EVALUATING THE CONTRIBUTION OF INTEGRATED WATERSHED MANAGEMENT ON CROP AND ANIMAL PRODUCTION: CASE OF KORIR WATERSHED, KILTEAWLAELO WOREDA, NORTHERN ETHIOPIA

BY
EFREM GIDEY

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR MA IN RURAL DEVELOPMENT TO INDIRA GANDHI NATIONAL OPEN UNIVERSITY, (IGNOU)

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ETHIOPIA

DECLARATION

I hereby declare that the Dissertation entitled *Evaluation of the contribution of watershed management activities on crop and production; case of Korir Watershed, Northern Ethiopia***,** Submitted by me for the partial fulfillment of the requirements for MA in Rural Development to Indira Gandhi National Open University,(IGNOU) New Delhi is my original work and has not been submitted earlier either to IGNOU or to any other institution for the fulfillment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

Place: Addis Ababa/Ethiopia

Date: _____

Signature: _____

Enrolment Number: **ID1051265**

Name: Efrem Gidey

Address: Mekele/Ethiopia

CERTIFICATE

This is to certify that Mr. Efrem Gidey, student of MARD from Indira Gandhi National Open University, New Delhi was working under my supervision and Guidance for his project work for the course MRDP-001. His Project Work entitled *Evaluation of the contribution of integrated watershed management activities on crop and animal production; case of Korir Watershed, Northern Ethiopia*. Which he is submitting, is his genuine and original work.

Place: Addis Ababa/Ethiopia

Chekol

Date:_____

Signature: _____

Name: Dr. Wondemageghn

Address of the Supervisor:

St. Mary's University College

School of Graduate Studies

Institute of Agriculture and

Development Studies

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ACRONYMS

ADLI	Agriculture Development Led Industry
BoFED	Bureau of Finance and Economic Development
CSA	Central Statics Agency
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
masl	meter above sea level
OoARD	Office of Agriculture and Rural Development
UN	United Nation

ABSTRACT

The Ethiopian Government is implementing natural resources development based agriculture. One of the natural resources development activities is watershed development in drought-prone areas of the country to address food insecurity and improve livelihood. Because of little research information and studies, this study assesses the contribution of implemented watershed technologies and practices along with their roles on crop production and animal production. The necessary information was collected using semi-structured questionnaire, focus group discussion and field observation, which was processed by SPSS software and analyzed by descriptive statics tools. In addtion to this remote sensing and GIS tool is used to analyze the land use cover change of the study watershed. The watershed practices in the study area include physical soil and water conservation measures, biological soil and water conservation, moisture harvesting structures and area enclosure activities. The findings reveals that the watershed management practices have improved water availability (springs, handug wells, and dam) and expanded irrigated farmlands. Framers have also got animal feed availability from the treated gully and area enclosure to increase animal production. As a result of the watershed development interventions, Crop production and animal production has increased significantly.) The main opportunities that resulted from the watershed management are the availability of interested beneficiaries in the watershed development and labour availability to work in the watershed while the challenges include the lack of full base line data on the watershed, maintenance budget, poor functionality of watershed development committee and needs more budgets for industrial inputs (Gabions). Therefore, increasing the knowledge, skill and attitude of house hold beneficiaries on the watershed management techniques, strengthening the watershed development committee by the government and NGO intervention, In addition to this, to solve the budget deficit for industrial input the integration of resources from government and NGOs should be encouraged for watershed development to increase the effectiveness and efficiency of watershed development project.

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Ethiopia is an agrarian economy based country where the agricultural sector plays an important role in the national economy, livelihood and socio-cultural system of the country. The sector supports employment of over 80% of the population, accounts for 45%-50% of the national GDP, and makes the largest contribution to raw materials for agro-industries, food security and foreign exchange earnings. (Canadian Food Security Policy Group, 2006). However, Ethiopia's agriculture is characterized by its very low productivity.

Among the various reasons for the low agricultural productivity in the country are: traditional agricultural practices and implements, small land holding as each generation splits, insufficient resources, high population growth in rural areas, underdeveloped rural infrastructure, unpredictable weather patterns, the decrease in rainfall periodic droughts, dependency on foreign grain, little access to information, training tools and skills to improve their farming methods and to diversify their crops (CDA, 2006). Recurrent drought and the accompanying degradation of the natural resources base and political instability as well as wars have also contributed to the persistent of poverty and frequency of food insecurity in Ethiopia (CDA, 2006).

The economic policy of Ethiopia aims at ensuring rapid and sustainable development through agriculture-centered development strategy. This strategy is known as Agriculture Development Led Industrialization strategy (ADLI), and concentrates mainly on the linkages between agriculture and other sectors of the

economy. Agricultural growth is seen as a guarantee against food insecurity in the country. The food security strategy of Ethiopia is based on three important aspects: a) increasing food and agricultural production, b) improving food entitlement and c) strengthening capacity to manage food (AyanaBogle, 2002). In order to improve agricultural production a major emphasis is given to increasing productivity through the diffusion of improved technologies. In the food entitlement strategy, the focus is on reducing vulnerability in drought prone areas. The strategy also focuses on strengthening emergency capabilities. It involves maintaining emergency food reserves and developing an effective early warning system (AyanaBogle, 2002).

The terms watershed, catchment, drainage area and river basin are all used to describe a land surface from which water flows downhill to a specified point on a watercourse. The difference between them is essentially a question of scale, whereby the watershed relates to the smallest size of catchments, generally located on the steepest slopes of a river basin. The watershed contains an array of inter-linked and interdependent resources and activities, irrespective of political boundaries. It forms a dynamic and integrated bio-physical, economic, social, environmental and political system containing people, agriculture, forestry, industry, services etc. Managing watersheds is a complex phenomenon; therefore, its management requires a variety of physical, social and economic policies and techniques, all aimed at minimizing the adverse consequences of natural disaster events, to improve and enhance the quality of life of the catchment community. Most, if not all, centrally planned watershed programme fail due to lack of involvement of people in the projects. Beneficiaries' participation appears to be crucial in planning watershed programmers as local people are closest to the real problem (op dingsdag, 2006).

South eastern zone of Tigray regional state is one of the drought affected zones of Tigray region and of course one of the food insecure zone and low level of livelihood conditions and Enderta woreda where the study conducted is found in south eastern zone of the region. The integrated watershed management progrmme is implemented in Arato watershed with the objective of improving the livelihoods of the targeted household through natural resource conservation, increased agricultural productivity and production and the water supply of the targeted area under the condition of climate smart agriculture. According (BoFED, 2003), due to recurrent drought and the highly depleted natural resource base of the region is not getting enough production from this agricultural sector. As the agriculture of the region is rain fed under dry land environment, the rain pattern is also erratic and unreliable not only that but also there is low soil fertility and low use of improved form of watershade technology.

To counter face the challenge of food insecurity and come out with a food secured climate smart agriculture in the future; the regional government is implementing various food security programs under the umbrella of the national food security strategy. The governments of Tigary region and donor agencies are implementing different food security programs on the basis of watershed approach. The watersheds have been viewed as useful systems for planning and implementing natural resource and agricultural development for many centuries (Brooks and Eckman, 2000).

Kilte awlaelo woreda is found in eastern zone of the Tigray region where the watershed management program is implemented in Korir watershed with the objective of improving the livelihoods of the targeted households and the communities through natural resource conservation, increased agriculture productivity and production and improving the water supply of the targeted areas.

This study tries to identify and evaluate the effect of the integrated watershed management program on the crop production and animal production of the targeted households in the korir watershed of the Kilte-awlaelo woreda.

1.2. Statement of the Problem

The integrated watersheds management approaches have been viewed as useful systems for planning and implementing natural resource and agricultural development for many centuries (Brooks and Eckman, 2000). Watershed management is a holistic approach which aims at optimizing the use of land, water and vegetation in an area to alleviate drought, moderate floods, prevent soil erosion, improve water availability and increase fuel, fodder and agricultural production on a sustained basis.

In order to attain sustainable food security and long lasting impact on livelihoods of the integrated watershed management programs must be combined with the efficient knowledge of the watershed management. While putting huge investment on food security programs through the watershed management approach there are many growing interest about the impact of those interventions. Especially the Ethiopian government as a general and the regional government in particular with the assistance of external donors are highly engaged in the implementation of watershed based food security programs.

In the study area since 1997 watershed development and management activities have been implemented by different development actors such as government and other NGO (BoFED, 2003). The watershed development works has enhanced in the production of crop and livestock in the study area. The watershed technologies and practices were also helpful in the reduction of poverty and food insecurity as a regional level.

Despite of the various efforts made by the Government and Community collaborating with the other NGOs, the contribution of the adapted community watershed practices and technologies have problem on the evaluations with relation to crop and animal production. Therefore, the aim of this study is to make detail study on the role of integrated watershed management activities on crop and animal production, in addition to this the study will fill the information gap so as to help farmers, planners and decision makers in their planning and implementation process related to watershed management, crop and animal production.

1.3. Objective of the Study

The general objective of the study is to investigate the roles of watershed management activities on crop and livestock production. The study has the following specific objectives

- Identify and evaluate implementing watershed management activities in the study area
- Assess and evaluate how the watershed management activities has improved crop and animal production
- Identify the opportunities and challenges associated with watershed management activities

1.4. Research Questions

- What are the watershed management activities implemented in the watershed?
- What is the impact of the watershed activities on crop and animal production?

- What are the opportunities and challenges associated with watershed management activities?

1.5 Significance of the Study

In the process of ensuring food security and rural livelihood enhancement knowing the exact contribution of a single watershed management program to overall food security of the targeted group is a basic corner stone in deciding whether to invest and expand similar massive watershed management food security programs elsewhere in the food insecure areas. To realize this fact, many efforts through the application of different proxy strategies to measure an impact, were made and are still going on but using different proxy measure of an impact cannot take us to a better conclusion of a single program. Nevertheless, the application of appropriate impact evaluation technique regularly with continues recordkeeping of program data can give a pleasant condition for better decision making. The output of formal impact evaluation practice leads to design better watershed management programs; moreover it can be good ground of learning and dissemination of best practices for further sustainability.

Therefore, this study will help in filling the existing knowledge gap of the concerned topic and will contribute to the community of Korir watershed, local and regional development actors to think of the importance of the impact evaluation practice of all similar watershed management programs and make appropriate watershed intervention which can enhance the food security and better livelihood through the improvement of crop and animal production.

