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Impact of watershed development on livelihood of rural farm households; In case of Burie zuria district, North West Ethiopia

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COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

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A THESIS SUBMITTED TO BAHIR DAR UNIVERSITY, COLLEGE OF BUSINESS AND ECONOMICS, DEPARTMENT OF ECONOMICS IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN DEVELOPMENT ECONMICS.

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DECLARATIONS

I **Tsegaye Simachew Yehun**, registration number/I.D. number **BDU1110451**, do hereby declare that this Thesis is my original work and that it has not been submitted partially; or in full, by any other person for an award of degree in any other university/institution.

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APPROVAL

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LIST OF ABBREIVATION AND ACCRONIMS

ADSWE …….……Amhara Design and Supervision Works Enterprise

AHM …….…..……Agricultural household model

ATT ……...……Average treatment effect of treated

CIA …….…..… Conditional independence assumption

CSA ……...……Central statistical agency

DFID …….…..…Department for international development

ESMF …….……Environmental and Social Management Framework

ETB … …….. Ethiopian Birr

FAO ……. …..…Food and agriculture organization

FDRE …….……Federal Democratic Republic of Ethiopia

IJEMA ……International journal of environmental monitoring analysis

MOA …….…. Ministry of agriculture

MOARD……Ministry of agriculture and rural development

NGOs ……. Non-governmental organizations

NNM ……. Nearest neighbor matching

PSM ……. Prosperity score matching

RCM ……. Radius caliper matching

RUM …… …Random utility model

SD ……Standard deviation

SLM …….……Sustainable land management

SLMP ……. Sustainable Land Management Project

SSS …….…..…Small scale irrigation

SWC ……Soil and water conservation

UNDP ……. United nation development program

USAID ……United States Agency for International Development

WB ……..…World Bank

WEI …….…. watershed Eco index

WOFED……. Woreda office of finance and economics development

WSDP ……Watershed development program

Abstract

The aim of this study is to assess factors that affect the watershed development and the Impact of Watershed Development on livelihood of rural farm households in Burie Zuria District, and to draw possible conclusions and provide policy suggestions. The source of data which is used in the study comes from primary and secondary data. The study used multi-stage sampling procedure to select sample households to distribute survey questioners for analysis. Using systematic random sampling, 147 Households (program users) and 175 program non-users are selected randomly from 1651sample households in six sample kebeles of Burie Zuria District from identified six micro-watersheds. Sample household-based interview and key informants' interviews were used in order to collect the data. In the study, demographic characteristics, social services, negative and positive relations of different variables were assessed.

The study was applied both qualitative and quantitative data. The researcher was uses STATA Version15 for the purpose of estimating demographic and expected outcome results extensively for the analysis of the data collected. The determinant factors that affect the watershed development are estimated based on the watershed development indicators and different household participation parameters using Heckman two stage and logistic regression models. And the impact of watershed development on livelihood of rural farm households is evaluated by comparing the watershed participant and non-participant households. Hence, this study applies a propensity score matching technique, which is appropriate when cross-sectional data are used and also revealed by using Heckman two stage regression model. The result revealed that, Watershed development program in the study area has brought positive impact on livelihood diversification and annual household income score for program user.

***Key words**: watershed development, participation in the watershed, watershed development index, livelihood diversification index and household annual income.*

CHAPTER ONE
INTRODUCTION

1.1. Background of the study

In the real world all living things are alive based on natural resources. The goal of most watershed development program is to increase agricultural productivity through soil and water conservation and rainwater harvesting at the micro-watershed scale (Priya Deshingkar, 2005). India's watershed development programs are one of the Government of India's (GOI) principal tools for poverty reduction in rural areas (Jim Smyle 2014). In general, Natural resource degradation resulted in long-term reduction in the quantity and quality of water and land resources, which negatively impact on the livelihoods of the rural poor who rely on these resources for their subsistence and livelihoods (Gebrehaweria *et al*., 2016).

Ethiopia has abundant resource opportunities to livelihood of rural farm households even the entire country's economy development. But in the current situation because of its Civilization, economic development and technological advancement status labor and land is a vital source of production. On the other hand, Ethiopia is the most exposed country to adverse effects of natural resource degradation due to its topography, rainfall distribution and its dependency on subsistence agriculture, poor natural resources management, high population growth rate, low economic development level, infrastructure problem and weak institutions in combination with low adaptive capacity. And 85 % of its population is depends on small scale and rain fed agriculture as a source of livelihood (UNDP, 2016). However, the complexity and fragility of Ethiopia's land scape makes its soil highly susceptible to land degradation is decreasing agricultural production and productivity from smallholder farmers with rapidly rising population in the country and thus resources degradation is harm and consequently the serious negative impact on farmers' livelihood.

Natural resources degradation is closely linked to community livelihood. For instance, in watershed development concept, soil and water degradation is the major effect on agricultural production and productivity, income generating activities and difficulty in accessing production for survival because all these opportunities are gained from the development of watershed (Gatbel et al., 2019). Thus, integrated Watershed development program is important to improve livelihood of rural farm households, improve ecosystem functions and for rural development. However, uncertainties those are dispersal and extent of social impacts attributable to watershed development interventions.

The twenty-first century is a time by which the world is getting seriously confronted by issues of sustainable use of natural resources under watershed development to improve rural livelihoods. It is clearly argued that a sustainable livelihood contributes to the harmonious development of related polices, poverty eradication and sustainable use of resources. Because at a day, soil and water are being degraded at an increasing rate and the case is worse in developing regions, where the majority of the population depends on these resources for its livelihoods (Hannam, 2003).

The Ethiopian economy is supported by its agricultural sector, which is also a fundamental instrument for poverty alleviation, livelihood sustainability and economic growth. However, traditional agricultural practices, the processes of over cultivation, deforestation, overgrazing and the problem of appropriate natural resource management lead to accelerate soil erosion and land degradation. Such activities have negative implications on productivity, household income and livelihoods of farm household as well as on poverty of the people (Teklewold *et al.,* 2011). Therefore, the overall objective of Participatory Watershed Development is to improve the livelihood of rural farm households in rural Ethiopia through comprehensive and integrated natural resource development. Through improved livelihood diversification opportunities, enhanced livelihood program and agricultural production and productivity. The Ethiopian government launches the sustainable land management project before more than ten years to combat land degradation and improve agricultural production and productivity enhance livelihood of rural farm household (MOA, 2013). Throughout the country, during 1980 and 1990 community based integrated watershed development program is emphasized to assure livelihood.

In Ethiopia, There is a greater need of livelihood diversification with the increasing inability of agriculture to hold the livelihood, climate change, poverty and other uncertainties over which rural people have no control. Diversification is help to enhance Livelihoods, food security, income generation and minimize unemployment and underemployment for rural farm households (Shubhadeep et al., 2012). In case, WSD can open up new opportunities by supporting agricultural intensification processes. Rural farm households implement different watershed development activities to assure livelihood. From those activities like agricultural practice management, means of livelihood diversification and natural resource development (Phillipo et al., 2015).

