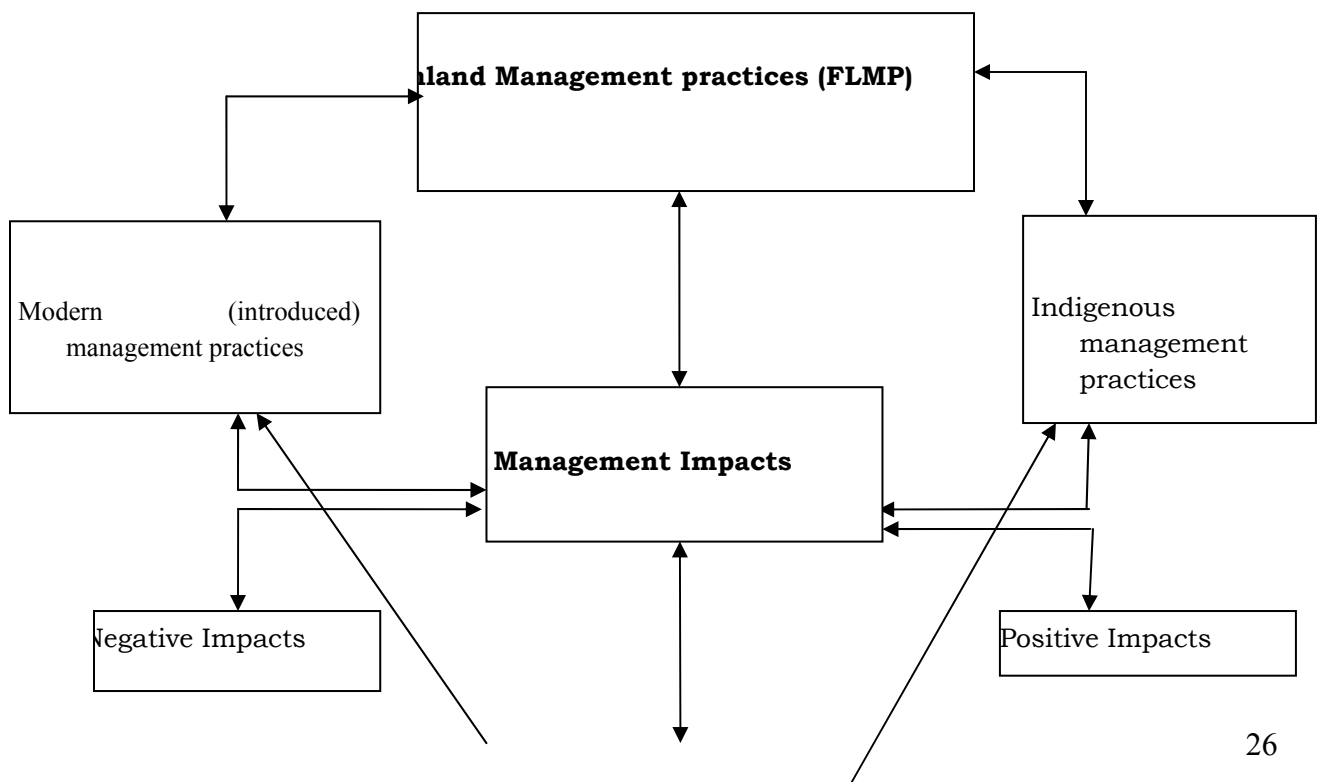
Compared to perennials, annual crops typically grow for shorter lengths of time each year and have shallower rooting depths and lower root densities, with most of their roots restricted to the surface foot of soil or less (Glover and Reganold, 2009). Even with crop management advances such as no-tillage practices, these traits limit their access to nutrients and water, increase their need for nutrients, leave croplands more vulnerable to degradation. These traits also make annual plants less resilient to the increased environmental stress expected from climate change (Glover and Reganold, 2009). Perennials are much more effective than annuals in maintaining topsoil. Soil carbon may also increase 50 to 100% when annual fields are converted to perennials. With their longer growing seasons and deeper roots, perennials can dramatically reduce water and

nitrate losses. They require less field attention by the farmer and less pesticide and fertilizer inputs, resulting in lower costs (Glover and Reganold, 2009).

Furthermore, Glover and Reganold (2009) additionally pointed that there are other benefits as well. Greater soil carbon storage and reduced input requirements mean that perennials have the potential to mitigate global warming, whereas annual crops tend to exacerbate the problem.

2.6. Conceptual Framework of the Study

Through reviewing the previous works, it is attempted to develop the following conceptual framework;



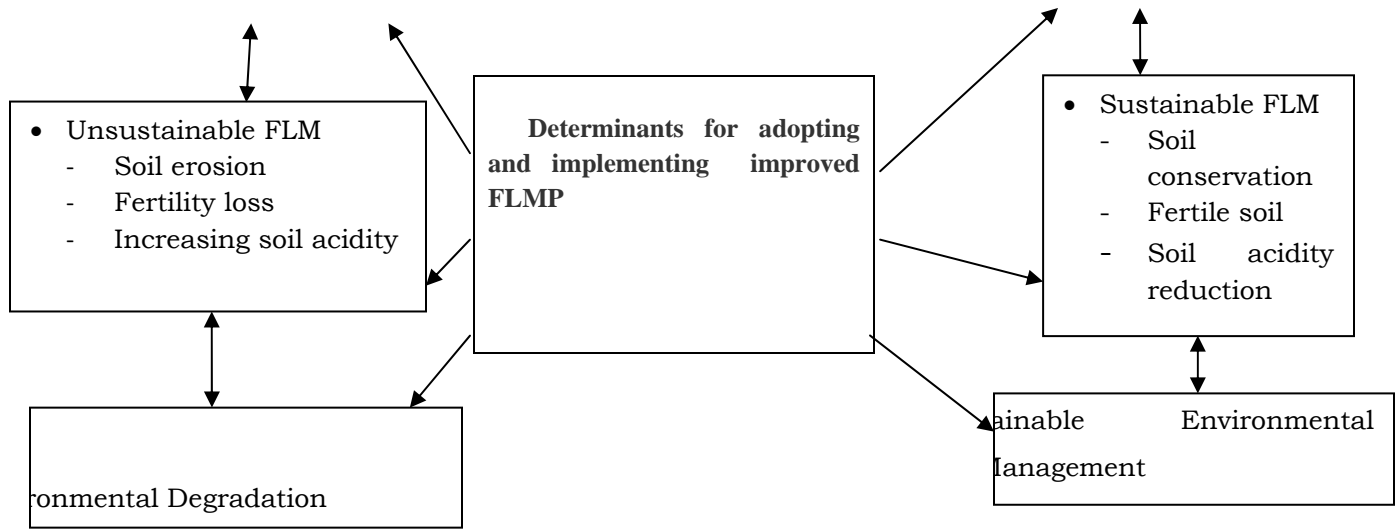


Figure1. Conceptual frame work of the study (own developed)

Chapter Three

Descriptions of the Study Area

3.1. Location and Size

Gozaamin which is one of the 17 Woredas of East Gojjam in ANRS lies between $10^{\circ} 1' 46''$ and $10^{\circ} 35' 12''$ N latitudes and $37^{\circ} 23' 45''$ and $37^{\circ} 55' 52''$ E longitudes. It is found at a road distance of about 250.8 km from Bahir Dar (the capital city of ANRS). The Woreda, having an area of 1217.8 km² (GWARDO, 2010), is bordered by Aneded and Debay Tiltatgin Woredas in the east, Machakel and Debre Elias Woredas in the west, Sinan Woreda in the north and Baso Liben Woreda and Oromia Regional State (Abay River) in the south (GWFEDO, 2010) (Figure2).

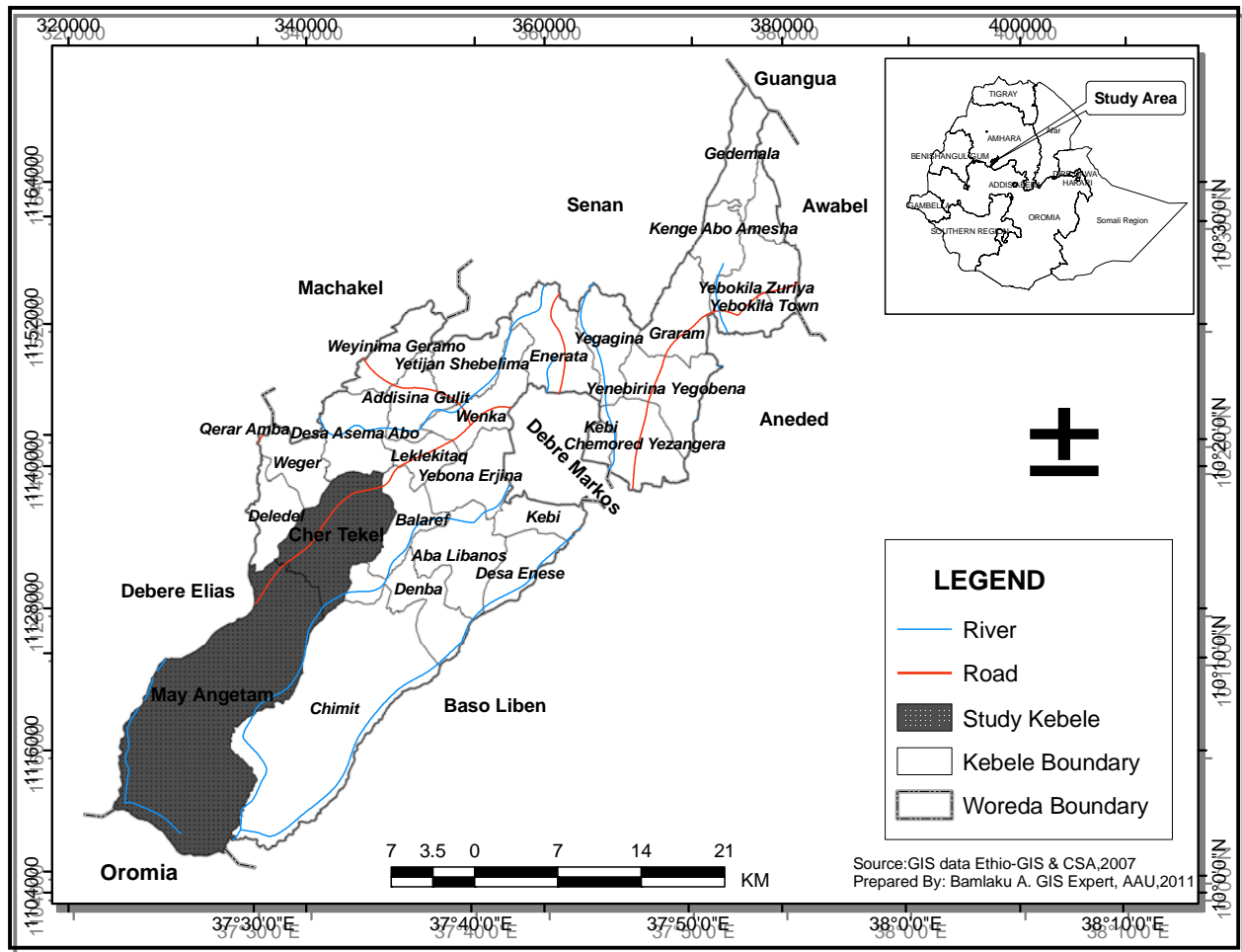


Figure 2. Location of Gozamen Woreda (Ethio-GIS and CSA, 2007)

3.2. Relief, Climate and Drainage

The elevation of the Woreda ranges between 1200 and 3510-masl. The altitude gradually declines from the north east to the south west. The major relief features include mountainous, undulating plain and valley (GWARDO, 2010).