1.6. Scope and limitation of the study

The study is limited to the impact assessment of the watershed management activities program on crop and animal production in Korir watershed of

Kilteawlaelo woreda. The impact assessment is based only on agricultural production, environment and water coverage and related impacts. It is based on the empirical evidences from the collected survey data of one Peasant Associations (Tabia) and remote sensing and GIS based impact evaluation. While estimating the environmental impact results are based on the responses of the surveyed households, observations and photos but the researcher did not make detailed technical measures on the environment. Hence, the study is limited in terms of providing comprehensive idea about overall impact, problems, potential solutions and opportunities to make inferences for possible policies and practices on issues related to the impact of the watershed management program on food security and sustainable agriculture.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Watershed Management in Ethiopian Highlands

Ethiopia is one of the most vulnerable country to the adverse effects of climate change due to its geographical location, topography and heavily dependent on rain-fed agriculture, under-development of water resources, high population growth rate, low economic development level, inadequate road infrastructure in drought prone areas, weak institutions in combination with low adaptive capacity (NAPA, 2007).

2.2 Watershed Management Technologies and Practices in Tigray

In Tigray, since the 1966, farmers were familiar with traditional soil and water conservation practices in their day to day activities such as locally we call “Deret” that synonymous with ‘grass strip’ or ‘soil bund’. But, their activities were not supported technically; however, currently technically supported physical and biological conservation measures were widely implemented to prevent soil erosion, land degradation and climatic hazards in the study area. The main purposes of mechanical/structural/physical soil and water conservation measures were to control the movement of water over the soil surface and limit its erosive capacity.

As the data from the farmers, the main physical conservation measures implemented in the study area were soil bund, deep trench, terraces, hill side terrace, haring bounce, half-moon, gabion, gully cutting and stone bund (www.eajournals.org).

Watershed management cannot be achieved without the willingness of local people to participate (Pretty and Ward, 2001 as cited in Tadesse). According to the group discussants, the households were participated in the implementation of the conservation measures. They were contributing free labor yearly (20-40 days) on communal land management. In the survey, an effort was made to see the participation of households in soil and water conservation. According to the survey data, 78.8%, 60%, 65.9%, 76.5%, 72.6%, 83.5%, 70.6%, 82.4%, 56.5%, 35.3% and 83.5% of the households were implemented construction of soil bund and stone trace, using fuel saving stove, crop rotation, check dam construction, planting and protection of forest, gully reshaping, cut and carry system, grazing land rehabilitation, irrigation practices, using improved agricultural input, compost preparation and water development practices respectively(www.eajournals.org).

2.3 Role of Watershed Management on Livelihood

Surface and groundwater availability increased due to the various water storage structures and biological and physical soil conservation resulted in increased cropping intensity and helped households to find new ways to raise incomes and reduce environmental risk. The watershed management helped households to diversify their livelihood activity (www.eajournals.org).

Income or livelihood diversity is important to cope with climatic risks. If one income source were lost then still have other sources of income which make households and communities better able to cope during hazards and therefore make them resilient (Adger, 1998).

Different soil and water conservation practices were contributing farmers to engage in different activities such as bee-keeping, trade due the access of credit and irrigation etc. Accordingly, the changes in livelihood diversification were

accredited to the soil and water conservation practices and application of improved agricultural inputs (household survey, 2014).

2.4 Impact of Watershed Management on Food Security

Watershed management contributes to all sectors (agriculture such as crop production and livestock, water availability and quality, health, ecosystem service, socio economic and all human livelihood activities) directly or indirectly through chain reaction available between sectors (MOARD, 2005).

The different watershed management practices were provokes households with different employment opportunity.

All the water that falls on the watershed collects into a single stream or river. A watershed management is thus a management of naturally demarcated area of land that is suitable for many development activities. 'Watershed development' is a critical intervention in low rainfall areas to make the land more productive (***see*** http://www.indiawaterportal.org).

Watershed practices and technologies: are activities or technologies done in the watershed development and management these including all the physical and biological soil and water conservation activities and the institutional arrangements done (Wikipedia).

2.4. Food security in Ethiopia

Food insecurity incorporates low food intake, variable access to food, and vulnerability a livelihood strategy that generates adequate food in good times but is not resilient against shocks. These outcomes correspond broadly to chronic, cyclical and transitory food insecurity, and all are endemic in Ethiopia. The main

triggers of transitory food insecurity in Ethiopia are drought and war. Seasonality is a major cause of cyclical food insecurity. Structural factors contributing to chronic food insecurity include poverty (as both cause and consequence), the fragile natural resource base, weak institutions (notably markets and land tenure) and unhelpful or inconsistent government policies [Sbahtu (2010:17)] in Devereux, 2000**).**

A broad-based approach to food security in Ethiopia must involve long-run productivity growth in agriculture, since 85% of the population is engaged primarily in farming. But the history of economic development also indicates that productivity growth has almost never occurred without the emergence of efficient and reliable markets. Reliable markets (a) provide the means to adopt cost-reducing technologies at various stages in the food system (e.g., seed and fertilizer distribution); and (b) offer incentives for rural households to shift from a subsistence-oriented pattern of production and consumption to more productive systems based on specialization and gains from exchange (e.g., generating greater amounts of income from high-valued crops and non-farm activities and using the income to buy food). Sustained improvements in household access to food in Ethiopia will require the development of more reliable food and input markets, involving a movement away from subsistence-oriented, household-level production toward an integrated economy based on specialization and exchange. Long-run productivity growth in agriculture will come primarily from input intensification. It is unrealistic to expect food production to sustainably grow at 3% per year to match population growth under low-input, traditional technology conditions (Ruttan 1991).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study has been conducted in, Korir watershed Kilte Awlaelo Woreda, eastern zone, Tigray region, northern Ethiopia. It is located in 563147E and 1491688N of south eastern of wukro. It has elevation of 2129m at the out let of the water shed.

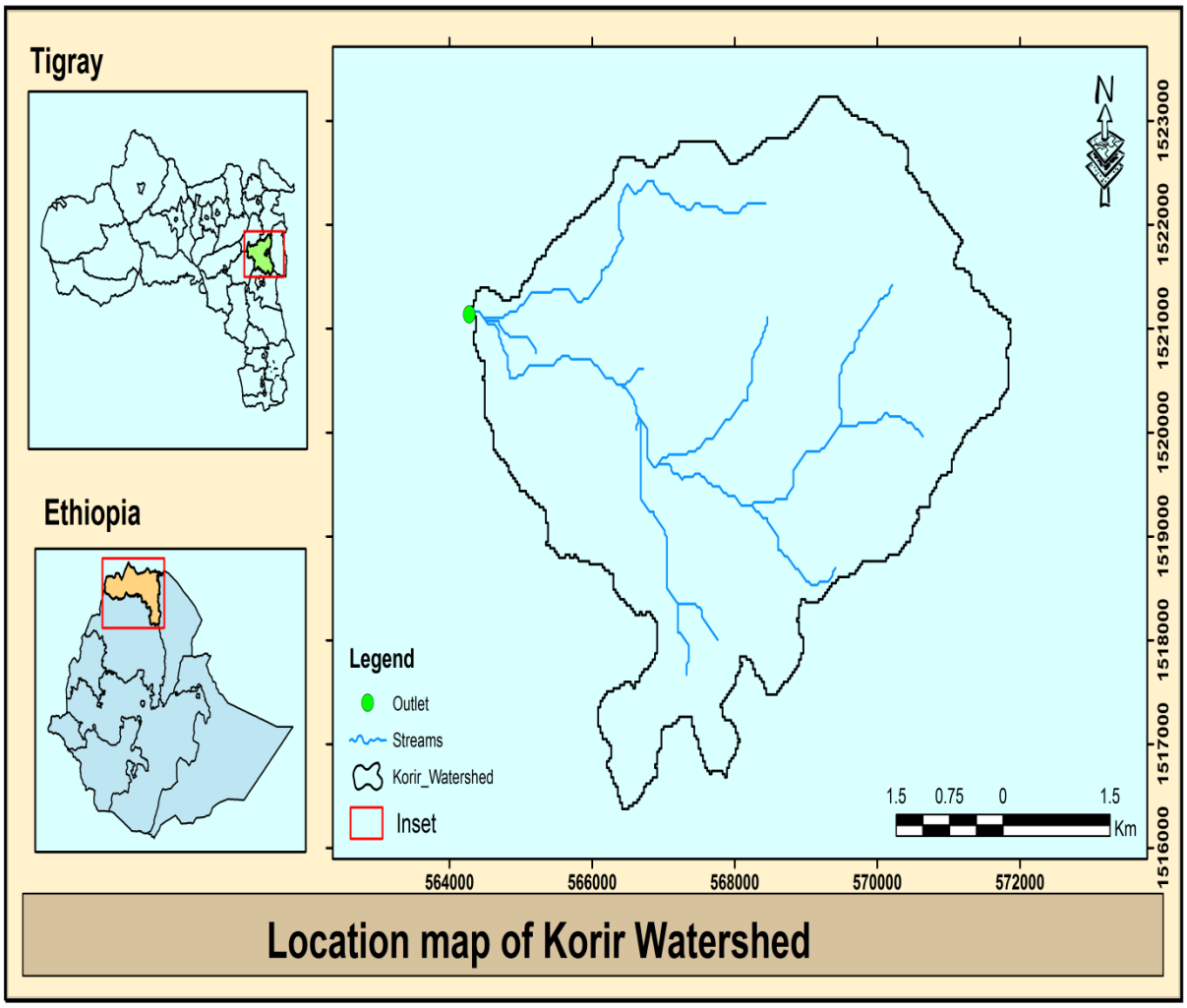


Figure 1: Location Map of Korir Watershed

3.2 Geographical Location and Climate of Kilteawlaelo Woreda

Kilteawlaelo woreda is located in the eastern zone of Tigray. It is one of the seven rural woreda of eastern zone.

3.2.1 Topography

The total area of the Woreda is estimated to be 101,758 hectares, with a landscape consisting of rugged hills, high plateaus & valleys. The altitude varies from 900-2400 meters above sea level (m.a.s.l).

3.2.2 Climate

Climate of the area was characterized by inadequate and erratic rainfall (with an average annual rainfall of less than 450mm) and mean annual temperature of 17-23^{0}c. The Woreda experiences a bimodal type of rain with a small shower of rain in the months of April and May and the main rain being usually from mid-June to mid-August. The rainfall patterns were very variable in time and space and difficult to predict

3.2.3 Infrastructure

The coverage of potable water were less than 64% within1.5km and coverage of primary education of the district was 100%.This indicates that strong attention was given for the millennium development goals in the district. (Kilte-awlaelo Office of Finance and plan report 2015)

3.2.4 Agriculture

Agriculture was the core means of livelihood of the community. The economic activity of the study area was predominantly crop and livestock production (mixed farming system). The crop production system of the study area was dependent on both rain fed and irrigation. From the total of 28,588 household heads, 30.6% were male household head. About20.5%of female household heads was irrigation users. The average landholding of a household of the wereda was 0.625 ha with minimum of 0.25 and maximum of 1hectare (source KilteAwlaeloWoredaOoARD 2014).