Subsequent increases in crop intensity can potentially lead to the creation of labor opportunities. It can also provide new opportunities for households to diversify their livelihood strategies. For instance, Promotion of income generation activities are also

intended to enable series of new income-based activities to emerge and expand, taking advantage of the multiple benefits generated by water harvesting and moisture conservation, increased productivity and diversity of agriculture activities and Small cottage industries are some of options that need to be exploited to increase and diversify incomes, and promote off-farm and on-farm employment for the poor. Then Livelihood diversification ensures to minimize households' dependence on natural resources, thus helping resource restoration.

Livelihood diversification refers to a key strategy for livelihood and hold potency for different risks of rural farm households. Enhancement of livelihood diversification has a vital role to engagement of rural farm households to less dependence on natural resources (Geremew et al., 2017). Although in the long term a broad transformation and diversification of rural economies away from a strong dependence on agriculture is desirable, more immediate gains in the welfare of poor households are most likely to come through the poor overcoming constraints of livelihoods through agriculture. Livelihood diversification of rural farm households enhances their return from on farm, off farm and non-farm income generating section (Ellis, 1998). Rural farm households performs off-farm income activities through livelihood diversification to reduce livelihood risk in case of low productivity and income tremors, in the incident of insurance market failure and credit market failure (Kassie, 2017).

In Ethiopian, Due to high dependency on rain-fed agriculture and other topographic and low adaptive capacity and other related factors, livelihood of rural farm household is tremors. Subsequently, through watershed development program the factors to improving the production function, diversification and wellbeing of the people who directly or indirectly depend on the watershed for their livelihood should be implemented (K. Palanisamia and D. Suresh Kumar, 2009).

Currently, the Ethiopian population is above one hundred million (UNDP, 2017). To assure the livelihood of the population, extensive system of agricultural production system may not satisfactorily response since the problem of technology adoption. Therefore trough Irrigation activities rural farm households produce more production and generate income for their livelihood. It means the increment of small-scale irrigation increases area covered of irrigation an activity which is used to increase sustainable production, to generate income and contribute to the consistency of food supplies (FAO, 2012).

1.2. Statement of the problem

Natural resources are being degraded at an increasing rate and the case is worse in developing regions, where the majority of the population depends on these resources for its livelihoods (Hannam, 2003). In Ethiopian, due to high dependency on rain-fed agriculture and other topographic and low adaptive capacity and other related factors, natural resource degradation is the main problem. But agricultural sector is the major means of income generation, improving livelihood sustainability and poverty reduction. Therefore, rural farm household diversifying as income generation approaches of entities or households through intensifying their number of activities irrespective of on-farm, off-farm and non-farm activities to enhance their livelihood (Saha & Bahal, 2012). But there is a knowledge gap on the choice and determinants of household livelihood diversification activities in the study area. In this regard, the study aimed to fill the knowledge gap and to estimate how watershed development helps to determine opportunities to diversify the livelihoods and generate more income to enhance livelihood.

Low productivity and ecosystem degradation have the combine effect and therefore, has locked the poor in a vicious circle of poverty and environmental degradation (Holden *et al.,* 2005). On the other way, watershed development program is a natural resource-based program which is mainly based on soil and water conservation being to enhance agricultural productivity through irrigation for livelihood of rural community (Joshi *et al.,* 2004, 2006). Therefore, watershed development is not only increasing the level of ground water in the program area but also downstream watersheds apart from increases irrigation potential.

Despite the huge efforts continued being implemented for watershed development strategies for decades to improve rural livelihoods, there is scares information related the impact of the effort on the livelihoods of rural farm household. And there is minimal information on the impact of WSDP on the level of groundwater that enhanced irrigation potential of Burie Zuria district in particular and Amhara region in general, to improve rural farm household livelihood. Therefore, this study will be concerned aiming to generate basic information regarding the impact of watershed development on livelihood diversification and better income utilization for better livelihood engagement. And investigate the potential of irrigation practices, intensity of participation and the contribution of irrigation on household income. In addition, it is used as base line information for watershed development for other corners of the country where the practice has not been adapted yet. Similarly, the outcomes of the current study will be used as an example of watershed development practices on

livelihood of rural farm households and could be used as supplementary material for the regional government to strengthen the investment in both human and financial terms and to scale up watershed development practices elsewhere in the country.

Generally; Natural resource degradation is the major environmental, socio-economic and policy challenge in Ethiopia (Aklilu, 2001). Due to the fact that; Traditional agricultural practices (not modernized agricultural sector), the farm household's livelihood is depending on land resources and the country's economy mainly based on agriculture products. WSD is a program designed to control land degradation and enhance livelihoods of farm households through improving agricultural production (MoAD, 2013).

The Problem is: In order to cop up natural resource degradation and climate change, rural farm households have been ensure WSD and diversifying on-farm, off-farm and non-farm activities to enhance their income and livelihood sustainability (Amare and Simane 2017b; Morton 2007). However, little has been known on the potential impact of WSD on livelihood of rural households. For instance, According to the official data of Bure Zuria Woreda Agriculture Office (2020), WSD activities have been implemented for the last 10 years, but limited information is available on its impact on rural household income and livelihood diversification.

Most studies conducted on impact of WSD mainly focused on its immediate results. For instance: Singh *et al.,* (2014); found that WSD could help to reduce the upper stream flood and have positive impact on WSD program, Gatbel Chot *et al.,* (2019); in their study revealed that WSD activities have significant advantage to improve land productivity, Bouma *et al.,* (2011); conducted a study and found that WSD has positive impact on downstream basins in terms of increasing source of water, WSD activities have been found to alter crop pattern and increase crop yields and diversification and there by provide enhanced employment and farm income (Kuppannan *et al.,* 2009). But hence, the peculiar difference of this study is its focus on investigating the impact of WSD on ultimate outcomes of the program towards enhancing livelihood diversification and household income.

1.3. Objective of the study

The general objective of the study is to examine the impact of watershed development on livelihoods of farm households in Burie zuria district of the Amhara National Regional State.
The specific objectives are:

- To assess the factors affecting the watershed development.
- To assess the impact of watershed development interventions on livelihood diversification.
- To investigate the impact of watershed development interventions on household income.

1.4. Research Questions

Based on the objectives stated above, the following vital questions are laid down to be assessed in the research:

- What determines the watershed development practices?
- What is the impact of watershed development interventions on livelihood diversification of farm households?
- What is the impact of watershed development on farm household income?