Table3.1. Division of relief types in Gozamen Woreda (GWARDO, 2010)

Relief type	Altitude (m)	Areal coverage (%)
Highly mountainous	>3500	10
Mountainous	2500-3500	16.53
Plain	1500-2500	67

Valley	<1500	6.47
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Due to the effect of altitudinal variations, Gozamin is divided in to three traditional agro-climatic zones (i.e., Dega, Woyna Dega and Kola). The southern part is predominantly characterized by Kola climate. Most of the northern and central parts of the woreda are dominated by Woyna Dega agro-climatic zones, whereas the northern tips have Dega agroclimatic zone (GWARDO, 2010).

The average annual rainfall ranges between 1448-mm and 1808-mm with the mean annual evapotranspiration of 1500-mm (Bekele and Negede, 2006). The wet season is 6 months with fairly distributed rains. However, the heavy rainfall is concentrated in the Meher season of June to September, and the amount of rainfall increases from south to north, and is sufficient for all types of crops growing in the woreda (Bekele and Negede, 2006).

The maximum and the minimum annual average temperatures are 25°C and 11°C respectively (GWARDO, 2010).

There are several rivers and springs that can be used for irrigation purpose. Chemoga River with 45km length which is a tributary of Abay is the largest in the woreda in its volume. Jedeb, Dejjil, Sibsib and Wutren are the other rivers with large volume. Most of the rivers flow down from north to south (example, Chemoga, Wutren, Sibsib) and south west (example, Jedeb and Dejjil) due to the influence of the undulating relief towards south.

3.3. Vegetation

The vegetation cover of the woreda is mainly the result of the climatic distribution and human activities. Since it is one of the areas where agricultural activities have been practiced for a long period of time and since it is one of the densely populated areas of East Gojjam, forest cover has

been minimized (Kiflemriam, 2008). The plant types are typically the result of climatic variations and include mainly *ficusalicitolia* (warka), *ecluea sehinmperi* (dedho), *acacia atbalia* (girar) and *acacia Abyssinia* (girar) in the kola areas. The plateau surface area is also dominated by *stereospermum kunihialum* (zana), *croten macrota-chy* (bisana) and *cordial Abyssinia* (wanza) and the higher surfaces with *pedocarpus gracilor* (zigba) and *juniperus procera* (tid). But, today the indigenous trees are being replaced by other secondary growth and eucalyptus tree is getting dominant mainly around residence areas and along river valleys and marshy areas (Tadesse, 1989). *Acacialahail* (cheba) is found in both Kola and Woyna Dega agro-climatic zones.

3.4. Soils and Land Use /Land Cover

The most dominant soil types of Gozamen woreda are Nitosols, Vertisols and Cambisols while, Pheazomes, Acrisols and Leptosols are associate soil types in different parts of the woreda (Bekele and Negede, 2006).

The areal coverage of Gozamen woreda varies mainly due to frequent shift of kebeles from one woreda to the other and consequent change in boundary. For example, GWARDO (2007) indicates that during the year 2006 when the number of kebeles in the woreda was 40 and the total area of the woreda had been 169, 305 kms, the land use (land cover were as follows:

Table3.2. land use/land cover in Gozamen woreda (GWARDO, 2008)

Land use type	Arial coverage (ha)	Percent of total area
Annual crop cover	73,575	43.46

Permanent crops	1784	0.12
Pastoral land	36,440	21.53
Forest and bush land	13,594	8.08
Settlement area	6,715	4.84
Potentially productive but uncultivated	4,998	2.95
Unproductive	32,199	19.02
Total	169,305	100

Nevertheless, as GWARDO (2010) indicates, today the total area of the woreda is 1217.8km² having 26 kebeles.

3.5. Socio-economic Characteristics

Gozamen has 156,279 (50.3% male and 49.7% female) people. From this total population, 98.7% and 1.3% are rural and urban dwellers, respectively. The population density is 128.43 persons per km² (ANRSBOFED, 2010).

Gozamen woreda has 37km high standard (asphalt) road which is part of the Addis Ababa – Bahir Dar – Gondar road crossing the central part of the woreda dividing it between north and south, and transverse from east to west through different kebeles. Up to the year 2010, more than 140kms of gravel and more than 24kms of community roads have been constructed (GWFEDO, 2010).

In Gozamen, the means of transport used includes traditional and conventional models of transport. The larger majority travel and transport activities are made by human portage and pack animals (Bekele and Negede, 2006).

As the Woreda Education Bureau (2010) report indicates 28445 and 1641 primary and secondary school students are enrolled in 38 primary and 1 secondary schools, respectively. There are also 45 alternative schools in the woreda. 510 primary school and 39 secondary school teachers are engaged on teaching. The primary education coverage has reached more than 90%.

The Woreda Environmental Protection, and Land Administration and Use Office (2010) report indicated that from the total rural population of 154, 186 (where, 46.5% and 2.9% are within the age group of <14 and >64 years respectively), 20.7% people have owned farmlands.

Gozamen has 6 health centers, 25 health stations with 1 health officer, 39 nurses, 54 health extension workers as well as 4 laboratory technicians and 4 pharmacy technicians. The health service coverage has reached to 98. 78% with more than 50% of clean water access (GWHO, 2010).

The most important farming input suppliers of the woreda are Ambasel Trading Enterprise, Ethiopian Agricultural Inputs Supply Enterprise and Gozamen Woreda Farmers' Union (GWARDO, 2010).

The office, moreover, indicated that there are 6 cooperative Unions, (Chertekel, Wuger, Libanos, Yebokla, Delenta and Fendeka cooperative Unions) which are appreciably promoting the supply and distribution of the agricultural inputs like fertilizers, hybrid seeds, pesticides and insecticides.

Farmer's Cooperative Services provide credits to farmers. In order to get the service, farmers are required to be organized into groups of 6 persons and to sign an agreement to the repayment in addition to the interest rate to be charged. On top of this, so as to facilitate the service, each Kebele has its own cooperative services committee having 5 members (GWARDO, 2010).

Traditional community organizations (GWARDO, 2007) such as *Edir*, *Mahiber*, *Wonfel* and *Ekub* which have a long lasting history in the woreda and play key roles to facilitate and harmonize the socio-economic cooperation of the community. For instance *Wonfel* is formed by those people who are willing to help each other on works like harvesting and threshing of crops. *Mahiber* is necessarily religious oriented cooperation of people whom they are under the roof of

the same religion. The members have an obligation to be administered by the rules and regulations of the organization and have the supremacy of solving problems or conflicts if happen among the members. Unlike *Mahiber*, *Edir* and *Ekub* are not most probably religious based but are wider. Especially *Edir* is most probably wider than the remaining traditional organizations. But they are likely organized on the basis of the will of the members to respect and led by the rules and regulations of the organizations. *Edir* plays a great role to help each other principally when unexpected risks like destruction of assets or death happen, whereas *Ekub* is purposefully organized to save money.

The economic base of Gozamen woreda is agriculture like being normally characterized by mixed farming system which is run by combining crop production and animal rearing together (GWARDO, 2010).

The most important crops to be produced in the woreda, (GWEPLAU, 2010), are cereal crops including wheat (*Triticum vulgare*), teff, (*Era-grostick teff*), maize (*Zea mays*), barley (*Hordeum vulgare*), white lupine (*Lupines albus*) and *ingido (tinctoria)*. Whenever preconditions, especially favorable farmlands are fulfilled, pulses such as horse beans (*Vicia faba*), chick peas (*Cicer orietinum*), peas (*Pisum sativum*), cow pea (*Vinga unguiculata*) as well as oil seeds such as linseed, Niger seed (*Guizotia abyssinica*) and *gomen (Brassica carinata)* can be produced. Vegetables such as onion (*Allium cepa*), garlic, potato (*Solanum tuberosum*), tomato (*Lycopers icon esculentum*), pepper (*Capsicum spp.*) and carrot (*Daucus carota*) are also produced. *Chat (Catha edulis)*, banana (*Musa spp.*), mango (*Mangifera indica*), papaya (*Carica papaya*), orange (*Citrus sinensis*), lemon (*Citrus aurantifolia*) and *gesho (Rhamnus prinides)* are becoming common productions in the areas where irrigation is possible.

Cattle, sheep, donkey, horses and equines are taken as animals which are considerably being raised in Gozamen, and bee keeping is the other method of agriculture to be taken place.

In the area, some people are involving on off-farm activities such as selling of local beverage, small scale trading, fire wood selling, pottery production and weaving as well as metal smith (Kiflemariam, 2007). Most of the households are pursuing such practices for the purpose of supplementing the family income to be generated from agriculture.

Chapter Four

Results and Discussions

4.1. Attributes of Sample Households

The attributes of sample household such as age, sex, labor force, literacy, size of livestock, etc. play pivotal roles on farmland management.

The total households participated in the study were 130, of which 81.5 and 18.5 percents were male and female households, respectively (Table 4.1). Male and female sample distributions of the study kebeles were 82.2 and 17.8% from Gabecha, 83.3 and 16.7% from Amarit, 71.4 and 28.6% from sub-kebele2 and 82.2% and 17.8% from sub-kebele3 (Table 4.1).

Level of education is one of the demographic features of households which has crucial role to increase information about environmental problems in general and causes and consequences of soil erosion and conservation practices in particular (Eyasu, 2007). Therefore, literacy has fundamental impacts on farmland management practices to be implemented. Educational backgrounds of the sampled households of the study area were 60% illiterates, 26.2% write and read and 13.8% formal education (Table 4.1). The maximum and minimum illiteracy rates have been respectively recorded in Sub-kebele 3 (72.4%) and Amarit subkebele (45.2%), whilst the maximum and minimum rates of formally educated respondents have been surveyed in Gabecha (17.8%) and Sub-kebele 2 (7.2%).

