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Watershed Management in Dodota District, Oromia Regional State of Ethiopia

Alemayehu Dechassa

A Thesis Submitted to
The Center for Environment, Water and Development

Presented in Partial Fulfillment of the Requirements for the Degree of Masters of Arts (Environment and Development)

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Abstract

Watershed Management in Dodota District Oromia Regional State of Ethiopia

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Addis Ababa University, 2012

The goal of most watershed development projects is to increase agricultural productivity through soil and water conservation and rainwater harvesting at the micro watershed scale. Accordingly, rehabilitated and developed water scarce watershed areas contribute to rural development through increased agricultural productivity; improved natural resource conservation and land and water development. In this study, the contribution of watershed management programme in Dodota district was assessed. To collect information relevant to the study 148 household heads, experts and elders were used as sources of data. Systematic random sampling method was employed to select household heads from selected kebeles. Structured questionnaire survey, key informant interview focus group discussion, and field observation were the major tools applied to collect the necessary information from watershed inhabitants. Descriptive statistics; percentages, mean and paired t-test was used to analyze collected data.

The finding of this study showed that the watershed management project was moderately increased forest area coverage, grass coverage, availability of wood and availability of grass resources. There was also improvement of access of water demand in terms source, quantity and trip time both for human and livestock. On the other hand, the watershed management use right transfer system was done more or less in a sustainable way. Local communities were also adopted SWC measures on private plot as a result of participation on watershed management. Finally, recommendations were given in the context of the study area.

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LIST OF ABBEREVATIONS AND SYMBOLES

AIDS	Acquired immune deficiency syndrome
AZFEDO	Arsi Zone Finance and Economic Development Office
CBPWDP	Community Based Participatory Watershed Development Planning
CD	Capacity Development
cm	Centimeter
COLTA	Community Organization and Leadership Training for Action
CSA	Central Statistical Agency
CW	Community Watershed Management Organization
CWT	Community Watershed Team
DDAO	Dodota District Agriculture office
EARC	Ethiopia Agricultural Research Center
EC	European Commission
EFAP	Ethiopian Forestry Action Program.
EPLAUA	Environmental Protection, Land Administration and Use and Authority
FAO	Food and Agricultural organization
FDRE	Federal Democratic Republic of Ethiopia
FFW	Food for Work
FGD	Focus Group Discussion
FSP	Food Security Programme
GTZ	German Technical Cooperation
ha	Hectare
HH	Household
HIV	Human Immune deficiency Virus
IDB	Inter American Development bank
IFPRI	International Food policy Research Institute
IGA	Income generating activities

IWM	Integrated Watershed management
Kg	Kilograms
km	Kilometer
KRF	Kalpataru Research foundation
m	Meter
m.a.s.l	mean above sea level
m^2	Square meter
mm	Millimeter
MOA	Ministry of Agriculture
MOARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of finance and Economic Development
MoWR	Ministry of Water Resource
NGOs	Non-Government Organizations
NMSA	National Meteorological Services Agency
^oC	Degree Celsius
ONRS	Oromia National Regional States
PD	Person day
PWSDP	Participatory Watershed Development Programme
qt	Quintal
SPSS	Statistical Package for Social Scientists
SSA	Sub-Saharan Africa
SSI	Small Scale Irrigation
SWC	Soil and Water conservation
UN	United Nation's
USAID	United State Agency for International Development
WFP	World Food Program
WMEC	Watershed Management and Environmental Conservation

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

The economy of developing countries depends on the performance of the agricultural sector, which in turn depends on how the natural resources are managed. In Ethiopia about 85% of people live in rural areas and depend on subsistence agriculture for their livelihoods (MoFED, 2002). However, in the majority of developing nations, there is degradation of the quality and quantity of natural resources as a result of population pressure and extensive agriculture. Environmental management based on an integrated planning approach should be placed in order to achieve an acceptable balance between the quality of the human environment and the quality of natural environment. According to Assefa (2009), the degradation of natural resources can be addressed through effective implementation of integrated watershed management.

To sustain their livelihoods, the rural poor are heavily dependent up on natural resources, particularly on land. Hence attacking poverty in rural areas is believed to be matters, improving poor people's ability to derive sustenance and income from more productively and properly managed land resources (Pretty et al, 2000; Habetewold, 2000). This in turn has led to substantial erosion hazards, diminishing soil fertility, disturbance of the hydrological cycle, land sliding catastrophe, desertification, erratic behavior of rain fall, and a further reduction in the ability to produce (Admase et al, 1985; Admase, 1988; Rahimeto, 1990 and Habtewold, 2000).

The productivity of agricultural lands in many developing countries is increasingly declining primarily because of land degradation, which is major cause of poverty in the rural areas (Hurni, 1988; Bekele, 2001; Sonneveld and Keyzer, 2002). The rates of such degradation do vary from region to region depending on relief, ecology, rain fall characteristics, land use cover, soil types and socio- economic realities. Some regions are more prone to drought than others and are often affected by food crisis. Of all the problems, soil erosion by running water is the most threatening and widespread ecological process, which accounts for 56% of the degraded land surface of the world (Oldman et al, 1990).

To address the land degradation and loss of soils, extensive conservation schemes were launched in Ethiopia, particularly after the famines of the 1970s. Since then, huge areas have been covered with terraces, and millions of trees have been planted (Herweg, 1993; Admase, 2000). However the efforts of these initiatives were seen to be inadequate in reversing the widespread and increasing land degradation (Shiferaw and Holden, 1998).

Soil erosion, deforestation and land degradation reduce the productivity of the soil and in turn affect the rain fall pattern (Pla, 2000). The ground water table also depletes leading to shortage of drinking water. These problems concern and affect the community and therefore involvement of the community in planning and implementation of the watershed programme is very much essential for the success of the programme.

In order to alleviate this problem the Federal Democratic Republic of Ethiopia (FDRE), together with European Commission (EC) support Small Scale Irrigation (SSI), Watershed Management & Environmental Conservation (WMEC) and Capacity

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Development (CD) projects in the drought–prone and vulnerable food insecure population. Of this activities watershed management programme is one that implemented in Dodota district. Therefore, to understand the existing realities at local scale conducting research on the contribution of WSM is inevitable.

1.2. Statement of the Problem

Access to water resource both for human and animals is the major problem in the Debeso and Adersho-kobo watershed. According to Dodota District water development office (2011/12), the majority of local households travel long distance which takes more than 3 hours to collect water. Similarly, DDoA reported that local farmers are highly dependent on communal grazing land in a very traditional and unwise manner. Moreover there were no organized and programme oriented conservation operations from the side of the government. As a result, forest resources were deteriorating rapidly in the past just before intervention of the project. However, European Commission Food Security Programme (ECFSP) (2006) reported that there was an improvement in water demand and natural resource recovery due to watershed management programme in the study area. Therefore, this research is to understand changes registered in access to water demand and forest products due to implementation of watershed management on the livelihood of rural people.

Additionally, DDoA (2011/12) indicated watershed management was handled by community since January (2003). However, after January (2003) the watershed was given to organized youth groups for its management and utilization. Therefore, assessment of the perception of local households on transfer mechanism is important to assure its

sustainability. Similarly, the participation of local household in watershed management is a vital in improving sustainability and augmenting people's technological adoption. However, there was no in-depth technical evaluation of the contribution of with respect to technological adoption of the programs particularly with intention of academic lesson, except financial and consultants reports. Thus, this study intends to fill the gap through assessing the contribution of watershed management efforts in improving local households' participation and technological adoption.

1.3. Objectives of the study

The general objective of the study is to assess the contribution of watershed management projects on the livelihood of rural people. Specifically, this study focuses on the following objectives:

- To assess the contribution of watershed management efforts in improving local households access to water resources;
- To assess the contribution of watershed management efforts in improving local households access to forest products;
- To assess the perception of local households on transfer mechanism of current management system;
- To assess local households participation on watershed management and technological adoption from community watershed to private plot;

1.4. Significance of the Study.

The study would try to reveal the contribution of watershed management program in improving local households' access to water, forest resources and technological adoption. Therefore, the outcome of the study will generate information for policy makers, governmental and non-governmental organizations to design and develop effective watershed management approaches by critical assessing the contribution of WSMPs on the livelihood of rural people. Therefore, the study will have significant contribution to learn and think more about how to better developed the ongoing new program in line with the local condition. The significance of the finding will not be limited to the area under study, but also other areas which have similar Scio –economic, institutional and natural recover back ground with that of the study area.

1.5. Scope of the Study

The study was delimited to Assessment of the contribution of WSM in improving water access, natural resource recovery as well as technological adoption. Specifically the study covered Debeso and Adersho-kobo watershed in Dodota District. These watersheds have been implemented under EC funded FSP and Dodota District Agriculture office. The sample watersheds were selected from watersheds implemented during 1995- 2000 E.C. All investigations worked in line with WSM contributions in improving local households' access to water resource, natural resource recovery, participation and technological adoption in the context of the local communities.

1.6. Limitation of the study

The absence of adequate/ in-depth base line data forced the researcher to depend highly on retrospective/ historical analysis with basing the local community as the main source of data. Additionally, because of budget, information and competence constraint, it was impossible to cover more than two watersheds (10 villages) of the study area. Therefore, Functioning of watershed Associations and users groups and soil fertility test of watershed area were issues that need further research.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Definition of Terms and Concepts

2.1.1. Watershed

A watershed is defined as the drainage basin or catchment area of a stream or river. In other words, it refers to the entire upstream topography around a defined drainage channel, which feeds water to the lower stream (Farrington et al, 1999). According to Brooks (1993) watershed is a topographically delineated area that is drained by a stream system, that is the total land area above some point on a stream or river that drains past that point. It could also be considered as the hydrologic unit that is increasingly recognized as a physical-biological and socio-economic model unit for integrated territorial planning and strategic land-use management at different scales.

On the other hand, Kalpataru Research Foundation (2001) defines watershed as an area of internal drainage above a common point of out let. The size of the watershed is dependent on the topography of the area. It is bound on all sides by a divide or ridge line. The watersheds are classified in to mini watershed and micro watershed depending on the size. The basic components identified in the watershed development are the soil and water conservation, water resource development, agricultural productivity and most important being the people's participation in development of watershed.

2.1.2. Participatory Watershed Development

Watershed development is a holistic approach to improve and develop the economic and natural resource base of dry and semiarid regions (Ninan and Lakshmikanthamma, 2001). It has Potential for growth, improvement in income levels and augmenting the natural resource base of the disadvantaged regions of the country (Singh, 1991). Accordingly, (Joshi et al, 2004, 2006) states effective use of land and water is fundamental to growth and development. Thus, the watershed development programmes include land, water and human resources as essential components. The watershed programme is primarily a land based programme, which is increasingly being focused on water, with its main objective being to enhance agricultural productivity through increased in situ moisture conservation and protective irrigation for socio-economic development of rural people. Similarly, (Desta et al, 2005) confirms that Participatory watershed development is rational and socially acceptable utilization of all the natural resources for optimum production to fulfill the present need with minimum degradation of natural resources such as land, water and the environment: in which people's needs and aspirations drive the planning process. It encompasses:-

- Land owners and the landless,
- Involvement of people in planning, implementation and monitoring and evaluation,
- Joint decision making,
- Make changes if necessary,
- Full participation of men & women,
- Multi - disciplinary & multi - institutional approach and Multi interventions.

Participatory[1] and integrated[2] WD is therefore essential for ensuring the sustainability of flows and exchanges between upstream and downstream areas within a given territory. While conventional WD focuses mainly on natural resources, participatory and integrated WD considers social, political and cultural factors as important (Bank-Netherlands, 2001).

2.1.3. Integrated Watershed Management (IWM)

Managing a watershed involves taking into consideration the interaction in time and space not only of individual plots but also of the common pool resources such as forests, springs, gullies, roads and footpaths, and vegetative strips along rivers and streams (Swallow et al, 2000). Watershed resources provide different services to different users, and these users are differentially affected by resource use decisions. This implies that participatory watershed management will often involve a process in which stakeholders jointly negotiate how they will define their interests, set priorities, evaluate alternatives, and implement and monitor outcomes (Bank-Netherlands, 2001).

Integrated watershed management (IWM) is a process of formulating and carrying out a course of action to managing human activities in an area defined by watershed boundaries in order to protect and rehabilitate land and water, and associated aquatic and terrestrial resources, while recognizing the benefits of orderly growth and development. It is an integrated and holistic approach to the development of an area with the ultimate

[1] The term "participatory" reflects the idea that such management "should be set up with the participation of the local civil society, including communities, private interests, local government and national line agencies" (FAO, 1998).

[2] The term "integrated" reflects the fact that "the scheme is to be developed, taking into consideration both natural resources use and conservation and socio-economic development needs, i.e. environmental and human factors"(FAO, 1998).

objective of improving the quality of the live of the people who dwell within it (FAO, 2000).

According to FAO (1998), Integrated watershed management (IWM) is the process of formulating and carrying out a course of action involving manipulation of natural, agricultural and human resources on a watershed to provide resources that are desired by and suitable to society, but under the condition that soil and water resources are not adversely affected. Watershed management must consider the social, economic and institutional factors operating inside and outside the watershed.

Integrated water resource management is the coordinated development and management of water, land and related natural resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Gregerson et al, 2007). According to (Parlak and Ozhen, 2005), watershed management is related to protection of water resources, capacity and feasibility of land, and vegetation to be managed for products and services.

Similarly, Araya (2001) stated that watershed management is the integration of technologies with in the natural boundaries of a drainage area for the optimum development of land, water and biomass resource to meet the basic needs of the people in a sustained manner. Each watershed has distinct characteristics that define its potential and problems. The size, shape, drainage, geology, rainfall, climate, surface condition, land use, ground water resources, indigenous conservation practices, existing communal land management systems, types of livelihoods and the scio- economic status of the population in the watershed determine its runoff, sedimentation, soil moisture and

nutrient conservation measures and its potential development (Shah, 1998 cited in Araya, 2001).

Scholars like Gregersen et al (2007) stated that integrated watershed management approach is distinguished from other land management practices in its holistic consideration of the linkage among all of the activities within the watershed and how these linkages affect each other and the sustainability of the natural resource base on which people depend.

Watershed resources such as vegetation, soil, and water are highly interactive. This implies the problems of devegetation, soil degradation and water resource depletion are interrelated. So that vegetation, soil and water cannot be managed for sustained availability in isolation from each other. Any effort of managing the natural vegetation cover is futile unless the expansion of cultivation in to areas with natural vegetation is stopped. This requires sustained or even improved productivity of cultivated fields, for instance through adequate SWC. Hence viewing the whole of a watershed as a system and treating simultaneously all forms of land uses n the unit is essential (Bewket, 2003).