The major crops cultivated include barely, Teff, finger millet, and wheat from cereals, field peas, horse bean, lentils and chickpea from legumes and linseed from oil crops. The productivity of these crops do not exceed 300-400 Kg per hectare due to poor soil fertility was one of the crop production constraints in the woreda their crop production system was integrated in such a way that crop residue and straw feed their animals while the animal waste used as manure and for preparing compost to improve soil fertility and crop productivity. The small land holding size (about 0.62 hectare) coupled with the low crop production per unit area make the people dependent for most part of the year on food aid, remittance, and cash for-work activities(Kilte-Awlaelo woreda OoARD, 2015).

Livestock, next to crop production, comprises a vital part of the farming system in the woreda. Major livestock herds in the woreda are cattle, sheep, goats, chicken, donkey, camel, mule and beehive. Oxen are the main source of drought power for plowing, and threshing, sheep, goats, and chicken are used as source of income and meat. Donkey, camel, and mule are used as means of transportation. Beehive used as source of income and honey (KilteAwlaeloworedaOoARD, 2015). Generally, the study area practices both free grazing and cut and carries system for

their livestock management from the watershed (Kilte Awlaeloworeda OoARD, 2016).

3.3 Socio-economy of the Woreda

Based on the national census conducted by the Central Statistical Agency (CSA, 2007) of Ethiopia and projected for 2015, Kilte-Awlaelo woreda OoARD 2015 has an estimated total population of 125,831 of which 48.79 are male and 51.21 are female. The total household heads are 28,588 of which male headed households was 20,010, while female-headed households constituted 8,578 of the total. The average household size of the study area was 4.4 persons per household.

3.3.1 Soil Texture

According to the Kilte AwlaeloOoARD, the textural classification of soil of the experimental site of the watershed total area was 2140.7 hectare. Out of which 20% was arable land and fertility status of this soil was classified as fertile soil 14%, medium 23% and less fertile 63%. (KilteAwlaeloOoARD, 2015)

3.3.2 Land Use

According to KilteawlaeloOoARD (2014), Kilte-Awlaelowereda has various land use types which could be classified into arable land, irrigated land, forest land, grazing land, hill side and residence. The wereda has a total area of 10 1,758 ha. Out of this 20% was arable land, 44.6% area closure, 7.8% grazing land, 27.6 hectare hill side and residence. Out of the total land under cultivation (20420ha) 63.2% was in rain fed and 36.8% was irrigated land. The experimental site

3.3.3 Population Characteristics of Kilte-awlaelo Woreda

Based on the study of CSA (2007), the total population of the woreda is 144,784 persons. Out of this size, 70,897 are males and 73,887 are females. The density of the population is 108.6 persons / kilometer square. Regarding the population profile, 46-48 per cent of the total population in the woreda are youngsters (whose age is below 16 years) while the remaining 52-54 per cent are middle age and old age groups. Life expectancy at birth remains at 47 years and infant and child mortality rates are high at 118 and 173 per 1000 births, respectively. The woreda is subdivided in to 17 rural kebele administrations. The economically active population is estimated at 51.04 per cent. More than 99 per cent of the populations are followers of the Ethiopian Orthodox Church. (Tigray Bureau of Information and Culture (TBIC), 2002)

3.4 The Study Watershed

The experimental site, Genfel Tabia, 45 km and 5 km far from Mekelle and Wukro respectively. Korir watershed was having an area of 2859.35 hectare with the land scape consisting of hills and a mountain the altitude was varies from 1921 – 2460 meter above sea level (m.a.s.l). Climatic conditions of the area are characterized by inadequate rainfall (450-550mm) and mean annual temperature was 21^{o}C. (KilteAwlaelo Office of Finance and Plan 2014)

Genfel tabia, containing the experimental watershed (Korir), has a total population of 7,238 of which male are 3414 and female are 3824. The total number of households was 1645 of which 1151 are male and 494 are female headed households, resulting in an average of 4.4 persons to a household (KilteAwlaeloWoreda Finance and Plan Office, 2014). Next to farming, participating in like food for work programs of governmental and non-governmental organizations in different infrastructure development projects and in

construction-building as daily laborer are common off-farm economic source of the people.

3.5. Study Methodology

3.5.1 Study Design

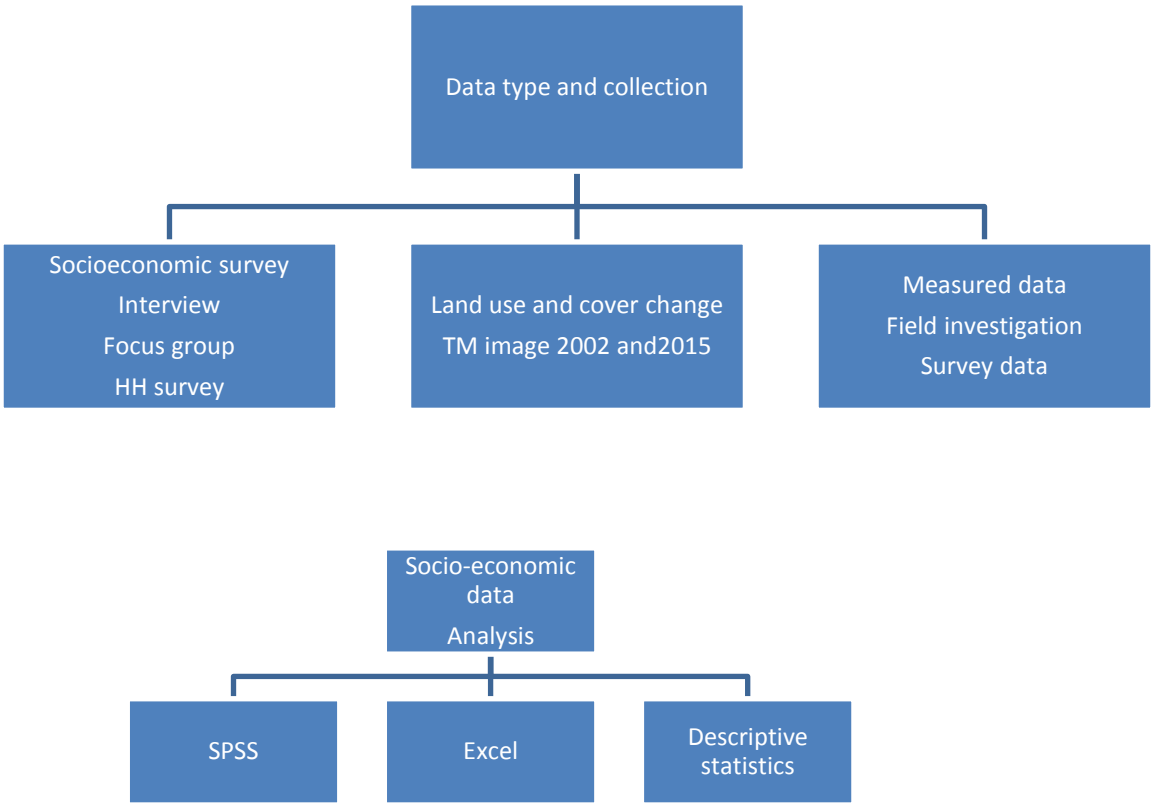


Figure 2: General flow chart of data collection and Analysis

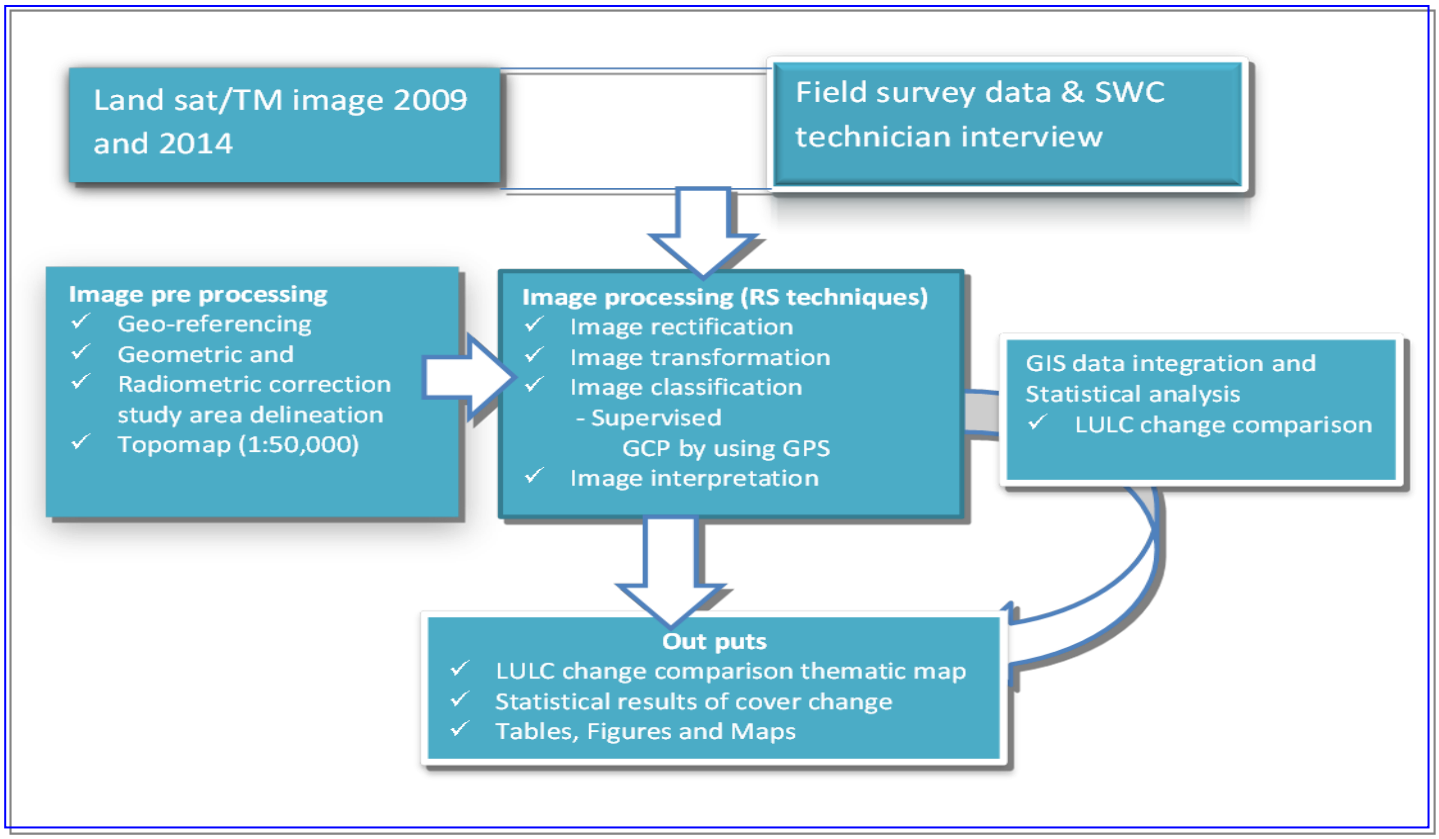


Figure 3: General flow chart of Land Use Land covers Change

3.5.2 Nature of the Data

The data sources were both primary and secondary data which includes qualitative and quantitative data. The data was time series data before and after watershed technologies and practices implemented.