The mean family size ranges from 5.3 in Amarit to 5.9 in Sub-kebele 2 and Sub-kebele 3. When the comparison of the family size is seen among the individual age groups, the maximum family size is shared by those whose age ranges between 14 and 64 years in both kebeles and their respective sub-kebeles. According to the Ethiopian age group classification, these family members are considered to be the working labor forces while the lowest number of family members lies in the age group of greater than 64 years followed by those whom they are in the age group of less than 14 years in both kebeles. The mean age ranges from 42.2 in Gabecha to 45.5 in Amarit. The economy of a country is strongly affected by the society's sex ratio and age structure, both of which have major influences on the labor supply and productivity of the society (Yohannes, 1988).

The other character of the households depicted on table 4.1 is their number of livestock. Thus, as it is displayed, the maximum mean number of livestock was surveyed in Gabecha (13.1) while the minimum number was recorded in Sub-kebele 2 and Sub-kebele3 (8.8).

Table4. 1. Attributes of sample house holds in the study area

Variables		Sample Kebeles									
		Chertekel				May Angetam				Total	
1. Sample Sub Kebeles		GA		AM		SK2		SK 3			
		Fr	%	Fr	%	Fr	%	Fr	%	Fr	%
2. Number of Shh	Male	37	82.2	35	83.3	10	71.4	24	82.8	106	81.5
	Female	8	17.8	7	16.7	4	28.6	5	17.2	24	18.5
	Total	45	100	42	100	14	100	29	100	130	100
3. Literacy of Shh	illiterate	28	62.2	19	45.2	10	71.4	21	72.4	78	60
	Only writing and reading	9	20	17	40.5	3	21.4	5	17.3	34	26.2
	Formally educated	8	17.8	6	14.3	1	7.2	3	10.3	18	13.8
	Total	45	100	42	100	14	100	29	100	130	100
4. Mean of Family Size	<14 years	2.2		2.17		2.64		2.64		2.26	
	14-64 years	3.31		3.12		3.21		3.21		3.22	
	>64 years	0.02		0.07		0.06		0.06		0.06	
	Total mean	5.5		5.3		5.9		5.9		5.8	
5. Mean of age of Shh		42.2		45.5		44.6		44.6		44.8	
6. Mean of number of livestock		13.1		12.9		8.8		8.8		10.9	

Where;

Shh- sample households
GA- Gabecha Sub-kebele
AM- Amarit Sub-kebele
SK2- Sub-kebele 2
SK3- Sub-kebele 3

4.2. Farmland Management Practices

In this part the principal indigenous and modern farmland management practices used in the study area coupled with their negative and positive impacts from the points of soil fertility augmentation and soil and water conservation practices are discussed. It is not easy, in fact, to put common criteria to strictly categorize farmland management practices into soil fertility maintaining, soil conservation or production increasing methods. This is because a specific management technique can directly or indirectly serve for different purposes though the final goal is to increase productivity. As a result, this categorization is done based on the direct purposes of the management techniques why farmers apply on their farmlands in the study area.

4.2.1. Soil Fertility Maintaining Practices

Soil fertility refers to the amount and availability of nutrients in the soil. To be fertile, soils should contain optimal amount of macro and micro nutrients that are essential for plant growth. It should contain good enough amount of organic matter and around neutral level of pH value (Lucero and Boggs, 2009).

In order to maintain the fertility of farmlands, there are different indigenous and introduced management methods advised by researchers and agricultural experts to be put in practice.

The classification of farmland management practices in to indigenous and modern (introduced) may be, actually, controversial. This is because an indigenous management system at a given locality may not be so in other localities. As a result, for this case, with the help of the information obtained from the sample households who are primarily engaged on farming, farmland management practices which are developed by farmers' experiences, and are time honored are categorized into indigenous methods. Contrarily introduced methods are grouped into introduced (modern) methods.

4.2.1.1. Indigenous Management practices

Manure: In Gozamen, the application of animal manures like *fig* (dry animal feces) combined with straws that are the remnants of plants used for animal fodders is important farmland management to be practiced. It also includes the byproducts of local food production processes like *atela* (the byproduct of local brewing) and others which are daily swept out of a house in dirt forms. This is applied by (93.85%) of sample households (Table 4.2).

According to the respondents, it is mostly used together with chemical fertilizers though they are not applied simultaneously. Unlike chemical fertilizers, manures are added to the soil long days ago before seeding either in the rainy or dry season.

Nevertheless, it is mostly limited to farm plots which are nearer to homesteads, locally known as *guaro*, mainly due to long distance of the farm plots. This negatively affects soil fertility enhancement on farther farm plots.

Crop rotation: In the study area, 97.69% of the respondents agree that they apply crop rotation on their farmlands (Table 4.2). Except maize, other most cereal crops are grown at a given farm plot after two or more years of production leaving the preceding and succeeding production seasons for other crops so as to enable the soil to replenish and restore fertilizing nutrients taken up by the produced crops during the preceding production season(s). Accordingly, for instance, it is popular in Gozamen to produce teff – *Niger seed* or linseed (mostly intercropped with white lupine) – wheat or barley – teff, etc sequentially at a farm plot.

In the study area, farmers are largely teff and wheat oriented in each production season. As a result of this, the rotation season can be two years or longer with respect to the availability of other alternative farm plots for cultivation of these crop types.

Legumes cropping: Repeatedly produced legumes in Gozamen include Fabian beans and peas, and they are basically produced in the form of intercropping and crop rotation. Farmers consider and use white lupine as a leguminous crop so as to maintain soil fertility through intercropping. Legumes production is not widely and intensively practiced as compared to other cereal crops

which cover only 53.85% (Table 4.2). The principal reason is farmers argue that legumes naturally require more fertile soil than other crops. This hinders farmers not widely practice the method and expand their productivity with better fertility management.

Ehura: It is a common farmland management method, especially in Woyna Dega agro-climatic zones like Chertekel kebele (Table 4.2). It is done by gathering several cattle of a given community at a farm plot, usually whom they are organized in one *Edir*. *Ehura* is practiced at night and in summer season. The owners of the cattle have their own turn to gather and kept the cattle on their farm plots in accordance with the rules and regulations they already set. The main theme of *Ehura* is directly to use the liquid animal manures (feces and urines) as fertilizer. In order to keep the manures from run off washing, after *Ehura* is put in practice, the farm plots will be ploughed within a short period of time, preferably over night.



Figure3. The Practice of Ehura (Photo by the author, 2010)

With regard to its negative impacts, findings reveal that it is not perhaps easy to practice *Ehura* if the farmlands are fragmented (found long distance each other), because extra destructions will happen on cultivated farm plots while cattle are moving. *Ehura* is also usually limited on farm plots near and preferably adjacent to grazing lands, and for only those farmers who own cattle. If not properly managed, it pollutes drinking water streams and causes destruction on installed soil conservation measures.

Beret: Except slight differences, *Ehura* and *Beret* are proportional in their characteristics. The differences are; in the case of *Ehura*, the cattle are gathered at a farm plot only for a night, because the next turner will take the advantage next day. Comparatively, in the case of *Beret*, the cattle stay at a specified farm plot for specified period of time, mostly from 1- 2 weeks. From the beginning up to the last day, the plot is always compounded with fences and the number of cattle is not as large as that of *Ehura*. *Beret* is commonly practiced in Kola agro-climatic zones like May Angetam kebele (Table 4.2). Unlike *Ehura*, it is usually limited to *guaros* and is only functional during winter season. However, as the information gathered from farmers revealed, the functionality of *Beret* is presently declining due to the intention of compost preparation at individual farmer level. The negative impacts aforementioned on *Ehura* also appear on *Beret*.

Crop Residues: According to the respondents, in Gozamen woreda, crop residues are commonly used for maintaining soil fertility in two ways. The first one is through shifting of animal feeding beds. In this case, farmers feed their cattle in different parts of their farm plots at different times. The common fodders of the cattle are grasses and straws or crop residues. While animals are feeding, there are remnants left on the soil and are through time biologically decomposed during farmland preparations.

Shifting animal feeding places is duly important for addressing the whole parts of the farm plots, but because of its laboriousness, this method is mostly, applied in the nearby farmlands of the homesteads locally known as *guaro*, where livestock are usually kept.

The second method is shifting of threshing floors locally called *audima*. In these both systems crop residues are mixed with soils during ploughing. However, respondent farmers, DAs and agricultural experts explained that it takes time to use crop residues as fertilizer since it requires a long period of time for decomposition to take place, but can be practiced in every farm plot.

The respondents, on the other side, warn that crop residues negatively affect farmlands' productivity in different ways. For example residues like maize stalks and wheat residues can transmit crop diseases from place to place and enable these diseases to sustain their life until the

next cropping season. If crop residues stay for a long period of time not decomposed, it will be comfortable for rodents breeding. Besides, they argue that since the most important sources of animal feeding are crop residues, using crop residues as fertilizer affects livestock production.

Fallowing: As a result of shortage of farmlands, application of fallowing covers only 1.5% of the respondents (Table 4.2).

Table4.2. Indigenous soil fertility maintaining farmland management practices

variables	Sample Kebeles				Total count (N=130)	Percent (%)
	Chertekel kebele (N=87)	Percent (%)	May Angetam kebele (N=43)	Percent (%)		
Manure	83	95.40	39	90.69	122	93.85
legumes cropping	46	52.87	24	55.81	70	53.85
Crop rotation	85	97.70	42	97.67	127	97.69
Fallowing	1	1.49	1	1.49	2	1.54
Ehura	78	89.66	0	0	78	89.66
Beret	0	0	30	69.77	32	69.77

4.2.1.2. Modern Management Practices

Compost: Composting is the biological decomposition of organic materials by bacteria and other organisms. The result is a dark, somewhat nutrient-rich soil conditioner (Mangan *et al.*, 2000).

In the study area, compost is prepared from animal manures, plant leaves as well as crop residues. However, the largest proportion of the inputs comes from animal manures. After its

maturity, compost is added in to the soil as fertilizer like that of the dry manures. It cannot be utilized alone, without additions of chemical fertilizers, because farmers are not trusted on compost to provide sufficient productivity unless it is utilized together with chemical fertilizers within the short productivity season as needed, especially for cereal crops. As it is indicated on Table 4.3, 59.23% of the respondent farmers prepare and apply compost.

The most important negative impacts or limitations of compost, standing from the farmers' point of view are; it fails to practice efficient utilization of farm plots if it is applied without the addition of chemical fertilizers, it is time taking and laborious (to prepare, transport and address several farm plots), it needs knowledge and training in order to prepare effectively which in turn requires trainers who are ready and have good knowledge regarding the instructions of better compost preparation. The raw materials, particularly animal manures are not easily available for those farmers who have small number of and/or no cattle.

Chemical (Inorganic) Fertilizers: Chemical fertilizers are defined as mainly any inorganic substance that has been synthesized either completely or partially and affects plant growth (Morgan, 2005).