1.5. Significance of the study

The research will generate information that would be helpful in formulating strategies in watershed development interventions by the practitioners and policymakers to have better knowledge as how to improve the livelihood of rural farm households extrapolating positive experiences to comparable areas for sustainable livelihood. Knowing the impact of watershed development intervention will help to achieve the national development goals that Ethiopia targeted through sustainable natural resource management by watershed development strategies to foster agricultural production and productivity enhancement. The results of this research also will help the research institution to adjust their effort towards generating watershed development technologies and adoption mechanisms of the agricultural knowledge to sustainable livelihood. In addition, the findings of the research will serve as benchmarks for further studies in the area.
Finally, the result of the study will help the rural development planner, policy makers, NGOs as an input informing the appropriate policies setting for rural income diversifications in watershed development program. On the other hand, identifying the determinants of income

diversification helps the agricultural development institutions to design policies that increase the diversification pattern of households, which eventually leads to increase total income and sustainable livelihood status of households.

1.6. Scope of the study

The study will focus on to determine the impact of watershed development on the livelihood of rural farm household problems as per the intended objective of the program. The research will draw a sample of household populations from micro watersheds which are treated groups from micro-watersheds under watershed programs and control groups from not the program. The study will be carried out at Bure Zurie district to evaluate the impact watershed development. Despite the multi-dimensional characteristics of measurement of impact evaluation, this study focuses on measuring the impact of the program on household income, irrigation-based income and diversification.

CHAPTER TWO
LITERATURE REVIEW

2.1. Definition of key Terms

Watershed: Watershed is an area from which runoff drains from rainfall is collected and drained through a particular confluence point in the drainage system.

Irrigation: Irrigation can be defined as the supply of water increased by artificial means, involving the use of water controls technology and including drainage to arrange excess water According (FAO, 1996a). There are several methods of irrigation systems how to obtain water for irrigation purposes from its sources. It is classified Small-scale irrigation (less than 200 hectare), medium scale irrigation (covering 200 to 3000 hectares) and large-scale irrigation (covering more than 3000 hectares).

Livelihood: It is a way of living to sustain one's life and provide basic needs. Livelihood can also define as based on "Less climate-dependent" or "indirectly agricultural" and "Non-climate-dependent" or "nonagricultural" environments (USAID, 2017). Which means, "Less climate-dependent" or "indirectly agricultural" livelihoods are defined as those which are indirectly engaged in or associated with activities related to the production. And also "Non-climate-dependent" or "nonagricultural" refers to livelihoods that are not directly vulnerable to, and therefore are less negatively affected by, either long-term/slow onset shifts in climatic norms for a particular region or sudden and unpredictable climatic shocks.

Diversification: Diversification can be defined as the maintenance and continuous inspire variation activities to maximize household income consistency, reduce the adverse impacts of seasonality, and provide employment or additional income. Livelihood diversification is an active and changing phenomena taking place in rural areas.

Impact Evaluation: An impact evaluation is an evaluation of the effects positive or negative, intended or not on individual households and institutions, and the environment caused by a given development activity such as a program or project (UNDP, 2009). Such an evaluation refers to the final impact as well as to the effects at the outcome level. An impact evaluation attempts to find out the changes that occurred, and to what they can be attributed and determine what portion of the documented impacts the intervention caused, and what might have come from other events or conditions (MOFEC, 2017). Impact evaluation does not simply measure whether objectives have been achieved or assess direct effects on intended

beneficiaries. It includes the full range of impacts at all levels of the results chain, including ripple effects on families, households and communities; on institutional, technical or social systems; and on the environment (UNDP, 2009).

2.2. Reviews of theoretical Studies

2.2.1. Theoretical concepts of watershed development

Participatory watershed development is the rational and socially acceptable utilization of all the natural resources for optimum production to fulfill the present need through soil and water conservation, control land degradation and environmental sustainability. Therefore, it should be underlined that people's needs and aspirations drive the planning process. Many countries particularly those having significant areas with complex, mountainous, and fragile ecosystems have developed national watershed programs or projects. In India, for Rain fed areas is a major initiative operating in conformity with the common approach for Watershed development. China successfully practices the concept of small scale watershed-based development and Other Asian countries like Nepal, The Philippines and Indonesia have also remarkable and often large-scale watershed development programs.

In Ethiopia watershed management initiatives enhance shifted from top-don infrastructure solutions to community-based approaches is ongoing before a year 1970s. For decentralized and participatory development, community motivation and organization arrangement, and natural resources lead by community by-law approach and tenancy practice are supportive policies and legal frameworks. And watershed development program planning is launched in the 1980's to developing macro watersheds for the purpose of integrated natural resource conservation and development programs (MOARD, 2005).

For long time recognition of the natural resource degradation, the Ethiopian government was applied large national program initiatives in the 1970s and 1980s to measure the problem faced. However, the efforts of these initiatives were insufficient to control the natural resource degradation problem because of the rapid rate of demographic growth. Since 1980, soil and water conservation to land rehabilitation perform through watershed development program through the government support. Through community-based watershed development program planning process, SLM II project implement natural resource development base on community needs and priorities guided by Watershed Development Guidelines (ESMF, 2013).

Like the rest Ethiopian regions, Amhara region people's major economic activities largely confined to cropping, livestock farming and forest manipulation whose misuses are strongly connected to the degradation of land resources. To solve the land degradation problem and to develop natural resources, different soil and water conservation measures have been constructed in the region for the last 30-40 years (ADSWE, 2016). The watershed development program is a natural resource-based program, which is mainly based on soil and water conservation being to enhance agricultural productivity through irrigation for livelihood of rural people (Joshi *et al.,* 2004, 2006). Rural farmers, other land users and the community who depend on the land must be involved from the very beginning of the planning process since they are the ones that will live with the end result.

Under rain-fed areas cultivated lands has low soil fertility due to run-off before being dumped in to downstream, based on soil and water conservation structures quality as well as siltation (Garg et al., 2012). This environmental problem will be worse because of high population pressure, poor land management and poor institutions (Bouma & Scott, 2006). Therefore, different types of treatment activities carried out in a watershed to ensure the sustainable livelihood of rural farm household.

The watershed development approach is a community based participatory approach that enhances the holistic development of agricultural production, social wellbeing and improve livelihood in the watershed development. It also forms an appropriate unit for analyzing the development linked resource problems, designing the appropriate solutions of identified problems and eventually evaluating the efficiency of the measures taken up. Low-productivity subsistence agriculture, reverse land degradation and increase the level of water use and local participation in water management. The challenge is grim but negotiating solutions that are participatory and pilot towards its stated goal of making rural agriculture the basis of economic growth.

The ambiguity of resource degradation and poverty in the rural areas of the developing countries became more evident, respective governments as well as international donors started to emphasize more on resource management projects with participation of the local communities. Over the past several years natural resource management is led by the central government directions. It means, development policies, projects and responsibilities from the central government even informally organized community groups. But, the recent situation indicates that decentralization of responsibilities and duties for development and management of natural resources to the community level through watershed development program.