3.6 Sampling Design (Technique)

In the study combination of purposive sampling technique, random sampling technique, the convenience and quota sampling methods have been applied.

Sampling size –sample size of the respondent was the representative of the total number of watershed population with that standard formula of sample size. Total Sample size 2525HH with 5% significance, Average size of the household is 5:

Male 134HHand, Female 78 HH which is 35% the reason for this is in the watershed there are more women headed households in the watershed.

3.7 Data Collection

Primary data: The primary data was collected through:

Socio-economic survey: a semi-structured questionnaire was prepared and organized. Stratified random sampling techniques (gender, profession, age) were followed. This method was used to collect the information about the socio-economic changes of households due to the technologies and practices introduced. Focus group discussion with the beneficiaries, key informants and experts were also used to triangulate the questionnaire and interview data.

Remote sensing and GIS data have been collected to analyze land use and cover change, rehabilitation, irrigation expansion and degradation change.

Secondary data were collected from both published and unpublished works (Reports) were collected and organized from government offices and NGO working in the study site. Specifically, quantitative and qualitative data on the implemented technology practice and household size will be collected.

3.8 Data Analysis Methods

To analyze all the specific objectives, the collected primary and secondary data sources related to house hold and socio economic were analyzed through the use of statistical analysis of SPSS Version 20. In addition to descriptive statistics such as the mean frequency of occurrence, tables and charts will also be used during the analysis. Remote sensing and GIS tools were also used to analyze the change after the intervention of watershed management activities in between 2002-2015.

CHAPTER FOUR

4. RESULT AND DISCUSSIONS

4.1 Demographic Profile

Demographic characteristics indicate the respondent's distribution by age, family size, committee membership, land ownership and average cultivation land holding size in hectare 0.25. The survey results in Table 4.1 showed that the age category of the respondent's ranges from 30 to 67 years and the mean average age of the respondent household heads were found 41.In addition, the finding describes the mean age of the male respondents and it was found 43 years and 36 years were found the average age of female respondents in the study area. Family size in the study area was found minimum 3, maximum 8 and a mean family size of 5. With regard to sex-disaggregated results, the survey showed that the male headed respondents have a mean family size of 5 and 4 were mean family size of female-headed household in the area respectively. Concerning educational status of households in the study areathe result showed that from the sample household heads 74 (34.9%) were found illiterate. Whereas, 138 (65.1%) of respondents in the study area were found to be literate.

When we see the committee participation of the household heads, the descriptive analysis of the survey respondents were found 53 (25%) not involved in any committee however; significance sample respondents159 (75%) were to be found involved in the committee member. The sex wise distribution of the committee membership, 123 (58) of the male headed households were participating in the committee and only 36 (16%) of the female headed household participating in the committee member however, 24 (11%) and 29 (13%) male headed and female headed respondents were not participated in the committee respect Regarding land ownership, 100% of respondents in the study area were to be found land owners

however, their owned land size were found maximum 9 tsimad, minimame1 tsimad with mean of 5 tsimad.

Table 4:0:1: Demographic characteristics of the respondents

Variables	Percent	Variables	Mean
Literate household head	65	Age	41
Membership in rural committees	75	Family size	5
Land ownership	100	Landholding size (ha)	0.25

4.2. Implemented Watershed Management Technologies and Practices

In efforts to address the cause and effects of severe natural resources degradation in the study area (watershed), the central approach was an integrated soil and water conservation which have been implemented by different NGOs in close collaboration with local government, and beneficiaries who reside in the study area. Rehabilitation of heavily degraded lands of the watershed has been the major component different project. Soil fertility management practices in the study watershed include fallowing and application of inter-cropping, crop rotation, alley cropping, conservation tillage, manuring, improved agronomic practices and fertilizer application.

According the report of Ethiopian Catholic Church wukro St Mary's Rural Development Project the survey data and survey observation made by the researcher there are free labor contribution SWC activities, cash or food for work SWC activities done. In order to increase the strength of the physical soil and water conservation measures and to enhance immediate benefits (economic and ecological services) in the watershed plantation of multipurpose trees such as

lacunae, suspania and Lucerne had been carried out for soil nitrogen fixing, animal feed and biological soil and water conservation. In addition to this grasses elephant grass, other grass species, other trees and herbaceous plants had been planted in the gully side and bed. Moreover, promoting 506 hectare of area enclosure activities, 426-hectare forest land management and agro forestry works in irrigation land had been implemented. (Watershed management techniques) which had been done on the watershed is described below in the Table 4.2.

Table 4:0:2: Physical and Biological measures

Physical measures		**Biological measures**		
Activity	**Land use type implemented**	**Activity**	**Unit**	**Quantity**
terracing	Hillside	Planting tree, shrubs, grass	No	850,000
Soil and stone bund	crop land	Area enclosure	hectare	480
Deep and shallow trench	grassland and hillside	Forest land mgt	hectare	526
Cut of drain percolation ponds	Cultivated land and grass land	Agro forestry works	hectare	40

According the survey result of this study, watershed techniques implemented in the study area were found in the following Table. In addition to this, different watershed technologies were implemented. Among these; water harvesting and moisture harvesting technologies were carried out in the watershed.

Table 4:0:3: Types of watershed techniques

S.No	Types of watershed techniques	S.No	Types of watershed techniques
1	Indigenous Terracing	6	Percolation pond/pit
2	ditches/trenches	7	House hold pond
3	soil bunds	8	Cut of drain
4	stone bunds	9	Gabion check dam pond
5	Erath dam	10	Gabion check dams

Figure 4: Biological soil and water conservation

Plantation of bamboo and other forage trees is one of the biological soil and water conservation measures done within the gully of the watershed as it is observed in the picture the gabion check dam minimizes sediment flow, speed of water erosion and it stabilizing the gully side \width\.

Figure 5: Physical and biological gully management practice in the watershed

The picture indicates (show) in the watershed management activities (gully rehabilitation) increases availability of animal feed such as suspania and different grass species. In addition to this, the biological measures (plantations) stabilizing thegully side and bed

Figure 6: Beekeeping intervention in the watershed

4.3. Income, Asset and Livelihood of Households before and after Watershed

4.3.1 Households Income and Expenditure Changes

This section compares household income and expenditure before data obtained from the sampled taken for interviewing and after the watershed program intervention in the study area. Table 4 shows that about 65% and 40% of the sampled households respectively reported that their expenditure was on school and house improvement. Results in Table 4.4 indicate that households, whose livelihood improved due to watershed rehabilitation were able to purchase agricultural inputs, house construction, send children to school and pay for medicine expense. As the result of the implemented watershed rehabilitation activities, majority of the inhabitants (78.83%) are able to cover their annual expenditure demands for 12 months. This was, however, not the case before the

watershed treatment, in which only about 48.4% covered their annual expenditure needs.

Improving the livelihood of the watershed inhabitants is one of the activities that the watershed project addresses through their implementation program. Therefore, household income is among some of the important variables that are likely to influence watershed management. Crops, livestock and their products and off-farm activities are the main sources of household income in the study areas. The response of the sample households in the watershed indicates that 60% of households‟ income has improved due to watershed project interventions while 40% of watershed inhabitants‟ income has not improved.

Table 4:0:4: Selected Household covers their expenditure annual income before and after watershed intervention

No	Expenditure Item	Before intervention		After Intervention % improvement		% improvement
		Yes	NO	Yes	No	
1	Purchase of Agricultural inputs & equipment	90	122	180	32	42
2	Improvement of the house	69	143	138	74	33
3	Purchase of medicine or drugs	85	127	170	42	40
4	Purchase of household equipment’s	89	123	176	36	41
5	Purchase of cloth	70	142	160	52	42
6	Purchase of Animals	96	116	181	31	40
7	Purchase of radio	85	127	168	44	39
8	Purchase of crops for consumption	185	27	175	37	-5
9	School expense	91	121	189	23	46
10	Rent farm land	90	122	144	68	25
11	Saving in banks	0	212	170	42	80

4.3.2 Household Access to Social Support Institution (Social Capital)

The contribution of social capital to food security in the study area was found as an important input on household's non-farm income improvement.

According to the interview made with the farmers of the watershed, the survey indicated that out of the total sample respondents,95% household are members of rural association (Ekub, Edir, farmers association, Women and cooperatives association) while the remaining 5% were non-members of any rural association. With regard, out of the total households who are members, of a given rural association 92% of the households were involved in non-farm activities. On the other hand, 8% among the households who were not members of the local institutions did not participate in non- farm income generating activities. One can simply understand from the above discussion, those households who are members of given association seems to have a better access to market information, and other social supports that enable easily adjust themselves ahead of time to protect the food shortage by engaging in non-farm income generating activities. Such social network may also play an important role in obtaining credit service and information support during participating seasons. This implies that a social network (capital) plays pivotal role on households' food security assurance and livelihood improvement.

4.3.4 Household Asset Ownership and Livelihoods of the Farm Households

Households need to have access to assets or livelihood resources that allow them to meet needs and improve their livelihood situation. To asses and evaluate the contribution of watershed management technologies on asset and lively hoods of the form households it is good to identify the five types of assets (capital) up on

which livelihoods are built. These are land owner ship access to irrigation livestock holding, form assets, housing domestic asset.

4.3.4.1 Access to irrigation

The study area is a potential for irrigation because of its access and availability of certain water sources and watershed management techniques and practices. Small scale irrigation and irrigation is getting big attention in the area. According to the report of the Woreda office of agriculture and rural development; in the watershed before the watershed management technologies (practice) implemented 102 hectares were irrigable land and 108 household beneficiaries whereas, after the implementation of integrated watershed management technologies, the irrigation land increases to 947.75 hectares and the beneficiaries also become 1436 households.

The survey data on irrigation shows that as 68% of the sample household practiced irrigation to produce vegetables like tomato, onion, cabbage, lettuce and hot pepper. The study result in Table .4.5 in indicators that 32 (15%) of the sample households who did not have access to irrigation were involved in rain fed agriculture and non-form income diversification The reason for the increase irrigation access is due to the watershed management techniques and practices and introducing water harvesting technologies implemented.

Table 4:0:5: Respondents access to irrigation land

Irrigation status in the watershed on your land	**number of farmers**	**Percent (%)**
Farmers having irrigation accesses	180	68
Farmers not having irrigation accesses	32	32
Total	**212**	**100**

4.3.4.2 Livestock Resources

In addition to crop production, to increase their level of income as well as home consumption respondents were involved in rearing livestock. The types of livestock mostly were sheep, goat, cows, oxen, pack animals (donkey, mule and horse) and local and exotic breed chickens.