Application of chemical fertilizers is practiced by almost all of the respondent farmers (98.46%; Table 4.3). The most prominent inorganic fertilizers which are widely and intensively being utilized in the study area are Diammonium Phosphate (DAP) and Urea. These fertilizers are added to the soil with seeding simultaneously. Sometimes, unlike DAP, Urea can be added to the soil after germination of the crops. They are commonly and widely used for cereal crops like *teff*, wheat, maize and barley. Compared to Urea, according to the respondents, the proportion of DAP utilization is larger. But they also explained that DAP can be utilized without the addition of Urea. Unless it is combined with DAP, urea, however, cannot be effectively productive. What is generally noticeable here, according to farmers, is that productivity without chemical fertilizers is not imaginable, but can be more effective if chemical fertilizers and organic fertilizers are combined together.

The farmers, further more, argue that it is better to utilize DAP and Urea simultaneously and complementarily though their proportion varies. This is because the functions of both fertilizers are different. For example, the preliminary importance of Urea is to facilitate the growth of plant germinates and DAP is decisively important to increase the productivity of seeds.

Regarding the negative sides or limitations, the interviews with key informants indicated that unlike organic fertilizers, inorganic fertilizers cannot maintain sustainable soil fertility, because inorganic fertilizers give service only for one cropping season. As a result, unless more additional fertilizers are added in the next cropping seasons where crop productivity becomes comparatively diminishing. Similarly, agricultural experts have noted that intensive application of chemical fertilizers destructs the natural fertility of soils.

In relation to the above statements, Morgan (2005), states that inorganic fertilizers may contain acids, such as sulfuric and hydrochloric acids that can raise already acidic soils.

“Actually, there is one thing which cannot be denied”, said a farmer, “it is must to keep at least two years for clearly understanding the effect of organic fertilizers on farmlands, whereas remarkable result will be understood within a short period of time for inorganic fertilizers if properly applied. This is the decisive factor why farmers prefer to use inorganic fertilizers than organic fertilizers.” In his mother tongue he said “*organic madaberia yemidersew yebeteseb hiot kalefe behuala new. Behiot derashachin gin chemical madaberia new.*” To mean that unlike chemical fertilizers, the result of organic fertilizers reaches after the family’s life passed away.

Table4.3. Modern farmland management practices used to maintain soil fertility

variables	Sample Kebeles				Total count (N=130)	Percent (%)
	Chertekel kebele (N=87)	Percent (%)	May Angetam kebele (N=43)	Percent (%)		
Compost	58	66.66	19	44.18	77	59.23
Chemical (inorganic) fertilizers	85	97.70	43	100	128	98.46
Application of lime	0	0	0	0	0	0

4.2.2. Soil and Water Conservation Measures

The conventional western approach to land conservation is a recent phenomenon in Ethiopia, though farmers do use traditional measures. Various conservation strategies have been introduced to enhance agricultural development and rural livelihoods. The challenge, however, is to come up with a conservation approach that helps to meet the short-term needs of the farmers and long-term conservation objectives simultaneously (Aklilu, 2006).

Similarly, in Gozamen, various indigenous and modern farmland management techniques are used by farmers. The sample households noted that unless indigenous methods and modern methods of soil and water conservation are developed as supplementary of one another, their effectiveness is under question.

4.2.2.1. Indigenous Methods

Contour Plowing: Contour plowing is intensively applied in Gozamen woreda by many of the farmers (i.e. 98.46%; Table4.4). These farmers have stated that contour plowing is practiced especially in the rainy season to minimize the energetic downward flow of floods and facilitates rain water percolation. They have, more over, stated the negative sides of contour plowing that it is difficult to practice effective plowing if always undertaken along the same direction. Thus, to minimize this impact, farmers plow their farms by varying the inclination of the furrows from different directions in different plowing time, locally called *saber ersha*. For steeply sloped farm plots, according to the respondents' explanation, it is mandatory to use other additional alternative measurement methods like terraces.

Diversion Ditches and Waterways: Diversion ditches are micro-channels constructed on cultivated fields to drain off excess water. Construction involves pressing the plough deep into the ground and running it diagonally across the farm plot. Ditches are different from normal plough furrows (in dimension and orientation), and their construction is executed in every cropping season. Waterways are ditches which are always constructed downward against the contour and to which diversion ditches are connected (Figure 4). They are permanent structures constructed alongside the cultivated fields. The deepness and wideness of water ways depends on the steepness of the slope and the amount of flood flowing from each diversion ditch, because the more steep the slope, the more will be the amount of flood.



Figure4. Diversion ditches and waterways (Photo by the author, 2010)

Diversion ditch

Waterway

Ninety eight percent of the respondents agree that they construct diversion ditches and water ways on their farm plots (Table4.4). According to these farmers, all farmlands either steeply slopping or gently slopping; there is positive demand towards ditch construction. They use ditches for two types of purposes. The first one is to prevent haphazard flowing of floods over farm plots (to give permanent direction). The second one is to prevent water logging or drain excess water mainly from flat farmlands.

Diversion ditches (drainage ditches) have their own negative impacts on farmlands and the surrounding environment. While diversion ditches are needed to be constructed, it is also strictly necessary to do so for water ways. Once waterways are constructed, the friction of the energetically downward flowing flood raises their wideness and deepness through time. Consequently, the chance of water ways to be developed in to deep gullies is very high. Further more, the construction of drainage ditches and waterways on up slope farm plots forces farmers to do the same thing at the lower slope farm plots either they are steep sloped or flat . This creates unintended extravagance on several farm plots. When a farmer was explaining this in his mother tongue, he said that *gorf shikib aymetetim*, in a sense that if once flood created it cannot flow up, so that it is must to drain it down (Figure 4).



Figure5. Waterway changed into gullies (Photo by the author, 2010)

The other impact of drainage ditches and water ways, as farmers and DAs responded, is the ending destination of down ward floods are grazing lands. These floods end up with a huge amount of soil deposits eroded from farm plots making the grazing lands muddy. The finding of this study, particularly in Gabecha subkebele, indicated that muddiness of communal grazing lands is making livestock raising difficult (Figure 6).



Figure6. The impact of waterways on grazing lands (Photo by the author, 2010)

According to the kebele Environmental Protection and Land Administration and Use expert and the practical observation, the main drinking water sources of the community in Gabecha subkebele are streams. However, as a result of the impact of soil deposition run along waterways, especially in the rainy seasons, shortage of clean water is becoming a devastating problem. Besides, while a farmer in Gabecha subkebele was explaining the negative impact of waterways and drainage ditches, he has taken Shuka wetland as a good example. All of the surrounding waterways are installed towards this wetland. According to him, before 10 years back, Shuka was fully a wetland which was covered by plant type locally known as *fila* (a type of plant seems like grass by which the roof of huts in the study area are covered).



Figure7. Part of shuka wetland covered with fila (Photo by the author, 2010)

Surprisingly, by now most parts of this wetland, (Figure 11), have been changed into normal grazing land because of soil accumulation running down from the upslope farm plots through gully like water ways.



Figure8. Parts of shuka wetland changed into grazing land (Photo by the author, 2010)

4.2.2.2. Modern Management Methods

Vegetation: It is practiced by 84.62 % of the respondents (Table 4.4). In accordance with the respondents, vegetation in Gozamen woreda, indeed, is an age-old practice which is inherited

from their fathers and forefathers. What made new, however, are the intention and the system by which plants are grown. In the past times, trees were planted irrespective of contouring on farm plots usually around the farmers' homesteads for construction purposes and means of income, though these demands now exist. However, aside to these demands, today contour planting of trees and perennial crops such as chat, coffee, and fruit plants is becoming other newly introduced alternative method of soil and water conservation in the form of agroforestry, especially around the homesteads.

In the study area plants like *Suspania* are becoming appreciable to be planted along terraces particularly *keters*. It helps to decrease the amount of splash erosion, and flood to be added in to the horizontal ditches of the terraces. According to the respondent farmers and DAs' explanation, the roots of the plants provide strength for the terrace like structures of soils dig up and installed along the ditches such as *keters* not to be affected by torrential floods.

Contour planting is importantly used to prevent rapidly flow of flood on farm plots and decreases soil erosion by facilitating water percolation. While a respondent was explaining in his local language he said that *bemesmer mezzratna metkel agdim endemares yikoterai*, to mean that contour planting is considered as contour ploughing. In the study area, maize, sorghum, beans and potatoes are most dominantly produced through contouring system.

The respondents also indicated that behind its importance, tree planting has its own negative impact on the growth and productivity of crops with respect to the variation of tree species. For example, eucalyptus creates inconvenience on crop growth and decreases productivity because of its absorbing capacity of large volume of ground water and makes the surrounding farm plots' soils dry. Its leaves are also not convenient for cultivation while they dropped on farm plots since they require longer time to be decomposed.

Terracing: In Gozamen, construction of terraces is implemented mainly in the form of, soil bund and *keter*. It is practiced by 52.31% of sample households (Table 4.4).



Figure9. The practice of terracing in the study area (Photo by the author, 2010)

With regard to the importance of terraces, key informants explained that terracing of farm plots enables a farmer to minimize soil and water loss through facilitating water percolation. If a little movement of soil even happens, the terraces enable the soils to be deposited and accumulated along the terraces. The accumulated soils are fertile so that farmers reconstruct terraces at different production seasons to redistribute soil fertility throughout the farm plots.

However, they tried to aware the negative impacts of terracing that for fragmented and small size farm plots terraces create extravagance and does not fit with the existing plowing technology and system. Terraces also make favorable conditions for bearing of rodents while they are not reconstructed in different cropping seasons and are labor intensive. When sudden destruction happens on a single upslope terrace, a serious destruction, consequently, goes to happen on the remaining down slope terraces which results a huge amount of soil erosion.

Generally, the progress of terracing in Gozamen woreda between the years 2003 and 2010 is displayed on Figure 10. The numbers (1, 2, 3.....9) on x-axis represent the years of terracing (2003-2010) respectively.