Soil and water conservation measurement activities are implemented based on soil type, land use type, the slop of land and agro-ecology (Hurni et al. 2016). These measurement activities reduce soil and water degradation and improved soil texture and infiltration rate, thus in the treated watershed soil fertility is increased it enhance the user's agricultural production than the non-users (Hailu, 2017 and Gebregziabher *et al*. 2016). And also the reduction in soil erosion and increased water retention lead to increased moisture content in the soil, more percolation of water downward due to increased water retention leads to an increase in the groundwater level thereby increasing its harnessing potential for use during the dry season for both agricultural and domestic purposes (Rockstrom et al., 2010).

Land degradation is not; therefore, the inevitable result of population increases or cultural traits, but a product of the interactive processes of human activities with the physical environment in a highly extractive socio-economic context (Zemenfes Tsighe, 1995). The degradation of land in Ethiopia is closely intertwined with the country's political economic realities, which changed the resource access profile of Ethiopian societies.

2.2.2. Theoretical concepts of watershed development contribution on livelihood

The term livelihood refers to a way of living to sustain one's life and provide basic needs (Khatun & Ray, 2012). Thus, there is no universally recognized definition to grasp the term livelihood (Scoones 2009). The most widely used definition of livelihood is the one offered by Chambers and Conway built on participatory research practices of World Commission on Environment and Development. Livelihoods approach suggests that improvement of natural resources through watershed development is not an end in itself, but it is a means to an end: 'reducing the incidence of rural poverty' (Turton, 2000). The livelihood approach provides a framework for analyzing the 'fit' between WSD activities, rural livelihoods and ultimately poverty reduction. The background of Soil and water conservation activities in Ethiopia is due to subsequent famines through the occurrence of droughts in the early 1970s forced the government to involve in conservation measures, initially through food aid programs (Amede *et al*., 2007). Gradually, the motivation shifted from food relief to natural resource conservation to enhance livelihood and development (Haregeweyn *et al*,. 2015).

In Ethiopian the agricultural sector has a vital role for food security, poverty alleviation, livelihood and economic growth. However, the sector is not mechanized, poor technology adoption and poor integrated watershed development. The consequence of natural resource

degradation, poor institutions, increasing population pressure, low diversification and low agricultural productivity affects livelihoods of rural farm household.

The Ethiopian administration has considerable investments in conserving the environment, with its main objective being the improvement of livelihood opportunities through improved environmental conditions that ensures sustainable and increased agricultural production. Hence, started SWC activities in drought prone and extremely land degraded areas During the 1980s. However, as farmers implement deprived of his interest and responsiveness, conservation structure designed by experts, the program was not effective. And participatory watershed management and Community Based Participatory Watershed Development Program are also launched. The program promotes and gives training to farmers on how to integrate SWC with livestock fattening, improved poultry and apiculture production, and fruit tree promotion. Despite these efforts to improve livelihood opportunities, as well as increase farm productivity through improved environmental conditions, the impacts of conservation practices on food consumption expenditure, food insecurity, and livelihood outcomes are not yet systematically analyzed.

Watershed Development Program (WDP) is a principal strategy for poverty reduction. The program is of particular relevance for improving rural livelihoods in the semi-arid rain fed agricultural regions of the country, because implementation of WDP facilitates securing a source of irrigation, or at least a source of protective irrigation such that the complete dependence on erratic annual seasonal rainfall for agricultural productivity could be reduced (Symle et al., 2014). The assessment of watershed development impact is used to inform rural farm households about the advantage of improving land productivity through natural resource conservation hence, increase their participation in the program towards their livelihood sustainable (Gatbel Chot *et al*., 2019).

Ethiopian population continues to grow and simultaneously agricultural production increases at decreasing rate is an indication of poverty prevalence for agro-dependent population. And also, the slop of landscape and climate condition makes the soil vulnerable to land degradation and consequently the serious problem of rural farm household livelihood status. Community livelihood is highly correlated to Natural resources degradation and it will be extremely affected in harmful watershed (Gatbel Chot *et al.,* 2019). For instance, a degraded watershed has a few or limited opportunities for water harvesting and management, difficulty in accessing sufficient water for irrigation purpose, no or limited opportunities to participate

in income generating activities because all these opportunities are based on watershed development.

2.2.3. Theoretical concepts of WD role on livelihood diversification

Livelihood diversification is the various selections of activities and survival capabilities of rural farm households to generate more income and improve their living standard (Ellis, 2000). The term "livelihood" refers to a way of living to sustain one's life and provide basic needs (khatun & Roy, 2012). Livelihood diversification is essential when the decreasing of agricultural productivity, environmental degradation, poverty and uncertainties over which rural people have no control. And it improves livelihood, to survive adversity, smooth consumption security, income generation and passable labor requirement.

Livelihood diversification occurs when household members have a portfolio of activities and communal proficiencies to exist and to develop their well-being (Ellis, 1998). It is undertaken by both poor and rich, the poor for survival and rich for wealth accumulation and prestige (Prrott et al, 2006). The components of rural livelihood diversification also grouped by sector (farm or non-farm), function (wage employment or self-employment) or by location (on-farm or off-farm) in the past decade recognition has grown that agricultural production is only one of the strategies that contribute to livelihoods. Rural households particularly the poor engage in an extensive range of activities. Through livelihood strategies, a watershed development is providing new opportunities by supporting agricultural intensification processes and also a means of livelihood diversification strategies for rural farm households (Cathryn Turton, 2000**)**.

In Ethiopia, rural farm households trust a broad choice of livelihood activities, most of which are depend on the abuse of natural resources and survival farming systems (Alobo Loison, 2015, Dercon, S.; Krishnan, P., 1996 and Woldehanna, 2002). And high population growth, land scarcity among youth, and lack of agricultural inputs and the associated low productivity have all been reported to drive diversification away from agriculture (Asfaw, 2017 & Kassie, 2018).

An important implication of livelihood diversification is that natural resource-based activities may become part-time and this could have negative consequences particularly for participatory resource management such as watershed and community forestry programs (Priya Deshingkar, 2005). Therefore, watershed development providing opportunities to the poor to diversify their livelihoods, often through the formation of self-help groups for

women, the landless and other marginal groups. In the watershed development, diversification is essential for alleviate natural resource degradation problem by minimizing the community pressure on natural resources and create employment opportunities for youths, unemployment and underemployment rural farm households to improve their livelihoods.

Rural farm household diversification as income generation approaches of entities or households through intensifying their number of activities irrespective of on-farm, non-farm and off-farm (Saha & Bahal, 2012). Households that adopt diversified livelihoods can cope with shocks use the Natural resource sustainability and also provide opportunities for future generation (schwarze &Zeller, 2005).

The agricultural activities are not the only means of improving livelihood and reducing poverty for rural households. Beside to on farm activities off farm and non-farm activities are opportunities for improving their livelihood in the watershed development. Livelihood diversification of rural farm household to generate income is because of at list pull factor and push factor motives. Pull factor for asset accumulation whereas push factor is to reduce risks and enhance resilience to shocks (Abdul-Malek and Usami, 2010).