Many watershed development projects around the world have performed poorly because they failed to take in to account the needs, constraints and practices of local people participatory watershed management, in which users help to define problems, set priorities, set technologies and policies and monitor and evaluate impacts is expected to improve performance. User participation in watershed management raises new questions for watershed research, including how to design appropriate mechanisms for organizing stockholders facilitating collective action (Beshah, 2003; Tesema, 2001).

Watershed management is simultaneously a technical and social undertaking. From a technical perspective, it involves reducing soil erosion, promoting vegetative cover, and harnessing rainwater resources. From a socioeconomic perspective, it involves coordinating the actions of numerous land users in a watershed who may have multiple, conflicting objectives (FAO, 1998).

2.2. Why watersheds?

Watershed development aims to balance the conservation, regeneration and use by humans of land and water resources within a watershed. Common benefits from successful watershed development projects include improved agricultural yields and increased access to drinking water. The overall attributes of the watershed development approach, by and large, are three fold, namely: promoting economic development of the rural area, employment generation, and restoring ecological balance (Farrington et al, 1999; Dolar, 2006) cited in singh, p; Behera, H.C. and Singh, A. 1991. According to (FAO 1999), the degradation of natural resources is the greatest constraint to sustainable agricultural development in most of the developing countries. The degradation could only be reversed with sustainable use and management of the land resources which intern could only be achieved by adopting a system of improved land, water and vegetation use based on an integrated approach for land resources development with direct involvement and participation of the different actors.

Watershed development projects results in increase agricultural productivity through soil and water conservation and rainwater harvesting at the micro watershed scale (Deshingkar, 2004). Accordingly, rehabilitated and developed water scarce watershed

areas contribute to rural development through increased agricultural productivity; improved natural resource conservation and more equitable and sustainable management of common property resources. Additionally watershed development aims to increase employment through labour-intensive soil and water conservation (Deshingkar, 2004).

According to CBPWSDP (2011), watershed is activity that physically easy to define and is units that can be replicated and incorporates all programs, resources and regulatory tools available to protect ecosystem and human health within a catchment. Therefore their development is successful only when the economic welfares of the watershed stakeholders are being improved, and thus, watershed development and economic development go hand-in-hand.

2.3. Principles of Watershed Development

The main principle of participatory watershed development planning encompasses the following issues:

Participatory: Involvement of primary stakeholders at the centre of planning, budgeting, implementation, and management of watershed projects (Desta et al, 2005; Government of India, 2008). It is important to secure meaningful participation on the part of the population. Experience points to a clear correlation between the level of people's participation and the level of efficacy of projects (Dutta *et al*, 1996). The advantages are many and wide-ranging. Thus, it is possible to arrive at an accurate identification of priorities, the contribution of innovative ideas, the incorporation of people's own traditions and lore, development in self-confidence as the project proceeds, a jealous control over resource use, self-support over the medium and longer terms; a

strengthening of the people's own forms of organization and the bringing into being of a virtuous circle of improvement.

Building up on local experience and strength: local knowledge is essential to improve existing technologies, to adapt new once and to manage natural resource and other resources once they are introduced and established. Recognition of cultural and local knowledge sustains watershed protection and development activities (Sumbalan, 2004).

Gender Sensitive: the extent that women and girls participate in project processes and Benefit from project outcomes. Therefore, need to be more sober and other measures introduced within a long-term strategic perspective, to strengthen social organization among the poor and women prior to watershed rehabilitation (Turton and Farrington, 1998).

Involvement and commitment of various disciplines: participatory watershed planning requires the involvement and commitment of the various disciplines. This is not only logical but also advantageous as different activities are mutually reinforcing. Watershed resources provide different services to different users, and these users are differentially affected by resource use decisions. This implies that participatory watershed management will often involve a process in which stakeholders jointly negotiate how they will define their interests, set priorities, evaluate alternatives, and implement and monitor outcomes (Swallow et al, 2000).

Under ideal conditions the district core team is composed of 10 experts: one soil conservation expert, one forestry/agro forestry expert, one agronomist, one water harvesting expert, one home agent, one live stock expert, one land use and

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administration food security expert (economist/ socio-economist), one cooperative/marketing and inputs expert, one rural road construction expert. In condition where there are no enough district experts as a proposed the district agriculture office is expected to fulfill at least the first four experts listed above (Desta et al, 2005).

Realistic, Integrated, Productive and Manageable: watershed development planning should be realistic, based up on local capacity, local available resources and other forms of government and partner support. Integrated conservation and development of the natural resources base is the guiding principle for watershed development together with the optimum use of social resources. To the extent watershed development activities should provide tangible and quick benefits to households. If a project does not generate enough benefits to improve the livelihood of the community, it will clearly not become sustainable. (WFP, 2005). This is possible if measures are designed to accommodate both production and conservation requirements. Some measures, however, need some time before the full benefits can be achieved. In this case, combination of measures with short and long term benefits is essential. This can be achieved if quality criteria and integration aspects of the intervention are met (Desta et al, 2005).

The Need for Flexible at Different Levels: flexibility is the key criterion required in PWDP to fit local conditions. Flexibility is needed during the selection of community watershed, their size (slightly smaller or larger than the ranges indicated) and clustering and during the steps of the procedures. Sensitivity and recognition of cultural and local knowledge, as well as, flexibility to negotiate with various stakeholders sustain watershed protection and development activities (Sumbalan, 2004).

***Cost Sharing /Empowerment/ Ownership Building*:** Cost sharing is very important because cost sharing by stakeholders contributes to the sustainability of a project or any watershed development activity for it also helps establishing the responsibility of the various stakeholders in the management of the resources. According to (Kakade and Hagade, 1998), cost sharing allows a sense of ownership over the assets created as well as a reflection on their involvement in planning and execution of the watershed program.

Complementary to Food Security and Rural Development *(including HIV/AIDS mainstreaming and basic services and social infrastructures):* watershed development planning will incorporate additional elements related to basic services and social infrastructure. These activities will all benefit from participatory watershed development frame work (Desta et al, 2005; Admase, 1988; Simane, 2002; and Bewket, 2000).

2.4.Elements and Characteristics of Watershed

In order to understand the elements and corresponding characteristics of a watershed, one should be able to look into the following major components characterizing the watershed. According to (Desta et al, 2005), the basic elements and characteristics of watershed include biophysical and socio-economic aspects:-

Biophysical aspect: This is the part that deals with the physical aspects of watershed such as climate, drainage, water, vegetation, soil, topographic features, land-use and the like.

Socio-economic aspect: socio-economic elements and characteristics of a watershed involve population, farming systems, social setups, economic activities, vulnerability profile, gender and the like. Watershed planning is democratic. It embraces the views of various categories of people in the watershed/s. although all community members are

expected to benefit from watershed development, specific attention is required to address problems of resource poor and vulnerable families and promote the empowerment of women (Desta et al, 2005; Simane, 2002; and Bewket, 2000).

2.5. Watershed Degradation Features

Watershed degradation has emerged in recent decades in many different parts of the world as one of the most serious examples of natural resource degradation, with negative environmental and socioeconomic consequences, particularly in developing countries. Although watershed degradation is sometimes taken to refer to water resources only (Mazvimavi 2002), it is best understood as the degradation of both soil and water in a watershed because of the interactions between soil erosion and land degradation, impoverishment of vegetation cover and depletion of water resources. Thus, for the purpose of this study, watershed degradation is understood as the long-term reduction of the quantity and quality of land and water resources in a watershed. Changes may be caused by a range of natural and anthropogenic factors, the most important of which are discussed in the following paragraphs.

Soil Erosion and Land Degradation: soil erosion is one of the most important components of land degradation. Soil erosion and degradation is a reduction soil depth and fertility. It is caused by erosion (soil removal, loss of nutrients), reduced soil water holding capacity and excessive exploitative use of land (cultivation of steep slopes, shallow soils, tillage, overgrazing, encroachment of forests/closed areas, and others). Land resource degradation occurs in various forms. In degraded watersheds, forms of degradation can be physical, biological and chemical (Desta et al, 2005).

Impoverishment of the Vegetative Cover: Impoverishment of the vegetative cover is reduction of the vegetative cover and biomass caused by climate factory, over utilization of vegetation such as cutting of trees, over use of crop residues for forage and fuel wood, over grazing, and burning, erosion and reduced soil fertility. Trees were felled for timber and firewood and to clear the ground for subsistence crops, bringing about significant environmental damage, such as soil erosion and species loss (Blackman, Ávalos-Sartorio, and Chow 2007).

Depletion of Water Resources: Ethiopia suffers from what is referred as "recurrent wastage of most of its rain water". With loss of water through surface run off, soil is also eroded, thus triggering the whole chain of negative consequences leading to chronic food insecurity. In most developing countries, only 20-50% of the total surface run off is controlled and effectively used. Ethiopia is among them as topography, inadequate farming practices, and lack of conservation hamper water and moisture retention and its efficient use.

Runoff is the portion of rain fall that does not infiltrate in to the soil where it falls down. Close connection with the condition of watershed can be made clearly showing that water is scarce where watersheds are degraded. Therefore, for effective harvesting and utilization of surface and sub surface water sources for both domestic, livestock and production uses, watershed development is the most appropriate modality (josi et al 2006 and Desta et al 2005) .

The linkages among these three factors are obvious: land degradation is mostly responsible for reduction of the vegetative cover and ultimately depletion of the water

resources which in turn makes the soil, water and vegetation more vulnerable to further aggravation in degradation of the watershed. The chain reaction could ultimately lead to desertification or disappearance of the land to sustain life and livelihoods (Simane, 2000; Beweket, 2003; Sigah, 1991, and Green land *et al* 1994).

2.6. Land Degradation In Ethiopia

The greatest challenges that hiders the productivity in the highlands of Ethiopia are high concentrations of population and livestock; these factors cause biophysical land degradation and hinder sustainable agricultural development in the country (EFAP, 1994; Bojo and Cassels, 1995; Herweg and Stillhardt, 1999). Therefore, to compensate for the low agricultural productivity, forest lands are being converted to arable land in Ethiopia for centuries. The natural forest cover in Ethiopia has declined considerably from 1900s approximately 40% to just less than 3% at present (Kuru, 1990; EFAP, 1994). According to Reusing, 1998 the rate of deforestation in Ethiopia, which accounts to 163,000 - 200,000 ha/yr, is one of the highest in tropical Africa.

Land degradation in the form of soil erosion, sedimentation, depletion of nutrients, deforestation, and overgrazing - is one of the basic problems facing farmers in the Ethiopian highlands, and this limits their ability to increase agricultural production and reduce poverty and food insecurity. The integrated process of land degradation and increased poverty has been referred to as the "downhill spiral of un-sustainability" leading to the "poverty trap" (Greenland et al, 1994). The immediate consequence of land degradation is reduced crop yield followed by economic decline and social stress.

Soil erosion is the main form of land degradation, caused by the interacting effects of factors, such as biophysical characteristics and socio-economic aspects. Degradation resulting from soil erosion and nutrient depletion is one of the most challenging environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile land (Amsalu and de Graaff, 2006).

The degradation of agricultural land causes a serious risk to current and potential food production in the highlands of Ethiopia (Hurni, 1988; Bekele, 2001; Sonneveld and Keyzer, 2002). Soil nutrient depletion, arising from continuous cropping together with removal of crop residues, low external inputs and absence of adequate soil nutrient saving and recycling technologies are also aggravates land degradation in Ethiopia (Bojo and Cassels, 1995; Sahlemedhin, 1999). According to study conducted by FAO (1998) in 38 sub-Saharan Africa (SSA) countries, including Ethiopia showed that Ethiopia is one of the countries with the highest rates of nutrient depletion.

Recognizing land degradation as a major environmental and socio-economic problem, the government of Ethiopia has made several interventions. As a result, large areas have been converted to terraces, covered by soil bunds, closed by area closures and planted with millions of tree seedlings. Nevertheless, the achievements have fallen far below expectations. The country still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly (Beshah and Berhanu, 2003). Of the various interventions, extensive conservation projects are carried out with the support of the WFP (World Food Program) (Bekele and Holden, 1998).

Though, the success rate has been minimal food aid has helped to fight hunger in famine-stricken areas. According to (Wood, 1990; Herweg, 1993) lack of involvement of local people in planning and implementation of the scheme and poor implementation and maintenance of the soil and water conservation structures were recognized as reasons for low success rates. Eventually, when the supply of food-for-work was discontinued, most of the participating farmers became unwilling to participate in the new conservation projects or maintain those already established. Additionally, (Ademase, 2000; and Tessema, 2001) stated that some farmers even removed the structures from their lands. Similarly, Bekele (1997) explained that only 25 % of the rehabilitation target has been accomplished and most of the physical soil conservation measures and community forest plantations were destroyed in Ethiopia.

2.7. Watershed Management Practices In Ethiopia

The Ethiopian government has implemented large national programmes in the 1970s and 1980s with intentions to protect the continuing soil erosion. However, the efforts of these initiatives were seen to be inadequate because of high rate of demographic growth within the country, widespread and increasing land degradation, and high risks of low rainfall and drought. As a result, the Ethiopian government has supported rural land rehabilitation, these aimed to implement natural resource conservation and development programs in country through watershed development since 1980 (MoARD, 2005).

During this time, watershed projects were merely considered as a practice of soil and water conservation. The achievements of early watershed projects were marked as the basis of major watershed initiatives in Ethiopia. But only technological approaches were

adopted from those early successful projects and the lessons related to institutional arrangements were neglected. The newly implemented projects neither involved nor took effort to organize people to solve the problem collectively. Accordingly, where village level participation was attempted they typically involved one or two key persons like village leaders. These projects failed due to their centralized structure, rigid technology and lack of attention to institutional arrangements (MoARD, 2005).

2.8. Community Participation In Watershed Management

According to (Jeffery and Vira, 2001, cited in: Dube and Swatuk, 2002), direct involvement of local people with the state, and transforming the common experience of conflict into co-operation can help to reveres environmental deterioration. Furthermore, Pretty and Ward (2001) stated Governments and NGOs have recognized that protection of watersheds cannot be achieved without the willing participation of local people. Therefore, successful watershed development could achieve through full local people's participation.