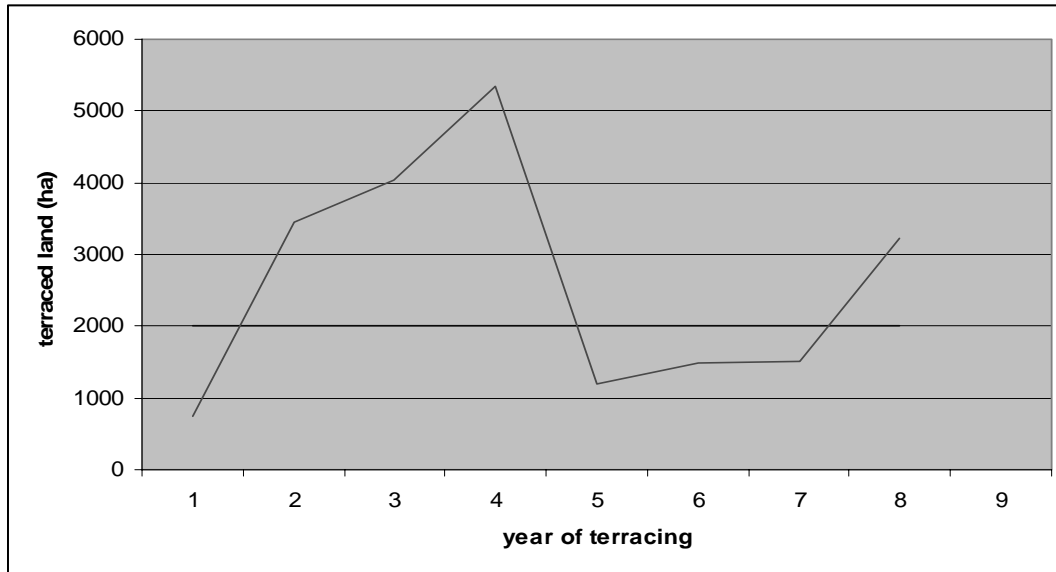


Figure10. The progress of terracing in Gozamen 2003-2010 (GWARD0, 2010)

Table4.4. Soil and Water Conservation Measures

variables	Sample Kebeles				Total count (N=130)	Percent (%)
	Chertekel kebele (N=87)	Percent (%)	May Angetam kebele (N=43)	Percent (%)		
Contour ploughing	87	100	41	95.35	128	98.46
diversion ditches and Waterway	86	98.85	42	97.67	128	98.46
vegetation	76	87.36	34	79.07	110	84.62
terracing	33	37.93	35	81.39	68	52.31
Contour planting	63	72.41	29	67.44	92	70.77

4.2.3. Weed and Insect Controlling Practices

Human labored weed control method (weeding) is implemented by most of sample households (88.37%) in the study area (Table 4.5). Likewise, the application of pesticides mainly 2,4-D and insecticides takes the most dominant share (96.15%) of weed and insect controlling mechanisms (Table 4.5). These farmers use both of the methods together as supplementary of each other.

Insecticides are agents of chemical or biological origin that control insects. Control may result from killing the insect or otherwise preventing it from engaging in behaviors deemed destructive (Ware and Whitacre, 2006). A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pests can be insects, mice and other animals, unwanted plants (weeds), fungi, or microorganisms like bacteria and viruses. Though often misunderstood to refer only to *insecticides*, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests (Ware and Whitacre, 2006).

Soil stuffing locally known as *chika beray* is the other method of controlling weeds. This method is implemented by all households in both kebeles (Table 4.5). Soil stuffing is practiced on farm plots prepared for only teff and sorghum production, especially on red soils.

According to the Agricultural and Rural Development Office Secretariat of the woreda, it is not advisable to apply pesticides and insecticides on farmlands unless a serious problem happens. The main reason is that spraying pesticides and insecticides negatively affects the human and animal health as well as bee keeping agriculture. However, most of the farmers are not willing to accept the advices, because it is time taking and laborious to avoid weeds through human labored weeding. It is similarly testing to control insects and crop diseases through such traditional controlling methods.

Farmers similarly share the above statements. They even have added that pesticides and insecticides decrease the growing period of crops. This is not positive for productivity because

the growth of the crops cannot go through the conditional growing process. Farmers argued that manually treated crops have long growing period and more productivity than treated by pesticides. Besides, pesticides are crop selective. For instance, the 2,4-D which is widely applied in the study area is necessarily used for *teff*, wheat and barley. Otherwise, if it is sprayed on other crops like beans, peas, linseeds and Niger seed, rather than weeds crops will be automatically destroyed. Moreover, when this chemical is sprayed on a farm plot, it causes a significant impact on adjacent cultivated farm plots covered by crops which cannot resist the effect of the chemical.

The Environmental Protection and Land Administration and Use Secretariat has indicated that so as to compensate the application of insecticides, the woreda is trying to develop farmers' awareness on traditional medicines. It is, for instance, indicated that it is possible to prevent grass hopper and other similar insects using a type of medicine prepared from cattle feces and a type of plant locally called *yejib shinkurt*. According to the office, there are other traditional methods under study.

In the same manner, respondents tried to point out that soil stuffing causes destruction on installed soil and water conservation measures. It also facilitates soil erosion.

Table4.5. Weed and Insect Controlling Practices

variables	Sample Kebeles				Total count (N=130)	Percent (%)
	Chertekel kebele (N=87)	Percent (%)	May Angetam kebele (N=43)	Percent (%)		
Manual weeding	82	94.25	38	88.37	120	92.31
Insecticides and pesticides	84	96.55	41	95.35	125	96.15
Soil stuffing	87	100	87	100	130	100

4.2.4. Crop Productivity Increasing Practices

In addition to the above described farmland management practices in Gozamen, farmers apply intercropping (63.08%), diversified cropping (97.69%) hybrid seeds (90%) and alley cropping to optimize crop produces of a given production season (Table 4.6). Except the application of hybrid seeds, according to respondents, others, especially intercropping and diversified cropping, are age old farmland management systems.

Intercropping (strip cropping) is the system of cultivating various crop types at a farm plot simultaneously. Although intercropping serves as a means of soil fertility and soil conservation method, the main theme of farmers in Gozamen is to maximize crop produces. “Intercropping enables me to harvest various types of crop produces from a small plot of land within the same cropping season. By now, this becomes the only alternative what I have to do for survival on the small plot of land I have” said a farmer. From popularly intercropped crops in the study area, like maize and potatoes, , wheat and gomen, barley and Niger seed, cow pea and maize, white lupine and Niger seed, linseed and white lupine and other vegetable types can be mentioned.

So as to have an insight on the negative sides of intercropping, sample households have tried to indicate that since different crops have different growing period (shorter and longer from one another) it makes working difficult, especially harvesting.



Figure12. The practice of intercropping (Photo by the author, 2010)

Diversified cropping is the system of cultivating different crops at different farm plots within the same cropping season. Unlike intercropping, in the case of multiple cropping crops are grown separately at separated or adjacent farm plots. But it is likely used to maximize produces and serve as risk avoidance. In the study area, teff, wheat and maize (the most dominant crops) are cultivated through this method in order to extend production (Figure 13).



Figure13. The practice of diversified cropping (Photo by the author, 2010)

Hybreed seeds are improved and environmentally adapted seeds usually distributed by Agricultural Offices. The principal seeds preferably adopted in the study area are maize, wheat and beans.

Alley cropping is an agroforestry practice where agricultural or horticultural crops are grown in the alleys between widely spaced rows of trees and/or shrubs. Alley cropping is a means to *diversify* and *intensify* production. By intercropping annual and perennial crops that yield varied products and revenues at different times, a landowner can more effectively use available space and resources (Workma, Allen and Jose, 2009).

In the study area, it was observed that alley cropping is adapted as a system of cultivating perennial crops (like chat, coffee and different fruits) with annual crops at the same farm plot.

Table4.6. Crop Productivity Increasing Practices

variables	Sample Kebeles				Total count (N=130)	Percent (%)
	Chertekel kebele (N=87)	Percent (%)	May Angetam kebele (N=43)	Percent (%)		
Intercropping	54	62.07	28	65.12	82	63.08
diversified cropping	85	97.70	42	97.67	127	97.69
Application of hybreed seeds	78	89.65	39	90.69	117	90

Box1

How do Organic and Inorganic Fertilizers Affect Farmlands?

Organic fertilizers are the results of long run natural processes. The function of farmers is to stabilize the prerequisites of the natural processes. For instance, compost is prepared after a long process of decomposition. The role of farmers is to fulfill the inputs and steps of which and through final matured compost is developed. Though not all in all, the same is true for animal manures and other nature dependant soil fertilizing processes.

Organic fertilizers require one's patience to consume their final fruits which is the main challenge by which those poor farmers of Gozamen are faced. The first need of the poor is because to get food. This also must be within a short period of time since they have not insurances to wait for the long process. Except a little impact on some of nature gifted drinking water sources, organic fertilizers are normally friendly for secured utilization of the scarce and limited farmlands once they are adopted and implemented. They have the capacity to provide long lasting insurance to maintain sustainable soil fertility and practice sustainable agriculture. Their impact is usually positive on our precious gift of nature- soil if are wisely and properly managed.

Chemical fertilizers are by far the function of human activities. In Gozamen, they are widely and intensively used as the preliminary measures to take a remedial action on the hunger of the poor farmers. Like that of their preparation, their function is also limited for a short period of time. The soils unless any organic fertilizer is added, require consecutively increasing rate of chemical fertilizers to be added which is becoming unaffordable for the poor. However, as long as there are no other alternatives, farmers continue their actions in such a way with continued elimination of soil fertility and the resultant poorness.

Generally, if it is needed to meet sustainable farmland utilization and productivity, it is must to develop the habit of organic fertilizer application. This, in turn, can be achieved if other insuring alternatives are obtained to enable the poor farmers waiting for the long processes of organic fertilizer preparations and their rewards.

Generally speaking, despite the sample kebeles are found in different agroecological zones, except *Ehura* and *Beret* and slight differences in application of compost, vegetation and terracing, as such significant differences are not recorded on most types of farmland management

practices to be implemented (Table 4.2, 4.3, 4.4, 4.5 and 4.6). Improved management practices are not widely and intensively applied as much as they should be.

4.3. Determining Factors of the Adoption and Implementation of Improved Farmland Management Practices

There are several factors by which farmers are negatively or positively influenced to adopt and implement improved farmland management practices. In fact, it is argumentative to categorize management techniques into improved (modern) or traditional, because the functionality and effectiveness of a particular farmland management technique differs through spatial and temporal variation as well as cultural and technological differences. By taking these factors into account, the considerable improved farmland management practices are those systems which can play great role to achieve remarkable changes to assure sustainable agriculture if are properly achieved in accordance with the economic, cultural and technological situations of the society. These include those methods that help to maintain organic soil fertility (like compost and vegetation) as well as chemical fertilizers. The others are soil and water conservation methods like terracing.

Livestock constitutes the chief component of the farming system in the area. Likewise, as it is illustrated on Table 4.7, the number of livestock farmers own has a positive and strong impact on the application of compost. The results of the statistical estimations reveal that the more number of livestock a farmer owns enables to apply compost on his/her farm plots (Table 4.5). The main reason is because larger proportion of the manures is obtained from livestock. The results similarly indicate that literacy and farmers' contact with DAs are positively affecting the application of compost. Farmers who are literate and perhaps accessible for DAS advices are more likely to apply compost. As it was pointed out by the kebele DAs, it is because literate farmers are more actively participating in extension services than illiterates.

Application of compost and number of labor forces has likely strong positive relationship. The statistical estimation indicates that households having families with more labor forces apply

compost due to their consequent involvement in preparation and transportation of manures to farm plots.