There is not yet universal consensus that greater livelihoods diversification in rural areas of SSA will necessarily lead to broad-based improvements in living standards (Alobo Loison 2015). And while there are many calls for development efforts to expand non-farm livelihoods and economies in SSA, the academic literature actually still remains unsure of whether and the extent to which growing non-farm activities may lead to increased poverty alleviation (Dorosh and Thurlow 2016). It the way of many development strategies and programs seek to design development interventions to better promote livelihood diversification

2.2.4. Theoretical concepts of household income through WD

Participatory watershed development is critical for rural farm household livelihood, improve living standard, alleviate poverty and diversification through managing natural resources endorse income generation opportunities, increase access to basic services and make livelihood systems resilient to shocks (MOARD, 2005). Watershed development is focus on environmental rehabilitation to reverse the current trend in land degradation, and as a source of income generation for rural farm households. Through integrated watershed development, water harvesting activities are a vital factor to improve livelihoods through providing opportunities for income generation. Moreover, in the watershed development income

generation opportunities like cash crops, bee-keeping, livestock fattening or dairy, and others, largely depend on the conditions or wellbeing of the watersheds. Watershed development activities have been found to alter crop pattern, increase crop yields and crop diversification and there by provide enhanced employment and farm income (Kuppannan *et al.*, 2009).

Watershed development is also intended to enable series of new income-based activities to emerge and expand, taking advantage of the multiple benefits generated by water harvesting and moisture conservation, increased productivity and diversity of crops, fodder and trees. Water harvesting is a component of watershed development which is a key factor to improve people's livelihoods through providing opportunities for income generation, restore and improve land productivity, support the rehabilitation of degraded lands, enhance the development of natural resources and contribute to small-scale infrastructure development (MOARD, 2005**)**. the impact of watershed development on the downstream basins that, source of sufficient water to increase vegetable crop activities leading to an increase in irrigation based income of the farmers, it has led to a drastic fall in runoff into the water reservoirs, more so during dry years that may adversely impact the supply of water (Bouma *et al.*, 2011).

Land degradation, loss of vegetation, soil erosion and complete dependence on rainfall for cultivation, keeps the agricultural productivity low in rain fed agricultural regions. Low productivity and thereby poor agricultural income further cause neglect of natural resources. WDP attempts to break this vicious cycle of poor incomes as a result of degraded natural resources and replace it with a virtuous cycle of sustainable agricultural livelihoods as a result of revived natural resources (Rekha Avinash Bhangaonkar, 2018). The main goal of watershed development approach is improving living standards and welfare of the most vulnerable rural households and communities through SWC practices on individual farm plots and communal land, rainwater harvesting, promoting sustainable agricultural practices, and income diversifying agricultural practices (Gebregziabher *et al.* 2016). Livelihood strategy drives sources of income; therefore, rural farm households generate their income from agricultural activities are likely to involve in natural resource conservation enhance agricultural production and productivity and subsequently increases their income. Therefore, rural communities who pursue agriculture as source of their livelihood are highly probable to implement conservation measures in their farmlands as intensification of agriculture is the survival option and they should work hard to improve crops production (Gatbel Chot *et al.*, 2018).

Through integrated watershed development irrigated cultivation, crop production, crop productivity and crop intensity increase which would improve income and employment. Since, the major objective of watershed development is increasing income and employment of rural farm households and resilience built to survive with climate stress enhanced livelihood of households (Reddy and Soussan, 2004). The benefits from watershed development are proportional to the land holding size of treated farming household. Farmers with larger land holding will have opportunities to use fertile land across the fields. This would allow them to subject non fertile land to food crop cultivation that are less risky to grow under adverse conditions, and allocate more productive land to cultivation of commercial crops with higher returns. Choosing a portfolio of crops, and allocating them to the appropriate land quality allows farming households to improve the chances of earning higher agricultural income (Rekha Avinash Bhangaonkar, 2018).

Through watershed development increase in soil moisture content in the cultivated land, availability of water in the privately-owned wells for irrigation, rate at which groundwater recharges and fills-up the well for irrigation supply are all dependent on the location of the field within a program. In most cases, households with agricultural land on the slope of the watershed (upper reaches close to the ridge line) earn relatively less agricultural productivity gains in comparison to households in the valley (lower reaches closer to the water harvesting structures or percolation tanks) of the watershed (Kerr, 2002).

2.3. Economic theories of watershed development and rural livelihood

In the Nineteenth Century neoclassical economic model, is used to show how a firm's production decisions are made, assumes that there is no interaction between the economy and the environment (Ernest Jowsey, 2003). Which means that, resources are treated as if they are unlimited as inputs into the production process, and any wastes that are generated, although they may increase costs of production in disposing of them, have no impact on the environment. Neo-classical economic theory predicts and justifies a gradual decline in the importance of the agricultural sector, in the absence of appropriate institutional capacities, handling critical and increasing transactional activities; there can be a precipitous collapse of output and incomes (Jens Sjorslev, 2006). Based on Neo-classical theories of commonly exclusive farm household microeconomic theories pursue to explain farm household economic behavior by making logical deductions from a set of prior assumptions about household goals and about the nature of markets within which households make their decisions (Modowa Trevor Gumoi, 2010).

In theoretical economics assumption resource depletion is a relatively recent phenomenon which indoors with the modem environmental problems allied with industrialization (Ernest Jowsey, 2003). Economic growth must eventually be limited by scarcity of natural resources David Ricardo (1772-1823). Several theories underpin the concept of household choice of livelihood diversification activities. These include the agricultural household model (AHM), Boserupian model and random utility model (RUM). These theories include the elements of the choice process which are; household first determines the available alternatives; it then assesses the attributes of each choice and finally uses a decision rule of maximizing utility to select livelihood activities from the available activities. Agricultural household model describes farm households as being consumers and producers of the outputs in subsistence economies. The household allocate there labor among diversified livelihood activities as to the amount of labor to allocate each of these activities are made jointly with in the family to maximize their utilities.

Economic theory of the household tries to capture the complex structures of households and their behavior (Paivi Mattila-Wiro, 1999). It means, information on the demographic structure, decision making process, resource allocation, income earning mechanisms and gender division of labor is a prerequisite for understanding the effects of public or private sector interventions at the micro level as well as their macro level consequences. The vital problems of existing theories are lacking, flawed, incomplete and not comprehensive because they do not provide a universal theory for all natural resources (Jowsey, Ernest, 2003). The main reason for this is that existing economic theories do not explain in an objective manner how different resources to which they apply.