This is one of the lessons learned from the failures of centrally planned watershed development projects through which local people have been either forced to construct terracing, bunding, rehabilitating gullies and other technical measures that external experts believed would cure watershed degradation (IDB, 1995; Kerr et al, 1996; Rhoades, 1998).

Farmers' participation is not only essential during planning phase of watershed development to rehabilitate land and water resources but also during implementation of soil and water conservation activities like terracing, bunding by food for work. Since,

they are closer to the real problems, and therefore they are aware of issues that experts may miss, and their objectives are more practical for economic development (Stocking, 1996). Furthermore, their participation in conservation work is also considered important in improving the adoption of the recommended technology (Ashby et al, 1996).

In most developing countries, like Ethiopia, most of the projects were centrally planned. As a result, soil and water conservation programs are promoted with standard technical solutions such as terracing, contour bunding etc. on the assumption that soil conservation measures are universally applicable and local farmers are unaware of soil erosion and ignorant of its causes and consequences (Pretty and Shah, 1999, cited in: Johnson et al, 2001). However, these measures, which were often forced on the people, may cause more erosion than their own indigenous practices, either because the new conservation works are not maintained or are technically less well adapted than existing practices (Kerr et al, 1996). The large majority of watershed development projects are based on rigid and conventional approaches considering only physical planning without attention to socio-economic or ecological conditions.

The needs and priorities for different users are different in each watershed. By seeking information from farmers about their constraints and priorities, their potential for new technologies, appropriate policies and technology can be designed for each watershed. Therefore participatory watershed management involves all actors to jointly discuss their interests, prioritize their needs, evaluate potential alternatives and implement, monitor and evaluate the project outcomes (Bekele and Gathriu, 2006). Ultimate User participation is vital for the success of watershed development projects. A participatory approach implies a major role for the community and involves partnerships with other

interested groups, from bottom to top, and with policy makers. But the key concern is to identify approaches that can attain an efficient, effective and accountable line between the community, the local bodies, the state and the central bodies (Carney and Farrington, 1998).

2.9. Ecological Significance of Watershed

Ecologically, watersheds provide critical habitat for many plant and animal species as well as transport paths for sediments, nutrients, mineral and variety of chemicals. Watersheds also provide water to human communities for drinking, recreation, navigation, hydraulic power and manufacturing (Bonnel, 2000 cited in Gorder et al, 2001).

It also provides agricultural land for subsistence and commercial farming to produce agricultural crops. Farmers engaged in agricultural cropping on watersheds that might also be used to grow forage or fodder for livestock production, trees for commercial purposes or environmental protection (Gregerson et al, 2007). Watershed provides trees as source of construction materials, fuel for people living both on up land watersheds and down streams, source of fodder for livestock and for wild life populations. Fruits leaves, young shoots and roots trees are often valuable food reserves for people. Trees play important role in manufacturing the ecological balance of many watershed environments. The root of trees hold soil in place as a result, control soil erosion and help to stabilize steep slopes (Gregersen et al, 2007).

2.10. Components of Watershed Development

According to (Pretty, 1995; Singh, 1991 and Mollinga, 2000), Watershed development consists of the following components namely:-

Land management: treatment that is done on the land that may be cultivated or uncultivated Such as contour bunding, graded bunding, contour trenching, staggered contour trenching and terrace bunds are covered.

Water management (Drainage line treatment): Where rainfall is unreliable and inadequate, water shortage severely limits crop production. As a result, Water conservation and harvesting can make crops survive during the dry period and in turn can stabilize and increase production.

Biomass development: The grass, shrubs and trees that are planted on the contour can protect the soil and provide fruit, fodder, fuel-wood and timber.

Animal Resource Development: As soil and water quality and quantity improve the availability of fodder increases. This gives opportunity to improve the productivity of livestock.

Human Resource Development: Formation of people's institutions and working through these institutions at all levels, involvement of women through formation of self help groups, and introduction of income generating activities are some of the activities undertaken to develop human resources. All these components are interdependent and interactive.

2.11. Impact of Watershed development on Life of Community and local resources

Watershed development can bring changes on life of the community in one way or another since, life of the community is dependent either directly or indirectly on natural resources such as water, land and vegetation. Effective and sustainable watershed development can bring better quality of life to any community in providing many important environmental, social and economic services (Bank-Netherlands, 2001). Well planned, politically supported and effectively implemented land and water management activities within an IWD context can help to reduce or eliminate some of the problems. The increasing need of accelerated population growth with the disparity of rain fall distribution will bring a change on food security achievement if and only if there is good watershed management. Sustainable watershed development can enable a country to bring good standard of living, enable a country to generate hydroelectric power at a lower cost to meet the national energy demand and provide surplus power to be marketed to neighboring countries in order to get foreign currency (MoWR, 2001).

Watershed management interventions involving the rehabilitation of degraded landscapes to restore flows of natural resources in turn lead to better management of the watersheds in some countries like Korea (Gregerseen et al, 1982 and Bocher, 1983). They confirms that many watersheds in the world are subject to agricultural cultivation, livestock grazing, timber harvesting and other forms of human interventions. More over better watershed management can bring better protection of the different local resources of vegetation, water and land resources as well as animals, which in turn minimize run off and consequently can increase productivity of the land.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Conceptual frame work

Sustainable use and management of the land resources could only be achieved by adopting a system of improved land, water and vegetation use. In this connection, the watershed condition of topography, soil, vegetation and land use has direct implications on the water resources in particular and on the behavior of the natural resources in general (FAO, 1999).

Rehabilitated and developed water scarce watershed areas contribute to rural development through increased agricultural productivity; improved natural resource conservation and more equitable and sustainable management of common property resources. Additionally watershed development aims to increase employment through labour-intensive soil and water conservation (Deshingkar, 2004). According to (Pretty, 1995; Singh, 1991 and Mollinga, 2000), Watershed management results in land, water, biomass supply, animal production and human resource improvement.

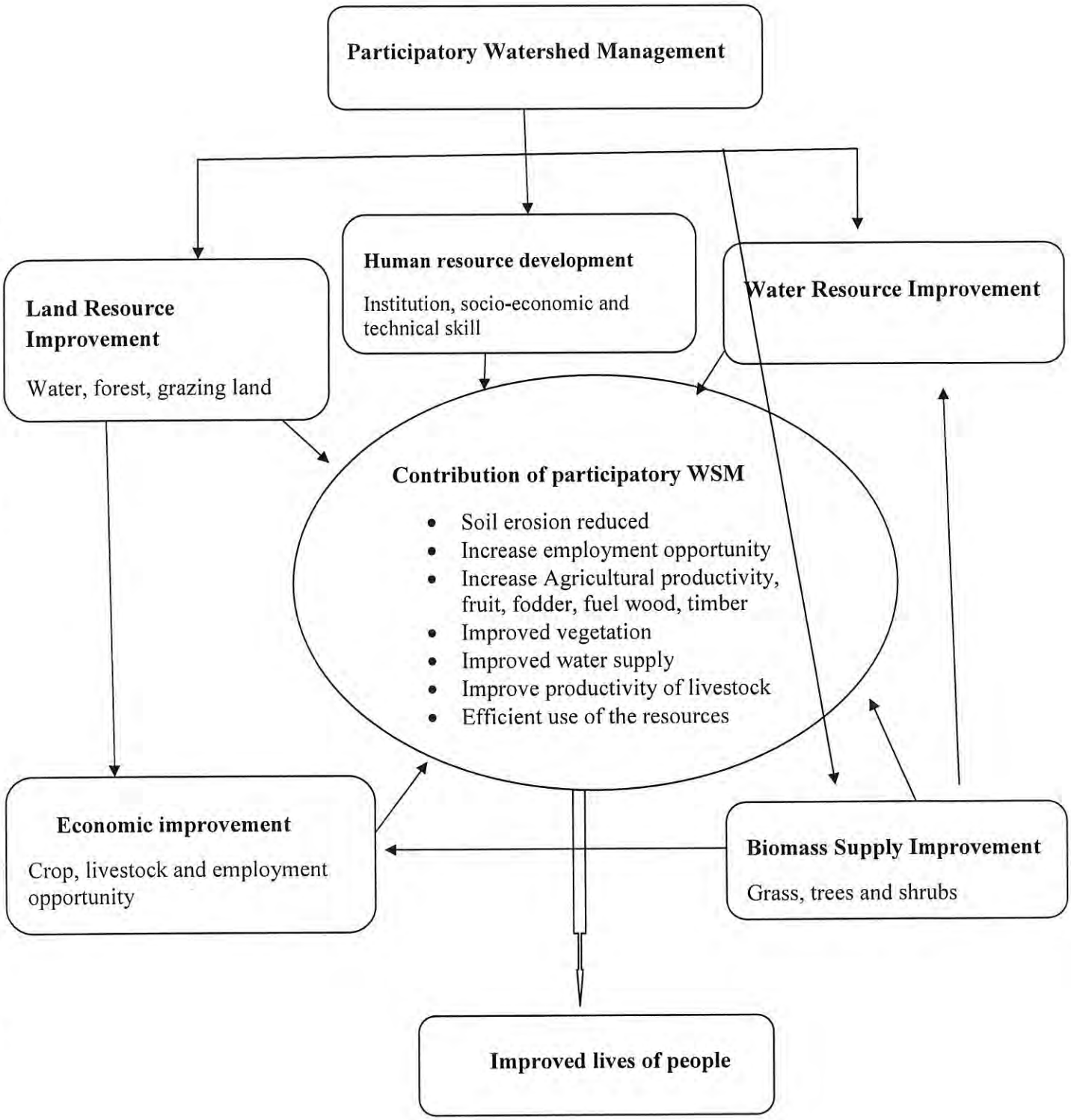

Figure-3.1: Schematic depiction of conceptual framework

Source: Modified from (Pretty, 1995; Singh, 1991 and Mollinga, 2000)

3.2. Source and Tools of data collection

3.2.1. Types and source of data

Data for this study came from two sources: primary and secondary sources. The researcher conducted the primary data collection. In this research, farmers were the major sources of primary data. In order to ensure the reliability and validity of the data collected, triangulation methods was employed during collection of primary data. These methods include focus group discussion and key informants. As part of the primary data, information was also collected from experts of Dodota District agricultural office.

The primary data obtained from the fieldwork was also supplemented with data obtained from secondary sources in order to bridge information gap from primary sources. Secondary sources of information used for this study include published materials such as reports, plans, official records, census records, project reports and research papers.

3.2.2. Tools of Data Collection

A combination of tools was used to collect relevant data. These include structured interview, key informant interview and focus group discussion document analysis and field observation. These methods generated relevant information for the study.

3.2.2.1. Structured interview

This was the most important tool of data collection in this research. On the bases of information obtained from techniques discussed above and literatures, questionnaire was developed (Appendix- IV). The questionnaires were handled by development agents. As local peoples are speaking *Afan Oromo.* Therefore, for the remunerators were from the

area who can communicate with the local language and those who know the area very well. Prior to implementing the survey, the questionnaire was used to train enumerators and tested for their clarity. Questioners that were found not to be clear to the local people and enumerators during training and testing were modified. Amendments were also incorporated into the questionnaire so as to make the idea easily comprehendible to the interviewees and enumerators.

The survey questionnaire covered a wide range of information which included household characteristics, income and expenditure, perception of sample households on watershed development, transfer mechanism and knowledge transfer from WSMPs to private plot. During the collection of information using structured interviews, attempt was made to make the process of interview more effective by making the process of interview two ways interactions. This was made by getting not only interviewer but also interviewee can also ask question. Finally, the response of the farmers fitted to possible lists of alternative answers, which were worked out carefully during the initial period of the fieldwork

3.2.2.2. Key Informant Interview

Individuals, who have experience and /or knowledge in the area of watershed development programme was selected and interviewed. The pre- planned checklists were practice among Woreda natural resource protection process owner and officers, Das, local administrators and community elders. Eight peoples (two elders, two youth, two women one District NRM expert) were selected from each watersheds through purposive

sampling and interviewed (Appendix-V.B). Field notes taken from the interviews were reviewed after each interview to verify its quality and consistency.

3.2.2.3. Focus Group discussion

FGD[3] was used as one of PRA technique for qualitative data collection. It helped to triangulate the finding of the research with formal surveys and key informant interview. Six to twelve members of participants in FGD are recommended to conduct more manageable and successful discussion. Therefore, FGD that included members of eight in each watersheds was held. The discussion was consisting of one district experts, one local Da, two community elders, one LLPP team member and two youth groups. In order to ease and make effective discussion; participants were grouped in to two, based on gender and job position. Semi-structured checklist (Appendix- V.A) was used for facilitating the discussion. Field notes taken for this discussion were reviewed after each discussion.

3.2.2.4. Document Analysis:

The researcher critically examined materials that were reserved in AZFEDO, DDoA archives for insight evidence on the prevailing problems. Furthermore, books, journals, articles, periodicals, internet websites, conference and proceedings were reviewed for obtaining different ideas on the studied problems.

3.2.2.5. Field observation

In order to augment some responses with evidences, the researcher employed field observation. The observation give emphasis to SWC measures on private plot, homestead

[3] FGD-is a small group of six to ten people led through an open discussion by skilled moderator (krveger, 1988).

plantation and water harvesting structures and area closer. In order to document the physical observation, pictures were taken with the help of digital photo camera (Appendix-VII).

3.3. Sampling Design

3.3.1. Sampling Technique and sample size

In order to select sample watersheds, discussions were held with the officials at the district level. Accordingly, sample watersheds were selected based on the available information (base line data at early stage of the programme), year of implementation (1995-2000) and progress of work after the programme ends. Based on this Adersho kobo and Debeso watershed were selected purposively from current five watersheds in the district. The selection of a sample households were based on the rule of thumb which took 10% of the population as a standard when the population is between 1,000 and 100,000 (Pagano, 1998).

Record of total households living in the study villages was obtained from *Kebele* Administration and DAs and there were about 1508 household heads residing in the watersheds. Using simple random sampling technique[4], study sample were selected from the list of households. Accordingly, 65 households from Adersho-kobo watershed and 83 households from Debeso watershed were selected for household survey.

The study was conducted in the two selected watersheds of Dodota District, which cover 10 villages and constitutes 148 households (Table- 3.1).

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[4] Random sampling is an appropriate method to take large sample from a relatively large population by giving equal chance for each respondent (Pagano, 1998).