As it is observed in Table 4.6 180 (85%) of the sample households own livestock as an integral part of their crop production while the remaining 32 (15%) households do not own livestock.

Watershed management interventions resulted in increasing animal feed from the area enclosures and crop residue from irrigation land. In addition to this different animal breed were introduced by different development NGO and government packages.

Table 4:0:6: Livestock holding condition of respondent

Livestock ownership	Before No	After No	Percent (%)
Farmers own livestock	126	180	25.5
Farmers no livestock	86	32	-25.5
Total	212	212	

4.3.4.3 Farm Assets

Farm assets are assets including from equipment (tools, house hold materials and house ownership). All the farmers own farm tools, equipment's to facilitate their farming activity however some of the farmers they also own some modern farm equipment such as motor pump and knap sect sprayers to facilitate their irrigation activities. Before the watershed intervention according to the interview made, the farmers had low farm asset ownership as the income of the farmers was low. After

the watershed intervention the income of the farmers increased this result to increase the farm assets including improved farm equipment their sleeping bed, roofing of the houses (corrugated iron) has been changed.

4.3.5 Households Access to Various Services

With regard to rural services, the dwellers in the sample villages have relatively a good access to both social and physical facilities; for example, all respondents have access to health extension service and about 95% to credit services. As explained in the focus group discussion, these services are important to improve income of households, improve their health security and knowledge, skill and attitude of respondents. In addition to this after the watershed management technologies intervention, all the sampled respondents have access to clean potable water of watershed management technologies on food security & climate SMART agriculture.

4.3.5.1 Access to Credit

Before the watershed intervention there was no tabia local credit and saving institution, after the watershed intervention to improve credit access and saving habit of the farmers from selling of crop production and animal production the government introduced the saving and credit institutions.

Household respondents were found 90% of them have access to credit and it is potential source of income in investment for the nonfarm activities. According to the focus group discussion of sample respondents, credit and saving services are important sources of investment, which enable households to start non-farm business easily or pay for transaction costs for those having non-farm self-employment establishments. In the absence of a well-developed rural credit markets, households cannot overcome financial constraints and able to participate in non-farm income generating activities.

4.4 Watershed Management Technologies and Food Security

Due to the implementation of different watershed management techniques the availability of water increases both in the rain fed and irrigation agriculture (Kerr, 2002). In addition to the expansion of irrigation infra-structure knowledge, skill and attitude obtained from extension services and supply of agricultural in puts such as pure and certified seeds, supply of DAP and urea fertilizer.

In the watershed there is an increase in land size on all farming type after the intervention of watershed techniques. This increment indicates that on the techniques of watershed the households have access to food production and increase their income by selling their product.

Table 4:0:7: Productivity and production in the watershed

No	Type of crops	Productivity Total in quintal/hectare		Total production in kilogram/ Household		Remark
		2002	2015	2002	2015	
1	Teff	5	18	250	900	Base line data and
2	Wheat	16	48	2976	8928	report from office
3	Barely	18	32	8100	14400	of agriculture and
4	Sorghum	26	60	2080	4804	rural development,
5	Others	9	15			Catholic Development Projects

Table 4:0:8: Land Use and Land Cover Change

LULC Change analysis of Korir watershed 2002 - 2015				
ID	**LULC_2002**	**LULC_2015**	**Change Practice**	**Area_ha**
1	Mixed tree Shrub	Cultivation	Agri expansion	**92.29**
2	Water	Cultivation		
3	Mixed tree Shrub	Bare land	Degradation	**60.85**
4	Cultivation	Bare land		
5	Bare land	Bare land	No change	**2351.48**
6	Cultivation	Cultivation		
7	Irrigation	Cultivation		
8	Irrigation	Irrigation		
9	Mixed tree Shrub	Mixed tree shrubs		
10	Water	Water		
11	Mixed tree Shrub	Irrigation	Rehabilitation	**354.73**
12	Bare land	Cultivation		
13	Bare land	Irrigation		
14	Cultivation	Irrigation		
15	Bare land	Mixed tree shrubs		
16	Cultivation	Mixed tree shrubs		
17	Irrigation	Mixed tree shrubs		
18	Bare land	Water		
19	Cultivation	Water		
20	Irrigation	Water		
Total				**2859.35**

Due to good watershed management bare land and grazing land were changed in to rain fed cultivation land. In addition to that increasing water availability for irrigation was then increase irrigation land as the focus group discussion result.

4.4.1. Livestock Population and Productivity

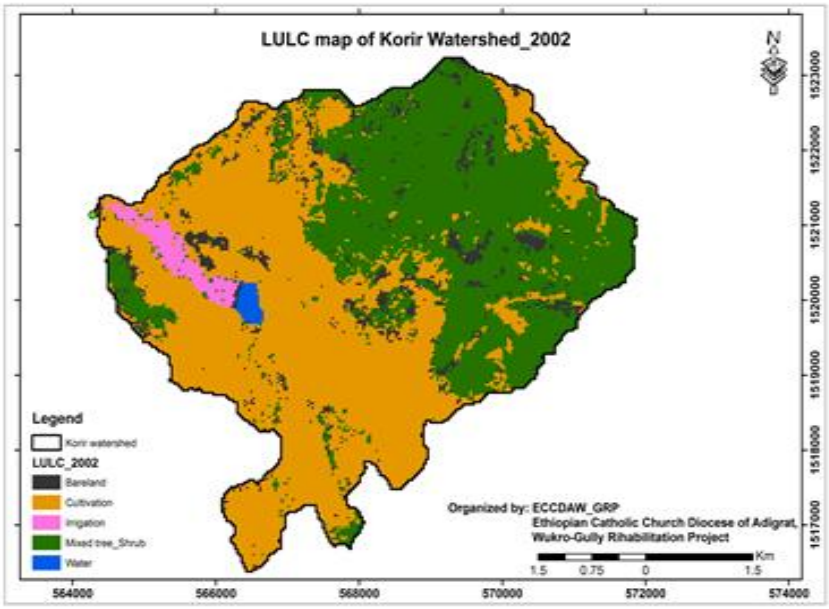
After the intervention of watershed management techniques the availability of forage biomass increases in the area enclosures, grazing lands and crop residue animal feed from rain fed and irrigation agriculture. The availability of animal feed and animal health services, availability of water for livestock results in increasing animal population and productivity in the area.

In general, the watershed management techniques intervention results from both crop production and livestock production enhances the availability of food from both farming. Not only availability, the diversity of food in the house holds also ensures the nutritional security according the report of Woreda office of heath. The increase on income of households in the watershed participants makes the households to improve their income for the purchase of other food type and improve their livelihood condition. In addition to this, crop production the livestock production also useful in the improvement of nutrition status and income of the households after selling of the livestock products.

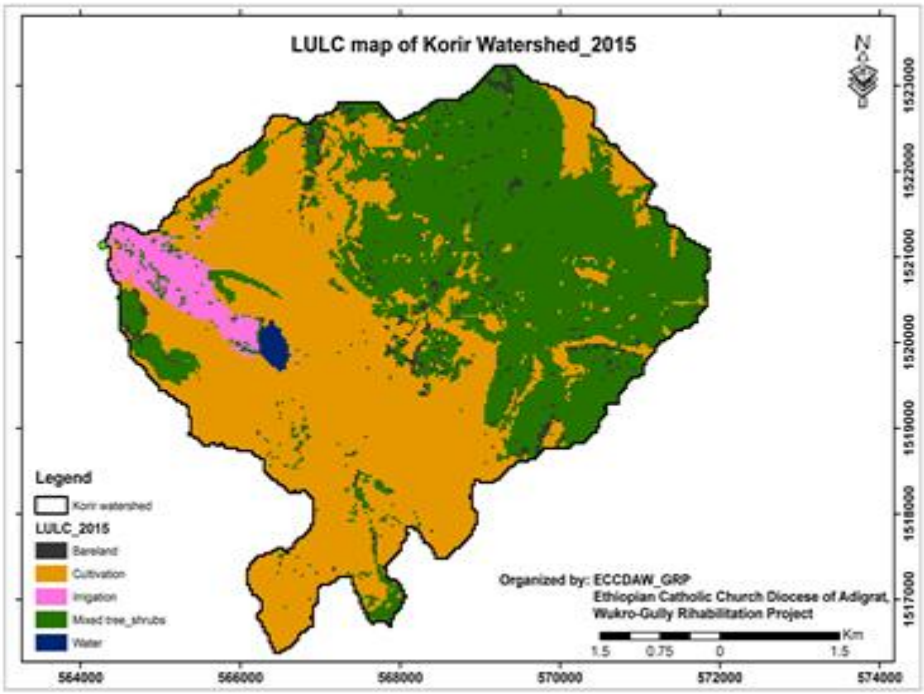
Livestock found in the watershed are: cattle, sheep, goats, donkey and mule as well as chicken and honeybee. Milk production, for example, increased from 1.5 to 2.5 liter per day from local cow. The number of animals reared in the watershed before and after the implementation of the watershed management increased. Except for the number of cows which showed a reduction because of replacement by high milk producing cows, the number for majority of the animals has increased.