2.4. Reviews of Empirical Studies

Ellis-Jones and Tengberg (2000) assumed that without any SWC, crop yields will decline approximately by 1.5% year-1, being equivalent to a 30% decline over 20 years. The positive effects of soil and water conservation (SWC) may occur through time and adoption of SWC agricultural technologies depends on the ability of the technologies to improve agricultural land productivity and income, and risk decisions facing individual households both in short and long term (Yitayal Abebe and Adam Bekele, 2014). A higher return from agriculture allows farmers to assign higher value to perceived livelihood loss in the absence of effective irrigation management in the community (Rekha Avinash Bhangaonkar, 2018). Currently nearly 60% of farmers in the community are horticulture farmers and its adoption spreads across all land holding sizes. From the total production, about 97 percent of Ethiopia’s food

crops are produced by rain-fed agriculture, whereas only 3% is from irrigated agriculture (FAO, 2015). Due to high dependency on rain-fed agriculture and other topographic and low adaptive capacity and other related factors, Ethiopia ranks the ninth most susceptible country in the world to natural disasters and weather-related shocks (Tongul and Hobson, 2013). However, as to international journal of environmental monitoring and analysis IJEMA's (2013) national level studies estimation, more than 2 million hectares of Ethiopia's highlands have been degraded beyond rehabilitation.

The existing irrigation development in Ethiopia as compared to the resource potential that the country has is not significant and the irrigation sub-sector is not contributing the expected share accordingly (MoA, 2011). While the country's irrigation potential is about 3.7 million hectares (WSDP, 2002), the total irrigated area is 190,000 ha in 2004, that is only 4.3 percent of the potential (FAO, 2005). Despite the above challenges, some of the implemented small-scale irrigation schemes are contributing well for sustainable livelihood and poverty reduction strategies as compared to rain fed agriculture.

In Ethiopia, irrigation plays the key role in the performance of agriculture, which increases income growth that is essential for national economic growth (Abebaw Abiyu *et. al*, 2015). he revealed that in Ethiopia, among the sixteen explanatory variables entered into the model, eight of them were found to be statistically significant namely: total income of the household, conflict over irrigation water utilization, and training and technical advice were significant at 1% ($P<0.01$) probability level; education status of household head, farm size, financial constraint, and proportion of irrigated land size were significant at 5% ($P<0.05$) probability level, and access to market information was significant at 10% ($P<0.10$) probability level.

Livelihood diversification is an effective way of solving the problems caused by poverty and environmental degradation. Diversification has identified a wide range of explanatory determinants for involvement in diversified livelihoods (Ellis, 1998; Khatun & Roy, 2012). Jointly determinants such as income, household size, education level, market access, land size, credit access and gender adversely define the household's involvement in diversified livelihoods. Correspondingly, Adepoju and Oyewole (2014) found that household size, total household income and primary education were the dominant determinants influencing the choice of livelihood activities implemented. The studies under review examined the human, financial and social capital determinants of a household's choice of activities. Therefore, focus on the factors that influence a household to choose a given livelihood activities and fails to explain the natural factors that influence a household to adopt a given number of

livelihood activities should have the vital role. Similarly, Yizengaw *et. al*. (2015) found that at ten percent probability levels variables including land size, livestock holding size, gender, distance to market and income and urban connection were significant determinants of livelihood activities. Additionally, Ibekwe *et al*. (2010) established that in Nigeria, non-farm income diversification among households was determined by variables such as occupation, education level, household size and farm output, conversely age of the household head was found not to have any impact. Amogne *et al*. (2017) studied livelihood diversification and vulnerability to poverty in rural Malawi using both the pull and the push factors that influence households.

The study on the impact of adoption of water conservation and intensification technologies such as bund construction and seed dabbling on outcomes that includes net returns, input demand and output supply, using cross-sectional data of low land rice farmers in Northern Region of Ghana using propensity matching procedure indicated that the adoption of these technologies positively influence output supply and net returns, as well as demand for inputs even though the effects vary according to the type of technology and outcome (Faletrmeier and Abdulai, 2009).

Rural farm households have followed one, two or a combination of livelihood activities to pursue their livelihood strategies. Accordingly, four livelihood strategies were identified which include the on-farm only strategy, on-farm plus non-farm, on-farm plus off-farm and a combination of on-farm off-farm and off-farm activities. Based on (Yenesew *et. al,* (2015), 39% of the households entirely depend on the on-farm only livelihood strategy, 17% households depends on on-farm plus off-farm, 21% of the respondents depends on on-farm plus non-farm, and the rest 23% of sample respondents depend on on-farm plus off-farm plus non-farm livelihood diversification strategy. And almost all average net annual income (88.9%) of the households were obtained from agricultural crop production and animal husbandry sources; and only 11.1% of the household's average net annual income are obtained from a combination of non/off farm activities.

2.5. Conceptual Framework

Watershed development process can be divided into three phases, i.e., Initiation Phase (Phase-I), Rehabilitation Phase (Phase-II) and Economic Development Phase (Phase-III) with very strong overlap between the last two phases (Gete Zeleke, 2014). The assumption is that most activities related to economic development follow sequential order. There are activities that will be implemented at Start-Up Stage and other activities that will come after sometime.

For instance fruit seedling plantation can be a Start-Up Stage intervention but income from fruit sell or packaging or improving nutrition will be at later Stage. Forage development activities could be the first Stage, but fattening or dairy could be after the forage is well developed. So, using this logic we can fairly determine the stage of the watershed under the economic development phase or not.

The models, which is formulate and the way to interpret the results should be guided by a comprehensive conceptual framework to avoid potential biases. Here are some of the theoretical relationships between dependent and independent variables. A number of alternative standards of livelihood indicators are used in the literature to assess the impact of watershed development interventions in households. The present review draws on a conceptual framework for analyzing impact of watershed development program on livelihood of rural farm households. This framework identifies two essential indicators of livelihood, namely: livelihood diversification and household income.

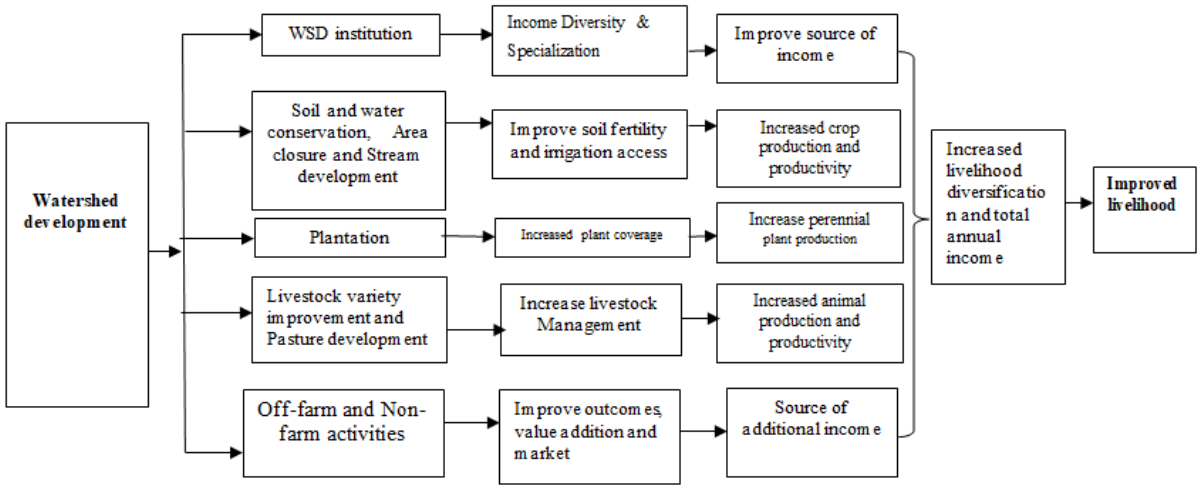

Figure1. Conceptual frame work for integrated impact assessment

Source: (Mishra, 2008) Integrated Impact Assessment for Explaining Differential Impact of Watershed Development Program.