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Table- 3.1: Number of sample households surveyed in selected watersheds

S.N	Name of watershed	No. of village covered	Population of the watershed	No. of sample households Surveyed
1	Adersho- kobo	3	665	65
2	Debeso	7	843	83
	Total	10	1508	148

Source: Household survey, 2012

3.4. Data Analysis

3.4.1. Descriptive analysis

The survey generated both qualitative and quantitative data. The first task was therefore, to summarize, categorize and code all qualitative responses into numeric values and then enter them in statistical package for social science version 15. Data analysis corresponds to changes in access to water and forest resource products, local households' perception on the contribution of watershed management programme, technological adoption and transfer mechanism of watershed management group. This was analyzed from information collected through structured survey, focus group discussions, key informant interview, document analysis and field observation.

Information obtained from key informant and focus group discussions were mostly in form of verbal/narrative information. These were written down during the survey and summarized. This information is more qualitative in nature and will be used to support the coded qualitative and quantitative data analysis. Descriptive statistics; percentages, mean and paired t-test are presented in tables and figures to enable easy interpretation and

quick visual comparisons of variables within the study area. Additionally, MS-Excel was used to generate tables and figures.

CHAPTER FOUR

4. General Description of the Study Area

4.1. Bio-physical Background

4.4.1. Location and Area

The study was carried out in Dodota district, which is located in Oromia National regional state (ONRS). It is one of the administrative units of Arsi Zone. Astronomically, the district is located between 7°52'09"N- 8°07'36"N latitude and 38°57'26"E- 39°06'00"E and 39°10'36"E- 39°22'23"E longitude. Dodota District is found North- west of Lode Hetossa district, West of Sire district, South of East shoa zone (Adama district), North of Hetosa District and East of Ziway Dugda district with the total area of 445.6 Km^2 (AZFEDO, 2011).

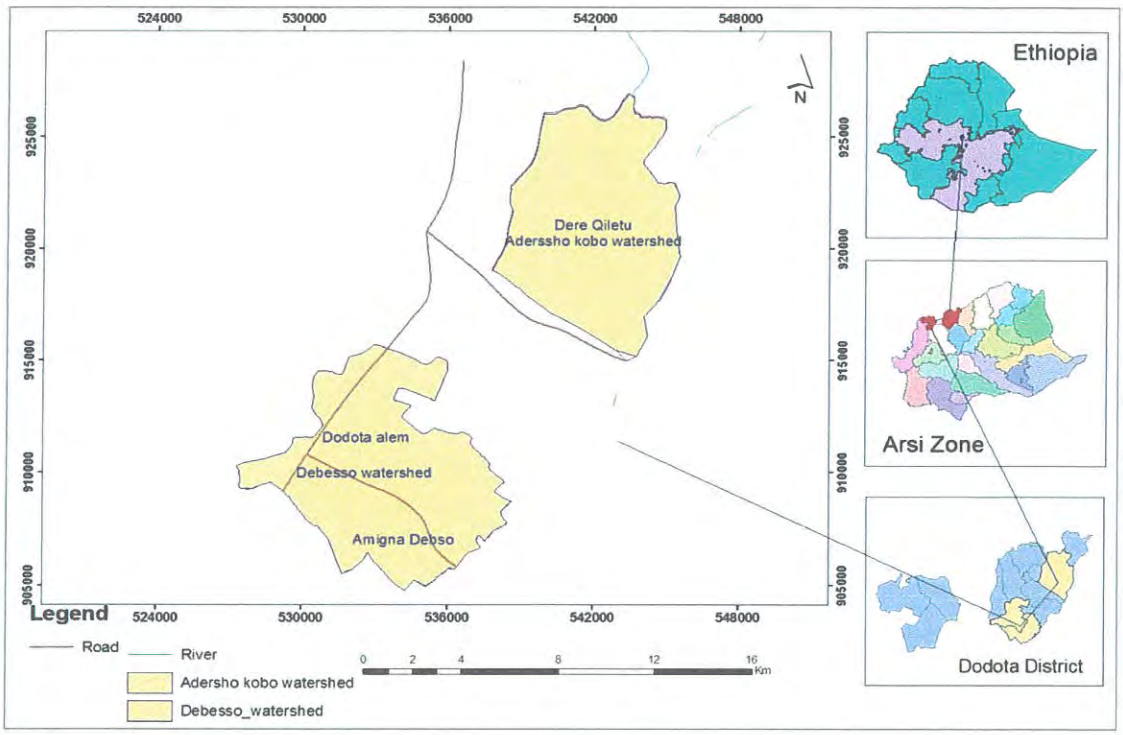

Figure- 4.1: Study area map

4.4.2. Demographic feature

According to AZFEDO, the District's population size was 98,772. Out of which 27.65 % are living in urban areas. This indicates that more than 72.35 % of the population of the district is living in rural area depending on agriculture. Of the total population, females accounted for 48.3 % (which is 47.72 % for Rural and 50 % for urban). An overall sex ratio of the District was 107 male per 100 female (101male per 100 female in urban and 110 male per 100 female in rural). An average numbers of house hold size is 5.0 for the District.

4.4.3. Climate and slope

The climatic condition is generally warm, the mean annual rainfall ranging between 800-900 mm and the annual temperature varies within the range of 20°c -25°c (AZFEDO, 2011/12). The elevation ranges between 1000-2000 meter above sea level and the slopes ranges from nearly flat to gentle slope. The rainfall pattern generally is uni-modal, with over 70 percent falling between April and August while the main rainy season ("kiremt") ranges from July – September and the dry season in the area is mostly from October to February (DDoA, 2011/12).

4.4.4. Vegetation cover and land use

The vegetation cover has been removed, and replaced by cultivation fields, grazing land and plantation of exotic species such as eucalyptus species mainly *Eucalyptus globules* and *E camaldulensus*. Remnants of the indigenous vegetation such as *Juniperus procera, Podocurpusgracilior, Oleaafricana* and other indigenous species are found scattered here and there. Thus, like other parts of the country, natural vegetation of the area has been

victim of the influence of man and its domestic animals. The remnant tree species in the catchments witness the land cover/ land use change that occurred because of the impact of human activities.

Types of land use changes from time to time depending on socio-economic change. For instance, the grazing land, natural forest and fallow lands are decreasing from time to time while cultivated and residential lands are increasing.

Accordingly, from the total area of the district the cultivated land (the lands covered by annual and perennial crops) accounts for about (8.67 %), the vegetation covered land (forest, woodland, bush and shrub) accounts for about 14.14 % (DDoA, 2011).

4.4.5. Agriculture

Agriculture is the main stay of farm households. Farming system is generally characterized by a mixed subsistence farming which includes crop production and livestock raring and in some areas cash crop production (e.g. vegetables and sugar cane). Even though agriculture engagement varies in location within the district, some crops are well growing. The major crops growing in the District are "teff", wheat, barley, maize and soya bean. It has wide potential for crop production regardless of low rain fall. Low level of diversification of crops, so as to cope with adverse weather as well as low level utilization of modern agricultural packages (extension) such as improved seeds, fertilizers and other related inputs, limited opportunities of off-farm employment are distinct characteristics of the study area. Most of the land is flat to gently sloping and is very conducive even for mechanization. There are some small scale irrigation practices near Awash River and lake koka.

4.4.6. Livestock Production

Since, this District is located in the central rift-valley of Ethiopia, livestock is an important livelihood. Cattle raring is the leading followed by poultries and goats. Sheep and donkeys are important animals.

4.4.7. Projects in the district

The District was assisted from European Commission fund, Agricultural Sector Support project and productive Sefty Net programmes, for completion of watershed development, minor irrigation, water harvesting structures, crop development and rural road construction (DDoA, 2011/12).

4.4.8. Profile of Selected Watershed

4.4.8.1. Debeso Watershed Profile

This watershed was identified during the year 1994 and covers 7 villages. The total area of the land is 4800 hectares, of which 3450 hectare is cultivated land. Whereas area under irrigation (spate irrigation) constituted only 125 hectare. There are 843 land holdings. The farming system of the watershed is a mixed farming system where crop husbandry is the most important component of the livelihood of the farmers. Crop husbandry is characterized by the cultivation of annual crops such as cereals and some vegetables. The largest portion of the land is cultivated by cereals like "teff", wheat, maize and soya bean etc (DDOA, 2011/12).

4.4.8.2. Adersho-kobo Watershed Profile

This watershed was identified during the year 1999 and covers 3 villages. The watershed area consists of 990.5 hectares, of which 400 hectare is cultivated land. There are 665 land holdings in the watershed. The farming system of the watershed is a mixed farming system where crop husbandry is the most important component of the livelihood of the farmers. Crop husbandry is characterized by the cultivation of annual crops such as cereals and some vegetables. The largest portion of the land is cultivated by cereals like "teff", wheat, maize and soya bean etc (DDOA, 2011/12).

CHAPTER FIVE

5. RESULT AND DISCUSSION

5.1. Demographic characteristics

5.1.1. Community Composition

The composition of orthodox and protestant constituted 21.5% in Adersho-kobo watershed and 45.8% in Debeso watershed (Table-5.1). The Muslim community in the sample constituted 78.5% in Adersho-kobo watershed and 54.2% in Debeso watershed respectively (Table- 5.1).

Table- 5.1: Community wise number of sample households in the selected watershed

S.N	Community	Adersho- kobo		Debeso	
		Number	%	Number	%
1	Muslim	51	78.5	45	54.2
2	Orthodox	11	16.9	25	30.1
3	Protestant	3	4.6	13	15.7
	Total	65	100	83	100

Source: Household survey, 2012

5.1.2. Gender

The population of sample household shows that in both watersheds, the gender bias is towards the male (Table-5.2).

Table-5.2: Gender wise sample population of the households surveyed

Sex	Adersho- kobo		Debeso	
	Number	%	Number	%
Male	57	87.7	67	80.7
Female	8	12.3	16	19.3
Total	65	100	83	100

Source: Household survey, 2012

5.1.3. Age Distribution

Three age groups for head of household/s are identified: 49.3% are between 20-40 years, 42% are between 40-64 years, and 8.7% are over 64 years (Table-5.3). The majority of the household heads (49.3%) are in the age from 20-64 years group. Farmers in this age group are assumed to have a good understanding the contribution of watershed development, so that they usually more interested in participation of watershed management programmes. The proportion of elderly farmers was 8.7%, an age group in which labor shortage could be a hindrance to participate in conservation structures in watershed management. However, these farmers usually participated in conservation structures constructed on communal land because of community decision and social incentive.

Table- 5.3: Age Distribution of Sample Household Head

Watershed	Number of sample HH	Age group			Total
		20-40	41-64	>64	
Adersho-kobo	65	52.3	38.5	9.2	100
Debeso	83	47	44.6	8.4	100
Grand total	148	49.3	42	8.7	100

Source: Household survey, 2012

Three age groups of family members were identified: 59.5% were less than 15 years old, 38.8% were between 15 and 64 years and 1.7% older than 64 years (Table-5.4). In most Ethiopian rural areas, the main sources of labor are the family members, including wife and children. The sample households are characterized by a high proportion of young population (0-15 years) and a low number of old-age persons (> 64 years). Generally, there are more young people than older people; because of poor health care people die at a relatively young age.

Table- 5.4: Age Distribution of Household Family Members (not counting household head).

Watershed	Number	Age group			Total
		≤ 15	15- 64	>64	
Adersho-kobo	318	57.5	40.3	2.2	100
Debeso	386	60.6	37.6	1.8	100
Grand total	704	59.2	38.8	2	100

Source: Household survey, 2012

5.1.4. Household size

A household[5] in both watersheds have on the average 5.8 persons (Table 5.5). Even though Debeso watershed has the smaller number of household members that is 5.5 and Adersho-kobo watershed has higher that is 6.1, the average family sizes of both watersheds were larger than the district's average family size of 5.0 per family (CSA,

[5] **Household** is a demographic concept, which is defined, as all persons who live in the same dwelling unit. The dwelling unit may be a house, an apartment or other group of rooms, or a room. According to definition both conventional and non conventional household consists of those individual who live in the same dwelling unit or in connected buildings and have common eating arrangements mostly under the leadership of an individual.(CSA, 1994).

1994 projection). This indicates that watershed project interventions did not integrate family planning in its activities.

Table- 5.5: Sample population distribution by number of household member

Household member	Adersho-kobo		Debeso		Both watersheds	
	House hold head	Percent	House hold head	percent	House hold head	Percent
One	0	0	4	4.8	4	2.7
Two	1	1.5	5	6.0	6	4.1
Three	5	7.7	13	15.7	18	12.2
Four	10	15.4	11	13.3	21	14.2
Five	12	18.5	8	9.7	20	13.5
Six	10	15.4	12	14.5	22	14.9
Seven	10	15.4	10	12.0	20	13.5
Eight	6	9.2	4	4.8	10	6.7
Nine	8	12.3	8	9.6	16	10.8
Ten	3	4.6	8	9.6	11	7.4
Total	65	100	83	100	148	100
Average	6.1		5.5		5.8	

Source: Household survey, 2012

5.1.5. Marital Status

Eighty five percent of the total heads of households surveyed were married (Table 5.6). Single heads of households constituted less than 1.5% of the total. 3.5% of the heads of households were divorced and 10% widowed.

Table- 5.6: Percentage Distribution of Household Heads by Marital Status

Watershed	Number of sample HH	Marital status (%)				
		Single	Married	Divorced	Widowed	Total
Adersho-kobo	65	-	89.2	3.1	7.7	100
Debeso	83	2.4	81.9	3.6	12	100
Grand total	148	1.3	85.1	3.5	10.1	100

Source: Household survey, 2012

5.1.6. Educational Status

Three educational levels for household heads and four educational levels for family member groups were identified, which include: "illiterate" (meaning no formal education), "grade 1 - 4" and "grade ≥5" for household head and "illiterate", "grade 1 - 4", "grade 5 – 8, and grade 9 – 12 for family members. From the survey result, about 69.6% of the household heads had no formal education, 19.6% have completed up to a grade from 1 to 4 and 10.8% have completed grade 5 or higher (Table 5.7).

On the other hand, about 45% of household family members were educated to a grade between 1 and 4, 27.8% had no formal education, 21% were reached a grade between 5 and 8, and 6.3% reached at grade 9 or 10. However, none of the family members have gone above grade 9 or 10 (Table 5.8). The majority of the households' family members in the study watershed were educated to a grade between 1 and 4; this indicates that the project included formal education support together with their watershed activities.