4.4.3. Land Use and Land Cover Change in the Study Watershed

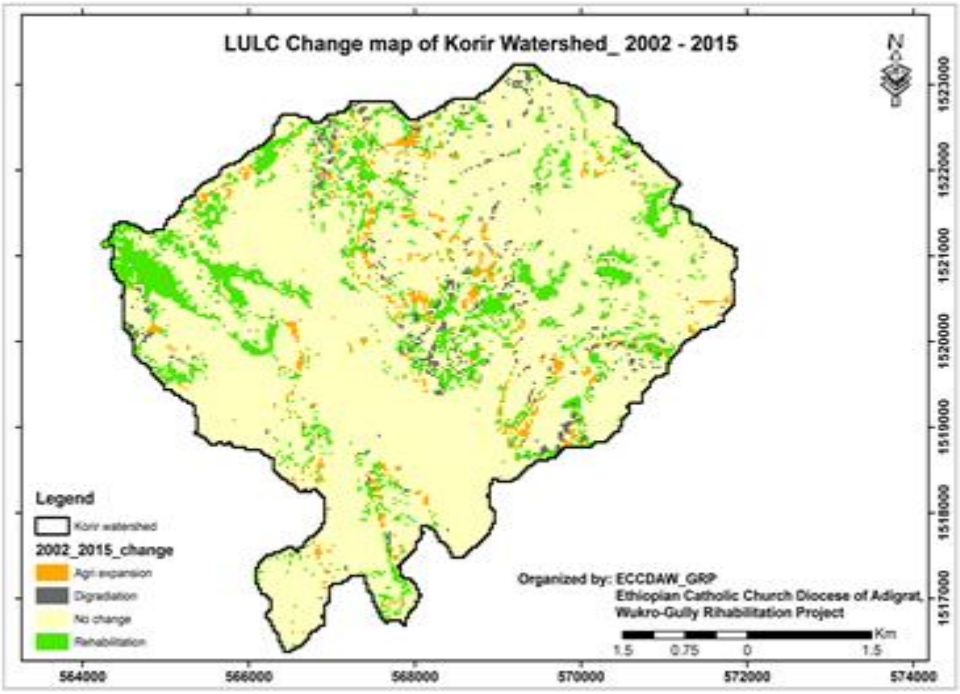
November 2002



November 2015



2002-2015 Change practices



Watershed evaluation Results

LULC Change analysis of Korir watershed 2002 - 2015

ID	LULC_2002	LULC_2015	Change Practice	Area_ha
1	Mixed tree_Shrub	Cultivation	Agri expansion	92.29
2	Water	Cultivation		
3	Mixed tree_Shrub	Bareland	Digradiation	60.85
4	Cultivation	Bareland		
5	Bareland	Bareland	No change	2351.48
6	Cultivation	Cultivation		
7	Irrigation	Cultivation		
8	Irrigation	Irrigation		
9	Mixed tree_Shrub	Mixed tree_shrubs		
10	Water	Water		
11	Mixed tree_Shrub	Irrigation	Rehabilitation	354.73
12	Bareland	Cultivation		
13	Bareland	Irrigation		
14	Cultivation	Irrigation		
15	Bareland	Mixed tree_shrubs		
16	Cultivation	Mixed tree_shrubs		
17	Irrigation	Mixed tree_shrubs		
18	Bareland	Water		
19	Cultivation	Water		
20	Irrigation	Water		
Total				2859.35

Change Summery 2002 - 2015

ID	Chang practices	Area_ha	GRP achivement
1	Agri expansion	92.29	***
2	Digradiation	60.85	Negative
3	No Change	2351.48	***
4	Rehabilitation	354.73	Positive
Total		2859.35	Highly Effective

Figure 7: Watershed Evaluation Results

Table 4:0:9: Major sources of water in the watershed

SN	Water source	Before watershed development intervention	After watershed development intervention
1	Spring development	3	15
2	Hand dang-well	0	25
3	River diversion	0	1
4	Pond	0	540
5	Dam and Check dams	1	2
6	Borehole	0	1
7	Tap water	0	2

Hand dug well and spring development activities

Physical conservation measures especially water harvesting structures such as percolation pond, shallow trench, deep trench, half-moon and hillside terraces had been constructed, this result in reducing the slope length and run off volume in the watershed. After the construction of those structures infiltration of the surface water resulted to develop new springs and hand dug wells as water source in the downstream of the watershed.

This implies that, the increased irrigated water help beneficiaries to have sustainable crop and livestock production and productivity in the watershed.

4.5 Opportunities and Challenges of Watershed Management Practices

4.5.1 Opportunities of Integrated Watershed Management Practices

The following opportunities are available in the watershed that can facilitate food security through the crop and animal production. Community that can be changed by intensive training and capacity building and 68 (32%) were found interested community on the watershed development, 67 (31.2%) of respondents were response free labor availability is as the major opportunity and 42 (19%) were response good climate condition to diversify crops is important opportunity, 36 (17%) nearby growing town/consumers for agricultural production also contributes to the watershed as an opportunity.

The opportunities of watershed management crop has increased in dry land farming, the soil loss due to erosion brought down, large extent of barren hill slopes were covered by vegetation, development of Agro- Horticulture and Agro Forestry, water resources were harvested through (deep trench, farm pounds, gully embankments), natural regeneration of grasses, bushes for animal feed and income of farmers increased considerably (MOARD, 2005.

Table 4:0:10: Opportunities in the watershed management

No	Variables	Frequency	Percent	Rank
1	Interested beneficiaries for watershed development	70	33.0	1st
2	Labor availability to work in the watershed	65	30.6	2nd
3	Good climate condition to grow different crops	39	18.39	3rd
4	Market availability in nearby towns	38	17.9	
	Total	212	100	

Willingness of beneficiaries to participate in the watershed development

As integrated watershed management needs the participation of the community willingness or interest of farmers to participate in the planning, implementing, monitoring and evaluation helps to get intended result as well as increase sustainability impact of the watershed.

Labor availability for the implementation of watershed development

As watershed interventions involved more physical SWC measure for activities there is a demand of more labor to implement the watershed technology and practices. There for labor availability is essential to implement watershed interventions in the studying area

Good climate condition for crop and animal production

Good climate condition helps to minimize risk of climate change as well as crop failure in the watershed. And to diversify different horticultural crops in irrigation land and field crops during rain fed agriculture. In addition to this the watershed was suitable for the introduced improved breeds of cows and chicken.

Market availability for the agricultural outputs

As horticultural crops are perishables in the irrigation land to reduce perish ability in selling of the production the market nearby towns is good opportunity to the farmers in the watershed.

Hence, possibilities of increasing water harvesting technologies in the watershed could increase sustainable productivity and production in the agriculture. In addition to this diversifying non-farm income for land less and unemployed in habitants is possible as there assessing as sand and stone quarrying including coble stone processing as opportunity in the watershed.

4.5.1 Challenges of Watershed Management Practice

Table 4:11: Challenges of watershed management practice

Variables	Frequency	Percent	Rank
It lacks data on given watershed base,	74	34.9	1st
It is expensive (needs industrial inputs)	76	35.8	2nd
It is not yet fully institutionalized by the committee	62	29.2	3rd
Total	**212**	**100.0**	

Lack of complete base line data

As watershed interventions needs more detail baseline data including full metrological data, soil condition, detail vegetation type and cover in the watershed there was no previously analyzed and documented data about the watershed this may result a significant change on the result of the research.

Lack of industrial input (industrial material)

Integrated watershed intervention involves construction of check dams through gabion works, cementing irrigation canals, cementing check dams. These activities resulted in demanding industrial materials such as cement, Gabion and Lessing weir. The industrial materials are expensive to be cover by individual farmers. There for, it is a challenge to farmers to get these industrial inputs.

Poor institutional (watershed development and Irrigation water users association committee) performance

Integrated watershed management activities need watershed development committee to distribute the benefits, implement or follow the bylaws of the watershed. Even though, the benefits from the watershed were distributed and most the bylaws were implemented there are activities which did not implement by the watershed or users committee such as maintenance of the gabion works.

According to the survey questionnaire, focus made with the households and secondary data from Wereda office of agriculture and rural development the major constraints (challenges) that hinder the watershed management techniques (practices) not to give sustainable benefits and ecological services were identified as follows.

It lacks full data on given watershed, it is expensive as it needs gabion works, it is not fully institutionalized arrangement in the watershed committee, market linkage and value chain of agricultural production. The major constraints described by respondents lack of base line data in the given watershed (78) 37%, as the 72 (34%) were also found expensive materials which needs the industrial input like Gabion. And significant number of respondents 62 (29%) replay the main challenge in the area were the committees' lack of full institutionalized the contribution of watershed management techniques.

Challenges for the woreda on watershed management practice were tabia community meeting, mass mobilization to small watershed practice, woreda and local level bylaws not implemented, with-out consider of ground truth report, rather than individual farmers plots local administrative more focused on community hillsides, farmers prefer to engage in food for work activities.

CHAPTER FIVE

5. SUMMARY AND RECOMMENDATION

5.1 SUMMARY

The general objective of the study was to investigate the roles of watershed practices and technologies on crop and animal production to achieve the objective questionnaires, survey, focus group discussion, observation and secondary data from relevant government and NGOs sectors where used and analyzed. As a result, to change the condition watershed development interventions were implemented in the study area, the intervention brings in the improvement of crop and animal production and climate smart agriculture though the improvement of water resources availability increase both for irrigation and potable water, animal feed availability, increasing irrigation and rain fed agricultural land, Vegetation cover in the watershed increase, income of house holed beneficiaries increase, security of house holed beneficiaries increased, asset creation by house holed beneficiaries, vulnerability of house holed by climate change in the study area decreased.

The second issue addressed in this study is identifying key constraints and opportunities that facilitate or hinder households' food security and climate smart agriculture in the watershed development intervention. The major constraints were lack of data on the given watershed base, it is expensive to implement because it needs industrial imputes, lack of institutionalized by the committee.

The major opportunities that facilitate watershed development intervention on food security and climate mart agriculture includes

Availability of free labor to promote watershed development intervention, possibility of privation of intensive and up dated trainings to enhance sustainability of techniques and benefits. In addition to this there is possibility of increasing non-farm income to minimize the vulnerability of land- use and other unemployed inhabitants in the water shed.

5.2 Recommendation

Based on the finding of the study the following recommendations were raised for better contribution of the watershed technique and practices for food security and climate smart agriculture in the study area.

- ✓ Increasing the knowledge, skill and attitude of house holed beneficiaries on the watershed management techniques such as construction of water harvesting structures, hillside terrace, irrigation water management and area enclosure improvement are essential asthis help implementation, monitoring and evolution as well as sustainability of watershed benefits and interventions.
- ✓ It lacks data on given watershed base, It is not yet fully institutionalized by the committee Intensiveand up-dated training which focus on water management, water productivity and climate smart agriculture should be strengthened
- ✓ To improve the watershed development committee in the area responsible bodies; beneficiaries, agricultural office and woreda administrator should do more and organized trainings to make the watershed institutionalized by the committee. In addition there should be a project to reduce the financial burden of the area and purchased the necessary input and expensive to implement (needs industrial inputs). The major challenge in access the base line

- ✓ Data in the area should solve by having proper recording and archiving system of the woreda up to Kebelle level regarding the watershed management. This could help the beneficiaries to skim better the watershed management fruits. Thus, efforts should be strengthened to the constraints and institutional arrangements of the watershed development intervention and benefits.
- ✓ Moreover, the integration of resources from government and NGOs should encourage the watershed level to increase the effectiveness and efficiency of the watershed development projects.
- ✓ Therefore, participation of beneficiary's on non- farm activity could helped in minimizing the vulnerability of the beneficiaries by climate change on the watershed.
- ✓ Thus, strengthening and promoting awareness creation about how rural households organize themselves and participate in various on farm income generating activities helps to reduce rural unemployment especially for landless youth

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Appendices

Appendix. 1 House hold questionnaires

GENERAL INFORMATION OF THE RESPONDENT (answers sob,1, 2,3,)