Impact estimation framework: The impact evaluation framework helps to organize the activities that constraints or enhance livelihood opportunities and shows their relations. From this a vital concept of different households has different access to livelihood assets for develop their livelihood approach through watershed development program.

Watershed development: rural farm household Livelihood is dependent on watershed development or constrained by the vulnerability context. Watershed development activities: establish WSD institution, soil and water conservation, area closure, stream development, plantation, pasture development, livestock variety improvement, off-farm and non-farm

activities that, in turn, determine the way in which structures operate. Everything cannot be effective in the absence of appropriate institutions and processes through which policies can be implemented. Processes are important to every aspect of livelihoods. And it provides incentives that motivate people to make better choices.

Livelihood outcomes: Livelihood outcomes are what people get from what they do and can either be more or less desirable (Flamme 2007). Therefore in this study through WSD activities, household annual income and livelihood diversifications outcomes are revealed. Those are the result or outputs of watershed development program. livelihood outcomes are the principal term used to denote the result of combination of activities and choices that households make/undertake in order to achieve their livelihood goals including productive activities, investment strategies, reproductive choices (DFID, 1999).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Description of the study area

The Amhara National Regional state covers a total area of 161.8 thousand km^2 (MOA, 2000). The total population of the region is estimated to be 21.5 million, of which 17.6(81.86%) and 3.9 million people lives in rural and urban areas respectively (CSA, 2010). The Amhara national regional state is currently structured under 15 administrative zones, 138 Districts and 22 town administrations. Bure Zurie district is one of the 15 districts in West Gojjam administrative zone which is located at 10^0 42.7'N latitude and 37^0 05.6'E longitude with an altitude of 713 to 2604 meters above sea level (masl). The minimum and maximum temperature of the area is 17^0c and 25^0c respectively. The mean annual rainfall of the district is 1000-1500 mm and the wide range of altitude difference allows for a variety of agricultural activities practiced. The capital town, Bure, is located 400 km North West of Addis Ababa and 148 km south west of the Regional state capital, Bahir Dar.

The topography of the district is 76% plain, 10% mountain, 7% undulating and 7% valley. The climatic condition is 1% highland, 77.23% mid altitude and 21.77% low land. The total area of the district is 58,795 hectares, of which 46.6% of is cultivated. The average household cultivated land holding is about 1.6 hectare.

3.2. Research design

Research design is the plan, structure and strategy of investigation proposed for obtaining answers to research questions (Orodho, 2005). Research design is defined as "a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings" (Burns and Grove, 2003). It ensures that the study would be relevant to the problem and that it uses economical procedures. This study adapted explanatory (casual) research methods since the study intended to examine the impact of watershed development on livelihood of rural farm household. Explanatory studies are important to focus on an analysis of a situation or a specific problem to explain the patterns of relationships between variables.

3.3. Research Approach

The study mainly depends on quantitative approaches in which the collected data was from a well-developed structured survey questioner and it was subjected to be analysis using

statistical software. The quantitative method helped to generate numerical data, which was statistically manipulated to meet the required objectives through descriptive statistics (frequencies and percentages), inferential statistics and impact analysis techniques to estimate the contribution of the program to enhance livelihood sustainability. And also used qualitative data to supplement the results of the study based on the data collected from respondents through questionnaire, individuals have been interviewed in relation the impacts of WSD on the livelihood.

3.4. Types and source of Data

The researcher used wide variety of materials, evidence, or data as well as sources of data to get a better look of the research condition and also to meet the purpose of the research. The foundation of good research mainly depends on the quality and the type of data used in the research study. Therefore, these sources of information are typically classified into two broad categories primary and secondary.

3.4.1. Primary Source of Data

A primary source of data provides direct or firsthand evidence about the research under consideration. Primary sources of data for the study were generated from a cross-sectional survey collected with due care of the validity, accuracy and reliability. A semi-structured questioner was designed and tested through pilot survey as well as further refined using comments provided from the Senior Advisor before producing the final data collection instrument. The data obtained in the primary data source was managed, coded, filtered and screened using Microsoft excel a head of conducting analysis using STATA Version15.

3.4.2. Secondary Source of Data

A secondary source, in contrast, lacks the immediacy of a primary record. As materials produced sometime after an event happened, they contain information that has been interpreted, commented, analyzed or processed in such a way that it no longer conveys the freshness of the original. In other words, secondary source of data could be assumed as second-hand information. The study utilized a wide range of secondary sources including; reference books, both published and unpublished journal articles related to the topic, text books, senior essays, online sources and also annual report of the Agricultural office and others.

3.5. Population of the Study

Population is defined as "the total number of units from which data can be collected", such as individuals, events or organizations (Parahoo, 1997). Similarly, Burns and Grove (2003:213) explained population as all the elements that meet the criteria for inclusion in a study. Due to the fact that the study is conducted in Bure Zuria District, the total farm households who are living in 19 rural Kebeles are considered as population of the study. Accordingly, the total population of the study is 16,560 farm households, of which 2,500(15%) are female headed households. Considering to the major themes of the study, the district identified a total of 86 micro-watersheds, where it include residence, arable, grazing, degraded and forestry lands.

3.6. Sampling Techniques and Sample Size Determination

Before proceeding to discuss about detail process of sampling techniques to select sample units, the experience of the researcher working as expert in Bure Zuria Agricultural Office, researcher's familiarity to the area, budget limitation, existence of good opportunities and support from the office and communities to collect data and generate necessary information are major justifications behind purposely selecting Burie Zuria district as case of the study. Onwards, the study used multi-stage sampling procedure to select sample units/sample households to distribute survey questioners for analysis. The first step was, stratifying kebeles of the district under three agro-ecological zones (dega, woyna-dega and kola). The second step was selecting two kebeles (one Kebele with developed watershed considered as treated and one Kbele with undeveloped watershed considered as control group) from each agro-ecological clusters using random sampling technique. The third step was identifying developed and undeveloped micro-watersheds with in the selected three Kebeles followed by randomly selecting one micro-watershed for each of respective selected kebeles. The fourth and final step was selecting proportionate number of sample households using systematic random sampling from a sample frame developed with respective to each selected micro-watersheds.