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Table-5.7: Educational level of household head

Watersheds	Number of sample HH	Educational level			
		Illiterate	Grade 1-4	Grade 5 and above	Total
Adersho-kobo	65	64.6	23.1	12.3	100
Debeso	83	73.5	16.9	9.6	100
Total	148	69.6	19.6	10.8	100

Source: Household survey, 2012

Table-5.8: Educational status of family member (not counting heads of household)

Educational level	Adersho- kobo	Debeso watershed	Total
Number	383	469	852
Illiterate	31.3	24.9	27.8
grade 1-4	45.2	50.8	44.9
grade 5-8	18.3	20.1	21
grade 9-10	5.2	4.3	6.3
Total	100	100	100

Source: Household survey, 2012

5.2. Land Resource analysis

Land holding of the sample household was assessed and the result indicates that, 3.6% of the households in Debeso watershed had no farm land, and almost half of the households had a grazing land. While all assessed households in Aderesho-kobo watershed have owned farm land and almost half of them had a grazing land (Table-5.9). This indicates that in both watersheds, there was less pressure on watershed area to use as feed source.

Table-5.9: Land holding of sample household

Watershed	Land type						
		Farm land				Grazing land	
	Land less	Up to 1ha	1-2ha	3-4ha	>4ha	Has no GL	0.125- 0.25ha
Debeso	3.6	36.1	15.7	34.9	9.6	51.8	48.2
Aderesho-kobo	-	30.8	33.8	30.8	4.6	52.3	47.7

Source: Household survey, 2012

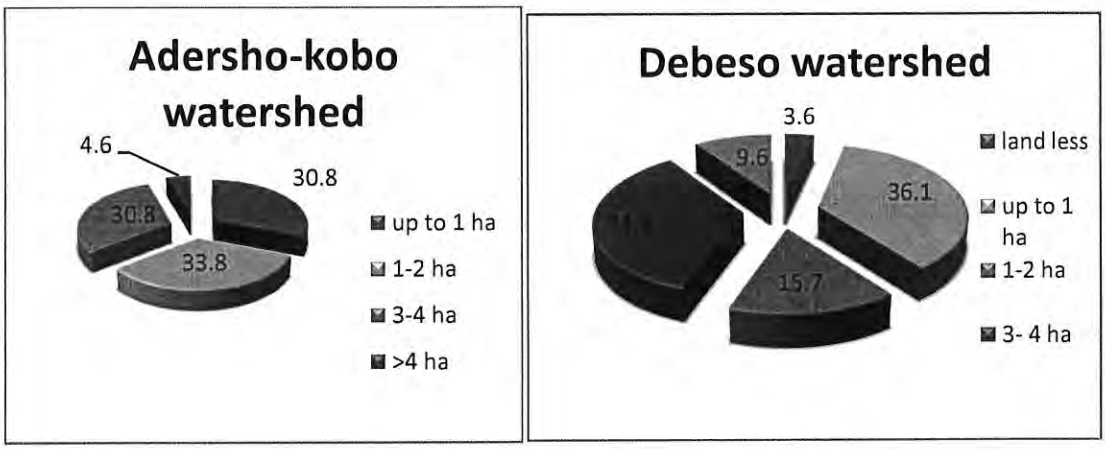


Figure-5.1: Farm land holding of sample households by watershed

Source: Household survey, 2012

5.3. Analysis of contribution of watershed management project

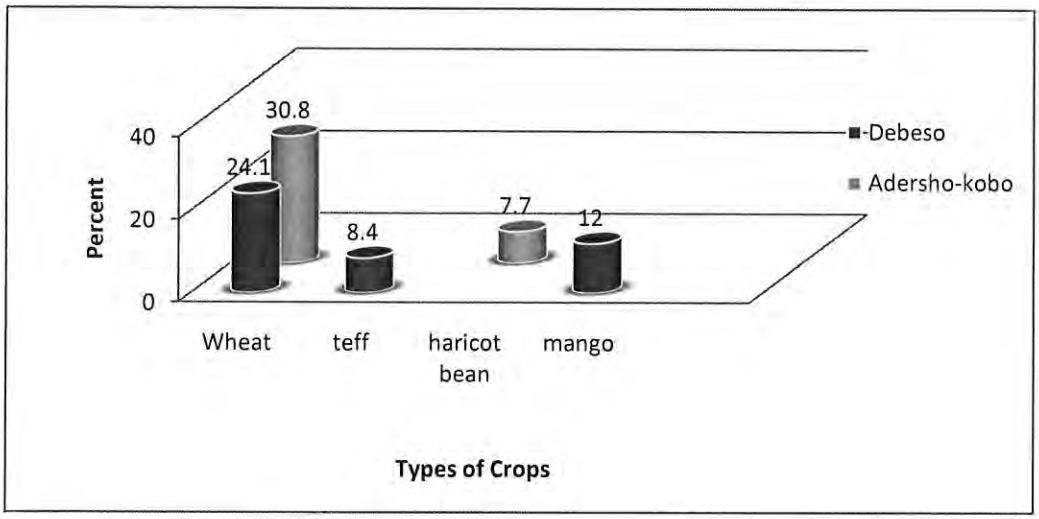
5.3.1. Analysis of Crop Production

According to data obtained from Dodota Dist ict Agriculture office, most farmers in the surveyed watersheds practiced subsistence mixed farming system. Data obtained from DDoA indicated that about 80% of the landholdings in Debeso and 74.5% of the households in Aderesho-kobo watersheds were used for cultivating crops.

Diversified crops were grown in the surveyed watersheds (Appendix- III). Major crops that were grown in Debeso watershed in descending order were: Wheat, "Teff", Maize and haricot beans. While Wheat, "Teff" and Maize were the major cereals in Aderesho-kobo watershed. From vegetable crops onion, tomato, and pepper was growing in both watersheds. Concerning forage crop production, Treluserne was growing in Debeso watershed. Elephant grass and Trelusern were growing in Adersho-kobo watershed.

5.3.1.1. Provision of Improved crop seeds

According to survey and focus group discussion, the project developer distributed improved crop seeds and vegetables such as "Teff", wheat and mango for Debeso watershed inhabitants and wheat and haricot bean seeds for Adersho-kobo watershed inhabitants. Consequently 24.1%, 8.4% and 12% of Debeso watershed inhabitants were got improved crop seeds of wheat, 'teff' and mango seedlings respectively. Whereas 30.8% and 7.7% of Adersho-kobo watershed inhabitants got wheat and haricot bean improved crop seeds (Figure 5.2).



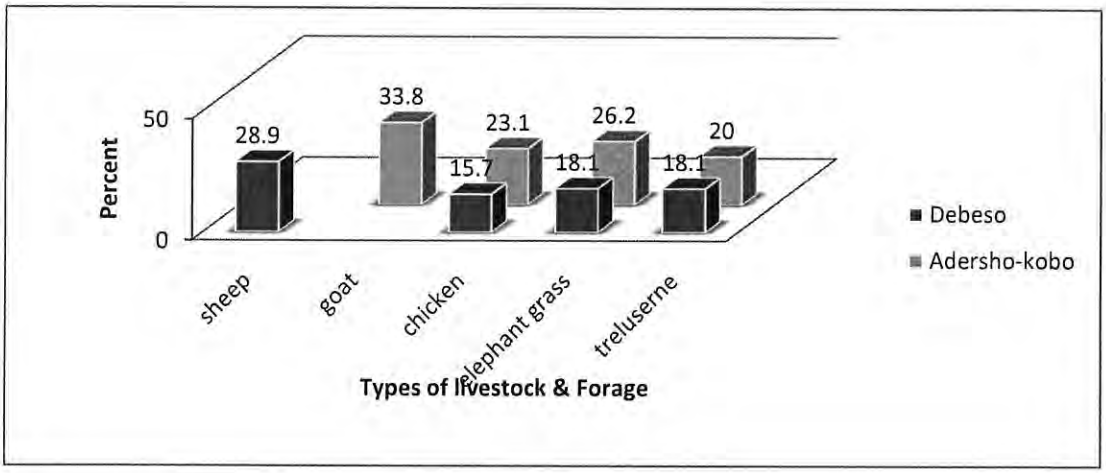
Source: Household survey, 2012

Figure 5.2: Households gets improved crop & vegetable seeds by watershed project intervention

5.3.2. Analysis of livestock production

The type and total number of livestock owned across all sample households is given in (Appendix- II). Sample farmers rear livestock for various purposes, including draught power, milk, meat, eggs, transport and other purposes.

Based on survey and key informants, in both watersheds the watershed project developer provided livestock and improved forage production. As a result 45% of the households in Debeso watershed received local varieties of sheep and improved varieties chicken while 57% of the households in the Adersho-kobo watershed received local varieties of goat and improved varieties of chicken from WSMPs through revolving fund. On the other hand 36% of the households in Debeso watersheds and 46% of households in Adersho-kobo watershed received improved forage seed of elephant grass and treluserne. (Figure 5.3).



Source: Household survey, 2012

Figure 5.3: Households gets livestock and forage support by WSMPs

5.3.3. Analysis of households' access to water resources

5.3.3.1. Source of household water demand

In order to assess the contribution of WSMPs in improving local households' accesses to water demand, local households' source[6] of water demand[7] before and after WSMPs were collected. Accordingly, 59% of sample households in Debeso watershed were used drinking water from river and pond while 41% were used tap water before WSMPs. However, after WSMPs 48% of sample households were used drinking water from river and pond while 52% of households used tap water (Figure-5.4).

In Adersho-kobo watershed 54% of sampled households used river and pond water while 46% used tap water before WSMPs but after WSMPs, 41.5% used drinking water from

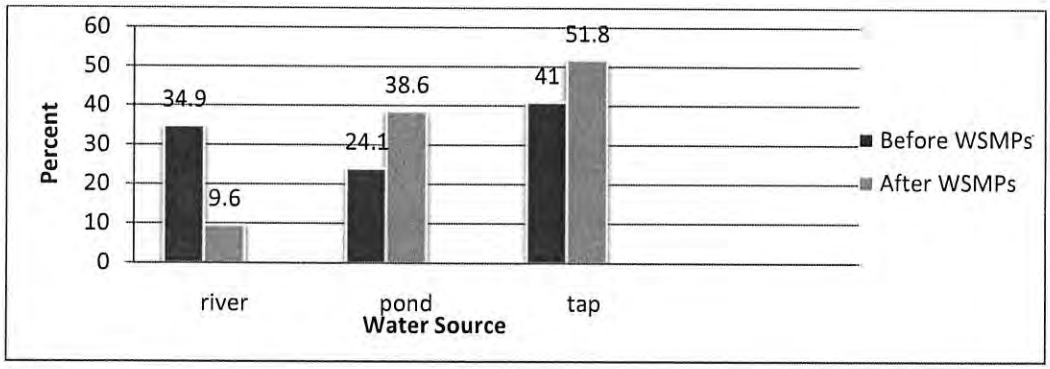
[6] Sources of household water- rain water harvesting in rain deficient areas are the ideal option that has been envisaged by government to supplement farming practices as well as human and livestock drinking water provision (ASSP, 2010).

[7] Household water demand-includes the water required for drinking, bathing, sanitary purpose, and water supply for small animals (Nega, 2010).

river and pond while 58.5% households used tap water (Figure 5.5). The result also indicates 25.3% of Debeso and 20% of Adresho-kobo farmers have shifted their source of drinking water from rivers to ponds and tap water. According to key informant interview, extension of new water supply and construction of community pond water harvesting structures with the help of the project was the main reason for the change of water source.

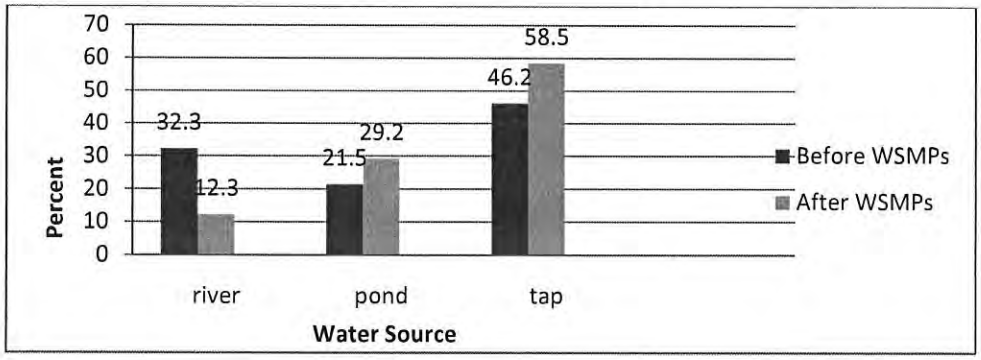
Survey result also shows, the sources of water for animals before WSMPs were rivers and ponds which accounts 84.3% and 15.7% before WSMPs in Debeso watershed. While 47% and 53% were reported after WSMPs. whereas rivers and ponds in Adersho-kobo watershed accounted 78.5% and 21.5% before WSMPs and 50.8% and 49.2% after WSMPs respectively (Figure 5.6 and 5.7).

The source of water for animal for the majority of sample households' that was 84.3% and 78.5% in Debeso and Adresho-kobo watersheds were rivers which took more than 3 hour to reach to the water sources before WSMPs. While after WSMPs 53% and 49.2% of inhabitants in Debeso and Adresho-kobo watersheds were used pond water inside the watershed for their animals (Figure-5.8). Therefore, WSMPs had an effect in improving local households' source of water demand.