S.N Question Possible response	**Possible response**	
1.1 Name of the interviewee:		
1.2 Sex of the interviewee (circle one	1. Male	2. Female
1.3 Age of the interviewee	Year----------	
1.4 Are you (interviewee) the Head of the Household? (circle one)	yes	No
1.5 Can you read/write? (circle one)	yes	No
1.6 If your answer for number 1. 5 is 'Yes', Where do you put yourse? (circle one)	1.Traditional Education (e.g., nay keshitimhirti)	
	2. Elementary incomplete	
	3. Elementary complete	
	4. Secondary incomplete	
	5.Secondary complete	
	6. Above secondary	

1.7. Basic Household Characteristics

S.N	Questions	Possible responses	
1.7	Are you or any house hold member a committee member? (circle one)	1.Yes	2.No ->2..1
1.8	How you feel the community committee(s) that you participate in satisfying users need?	1. Functions well 2. Functions better 3. Functions poorly	

2 Types of forests Afforested/Reforested for climate resilient initiatives in Watershed

S.N	Types of watershed Management practices	Do use this method? 1. Yes 2. No	How well effective to improve soil fertility? 1. None 2. Some 3. high 4.Very high	How do you learn these practices? 1. From parents 2. From neighbors 3. From training 4. From NGOs 5.From school 6.Others(specify, if any)
1	Fallowing			
2	Crop rotation			
3	Intercropping			
4	Manure			
5	Composting			
6	Fertilizer			
7	Mulching			
8	Legume trees			
9	Others(specify, if any)			

S No	Tree Type(species)		Do you plant this tree? 1.Yes 2.No	When did you plant and where?		How much the importance of these planted trees? 1.Nothelpful 2.Helped little 3.Helpedalot 4.Helped very much	What is the most important use of these trees?
	Local Name	Scientific Name		1.Before watershed interventions 2. After watershed intervention	1.Homestead 2. Farm Land 3.Communal land		
1	Bahri-zaf	Eucalyptus					
2	Chea	Acacia abyssinica					
3	Daero	Cordiaafricana					
4	Tsihdi	Juneperese					
5	Saspanya	Sesbaniasesban					
6	Tiri_Luser n	Tree Lucerne					
7	Lusnya	Leucaenaleuco cephala					
8	Gravilla	Gravillarobusta					
9	Acacia Akaka	Acacia saligna					
10	Giba						
11	Milieu						
12	Mekie						
13	Awlie	Others(spec					
15	Seraw						
16	Momona	Acacia Albida					

3. Types of water resources implemented for climate resilient initiatives in Watershed

S.N	Major Source	Before watershed development intervention		After watershed development intervention	
		Rainy Season 1. Yes 2. No	Dry Season 1. Yes 2. No	Rainy Season 1.Yes 2.No	Dry season 1. Yes 2. No
1	Spring /unprotected				
2	Spring /Protected				
3	Hand Dug well				
4	River				
5	Pond				
6	Dam				
7	Lake				
8	Rain water				
9	Borehole				
10	Tap water				

4. Types of institutions supporting for climate resilient initiatives in Watershed

S. N	Service (Support) at community Level	Availability of Services? 1. Yes 2. No		Rate of Services 1. Excellent 2. Good 3. Bad 5.Extermly Bad	
		Before watershed development interventions	After watershed development interventions	Before watershed development intervention	After watershed development interventions
1	Water supply for (drinking and Livestock)				
2	Training				
3	Educational support(school and KG)				
4	Supplementing of Agricultural input (improved seed, fertilizer, chemicals, etc)				
6	Support water harvesting				
7	Access to credit				
8	prevention of livestock disease and artificial insemination				
9	Supporting for preventing of crop pests and advice				
10	Supplying of improved livestock(Sheep, goat, chicken, bee, cow, ox, heifers)				
12	Supply of forage seeds				

13	Supporting for compost preparation and utilization				
14	Supporting for establishing private nursery				
15	Supporting for rehabilitation of gullies				
	Supporting for infrastructure(rural electrification, school, water point, veterinary clinic, road, health centered)				

Question for objective II: Assess and evaluate how the watershed management practices has improved the sustainable livelihood assets of the farm households

II. Wealth, Income, Land holding and Land productivity

S.N	**Questions**	**Possible responses**
2.1	Do you own or rent land for agricultural use in the last 12 months?	1. Yes 2. No
2.2	How did you use the farm land during the last 12months?	1. Used for own crop production 2. Rented it out 3. Remained idle (fallow) 4 Others(specify)_____

2.3. If Q 2.1 is yes, what is the size of land under different use during the last 12 months intsimdi?

Code	Land type	Area in tsimdi
1	Total land owned	
2	Crop land, Rain fed	
3	Cropland, Irrigated	
4	Pasture area	
5	Forest/trees	
6	Homestead	

2.14. Crop produced during the past 12 months and sales (Rain Fed)

2.4	If you rented land in the past 12 months, which type of land and the rent per tsimdi?	Code Size of land	Land type	Size of land Rented (tsimad)	(Rental Birr	
		1	Rain fed			
		2	Irrigated land			
		3	Pastured land			
2.5	Which type of selected variety of crops did you introduced in last 3or 4 years, and are you now planting these improved seed on a regular basis? (circle on the crop variety)			1. Sorghum 2. Chickpea 3.Teff 4. finger millet 5. Sesame 6. pulses 7. Ground nut 8. Pigeon pea 9.wheat 10. Maize 11. Barely 12.Hanfets 13 others(specify)		
2.6	Have you noticed an increase in production from these new varieties of crops?(circle one)			1.Yes 2.No		Q2.12
2.7	If Q 2.6 is yes, on which varieties of crops did you noticed the increased Production?			1.yes	2.No	
		1. Sorghum				
		2. Chickpea				
		3.Teff				
		4pulses				
		5. wheat				
		6. Maize				
		7. Barely				
		8.Hanfets				
		9. others(specify)				

2.8	If Q2.6 is yes, what do you think is /are the 3 main reasons for the increase in crop production?	1.Improved soil fertility			
		2.Better efforts(labor			
		productivity)			
		3.Improved cultivation Practices			
		4.Better availability of rain water			
		5.Better water harvesting			
		. Others specify			
2.9	If Q 2.6 is Yes, did the increase in the production of these selected varieties improve the availability of food or income for your households?		1.yes	2. No	
2.10	If Q2.9 is Yes, what is the quantity produced for different varieties in the last 12 months?		Area Planted, (Tsimidi)	Production, in (kg) per tsimidi	Current market price per kg
		1. Sorghum			
		2.			
		3.Teff			
		4.			
		5.			
		6. pulses			
		8. Pigeon pea			
		9.wheat			
		10. Maize			
		11. Barely			
		12.Hanfets			
		13.others(specify			
2.11	If Q 2.9 is No why? (multiple answer is allowed)	1. The increase in production is not proportional to my family size 2. The increase in production is not proportional to the family labor devoted 3. Even though I produced more, the price fluctuation reduced the income from the sale of these crops 4. The income I get, does not much with expense (the cost of other commodities that are need for the HH is higher than my income from the sales of these produces) . 5 Other specify _____			

2.12	Did you or your family member know any technique/ methods of crop production?		yes	No	
2.13	If Q 2.12 is yes, Which technique/s are you using now? (Multiple answer is possible)	1. Integrated pest management (IPM) 2. Row planting 3. Inter/mixed cropping 4. Crop rotation 5. Seed preparation/selection 6. Soil preparation	7. Vegetable production 8. Post harvest management 9. Fertilizer applications 10. Composting 11. Green maturing 12. Irrigation 13. other, specify		

Sr. No.	Type of crop produced	Area (tsimdi)	Amount of seed used (kg)	Cost of seed or seedlings (Birr)	Day of worked per year	Production (qt)	Amount sold (qt)	Income from sales (Birr)
1	Sorghum							
2	Barley							
3	Teff							
4	Wheat							
5	Maize							
6	Hanfets							
7	Barely							
8	Potato							
9	Onion							
10	Pepper							
11	Tomato							
12	Cabbage							
13	Carrot							
14	Others Specify							

2.15. Amount and cost of fertilizer and chemicals used for the crop specified in Q2.14

Sr. No.	Type of crop to which fertilizer applied	Urea (kg)	DAP(kg)	Cost of fertilize (Birr)	Manure (kasha?)	Compost (kasha?)	Cost of chemicals applied (Birr)
1							
2							
3							
4							
5							

2.16	Did you use irrigation to grow crops during the past 12 months?	1. Yes 2. No	Q 2.28

2.17. What is the source of water for the irrigation?

S.No	Source of irrigation water)	Possible response (tick)
1	River with traditional canal	
2	River diverted with lined canal	
3	Pond or horeye	
4	Spring/wells using traditional means	
5	Spring/wells developed with pumps	
6	Others (specify)_____	

2.18. What type of crop produced during the past 12 months and sales income (with Irrigation?)

Sr. No.	Type of crop produced	Area (Tsimdi)	Amount of seed used (kg)	Cost of seed or seedlings (Birr)	Production in QT	Frequency of production per year	Amount of sold (QT)	Income from sales (Birr)
	Onion							

	Pepper							
	Tomato							
	Cabbage							
	Carrot							
	Papaya							
	Mango							
	Orange							
	Banana							
	Guava							
	Potato							
	Lettuce							
	Swiss chard							
	Spices							
	Others							

2.19. Amount and cost of fertilizer and chemicals used for the crop specified in Q2.18

Sr.No	Type of crop to which fertilizer applied	Urea (kg)	DAP (kg)	Cost of fertilizer (Birr)	Manure (kasha?)	Compost (kasha?)	Cost of chemicals applied (Birr)

2.20	Do you own or pay rent for using the land	1. own the plot 2. rent the plot	
2.21	Does your total annual income cover your household expenditure?	1. Yes 2. No 3. Difficult1. (If "Yes" skip to Q. 6) to tell	

	that is irrigated in the past 12 moths		
2.22	If you rent the irrigated land, how much do you pay for the land you rented?	_____Birr _____ % of crop _____ other payment	
2.23	Have there been any changes in the availability of irrigation water to you since you use irrigation.	1. Increase in water 2. Decrease 3. no change	Q 2.24
2.24	If Q 2.22 is Decreased, What was the cause for the water shortage?	1. Damage of irrigation water canals 2. Leakage of irrigation water canals 3. Lack of maintenance of water point 4. Lack of equitable distribution of water 5. Shortage of water due to upstream water shortage 6.shortage of rain fall . Other, specify _____	
2.25	Is there today an active committee or group in the community that is responsible for maintenance and management of the irrigation water system (the water sources, canals, etc…)?	1. Yes 2. No	Q 2.27
2.26	If Q 2.24 Yes, in your opinion do you think this committee has been efficient in managing the irrigation system? (Rate their performance	1. Excellent 2. Very good 3. Fair 4. Poor 5.Very poor	
2.27	If Q 2.25 Poor or very poor, why?	1. Don't meet often enough 2. Not enough input from water users . others specify _____	
2.28	During recent droughts, and since the irrigation system was established, was irrigation water still available in sufficient quantity to irrigate crops in a normal way.	1. Yes 2. No	