Contrarily, number of plots farmers own (though not significant) and the distance of farm plots from framers' homesteads have strongly negative association with compost application. Increasing the number of plots mostly causes increasing the distance away from the homesteads as well as decreasing in size. The interview finding indicated that in the study area, there are farmers who travel more than about 7 kilo meters to farm, which is the most important challenging factor making transportation of animal manures and compost laborious and time taking. Likewise, while we look from KMD 0-0.5 to KMD >2kms, the association between distance and application of compost becomes negative (Table 4.7)

Basically, farmers underlined that in the woreda even in each kebele there are agro-climatic variations having different productivity potential. This also affects the types of crops to be cultivated. For instance, fruits are more dominantly cultivated in kola agro-climatic zones. As a result, owing more than one number of plots enables a farmer to be beneficiary from various productions. Nevertheless, unless continuous treatment is undertaken, the probability is higher for productivity to be terminated within a short period of time.

As it is indicated on the second segment of the Table 4.7, unlike compost, chemical fertilizer application has negative and positive relationship with number of livestock and distance respectively. With decreasing distance the relationship between application of chemical fertilizers and distance becomes weak. This is because increasing the number of livestock and nearer is the farm plot leads farmers to minimize the proportion of chemical fertilizers application due to the more organic fertilizers likely to serve as dominant soil fertilizing inputs.

Table4.7. Determinants of adoption and implementation of improved fertilizers

Explanatory Variables	Compost			chemical fertilizers		
	β	Std.errors	sig.	β	std. errors	sig.
AGE	0.148	0.192	0.025	0.140	0.333	0.267
SEX	0.128	0.313	0.090	0.266	0.360	0.078
LITERACY	0.704 *	0.300	0.001	0.157	0.210	0.075
LABFOR	0.561 *	0.196	0.006	0.024	0.349	0.094
NULIVE	0.751 *	0.233	0.021	- 0.071	0.219	0.008
NUPLOT	-0.504 **	0.487	0.085	0.194	0.200	0.183
DAADVICE	0.700 *	0.202	0.044	0.122	0.300	0.189
PARCOMFO	0.370	0.309	0.046	0.348	0.187	0.007
DISTA						
KMD 0-0.5	1.022*	0.496	0.000	0.193	0.195	0.040
KMD 0.5-1	0.997 *	0.376	0.007	0.711*	0.284	0.047
KMD 1-1.5	-0.333	0.433	0.039	0.727 *	0.282	0.014
KMD 1.5-2	-0.409	0.452	0.174	0.727 *	0.382	0.014
KMD 2-2.5	-0.571 **	0.466	0.265	0.727*	0.383	0.033
KMD >2.5	-1.600**	0.565	0.268	0.727 *	0.382	0.044

Nagelkerke R Square 0.475

Number of observations = 130,

Sig. = significance

Std.errors= standard errors

* strong relationship and is significant at 0.05

** strong relationship but not significant at 0.05

The other farmland management methods considered are vegetation (tree planting and agroforestry) and terracing. The major determinants of these management practices are depicted on Table 4.8. Vegetation has positive relationships with sex and DAs advices, in a sense that vegetation increases with increasing in the number of male headed households and the number of households whom they contact with DAs and get advices. On the contrary, it is negatively influenced by increasing number of plots and distance. It is obvious that vegetation and structural soil and water conservation measures require day- to-day treatment, which is why farmers prefer

to practice vegetation around their homesteads. It is also helpful to keep their plants from theft and animal destruction if it is nearer to their dwellings.

Terracing is closely and positively related with sex, DAs advices, and households' participation on community forums and number of labors in the family. Terraces though are constructed in different ways like *keter* and soil bund, according to the farmers' views, require more labor and time. The statistical estimation assures this view. Terracing is more applicable by male headed households than female headed ones as well as those households who are nearer to DAs advices. It is because most of female headed households do not directly cultivate their farmlands rather they provide for male headed households for sharecropping with a short term contract. This made farmers reluctant to practice long run management methods like terraces and vegetation on sharecropping farmlands.

Table4.8. Determinants of adoption and implementation of vegetation and terracing

Explanatory Variables	Vegetation			Terracing		
	β	std. errors	sig.	β	std. errors	sig.
AGE	0.067	0.165	0.068	0.061	0.158	0.369
SEX	0.766*	0.277	0.014	0.496	0.520	0.034
LITERACY	0.200	0.260	0.441	0.446	0.243	0.025
LABFOR	0.236	0.190	0.215	0.524**	0.167	0.088
NULIVE	0.387	0.229	0.091	0.017	0.113	0.015
NUPLOT	- 0.649*	0.466	0.016	0.027	0.163	0.045
DAADVICE	1.667*	0.522	0.000	0.871*	0.443	0.046
PARCOMFO	0.054	0.087	0.179	0.730*	0.465	0.016
DISTA						
KMD 0-0.5	1.295*	0.379	0.000	0.062	0.309	0.045
KMD 0.5-1	0.861 *	0.106	0.040	0.200	0.464	0.238
KMD 1-1.5	0.432	0.283	0.098	0.110	0.214	0.000
KMD 1-1.5	-0.085	0.028	0.096	0.231	0.030	0.000
KMD 2-2.5	-0.042	0.370	0.099	0.332	0.121	0.110
KMD >2.5	-1.921*	0.691	0.018	0.308	3.118	0.043

Nagelkerke R Square = 0.406

Number of observations = 130, * strong association and significant at 0.05
Sig. = significance ** strong association but not significant at 0.05
Std.errors = standard errors

The other apparent determining factors raised by large number of respondents as constraint were their energy sources and animal feeding system. In the study area, animal manures in the form of dung-cake, and crop residues like maize stalk, and other plants are widely used for fuel energy and even popularly play great role for commercial purposes. The animals' feed is also dependant on the fodder principally prepared from crop residues.

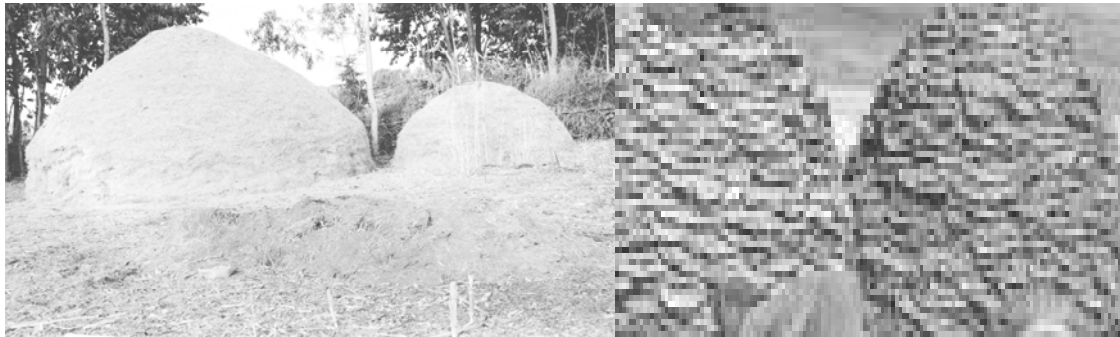


Figure14. Collected crop residues and dung- cakes (Photo by the author, 2010)

Agricultural experts of the Woreda (mainly from Agricultural and Rural Development Office and Environmental Protection and Land Administration and Use office) in the same manner blamed the culture of the society (grazing system, ploughing system, unwillingness of farmers for carrying responsibility). They stated that even though uncontrolled grazing is obvious in many parts of Ethiopia, combined with the largeness of the number of cattle, it is an outstanding challenge in Gozamen. This is because, except in meher season, cattle have the chance to graze freely. This creates a serious hindrance on vegetation and causes destruction on the installed structural conservation measures.

The plowing system is popularly traditional oxen- pull oriented which needs farm plots to be wider and free of barriers and the same is true for soil stuffing. The problem is, therefore, how to make structural management systems like terraces including stone terraces familiar with this system.

As it was understood from the discussions, shortage of water is likely to be the other apparent determining factor. Shortage of water alters vegetation like planting of perennial crops and forces farmers to be seasonal and cereal crop oriented and in turn makes farm plots bare for a long period of time after harvesting.

To minimize their laboriousness in the study area, the management methods especially the structural ones predominantly *keter*, are constructed through the participation of the community when a construction is needed at a farm plot and while destruction happens, the reconstruction will go in such a way for the next production season.

Aside these, the government has not specified viable policies regarding actions to be taken while a farmer is not taking care of the management measures installed on his/her farm plots. Since farmers understand this gap, they are reckless while destructions happen on the management techniques. As a result, the government policy, according to the experts, takes its own share of putting limitations on adoption and implementation of improved farmland management practices as well as their sustainability.

Box2

What did Key Informants Say on Introduced Farmland Management Practices?

It is indisputable to say that adopting and implementing of improved management practices on farmlands is crucial to attain remarkable changes on income level of the Ethiopian huge number of population – farmers, where they are dependants of hand- to- mouth small scale farms. The questions to be underlined is why, how and where to implement better management practices. For example, in Gozamen farmers are advised to apply limes on farm plots. However, it is not appreciated by large number of farmers since they do not know what its implication is on their life except adding further extravagance.

The how and where to implement questions also lead us, for example, to keter and compost application. It is practically checked up in Gozamen that if properly applied, keter is undoubtedly benefiting method of soil and water conservation. It is recommended to be put in practice if and only if the slope is greater than 8%. Whereas, for less than 8% sloping farm plots, traditional ditches are considered to be adequate. It is, further more, not doubtful that slope increases downward run off which means traditional waterways must be constructed across the keters so as to drain the run off coming from the upslope farm plots' ditches. This simply means downward flow of water and removal of soils is not checked making the constructed keters valueless and causes unintended extravagance on the farm plots.

The other example is compos. The Agricultural and Rural Development Office of the woreda has planned to prepare about 296, 000m³ compost per year. This requires longer time and labor as well as a huge amount of inputs, especially animal manure until well matured compost is prepared. Nevertheless, what surprises is the indigenous methods like Ehura and Beret which relatively require less time and labor are ignored, where the questioning of how to integrate the indigenous and modern management methods is left out of appreciation as technology.

Generally, unlike their positive impacts, introduced methods are putting question mark on the functionality and sustainability of relatively less costly, less laborious and environmentally adapted indigenous management methods, particularly Ehura and Beret in the study area. The main problem here is, overwhelmingly, to give less value for indigenous methods and the presence of poor understanding on how to integrate the introduced and indigenous management techniques.

These are not the only determinants by which farmers in Gozamen are faced, but there are other indirect determining factors behind the above stated constraints. For instance, DAs advice is one of the principal determinants. However, the beneficiaries of these services are limited. The participation of farmers in panel discussions and community forums is, in the same manner, the other determining factor having limited functionality (Figure 14). Farmers who are benefiting from agricultural extension services from DAs in the study area are below 60%. In the same manner, their participation on discussions and community forums is by far lower (i.e. 40%).