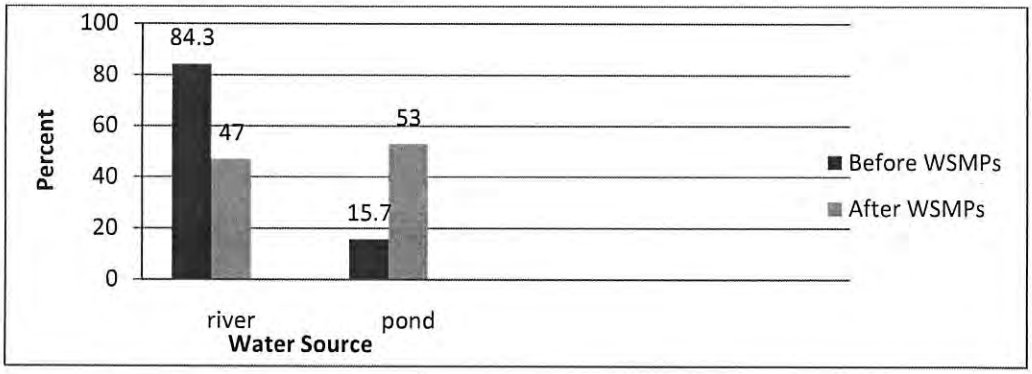
Source: Household survey, 2012

Figure - 5.4: Response of household for source of drinking water for human- Debes



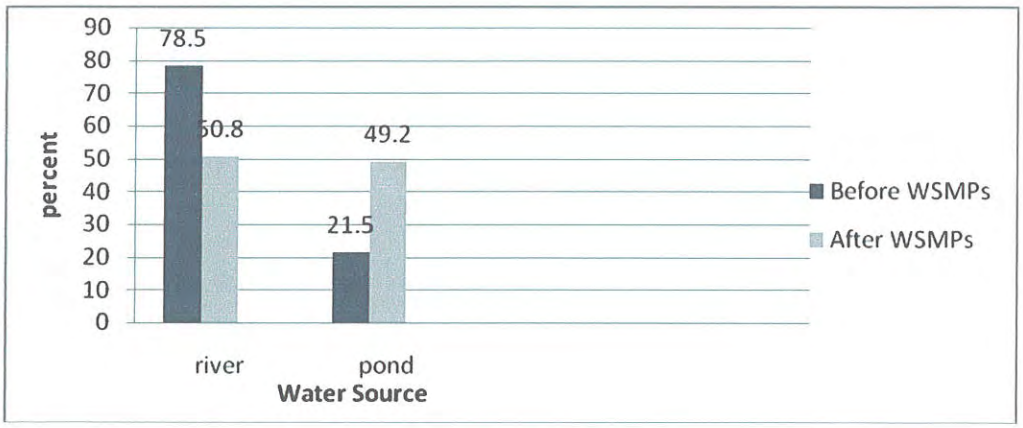
Source: Household survey, 2012

Figure - 5.5: Rseponse of household for source of drinking water for human- Adersho-kobo



Source: Household survey, 2012

Figure - 5.6: Rseponse of household for source of water for animal –Debeso



Source: Household survey, 2012

Figure 5.7: Rseponse of household for source of water for animal- Adersho-kobo

Source: Field observation

Figure-5.8: Sample of community pond constructed by WSMPs to access domestic water

5.3.3.2. Household water demand

Sample households were asked for the improvement of household water demand compared to previous. Accordingly, 87% of them respond as it was improved while only

13% of them replied the same or no improvement (Table-5.10). When they rate the improvement 66.9% of them indicated the improvement was due to nearness, cleanness and development of additional new source while 19.6% of them replied consistency and 13.5% of them respond as there was no improvement. (Table -5.11).

According to key informants, community and family ponds construction, extension of new water sources and development of new water points in both watershed areas with the help of watershed developer was mentioned as the main reason for this improvement. Therefore, WSMPs hand positive effect in improving quantity of household water demand.

Table-5.10: Response of sample household on quantity of household water demand compared to previous

Watershed	Sample household	Human		Animal	
		Improving	Same	Improving	Same
Debeso	83	85.5	14.5	88	12
Aderesho-kobo	65	89.2	10.8	84.6	15.4
Total	148	87.1	12.9	86.5	13.5

Source: Household survey, 2012

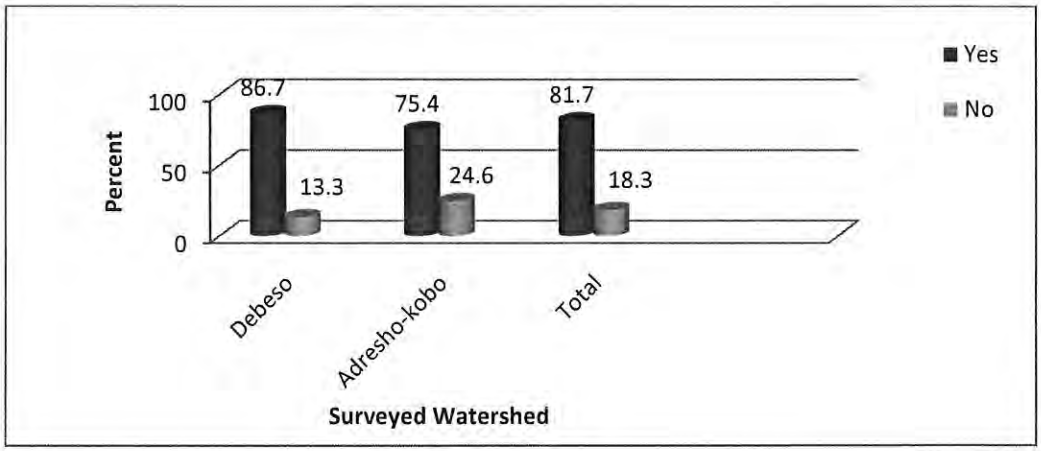
Table-5.11: Response of sample household on improvement quantity of water available

Watershed	Sample HH	Combination(nearness, cleanness, new source	Consistency	Same
Debeso	83	60.2	27.8	12
Adersho-kobo	65	75.4	9.2	15.4
Total	148	66.9	19.6	13.5

Source: Household survey, 2012

5.3.3.3. Quality of household water available

Assessment of quality[8] of households' water available as compared to previous showed improvement. Accordingly, figure 5.9 indicated that 81.7% of the respondents in both watersheds indicated the quality of water available was improved while only 18.3% of them responded as there was no improvement.



Source: Household survey, 2012

Figure 5.9: Response of sample household for improvement in quality of water demand

5.3.3.4. Trip time to fetch water

The trip to fetch water is the most time consuming tasks that the farmers faced. In this study, the ranges of time required to reach the nearest drinking water sources before and after WSMPs were assessed. Accordingly, 72.3% of Debeso watershed inhabitants indicated before WSMPs they were travel about more than 3 hours to reach to the nearest water source, 19.3% of them indicated as they go 1-2 hour and only 8.4% of them said they got water in less than 1 hour. But after watershed development 68.7% of sample

[8] Water quality can be thought of as a measure of the suitability of water for a particular use based on selected physical, chemical, and biological characteristics.

households got water in less than 1 hour, 24.1% of them go 1-2 hour and 7.2% of them go more than 3 hour (Table-5.12).

On the other hand in Adersho-kobo watershed the time required to reach the nearest water source for 47.7% of sample households were 1 -2 hour, 40% of them go more than 3 hour and only 12.3% got water in less than 1 hour before WSMPs, nevertheless, after WSMPs 64.6% of sample population got water in less than 1 hour, 27.7% of them go 1-2 hour and 7.7% of them go more than 3 hour (Table- 5.12). Thus, the WSMPs have contributed in reducing women's and children's regular work load, which was collecting water from distance areas.

Additionally, paired t-test analysis indicates, there is strong evidence that on average, the watershed development programme does lead to improvement in trip time to fetch water

(Table -5.14 and Table- 5.16).

This finding is consistent with findings of kalpataru Research Foundation (2001) in Karnataka and Andhra Pradesh watersheds of Indian. The result of this study states watershed development contributes to the availability of drinking water for livestock and horticultural crops. Farrington et al, (1999) also noted that the successful watersheds have in fact reduced runoff water and recharged ground and surface water aquifers, improved drinking water supply, increased agricultural intensification and crop productivity. Thus findings in Debeso and Adersho-kobo sub catchments domestic water both for livestock and human was improved in terms of quantity, quality and trip time to source.

Table- 5.12: Response of HH for time to fetch drinking water

Watershed	Sample HH	Time to fetch water					
		Before WSMPs			After WSMPs		
		<1 hour	1-2 hour	>3 hour	<1 hour	1-2 hour	>3 hour
		%	%	%	%	%	%
Debeso	83	8.4	19.3	72.3	68.7	24.1	7.2
Adersho-kobo	65	12.3	47.7	40	64.6	27.7	7.7
Total	148	10.1	31.8	58.1	66.9	25.7	7.4

Source: Household survey, 2012

Table-5.13: paired sample statistics on trip time to fetch water Debeso watershed

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	how trips changed before project intervention	2.64	83	.636	.070
	how trips changed after project intervention	1.39	83	.621	.068

Table-5.14: Paired sample test on trip time to fetch water- Debeso watershed

	Mean	Std.dev.	Std. error mean	95% confidence interval deference		T	Df	Sig(2-tailed)
				lower	Upper			
how trips[9] changed before project intervention- after project intervention	1.253	.998	.110	1.035	1.471	11.44	82	.000

Source: Household survey, 2012

[9] Trip time is time required to fetch water that is double trip. But it does not indicate time elapsed in waiting turn.

Note: The table value for $t_{11.44,\ 82}$ is 1.987. The calculated t value is greater than tabulated t value. As a result, the null hypothesis is rejected and the trip time to fetch water is significant at less than 1%. Therefore, paired sample test indicate that watershed development programme on average, led to improvement in trip time to fetch water.

Table-5.15: paired sample statistics on trip time to fetch water Adersho-kobo watershed

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	how trips changed before project intervention	2.28	65	.673	.084
	how trips changed after project intervention	1.43	65	.637	.079

Table-5.16: Paired sample test on trip time to fetch water- Adersho-kobo watershed

	mean	Std.deviation	Std error mean	95% confidence interval deference		T	Df	Sig(2-tailed)
				lower	Upper			
how trips changed before project intervention- after project intervention	.846	.939	.117	.613	1.079	7.263	64	.000

Source: Household survey, 2012

Note: The table value for $t_{7.26,64}$ is 1.995. The calculated t value is greater than tabulated t value. As a result, the null hypothesis is rejected and the trip time to fetch water is significant at less than 1%. Therefore, paired sample test indicate that watershed development programme on average, led to improvement in trip time to fetch water.

5.3.4. Analysis of households' access to forest resources

5.3.4.1. Forest area coverage

Based on key informants, before watershed management project intervention tree coverage was diminishing rapidly due to human and natural factors. Farmers were highly depending up on natural forests in a very traditional and unwise manner. Additionally, there were no organized and programme oriented conservation operations. According to survey, the majority of the respondents (57.7%) indicated that moderate change has been registered along communal land due to physical and biological conservation activities. Inconterary, 6.3% of the respondents responded the coverage of tree species has shown no change; whereas 3.5% of them replied as the coverage has shown slight decrement (Table-5.17).

Table- 5.17: Response of sample household on changes of forest area coverage after WSMPs

Watershed	Perceived trend of change (%)					
	Increased slightly	Increased Moderately	Increased Highly	Decreased slightly	Decreased highily	No change
Debeso	16	59	16	5	-	4
Adersho-kobo	24	56	9	8	-	3
Total	19.5	57.7	13	6.3	-	3.5

Source: Household survey, 2012

5.3.4.2. Availability of wood

Forest contributes a lot in satisfying a short term economic needs of the people through providing wood for fire and construction, other than preventing soil erosion. In this study an attempt has made to see if sample households accessed fire wood and/or used forest which has resulted from project area closer. Accordingly, on average, 53.7% of sample households in both watersheds respond as availability of wood for fire was increased moderately after WSMPs. While 26.3% and 8.2% and of them respond as it was increased slightly and highly. On contrary 7.3%, 4.7% of them respond as it was decreased slightly and there was no change (Table-5.18).

Key informants and focus group discussion indicate that in recent years due to consistency of rain fall, cereals and stalk crop production is increased. As a result, maize, sorghum and wheat stalk is used as alternative means of fire wood. Additionally, homestead plantation carried out with the aid of the project and increased number livestock as result of animal restocking assist the wood demand of the society after WSMPs. However, due to population growth wood supply for fire wood does not satisfy the existing demand adequately. As a result the cost of firewood has still been gowning up near and at the study area.

Study conducted by L. Berry in 1989-90 suggest that nationwide 18 percent of energy in rural areas is supplied by dung and crop residues and this percentage has probably grown since then as rural populations have grown and wood land is converted to cultivation. According to key informants, as a result of increment in forest area coverage the number of wild animals has increased moderately.

Table-5.18: Response of sample household on availability of fire wood after WSMPs

Watershed	Increased slightly		Increased highly		Increased moderately		Decreased slightly		No change	
	No	%	No	%	No	%	No	%	No	%
Debeso	23	27.7	5	6.5	45	54.5	6	7.2	4	4.4
Adersho-kobo	16	24.6	7	10.4	34	52.6	5	7.7	3	5.0
G/total	50	26.3	12	8.2	79	53.6	11	7.3	7	4.6

Source: Household survey, 201

5.3.4.3. Grass coverage

Jest like the situation in forest resource, grass is also deteriorating rapidly in past before intervention of the project. After intervention of the project, however, moderate changes have been registered in grass coverage along homesteads and protected forest lands. According to the survey, the majority of the respondents (62.3%) indicated that the grazing land coverage has shown moderate increment because of conservation activities' with the aid of the project. Inconterary 10.6% of the respondents say coverage of grazing land has shown slight decrement, whereas as 6.1% of the respondents indicated as the coverage of grazing land has shown no change (Table-5.19).

Table-5.19: Response of sample household on changes of grass area coverage after WSMPs

Watershed	Perceived trend of change (%)					
	Increased slightly	Increased Moderately	Increased Highly	Decreased slightly	Decreased highily	No change
Debeso	13	64.5	8	12	-	2.5
Adersho-kobo	10	59.6	11	14	-	5.4
Total	11.7	62.3	9.3	10.6	-	6.1

Source: Household survey, 2012

According to sampled household survey, the change in livestock feed source among the community has contributed to recovery of grass area coverage. Assessment of sample households' livestock feed source before and after WSMPs showed that the main sources of feed for livestock before WSMPs were communal grazing land. However, after WSMPs there was a change in the degree of using communal grazing land as a source of forage.

According to the study, 50.6%, 39.8% and 9.6% of sample households in Debeso and 56.9% and 43.1% in Adersho-kobo were used communal grazing land, own grazing land and cut and curry grass respectively before WSMPs. But after WSMPs 28.9%, 36.1% and 34.9% of households in Debeso watershed and 32.3%, 46.2% and 21.5% of Adersho-kobo inhabitants were used communal, own grazing and cut and curry grass as feed source. As a result, 25.3% of the farmers in Debeso and 21.5% of farmers in Adhrsho-kobo have shifted from using communal grazing land towards using cut and curry grass. (Table-5.20).This indicates farmers' attitudinal change towards using free grazing.

Accordingly, the rehabilitated area closer began supplementing grass resource products. This was promising for sustainable management of the watershed. Therefore, WSMPs has an effect in improving local households livestock feed source.