2.29	Have the number of the different types of crops you have been growing changed over the last 5 years?	1. Yes 2. No			Q 2.30
2.30	If Q 2.28 is Yes, how?	1. The no. of different types of crops grown increased 2. The no. of different types of crops grown decreased			
2.31	What are the number of months you could feed your family from own production and other Sources?		Own production	Other sources	
		Number of month			
2.32	If you or your family participated in the Safety Net Program (PSNP), how many months does the food/cash provided covers the household food need?	amount			
2.33	If the food available decreased, what could be the reasons? (multiple answer is allowed)	1. Low production due drought 2. Low production due to poor soil 3. Larger family size 4 Other (specify)			
2.34	When there is food gap (shortage), how do you meet the food demand of your household/family? (State the options in the order of importance				
		1. Borrow money/food			
		2. Sell livestock			
		3. Rent out land			
		4. Sell household furniture			
		5. Sell jewelries			
		6. Sell firewood/ charcoal			
		7. Involve in petty trade			
		8. Involved in wage work			
		9. Migrate to			

		town		
		10 . Others (specify)____		
2.35	Did you have oxen for plowing?	1.Yes		Q 2.36
		2. No		
2.36	If Q 2.34 is No now, why?(multiple answer is allowed)	1.I have sold it 2.My land doesn't need oxen 3. I don't know how to do it	4. I have no land 5. The oxen died .Other (specify	
2.37	What are the numbers or other livestock that you have now?	Number of livestock		
		1. Cows ____ Nos4.Pack anim_____Nos 2. Sheep _____Nos 5. Bee colo_____Nos 3. Goats _____Nos. 4. Others specify----------		
2.38	If you have more animals now, how have you managed to obtain them?	1. Purchase with income earned from production 2. Payment of debt from someone 3.From animal reproduction 4. Other (Specify) _____		

2.39Type of income generation activities and income earned during last 12 months

Sr. No	Type of income generation	Income/Profit (Birr)
1	Petty trade	
2	Household enterprise	
3	Wage work other than PSNP	
4	PSNP	
5	Beekeeping and sale of Honey	
6	Others _____(specify)	

2.40Are you a member of any local (social institution) a) Yes) No

Question for objective III: Measure the role of watershed management practices on household food security and climate smart agriculture

Line	PRODUCT TYPE	Units type	No units produced per year	Value per unit (Birr)
1	Cut poles from the tree			
2	Cut branches			
3	Fodder (leaves)			
4	Fuel wood			
5	Charcoal			
6	Grass (cut and carry)			
7	Honey production			
8	Fruit production			
9	Egg			

S.N	Question			Possible response	Skip
2.41	What is the source of water for livestock? (multiple answer is allowed	Code	Source of water for animal	Tick on the response	
		1	River		
		2	Unprotected spring		
		3	Pond		
		4	Hand dug well(protected)		
		5	Protected spring		
		6	Deep well		
		7	Water tap at house		
		8	Shallow well (drilled)		
2.42	Did you or any member of the household participated in the Water supply scheme development?			1. Yes 2. No	Q 4.10
2.43	If Q4.8 is Yes, how did you or your household member		1. Free labor Contribution 2. Local construction material supply 3. Coordination or facilitation 4. Water committee 5. Guard 6. Wage worker for construction 7.cash 8. Site selection 9.land provision without compensation 10. Others (specify		
2.44	How much time does it take to fetch water round trip not Including waiting time?		Seasons	Time (in minutes or hour)	
			1. Dry season		
			2. Wet season		
2.45	How long do you queue/wait / to fetch water?		Seasons	Time (in minutes or hours)	
			1. Dry season		
			2. Wet season		
2.46	Total amount of water collected by the household per day? (Ask no. of trips per day and the no. of Jerrican or other container used to fetch water, make sure to ask the size of the container)		Season	Total amount of water collected per day	
			Dry season		
			Wet season		
2.47	How do you treat	Cod	Drinking water	Tick on the response	

	drinking water before use?	e	treatment		
		1	Add Wuha Agar		
		2	Boiling		
		3	Filtering with sand or cloth		
		4	Sedimentation by its own		
		5	No treatment		
		6	Others (specify		
2.48	If Q4.13 is NO TREATMENT now, why? (Do not read the answer. One or more answer is possible)	1. No need, the water is pure 2. Would like to treat, but do not know how to treat the water 3. Shortage of time 4. Use of water as fetched is a tradition 5 Others (specify)			
2.49	Is the water supply in your area fairly distributed to households?	1. Yes 2. No			
2.50	Was /is there any conflict between households or community on the water use?	1. Yes 2. No □			Q 4.18
2.51	If Q 4.16 is Yes, what do you think is the cause of the conflict?	1. Water shortage 2. Insufficient cattle trough 3. Unfair water distribution (not available to all HHs) . Others (specify)			
2.52	Who is responsible to repair the water supply points if damaged?	1. Staff of the water resources office (government) 2. NGO 3. Trained community member 4. Technicians . Others (specify)			
2.53	If Q 2.19 is No, what is the reason?	1. It is expensive 2. I do not have money 3. I can fetch water freely, no need to pay . Others, specify _____			
2.54	Are you satisfied with the management of the water point by the water Committee?	1. Yes 2. No			
2.55	Did you or your household member get any benefit from the current water supply?	1.Yes 2.No			

2.56	If Q4.22 is yes, What are the major benefits obtained to you or your household members from the water supply?	1. Time savings 2. Improve income 3. Health improvement 4. More water for other uses . Others, specify _____	
2.57	If your response for Q4.23 is health improvement how do you see the incidence of water born disease?	1. It is significantly reduced 2. It is moderately decreased 3. It is not decreased .others, specify_____	
2.58	If your response for Q4.23 is Time saving, how do you or your family members use the extra time saved in collecting water from the new sources?	1. Schooling 2. Other work to earn income 3. Care for children 4. Socializing 5. Rest Others specify	
2.59	If Q4.27 is Yes, is less time spent Providing water for your livestock?	1. Yes 2. No 3. No change	
2.60	Compared to past 5 years, how do you evaluate the water quality now?	1. Good 2. Poor 3. No Change	
2.61	What are the outstanding problems of Water supply in your area now? (Rank)	1. No problem 2. Shortage in quantity 3. Poor water quality 4. Operation of the constructed water source is faulty 5. Management of water point 6. Maintenance of the water point 7. Others , specify _____	
2.62	During the drought season, did you suffer from a lack of Household water or water for your livestock?	1. Yes 2. No	
I.			

S.N	Questions			Possible responses	Skip
2.63	Do you have access to clean and safe drinking water that used for domestic consumptions? (tick on one)			1.Yes 2.No	
2.64	What are the sources of drinking water for domestic consumption?(multiple answer is allowed	Code	Source of drinking water	Tick on the response	
		1	River		
		2	Unprotected spring		
		3	Pond		
		4	Hand dug well		
			(protected)		
		5	Protected spring		
		6	Deep well		
		7	Water Tap at house		
		8	Shallow well (drilled)		
		9	Other (specify)		
2.65	How much liters of water do you consume daily? _____liters				
2.66	Is more water (for different purposes) available all year round for your HH? (circle one)			1.Yes 2.No	
2.67	Are you a member of the water users association? (circle one)			1.Yes 2.No	
2.68	Do you feel the users have enough say in how the system is operated? (circle one)			1.Yes 2.No	

Selected Household covers their expenditure annual income before and after watershed intervention

No	Expenditure Item	Before intervention		After Intervention % improvement		% improvement
		Yes	NO	Yes	No	
1	Purchase of Agricultural inputs & equipment	90	122	180	32	42
2	Improvement of the house	69	143	138	74	33
3	Purchase of medicine or drugs	85	127	170	42	40
4	Purchase of household equipment's	89	123	176	36	41
5	Purchase of cloth	70	142	160	52	42
6	Purchase of Animals	96	116	181	31	40
7	Purchase of radio	85	127	168	44	39
8	Purchase of crops for consumption	185	27	175	37	-5
9	School expense	91	121	189	23	46
10	Rent farm land	90	122	144	68	25

11	Saving in banks	0	212	170	42	80

Question for objective IV: Identify the opportunities and challenges associated with watershed management practices

Problems (challenges) Associated with Watershed Management Approach and Possible Solutions

5.1. What type of problems did you observe in the water shed management approach?

Code	Possible Problems for Discussion	Tick on confirmed points
1	It lacks data on given watershed base,	
2	It is expensive (needs industrial inputs)	
3	It lacks data on given watershed base It is not yet fully institutionalized by the committee	

5.2. On your opinion, what are the possible solutions to the problems associated to the Watershed management approach? (It *is open-ended question*)

1. _____
2. _____
3._____
4._____
5._____

5.3 What are the possible opportunities?

Code	Possible opportunities	Tick on confirmed points
1	Interested for training	
2	Labor availability	
3	Good climate condition	
4	Market availability in nearby site	

Annex II: Focus group discussion points for Qualitative Data Collection

I. Wealth, Income, Land holding and Land productivity

1. How do you evaluate your land productivity without the watershed management and with the watershed management?
2. Did the conservation measures on your land accompanied with moisture holding and then better productivity? Do you use improved seeds for better productivity?
3. In your area did the project participants own wealth or increases income because of their participation in watershed management project? If yes how explain by more discussion?

II. Environmental Impact (Natural Resources Management)

1. How do see the Environmental change over the last five years?
2. What change did the watershed management project made to your area?
3. Are there more conservation measures done by the project on communal and private land?
4. What proportion of communal land that need treatment has been covered with protection measure since the past five years? If not all, why not? Who is responsible to maintain the constructed natural resource conservation measures, especially the one which was constructed in the communal land?

Did the communities have undertaken any maintenance work in natural conservation structures so far?

5. How do you manage the communal land or enclosure in your area? What are the mechanisms to share the benefits from the conserved communal land among the communities?

In your opinion do you think the benefit sharing system is providing equitable benefits? If yes how? If not why?

6. What impact do you observed after the construction of soil and water conservation measures?
7. Is there any benefit that is gained from the natural resource conservation to the community?
8. Are there additional direct or indirect benefits to the households in the community, apart from cash or food income from wage payment, derived from the natural resource conservation activities? Probe the group to explain in terms of house hold income and overall household benefit including other benefits such as grass cut- carry ground water recharge, wildlife, and microclimate

Improvement, etc….

9. In your opinion, do the NRM activities of the project contribute to the food security in the watershed? if yes ,how ?if no ,why?
10. Do you or anybody in your localities built assets (at household level) due to the involvement of natural resource conservation activities or the benefit obtained from the conserved areas?
11. Would you please tell us the any improvement in the lives of your community and households (in terms of increase income, increase productivity) due to the natural resource conservation measures?