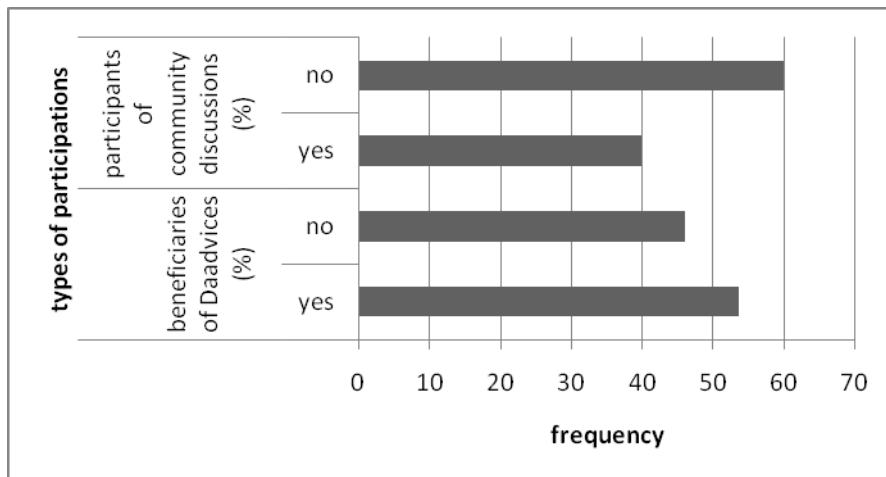


Figure15. Farmers' participation on DAs advices and community forums and panel discussions

The question that can be raised here is about the constraining factors by which farmers are halted not to get extension services. From the total 58 (who do not get advices) farmers, most of (36.2%) argue that the advices offered by extension workers do not consider the economic background and ability so that they are not easy to make functional (Table 4.9). About 32.7% of the farmers cannot get the services since they do not know what types of benefits can be obtained from extension workers followed by those farmers who have not access for the service due to unavailability of DAs in their near surrounding.

Table4.9. Constraining factors of benefiting from extension services

Possible reasons	frequency	percent
Because there is no any DA assigned in our locality	12	20.7
Because the DAs are not interested to do so	6	10.4
Because I am not familiar with the work of the DAs, so that I do not contact them	18	32.7
Their advices do not consider our economic background and ability so that they can not be functional	21	36.2
I do not need any advice	0	0
Total	58	100

Heterogeneity of participants in community forums and panel discussions can be considered as other determining factor of adoption and implementation of improved farmland management practices. Heterogeneity in this case includes the involvement of ordinary farmers, DAs, model farmers and agricultural experts as well as all these bodies come from different areas. It is too important if so in order to share different knowledge and experiences. Unfortunately, in Gozamen, this is not popularly practiced. As Figure 15 clearly displays, the discussion is mostly held among model farmers, ordinary farmers and DAs living in the same locality. More than 80% of the participants have ever involved in the discussion constituting only model and ordinary farmers and DAs of the same locality.

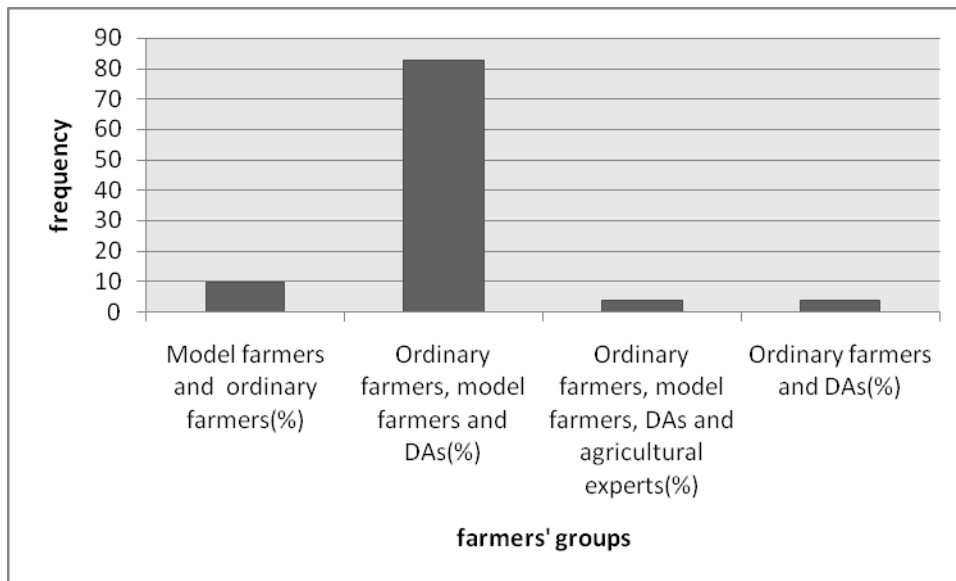


Figure15. Participants on community forums and panel discussions

The study has, moreover, acquired that the discussions are held usually at kebele level through oral discussions. The provision of trainings is also characterized by short term oral discussions with limited number of model farmers. Limited access to field trainings and unpopularity of inviting the majority farmers for such discussions and trainings on the other hand is the main challenge to put improved farmland management in practice.

In general, although several management practices are going on in the study area, as the practical observation, discussions and interviews have indicated, it is difficult pertly to say that they are widely accepted and intensively implemented, particularly those of improved or introduced management practices, since their functionality is limited only for small number of farmers and farm plots. Traditional management practices take the dominant share with respect to their intensive implementation, and some of environmentally adapted and less costly indigenous management practices have not gotten attention.

Chapter Five

Conclusion and Recommendations

5.1. Conclusion

The most popular indigenous farmland management practices in Gozamen that are intended to maintain soil fertility are the application of manures, crop rotation, cultivation of leguminous crops, crop residues, *Ehura* and *Beret*. The newly introduced management practices with similar intention include the application of compost and inorganic fertilizers. Contour plowing, construction of waterways and diversion ditches are widely accepted farmland management practices for the main theme of soil and water conservation. Regardless of their intensity, vegetation and terracing are considered to be modern soil and water conservation measures. Weed and insect preventions are undertaken through traditional (human labored) management practices and the application of insecticides and pesticides mostly as a supplementary of one another. Intercropping, multiple cropping and application of hybrid seeds are primarily intended so as to increase crop productivity and serve as risk avoidance.

Compared to the other management practices, indigenous management methods like structural soil and water conservation measure (waterways and diversion ditches; agronomic management methods like contour plowing, intercropping, multiple cropping; introduced methods such as application of inorganic fertilizers and pesticides and insecticides) have widespread acceptance and intensive application in the study area. Chemical fertilizers are more widely and intensively implemented than organic fertilizers. Even though most of the newly introduced management practices have not still gotten wider acceptance and implementation, environmentally adapted and less costly indigenous management practices such as *Ehura* and *Beret* are not noticed and their implementation is diminishing.

Except *Ehura* and *Beret* and slight differences on application of vegetation, compost and terracing, there is no significant difference on the application of most of farmland management practices, especially indigenous methods, between the two sample kebles.

Any farmland management practice has its own negative and positive impacts on agricultural productivity and the surrounding environment. For example, generally speaking, it was found from this study that although they require long processes, organic fertilizers help to maintain long run soil fertility with less cost on the environment, if they are properly managed. On the contrary, inorganic fertilizers help to achieve crop productivity with in a short period of time but maintain short term soil fertility (usually for a single cropping season). Likewise, insecticides and pesticides have their own impacts on the environment and health of animals, plants and human beings.

There are several factors determining the adoption and implementation of improved farmland management practices in Gozamen. Of which age, sex, number of labor forces, number of livestock, number of farm plots, contact with DAs and farmers' participation on community forums and panel discussions with regard to farmland management are the main determinants. Government policies, sources of fuel energy, animal feeding systems, grazing and plowing systems and farmers' awareness of carrying responsibility are the other factors constraining the adoption and implementation of improved farmland management practices.

The problem of properly integrating indigenous farmland management techniques with that of the newly introduced ones (such as *keter* and diversion ditches and waterways, and compost with *Ehura* and *Beret*) has also pertinent influences particularly on the implementation and sustainability of the management methods. Absence of other alternative off-farm engagements to wait for collapsing and/or requiring of long periods of time to make management techniques effective, on the other hand, puts its own direct or indirect limitations on adoption and implementation of improved farmland management practices.

Farmers' trainings and community discussions are predominantly not taken place with the help of field works and demonstrations. The discussions are, moreover, concentrated only among dwellers of a single locality where integration and sharing of different experiences and knowledge cannot in advance be developed.

5.2. Recommendations

On the basis of the findings discussed and analyzed, which are drawn from the data generated through different instruments, the following recommendations are provided for proper implementation of effective and sustainable farmland management practices.

- Due attention should be given for adoption and proper implementation of organic fertilizers and other improved structural soil and water conservation measures in order to maintain sustainable soil fertility and productivity.
- Crop residues and animal dung (in the form of dung –cake) are using as a source of cash which largely reduces application of organic fertilizers. Such types of practices may be perhaps changed through continuous communications and discussions with farmers. For instance, enormous amount of money is spent every year from farmers of the woreda to purchase inorganic fertilizers. If the cash obtained from crop residues and dung-cakes sold is compared with that of the amount of cash spent for purchasing inorganic fertilizers, as such significant difference may not be recorded, even the later may be excess. Therefore, once farmers understand how much money they can save when organic fertilizers are applied compensating application of inorganic fertilizers, farmers themselves will tend to avoid these activities though it may require longer time. This definitely requires continuous and wide spread awareness creation.
- Alternative energy sources should be developed to minimize wood and dung cake energy consumption.
- Alternative off-farm engagements should be expanded so as to enable farmers to afford risks which result from failure of, particularly, introduced farmland management methods. This is because while management techniques are put into force for the first time, unexpected failure sometimes happens. However, if farmers have the chance to supplement the costs incurred from this failure, they can easily wait for further modifications and proper implementation. It is also prominently important to enable farmers waiting for time taking processes of organic fertilizers to be fruitful.

- Modern management methods should not take the advantage of applying indigenous management methods, because it is becoming a common problem of ignoring environmentally adapted and less costly indigenous management practices while modern management practices are going to be on ground. Introduced management methods should also be appropriately integrated with that of indigenous management methods. For instance, terraces are constructed parallel to the contour. Unlike wise, diversion ditches and waterways are constructed along the contour causing energetic run off. As a result, diversion ditches should also be developed horizontally helping the terraces, or if the terraces are intensively installed, diversion ditches can be necessarily avoided. Nevertheless, it is better to avoid waterways while once terraces are installed.
- Soil and water conservation measures should be implemented appropriately on farm plots where they are needed. For example, where *keter* is found necessary to be implemented at farm plots, the adjacent up slopping and lower slopping farm plots should be the beneficiaries of the construction. The reason is because *keter* is developed usually at lower farm plots in the study area, when the upper farm plots are not sloppy. However, it is popular to construct diversion ditches and waterways in order to avoid water logging at up slopes, or if it is little, to divert the existing flood. This enforces on the lower slopping farm plots to do the same thing. For this reason, if once *keter* or other terraces are needed to be implemented at a given area, all the upper and lower slopping farm plots should take the advantage. Otherwise, when water logging follows, it is better to harvest the water through developing ponds on every plot and use as irrigation during the dry season. This keeps farmers to reduce run off destruction of terraces, generally reducing erosion.
- Trainings should be provided with field works and field observations. Demonstrations and visual views can also play great role to develop mental images on farmers. Thanks technology, today better management techniques can be recorded in the form of visual images from where they are effectively implemented and can be viewed for farmers every where needed to be applied. This makes adoption and implementation of new technology simple and reduces unwanted failure.