Table-5.20: Response of sample households for livestock feed source

Watershed	Before project intervention			After project intervention		
	Communal grazing land	Own grazing land	Cut and curry grass	Communal grazing land	Own grazing land	Cut and curry grass
Debeso	50.6	39.8	9.6	28.9	36.1	34.9
Adersho-kobo	56.9	43.1	-	32.3	46.2	21.5

Source: Household survey, 201

5.3.4.4. Availability of grass resources

According to the survey, in both watersheds grasses for forage and thatch had been made available inside area closer due to project inputs. Sample households were asked if they had used the grass resources in the area closer which have been developed with aid of the project activities, and the majority of them responded as they do so. Sample households were asked to compare availability of grasses and for what purpose they do have used the grasses before and after the project, about 62.7% and 58.5% of the respondents in Debeso and Adersho-kobo watersheds respectively stated that the availability of grass has increased moderately. Accordingly, most of them said that they have used it primarily for fodder through cut and carry and secondly for thatch (Table- 5.21 and Figure-5.10).

This finding is consistent with findings of Montesanot (2007) in kebelie Chekorti sub Catchment. The result of this study states grass for forage and thatch has been moderately available after watershed development. Girma (2006) also confirms that because of food

aid programme intervention in Tach Gayint woreda (Amhara Regional State), moderate increase have been registered in natural resource including the fertility of soil. Thus findings in Debeso and Adersho-kobo sub catchments grass for forage and thatch has been moderately available after watershed development.

Table-5.21: Response of sample household on availability of grass after WSMPs

Watershed	Decreased slightly		Increased slightly		Increased highly		Increased moderately		Use	
	No	%	No	%	No	%	No	%	Fodder	Thatch
Debeso	9	10.8	16	19.3	6	7.2	52	62.7	62.7	37.3
Adersho-kobo	5	7.7	11	16.9	11	16.9	38	58.5	58.5	41.5

Source: Household survey, 2012

Source: Field observation, 2012

Figure-5.10: Photo of area closer after WSMPs

5.3.5. Analysis of transfer mechanism of current management system

5.3.5.1. Perception on management system

The assessment of local households' perception on previous and current management system of both study watersheds showed as they were well aware about the management system[10]. On the average, 81.1% of sample households in both watersheds reported as the watersheds were managed by the community previously while 7.4% and 11.5% of them reported as the watershed was managed by *woreda* Agriculture office and *kebele* Administration respectively (Table-5.22).

When further asked the current management system, on average 75.7% of sample households in both watersheds reported as the watershed was managed by kebele youth groups while 12.2%, 7.4%, and 8.4% of them reported as the watershed was managed by community, *woreda* Agriculture office and *kebele* Administration respectively (Table-5.22). According to key informants, EC funded FSP were key in improving knowledge of watershed inhabitants.

[10] One of the key informant indicated the watershed was managed by community till January 2003. But after all concerned watershed inhabitants were discuss on the issue and reach on consensus the watershed has been handed back to this organized youth group for its management and utilization (Telahun, 2012).

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Table– 5.22: Response of sample households on previous and current management system

Watershed	Previously WS managed by				Currently WS managed by			
	Community	*Woreda* agriculture	*Keble* Admn.	*Kebele* youth	Community	*Woreda* agriculture	*Keble* Admn.	*kebele* youth
Debeso	80.7	7.2	12	-	15.7	6.0	8.4	69.9
Adersho-kobo	81.5	7.7	10.8	-	7.7	9.2	-	83.1
Total	81.1	7.4	11.5	-	12.2	7.4	8.4	75.7

Source: Household survey, 2012

5.3.5.2. Perception on WSM use right transfer system

Studied watershed's local households' were aware how youth groups were handled the watershed management and use. As indicated in Table-4.23, on the average 78.4% of both watershed inhabitants stated that the use right transfer of the watershed to the youth groups based on their consensus whereas 11.5% and 10.1% of them indicate as it was the decision of *woreda* Agriculture office and *Kebele* Administration..

When further asked their perceptions if there was member of community who might not support current management system, averagely 91.9% in both watershed said that they support the transfer while on contrary 7.2% and 9.2% of them do not support the transfer to the youth group. In addition 89.2% of sample households in both watersheds replied as the current management system undertaken by the youth group association might not brought conflict over the natural resource in the future and on contrary 10.8% of them indicated as it bring conflict (Table-5.23).This shows that the use right transfer is done more or less in a sustainable way.

According to key informants and focus group discussion, jobless community members were selected and organized in groups. All concerned watershed inhabitants were discuss on the issue and reach on consensus. The watershed is divided in to subunits which are supposed to be well manageable for small groups of people and this team has been trained on the watershed management and its sustainable utilization methods and given legal entity to sue and to be sued as well. By-laws are developed and agreed for by the team members and concerned district office. Finally the divided and treated watershed has been handed back to this organized group for its management and utilization. This indicates sustainable management system and the watershed. Therefore, WSMPs has an effect in raising the awareness of local holds in watershed management use right transfer system.

Table-5.23: Response of sample households on watershed management use right transfer system.

Watershed	How those given watershed management?			Do you think there is community who do not support CMS?		Do you think CMS might bring conflict over NR?	
	By community	By *wored* agriculture	By *kebele* Administration	Yes	No	Yes	No
Debeso	74.7	14.5	10.8	7.2	92.8	9.6	90.4
A/kobo	83.1	7.7	9.2	9.2	90.8	12.3	87.7
Total	78.4	11.5	10.1	8.1	91.9	10.8	89.2

Source: Household survey, 2012

5.3.6. Analysis of local households' participation on WSMPs

Generally all sample households were participated in implementing SWC measures on communal land. However, when asked how often they participated in implementing

SWC measures on communal land on the average 86.5% of sample households in both watersheds respond as they participated 5-8 days per month out of 8 implementation days set by community decision while 13.5% of them participated less than 5 days (Table-5.24). This implies that the majority of sample households were participated in conserving their environment.

As indicated in Figure 4.10, community consensus was reported by 53% of the households as their main reason for participation in SWC programs in Debeso watersheds while 33.7% and 13.3% of them reported understanding benefit and economic incentives respectively as their main reason for participation. On the other hand, knowing its benefit was reported by 53.8% of the households as a major reason for their participation in SWC measures in Adersho-kobo watershed while 29.2% and 16.9% of them reported community consensus and economic incentives respectively as their main reason for participation. This implies the majority of both watershed inhabitants have volunteer[11] participation in conserving their environment.

This finding is contrast to findings of Assefa (2009) in the koga watershed. The result of this study states farmers usually implemented and accepted soil and water conservation structures because of having access to money for rented oxen as well as hired labor. Tesfaye (2011) also confirms that the majority of the households in Lenche dima, Tsegur

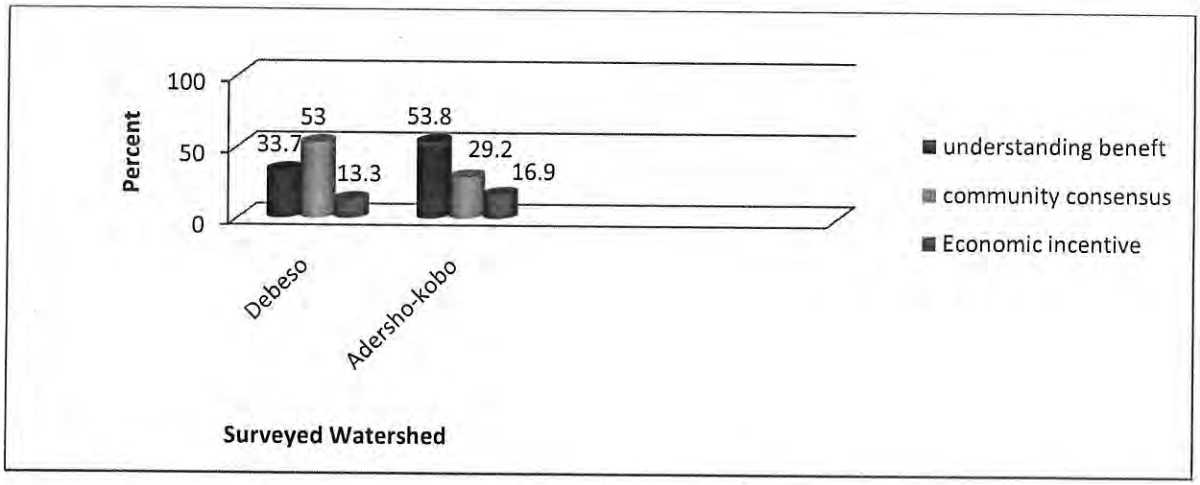
[11] One focus group discussion participant member indicated the name of district Dodota derived from a tree named *''Dodoti''by affan Oromo 'acacia absinica'* which covers the all area Distrit in past. But fortunately due to natural and human factors in general this indigenous tree was extinicted. This results climate change and fall in crop production. As a result the whole district face alarming food shortage in 1994 E.c. at the end of 1994 Dodota District Agriculture offices held discussion on how we can protect the issue through watershed development. Even though we did not dream a radical reverse of the problem we accept the idea at a time and participate in WSDPs. We have seen a change year after year know vegetation cover has increased and flood effect at downstream area is dramatically reduced. This has been well acknowledged by the farmers. Wildlife's, like leopards, greater kudu, lesser kudu, warthog and different types of birds area reappearing in the watershed(Mamo, 2011/12).

eyesus and Dijjil watersheds want to implement SWC structures on communal land through payment. Thus findings in Debeso and Adersho-kobo sub catchments participation of local households in implementing SWC measures on communal land was due to community consensus and knowing its benefits.

Table-5.24: Response of sample household's participation on communal land

Watershed	Local household participation in Construction of SWC measures on communal land		Days participate on construction of SWC measures	
			< 5 days	5-8 days
	No	%	%	%
Debeso	83	100	16.9	83.1
Adersho-kobo	65	100	9.2	90.8
Total	148	100	13.5	86.5

Source: Household survey, 2012



Source: Household survey, 2012

Figure 5.11: Response of sample household on reason for their participation

5.3.7. Analysis of local households' contribution on WSDF

The contributions[12] of sample households during watershed development were assessed. Accordingly, all of sample households in Debeso watershed replied as they contributed 10% of the cost of the work excited in labour, while all of sample households in Adersho-kobo watershed respond as they contributed 20% of the cost of the work excited in labour (Table-5.25). This implies sample households have a sense of ownership over the assets created as well as a reflection of their involvement in planning and execution of the watershed development program.

According to key informant from Agriculture office, Debeso watershed inhabitants were contributed 10% of the work excited at the initial year but their contribution was raised to 15% in 2nd and 3rd year of programme implementation. On the other hand, having experience from Debeso watershed Adersho- kobo watershed inhabitants decided to contribute 20% of cost of the work excited in labour.

Table- 5. 25: Response of sample household for their contribution on WSDF

Watershed	Contribute labour	Contribute cash	Have no contribution
Debeso	97	-	3
Adersho-kobo	95.5	-	4.5

Source: Household survey, 2012

[12] For effective management of a watershed, WDF is established out of the contributions from the stake holders. The contribution should be a minimum of 10% of the cost of the work executed on private lands and 5% in case of common property (Kakade and Hagade, 1998).

5.3.8. Analysis of knowledge transfer

5.3.8.1. Construction of SWC measures on their private plot

In order to assess knowledge transfer, sample households were asked if they start construction of SWC measures on their private plot. On the average, 67.6% of the sample households in both watersheds responded as they implemented SWC structures on their private plot while 32.4% of them responded 'not' (Table-5.26). Disaggregated by watersheds, 68.7, and 66.2 percent of the respondents in Debeso and Adersho-kobo watersheds have SWC measures on their private plot.

5.3.8.2. When did you start?

Those sample households implemented SWC measures on their private plot were asked when they did start construction of SWC measures on their private plot. On the average, 51.4% of sample households in both watersheds responded as they implemented the structures after WSMPs while 16.2% of them responded as they were already implemented the structures before WSMPs and 32.4% of them respond as they did not still started construction of SWC measures on their private plot. The study shows on average an additional 35% of inhabitants in both watersheds were got knowledge on SWC and implemented the structures as a result of watershed development (Table-5.26). Therefore, WSMPs has contribution in knowledge transfer from community watershed management to private plot.

Table-5.26: Response of sample households on construction SWC structures on private-plot

watershed	Do you start construction of conservation structures on your private land		If yes when do you start		
	Yes	No	Before WSDPs	After WSDPs	I do not start SWC
Debeso	68.7	31.3	20.5	48.2	31.2
Adersho-kobo	66.2	33.8	10.8	55.4	33.8
G/Total	67.6	32.4	16.2	51.4	32.4

Source: Household survey, 2012

5.3.8.3. How do you learn those methods?

According to the survey, half of sample households were acquired knowledge on SWC measures as a result of participation on communal land. As indicated in Table-5.27, averagely 50.7% of Sample households in both watersheds reported as they acquired the knowledge through participation on communal land While 16.9% of sample households respond as they learn from parents and neighbors and 32.4% of them respond as they do not know SWC measures (Table-5.27). Disaggregated by watersheds 54.2 and 46.2 percent of sample households in Debeso and Adersho-kobo watersheds were got knowledge due to participation on communal land.

When further asked the project from which they did learn those methods, averagely 49.3% of sample household's in both watersheds respond as learn from European

commission funded food security programme (Table-5.27). This indicates that the WSMPs have had contributed a lot in knowledge transfer.

Table-5.27: Response of sample households on how did they learn those methods

Watershed	How do you learn those methods				If from project which one			
	From parents	From neighbors	From the project	I don't know	PSNP	EC funded FSP	ASSP	I do not know
Debeso	8.4	6.0	54.2	31.3	9.6	50.6	8.4	31.3
Adersho-kobo	10.8	9.2	46.2	33.8	12.3	47.7	6.2	33.8

Source: Household survey, 2012

CHAPTER SIX

6. CONCLUSION AND RECOMENDATIONS

6.1. CONCLUSION

The watershed management program with the aid of EC funded FSP has contributed moderately to livelihood of the watershed. The project has played significant role in the process of improving natural resource recovery, access to water resources and technological adoption of the community.

According to the study, domestic water both for human and livestock showed improvement in terms of source, quantity, quality and trip time to fetch water after WSMPs due to community ponds water harvesting structures, extension of potential water source, and additional water points constructed with the help of the project. These contributed a lot in reducing workloads for women and children.

The study also found out, as a result of the WSMPs forest area coverage, grass coverage, access of wood for fire and grass for forage and thatch have been made available moderately inside area closer due to physical and biological conservation activities. But A few farmers' that used the communal land privately before WSDP as grazing land respond as if the project contribute nothing in improving forest resources.

According to the study, the watershed management use right transfer was done more or less in sustainable way. As a result, majority of them indicated as the management system did not bring conflict over the natural resource so far.