- Community forums and panel discussions should be held among farmers from different areas having different experiences. It is because there are various and significant management practices adopted and implemented in different parts of Ethiopia with different living habits. The discussions should also be heterogeneous where ordinary farmers, model farmers, DAs and agricultural experts participate. As a result, when the discussions are held among these people, they can share various relevant experiences and knowledge.
- Trainings and discussions should be accessible for all farmers.
- In the study area most of the indigenous management methods, particularly structural soil and water conservation measures are implemented irrespective of considering topographic variations. Thus, the types and intensity of the management practices should be with respect to the steepness of the slope of farm plots.
- Viable policies should be set regarding the types of actions to be taken while farmers become reluctant of taking care of their farm plots with deep awareness creation.
- Further works should be, generally, undertaken to develop farmers' awareness how to properly integrate indigenous and introduced farmland management practices and enhance the application of improved management practices throughout the woreda.

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Appendixes
Appendix I

Addis Ababa University
School of Graduate Studies
Geography and Environmental Studies Department
Questionnaire to be filled by Farmers

Dear Sir/Madam,

You have been selected to participate in the study designed to collect information on the practices and aspects of farmland management in reference to some selected kebeles of Gozamen Woreda.

As a result, I kindly ask you to share me your opinion and experiences, taking few minutes from your schedule of time. Your genuine cooperation is very important, because you represent many other farmers who have similar experiences. The genuine response you provide is highly valuable and determines the effectiveness of this investigation. Please, be assured that I will treat your responses confidentially and will not be used for any purpose other than research.

You are not expected to write your name on the questionnaire.

Thank you in advance for your cooperation!

Part one: Background Information

1. Sex _____
2. Age _____
3. Kebele _____
4. Sub-kebele _____
5. literacy
 - a. illiterate
 - b. only writing and reading
 - c. formally educated
6. Family size
 - a. <14 years _____
 - b. 14-64 years _____
 - c. >65 years _____
 - d. total _____

Part Two: General Questions

Direction; Circle or fill in the blanks for the following questions; choosing more than one alternative is possible where necessary.

1. What types of farmland management practices do you apply in your farmlands to maintain soil fertility?

- a. Chemical fertilizers
- b. Animal manure
- c. compost
- d. Crop residues
- e. lime
- f. crop rotation
- g. fallowing
- h. leguminous crops
- i. Ehura
- j. Beret
- k. If others please specify

2. What types of advantages and disadvantages have you understood as a result of the management practices in accordance with question number 1? Please explain.

Advantage.....
.....
.....

Disadvantages
.....
.....

3. What types of soil conservation techniques do you apply in your farmlands so as to control soil erosion?

- a. Terracing
- b. Intercropping
- c. Contour ploughing
- d. diversion ditches construction
- e. Vegetation cover
- f. Contour planting
- g. Agro forestry
- h. Mulching
- i. Soil bund
- j. If others please specify

5. What strengths and limitations do you have observed from the conservation techniques you implemented in relation to farmland and environmental protection?

Strengths.....
.....

Limitations.....
.....

6. What types of management mechanisms do you apply in your farmlands in order to increase crop productivity?

- a. Chemical fertilizers
- f. diversified cropping

- b. Intercropping
- c. Animal manure
- d. Compost
- e. Hybreed seeds
- g. mono cropping
- h. If others please specify.....

7. Did you have observed any damage on the farmlands and the surrounding environment as a result of the practices you applied in accordance with question number 6? If so please explain.

.....

.....

.....

9. How do you control weeds and insects in your farmlands?

- a. Manually removing the weeds and insects
- b. Using pesticides and insecticides
- c. I do not use any method
- d. If any other, please specify.....

8. What types of advantages and disadvantages have you understood from the methods you used for question number 7 on the farmlands and the surrounding environment?

Advantages.....

.....

.....

Disadvantages.....

.....

.....

9. Do you apply modern techniques of soil conservation like terraces (keter, soil bund, soil terraces) and vegetation in your farmlands?

- a. Yes
- b. No

10. If your answer for question number 9 is **no**, what might be the reasons behind?

- a. Because I have a small plot of land and is not convenient for such practices
- b. Because my farmlands are fragmented and found at different areas that made difficult to apply such techniques
- c. Because I do not know the importance of these practices
- d. I am not familiar how they can be made
- e. Because there is information gap between the agricultural experts and farmers how they can be constructed and implemented making their relevance poor.
- f. Because they create insects and affect crops
- g. Because they make plowing difficult
- h. They are laborious to be made, but I am working alone so that I can not do such activities

- i. Because they results extravagancy on my farmlands
- j. If any other reason, please specify.....
.....
- 11. Do you get advices from DAs and other agricultural experts with regard to farmland management?
a) Yes b) no
- 12. If your answer for question number 11 is **yes**, how frequently do you contact with them?
A. Once a week d. Once a year
B. Every month e. If other, please specify.....
C. Once every six month
- 13. If your answer for question number 11 is **no**, what do you think the possible reasons behind?
a. Because there is no any DA assigned in our locality
b. Because the DAs are not interested to do so
c. Because I am not familiar with the work of the DAs, so that I do not contact them
d. Their advices do not consider our economic background and can not be functional
e. I do not need any advice
f. If any other reason, please specify.....
- 14. Do you participate in community forums and panel discussions regarding farmland management in your locality?
a. Yes b. No
- 15. If your answer for question number 14 is **yes**, who are the participants in the discussion?
a. Model farmers and other ordinary farmers
b. Ordinary farmers, model farmers and Das
c. Ordinary farmers and Das
d. Ordinary farmers, model farmers, DAs and agricultural experts
e. If any other, please specify
-
- 15. If your answer for question number 15 is **no**, what might be your reasons?
a. Because there is no such discussions in our locality
b. I haven't ever been invited to participate
c. I am not interested to participate
d. If any other, please specify
-
- 16. Do you apply organic fertilizers such as animal manure, crop residues and compost in your farmlands?
a. Yes b. No
- 17. If your answer for question number 17 is **no**, what do you think the reasons?

- a. Because my farmlands are fertile by nature
- b. My farmlands are far from my home making the transportation laborious
- c. The animal manures and crop residues are necessarily important for fuel and livestock feeding
- d. I do not know the significance of organic fertilizers
- e. Because I do not have appropriate knowledge how compost can be prepared
- f. Crop residues cause plant diseases so that they are harvested in the winter
- g. If other reasons, please specify

18. What are the dominant crops you are experienced to cultivate?

.....

20. How many plots of land do you have?

- a. Only one c. Three
- b. Two d. more than three

21. Which types of management practices are indigenous and which are newly introduced? Please specify?

.....

22. What are the impacts of introduced management practices over the indigenous ones and vice versa?

.....

23. Where do you practice terraces, vegetation, diversion ditches and waterways as well as check dams?

- a) Near the homesteads
- b) At distant farm plots
- c) At steep slopping farm plots
- d) At gently slopping farm plots
- e) At any farm plot

24. What look the advices of DAs and other agricultural experts like regarding indigenous management practices?

.....

25. What types of management practices and at what distance of your plots of farmland from your homestead do you implement? Please, by looking the following table below put \surd mark in

front of the management practices you implement with respect to the actual plots of land where you apply.

No	Types of management	Distance of the plots from the homestead (km)					
		P1 0-0.5	P2 0.5-1	P3 1-1.5	P4 1.5-2	P5 2- 2.5	PP P6 >2.5
1	Chemical fertilizer (DAP, UREA)						
2	Organic fertilizer(manure and compost)						
3	Crop rotation						
4	Fallowing						
5	Cultivating legumes						
6	Strip cropping						
7	Vegetation and agroforestry						
8	Contour planting						
9	Mulching						
10	Multiple cropping						
11	Mono cropping						
12	Hybrid seeds						
13	Terracing						
14	Soil bund						
15	Contour plowing						
16	Diversion Ditches						
17	Modern ditches (keter)						
18	Human labored protection of weeds and insects						
19	Insecticides and pesticides						

Appendix II

Semi- structured interview guides for key informants

1. Name of the interviewer _____
2. Date _____
3. Position of the interviewee _____

General questions

1. What are the most important farmland management practices to be practiced in the study area;
 - ii. maintain soil fertility
 - iii. control soil erosion
 - iv. control weeds and insects
 - v. increase crop productivity
2. Which types of management practices are indigenous and which are newly introduced?
3. What are the impacts of introduced management practices over the indigenous ones and vice versa?
4. What do you think about the advantages and disadvantages of each management practices with reference to farmland management and environmental protection?
5. What types of deeds have your bureau done on farmland management practices, like terraces, vegetation, organic fertilizers, etc.?
 - a. How is their continuity?
 - b. How is the participation of the community?
 - c. What types of constraints have the bureau and the farmers faced to adopt and effectively implement?
 - d. What are the advantages and disadvantages imposed by the management practices on the;
 1. farmlands
 2. Physical environment?
6. Does the bureau prepare community forums and panel discussions, and does it provide trainings regarding farmland management?
 - i. If it is so, who are the participants?
 - ii. If not, what are the main reasons?
7. What are the strategies proposed by your bureau on farmland management in the future?
8. How do you generally evaluate the farmland management practices currently being practiced in your surrounding?

Appendix III

Observation checklist

1. What are the practical farmland management techniques to be implemented?
 - a) To maintain soil fertility?
 - b) For soil conservation?
 - c) To increase crop productivity?
2. What types of impacts are clearly observed on the farmlands and the surrounding environment resulted from the management practices?
3. How do the current conditions of cultivated lands explained?
 - a) Degraded
 - b) moderate
 - c) not degraded
4. What are the dominant crops to be cultivated in the study area?
5. What looks the intensity of the management practices like?
6. Is there any variation in the types of management practices and their intensity with respect to agro-climatic and topographic variations?
7. What looks the integration of indigenous and newly introduced farmland management practices?
8. Where do terraces, vegetation, diversion ditches and waterways to be practiced?
 - a) Near the homesteads
 - b) At distant farm plots
 - c) At steep slopping farm plots
 - d) At gently slopping farm plots
 - e) At any farm plot