The survey result also indicates the participation of local households in implementing SWC measures on communal land was generally good. On average, 86.5% of sample households in both watersheds participated 5-8 days per month out of 8 implementation days due to community decision and knowing its benefits. Additionally both watershed the local households indicated as they contributed 15-20% of work executed in labour.

According to survey, there was technological adoption of SWC measures on private plot as result of knowledge acquired from participation on communal land.

6.2. RECOMMENDATIONS

As far as the contribution of watershed development project on the livelihood of watershed inhabitants was concerned the following points were recommended.

- The ongoing watershed development has to continue in more enhanced manner through advocating and exploiting the merit of building on indigenous knowledge, addressing of farmers priorities and opening the door of participation for local households.
- Emphasis has to be given to replication of community forestry development and homestead plantation as well as water harvesting structures so as to maximize the supply of the resource.
- The local government has to convince farmers to change their attitude in the way of using common poll resources.
- There is a need for more thrust on community participation from local administration as well as development agents for the ongoing WSMPs in the district.

- In order to raise level of participation of rural communities, the Government has to give education and community training through extension works as well as design strategy for practice adaptation and transfer how Debeso and Aderesho-kobo model works are disseminated elsewhere in the country with similar physical and social environment.

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Appendices

Appendix I: Conversion factors used to estimate tropical livestock units (TLU)

Animal	TLU
Calf	0.25
Heifer	0.75
Cow and ox	1
Horse	1.1
Donkey	0.70
Sheep and goat	0.13
Chicken	0.013

Source: Strock*et al.*, (1991)

Appendix- II: Type and number of livestock owned by sample households

watershed	Debeso		Adersho-kobo		Total	
	No	TLU	No	TLU	No	TLU
Oxen	144	144	108	108	252	252
Cows	79	79	38	38	117	117
Calves	46	11.5	26	6.5	72	18
Sheep	251	32.6	153	19.9	404	52.5
Goat	37	4.8	25	3.3	62	8.1
Donkey	117	81.9	62	43.4	179	125.3
Chicken	204	2.7	147	2	351	4.7
Total		356.5		221.1		577.6

Source: Household survey, 2012

Appendix-III: Response of HH Heads for Major Crop Production by watershed

Major crops	Debeso		Adersho-kobo	
	No	%	No	%
Wheat	55	66	40	61
Teff	18	21	13	20
Maize	6	7	7	11
Haricot Bean	2	3	1	2
Vegetable	2	3	1	2

Source: Household survey, 2012

Appendix- IV: Structural survey questionnaire for formal interviewer

Farmers survey on contribution of Watershed development in Debeso and Adersho-kobWatershed, Ethiopia

Master's Thesis Survey

AlemayehuDechassa

Addis Ababa University

1. General information

1. Sex of house hold head

   1 = Male 2 = Female
2. Age of house hold head ----------(in years)
3. Family size (in number)

   1 = male -------- 2 = female ----------
4. Educational level of household grade----------
5. Marital Statusof household

   1 = Single 2 = Married 3 = Divorced 4 = Widowed

2. Household Characteristics

Household family members' information

2.1. Sex

Male_____ (No),

Female_____ (No)

2.2. Age

0-15yr_____ (No),

16-64yr_____ (No),

Greater than 64 _____ (No)

3.1. Education

6. Educational level of household family member grade----

S.N	Name	Sex put ( )		Educational status
		male	Female	Code A
1				
2				
3				
4				
5				
6				
7				
8				

Code Box for question 4

Code A: 1 = illiterate 2 = 1-4 grade 3 = 5-8 grade

4 = 9-12 grade 5 = diploma 6 = BSc degree 7. Abovbe BSc

7. Land owner ship of the household

Type of land	Amount in timad
Farm land	
Grazing land	

1. Socio-economic status

7.1. Social

i. Religion

1 = Muslim 3= Protestant

2 = orthodox 4 = Catholic

7.1. 2. Ethnicity

1 = Oromo 3 = Gurage

2 = Amhara 4= tigre

7.2. Economic

Expenditure and Income of the Household

7.2.1. What is your expenditure in the last 5 years? Use amount in birr.

Item of expenditure	2003/2004	2002/2003	2001/2002	2000/01
• Clothing				
• Community contribution				
• Fertilizer				
• Food items				
• Kerosene				
• Land use fee				
• Religious festival				
• Schooling of children				
• Seeds				
• Transport				
• Others				

Crop production

7.2.3. What type of crops do you produce in (hectare) in the watershed area in the last 5 years?

Crop production/ type	Within the watershed				
	2003/2004	2002/2003	2001/2002	2000/01	1999/98
• Maize					
• Barely					
• Wheat					
• Teff					
• Onine					
• Carrot					
• Orange					
• Tomato					

• Papaya					
• Banana					
• Green pepper					
• Mango					

7.2.4. Do you use any improved crop/vegetable seeds? 1= Yes 2= No

7.2.5. Ifanswer for question no.7.2.4 is yes, what is/are your source of improved crop/ vegetable/seeds

1= myself 2= from EU project 3= borrowing from relative 4= Sefty net programme 5. Other

7.2.6. What is/are improved crops/vegetable seeds do you get from the above sources?

1="Teff" 2= wheat 3= haricot bean 4= maize 5= barley 6= mango 7= onion 8= I do not get any

Live stock production and live stock feed source

7.2.6. List down the live stock you have with the feed source

Animal type	Total population Use number	Dry season feed feed source Code A	Wet season feed source Code A
• Ox			
• Cow			
• Heifer			
• Young bulls			
• Calf			
• Goat			
• Sheep			
• Donkey			
• Mule			
• Hourse			
• Bee hive			
• Poultry			
• Camel			
• Other			

Code Box for question 7.2.4

Code: A 1 =own grazing land 2 = communal grazing land 3 = cut and curry grass

7.2.7.Do you produceforage for your livestock? 1. Yes 2. No

7.2.8. If answer for question no.7.2.7 is yes what was the seed source of your forage production?

1= myself 2= from EU project 3= borrowing from relative 4= Sefty net programme

7.2.9. What type of improved forage seed do you get from the above sources?

1= elephant grass 2 =bana grass 3= treluserne 4= I do not get any

7.2.10. Do you have any livestock? 1= yes 2= no

7.2.11. If answer for question no.7.2.8 is yes, what is the source of your livestock stock

1= buy myself 2= from EU project 3= get from relative 4= Sefty net programme

7.2.12. What is/are the type of livestock do you get from the above sources? Circle all you get

1= goat 2= sheep 3= chicken 4= ox 5= cow 6= I do not get any

3. Questions related to water Supply Aspect

8. Thick your Major Source of drinking water?

S.N	Major Source	Before project intervention		After Project intervention	
		For cattle	For human	For cattle	For human
1	Spring				
2	River				
3	Pond				
4	Bore hole				
5	Tap water				
6	Harvested Rain water				

9. Comparing to previous how you do rate the quantity of water available for human being?

1 = Improving 2 = Same 3 = Worsening 4 =Difficult to categorize

10. Comparing to previous how you do rate the quantity of water available for animals?

1 = Improving 2 = Same 3 = Worsening 4 = Difficult to tell

11. If answer for question No. 9 & 10 is improving, how do you rate the improvement? (More than one responses)

1 = Nearness to the home 2 = Consistency 3 = New source of water 4 = Cleaner

12. Do you agree that the quality of water available is increased?
1= Yes 2 = no
13. If your answer for question No 12, is not what is the problem?

1 = Turbidity due to flooding 3 = Algae development
2 = Livestock contamination 4 = Bird and wild life Contamination
14. Rank out the major problems, which affect the water quality of the source?

1= Turbidity due to flooding 2= Algae development

3= Livestock contamination 4. Bird and wild life Contamination
15. How were the trips to fetch water changed after project intervention?

1 = Decreased (bellow 1 hour) 2 = same (1-2) hour 3 = Increased (above 3 hour)
16. .For long does the water source give service in a day?

15.1. Before project intervention

1= for 2 hour only 2 = Four 3 hour only 3= Full day 4= Half day

15.2. .after project intervention

1= for 2 hour only 2 = Four 3 hour only 3= Full day 4= Half day

4. Question related to forest product resources

17. Do you use the forest resulted from project area closer for source of fire wood/construction after project intervention?

1= yes 2= no
18. If your answer for question no. 17 is not, what is your source of fire wood?

1= homestead plantation 2= cow dung 3= crop residue 4= kerosene
19. What is/are the activities/ techniques being used by the project in conserving tree in theCatchment?

1 = Seedling preparation 2 = Awareness creation
3 = Reforestation 4 = Gully reclamation
20. How do you describe the forest area coverage after the intervention of the project?

1 = Decreased slightly 2 = increased moderately
3= Increased slightly 4 = increased highly) 5= No any change
21. How do you describe the grass area coverage after the intervention of the project?

1 = Decreased slightly 2 = increased moderately
3= Increased slightly 4 = increased highly) 5= No any change
22. Do you use grass resource in area closer after project intervention?

1= yes 2=no
23. How do you describe the availability of wood after the intervention of the project?

1 = Decreased slightly 2 = increased moderately
3= Increased slightly 4 = increased highly) 5= No any change
24. How do you describe the availability of grass after the intervention of the project?

1 = Decreased slightly 2 = increased moderately

3= Increased slightly 4 = increased highly) 5= No any change
25. For what purpose you were using grass resources?

1 = Animal fodder 2 = Thatching 3 = Sale 4 = Combination

5. Question related to Participation on communal land

26. Do you know these conservation structures, such as Terrace, Stone bounds, Soil bound, Tree planting, Check dams, Micro besin, Funaju, Planting vetivergrass that constructed to control soil erosion on communal land?

1= Yes 2= No

27. Do you participate in construction of those conservation structures to control soil erosion on communal land?

1= Yes 2 = No

28. If your answer to question No 25 is 4.2yes, what was the drive that initiated you to participate?

1= Myself 2= Extension agents (government)

3= Social incentive 4= Economic incentive/ payment

29. If your answer to question No 25 is not, why didn't you take measures?

1 = High labor demanding 2 = I don't know the benefit
2 = Land owner conflict

30. How often do you participate in construction of conservation structure to control soil erosion on communal land?----------days per month.
31. What was your contribution watershed development fund?

1 = labour contribution 2 = cash contribution

3 = have no contribution

6. Question related to transfer mechanism

32. Who manage the watershed previously?

1 = Community 2 = Keble's youth group 3 = Woreda agriculture and rural dev't office

4 =Kebele administration 5 = I don't know

33. Who manage the watershed currently?

1 = Community 2 = Keble's youth group

3 = Woreda agriculture and rural dev't office 4 = Kebele administration
3 = I don't know

33. How was the above given watershed management?

1 = Byworeda administration decision 2 = By kebele administration decision

3 = By community consensus 4 = ByWoreda agriculture office decision
5 = I do not know

34. Do you think there are members of community who do not support current management strategy?
1 = Yes 2 = No
35. Do you think there will be a conflict over the natural resource in the future?
1 =Yes 3 = No

36. If your answer to question No 36 and 37 is yes, can you suggest better sustainable management strateg

1.----------

2. ----------

37. Do you start tree planting activities(for the purpose of fuel wood and construction)

1 = yes 2 = No

Appendix-V: Checklist for focus group and Key informant discussion

A. Checklist for Focus Group Discussion

Name of participant----------

Sex----------

Age----------

1. Do you fell there is income improvement during the year 2000/01-2003/04? What was the reason for the improvement as well as for no income improvement?
2. Is there any assistance that WSDP developer provide for the community? What are they?
3. What are the activities that the project developer does to implement SWC measures and access water demand?
4. Do you feel that quality and quantity of water available improved for watershed inhabitants? What was the reason for improvement or no improvement?
5. What was the source of wood demand of watershed community?
6. Is there training programme given to watershed community? Which organization arranges the training? How many days? Which groups of community attend the training? Youth, elders. omens, kebele officials
7. How the kebele manages the watershed and ? Previously and currently. How those given the watershed?
8. How do you describe the availability of grass and fuel wood after WSDPs? Increased decreased, no change. If decreased or same why? If increased why?.
9. Is there species of trees/ grasses there were introduced or recovered? Mention the trees /grasses introduced?
10. How many head load of grass do you get before and after intervention of the project?
11. What was the price of one head load of grass?
12. What is the source of your fire wood? Rank according to your consumption.

1. Communal forest 2. Cow dung 3. Homestead plantation 4. Crop residue 5. Kerosene

B. Checklist for key informant interview

Name of household---------- Sex----------

Got/kebele---------- Age----------

For farmers

2. . Is there any awareness creation activity done on watershed community? What are there?

2 Have you observed any species of trees that are introduced and or recovered after the intervention of the project? If yes mention species of trees that are introduced? ----------

3 Have you observed any species of grass that are introduced, and or recovered after the Intervention of the project? If yes mention species of trees that are introduced? ----------

For District Experts

4 What was the trend of income from crop production, livestock, labour and remetance and sell of forest resource products.

5 Who manage the watershed previosely and currentely. How the watershed given to those groups? Is there by-law? Who develop the by-law.

6 What was the contribution of local households WSDF in Debeso and Adersho-kobo watershed.

8. Is there any awareness creation activity done on watershed community? What are there?

9. Have you observed any species of trees that are introduced and or recovered after the intervention of the project? If yes mention species of trees that are introduced? ----------

10. Have you observed any species of grass that are introduced, and or recovered after the Intervention of the project? If yes mention species of trees that are introduced? ----------

11. What was the reason for this change?----------

Thank you very much for your cooperation!!!

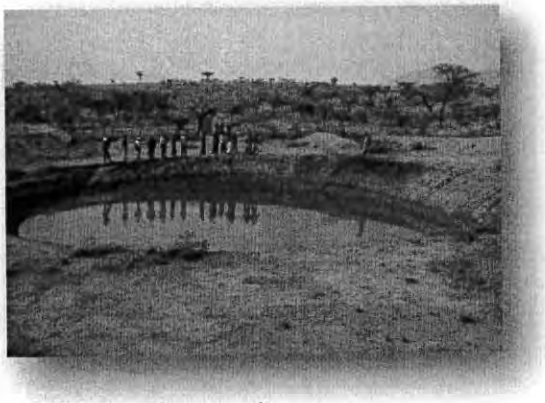
Appendix-VI: student t-distribution

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Appendix-VII. SWC measures constructed on private plot community pond and area closer

SWC measure on private plot



Community pond

Fourth year rehabilitation