As a result of this random selection, three treated Keble namely, Gebgedel, Adele Agata and Sertekeze are selected from dega, woyena-dega and kolla respectively. And Chenetaly, Zagera and SertekezeQuante treated micro-watersheds are selected randomly from each kebele. And also three control (non-treated) kebeles namely, Agni Fereda, Wadera gendeba and Fezel kebeles are selected from Dega, woyna-dega and Kolla respectively. Eliene,

Meshige and Fezel Quante control micro watersheds also selected randomly from each Keble.

Sample size determination takes into account both availability of limited resources and number of explanatory variables used in the econometric model regression. The study is depended on total number of treated and control households in order to determine the sample size of the study which was calculated based on Yamane (1967:886) sample size determination formula. It was calculated as follows:

$$n = \frac{N}{1+N\,(e^2)}$$

$$n = \frac{1521}{1+1521\,(0.05^2)} = \quad 322$$

Where: n refers sample size of households

N is total household population size and

e Represents the degree of precision = 0.5 % with the given level of 95%

Finally, by using proportionate sampling technique 147 households from developed and 175 households from undeveloped micro-watersheds are selected from sample Keble of the Woreda.

Therefore, the proportionate number households were calculated from each micro-watershed as;

$$n_i = \frac{N_i}{N} * n$$

Where: $n_i$is number of households selected from each developed and undeveloped micro watersheds

N_i is number of households from each developed and undeveloped micro watersheds

N is the sum total number of households from all selected developed and undeveloped

n is total sample size.

The beneficiary (treated) and non- beneficiary (control) farm households for the study were selected by using systematic sampling which is a technique an initial starting point is selected by a random process, after which every n^{th} number on the list is selected to constitute part of the sample.

Table 3. 1Sample household's distribution across treated and control kebeles

Distribution of Sample Respondent Households across sub-units micro-watershed							
S/N	treated Sample Keble	Micro-WSD(treated)	No. HH	control Sample Keble	Micro-WSD(control)	No.of HH	Total
1	Gieb Gedel	Chenetaly	33	Agni Fereda	Eliene	63	96
2	Adel Agata	Zagira	57	Wadera Gendeba	Misheg	62	119
3	Sertekeze	Sertekeze Quante	57	Fezel	Fezel Quante	50	107
	Total		147			175	322

3.7. Data collection techniques

The researcher is used quantitative data which rely on structured data collection instruments that fit diverse experiences into predetermined response categories. The study is mainly utilized primary data collected using household survey questionnaire. Enumerators are assigned to collect the survey data. The survey questioner collected by the enumerator is cross checked On the other hand, for this study secondary data from the concerned Government institutions including Woreda Office of Finance and Economic Development (WOFED), Woreda Agricultural office, sustainable land management program(SLM), the Central Statistics Agency (CSA) and other reliable institutions is collected. Moreover, findings of previous empirical studies and journals are used to triangulate and make comparative analysis among theoretical and empirical bases and findings.

3.8. Data analysis Techniques

3.8.1. Descriptive statistics

The collected primary data was filled and analyzed using STATA Version 15 software to generate both descriptive statistics and econometric regression results. Descriptive statistics includes mean, mean comparison test standard deviation (SD), frequency, ratio, and percentage, tabular and graphical representation is generated.

3.8.2. Econometric Analysis and Model Specification

The study engaged a wide-range of econometric regression model which intend to address basic objectives of the study as well as to cross check and triangulate findings of the study across different models.

Binary logistic regression was used to investigate determinants of a household to participate in watershed development, while Heckman two-stage was used to examine determinants of watershed development which was also measured via index developed using watershed development indicators. Meanwhile, propensity score matching was mainly used to evaluate the impact of watershed development on annual income and livelihood diversification of rural farm households.

Logistic regression: Logit analysis is in many ways the natural complement of ordinary linear regression whenever the regressand is not a continuous variable but a state which may or may not hold, or a category in a given classification. When such discrete variables occur among the independent variables or repressor's of a regression equation, they are dealt with by the introduction of one or several (0, 1) dummy variables; but when the *dependent* variable belongs to this type, the regression model breaks down. Logit analysis or logistic regression (which is two names for the same method) provides a ready alternative (Cramer, 2003).

For the purpose of this study, logit regression was used where the dependent variable takes a binary form either "participant" or "non-participant". To identify key determinants of watershed participation, the first step was computing a dichotomous variable indicating whether the household participated or not. That is,

$$\text{Household's participation in WSD} = \begin{cases} 1, \text{if } 1, \text{if a household participated in WSD} \\ 0, \text{otherwise} \end{cases}$$

$$\text{Logit}\,(P_i) = \ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n$$

Where, P_i indicates the probability of a household i to participate in watershed development and $x_1, x_2, \ldots x_n$ refers explanatory variables that determine participation of a household in watershed development.

Heckman two stage regression model: In this study the outcome equation is used to explain the determinant factors of outcome variables in the developed watershed. If a data set used for a regression suffers from selectivity bias, then the regression analysis, for example, Ordinary Least Squares (OLS), which compute the effects of characteristics of this

population on other characteristics, will be biased (Sauer et al., 2012). Therefore, if two decisions are involved, determinant factors of the outcome variables and developed watershed users selection level, then a two-step procedure was appropriate, which was adopted in this study to correct for sample selectivity bias.

Using the Heckman sample selection model, the first stage was the decision of outcome equation, which helped to identify the factors affecting the expected outcomes in the developed watershed. Then in the second stage, OLS regression was fitted along with the Probit estimate of the inverse Mill's ratio, a selectivity term that was added to the outcome equation that the factors affecting outcomes from the effect of watershed development by watershed development users. The inverse Mill's ratio was then used as a variable for controlling the bias due to sample selection. Then, if OLS regression is employed excluding the non-participants from analysis, a sample selectivity bias will be formed in the model. So, to overcome this problem, Heckman (1979) sample selection model was employed to analyze determinants of outcome variables through watershed development and participation in the watershed.

The selection equation for decision of sample households either to watershed development users or not in the determination of outcome value could be formulated as binary response model which could be analyzed employing the specification of the probit regression equation as expressed by Wooldridge (2002):

$$Y^* = a_{xi} + \beta_{xj} + u_x, u_{xi} \sim N(0, \delta^2)$$

$$\text{Y} = \text{WD}P_i = 1 \text{ if } Y^* > 0$$

$$\text{Y} = \text{WDP} = 0 \text{ if } Y^* \leq 0$$

Where; Y* is a latent (unobservable) variable representing household discrete decision whether to participate or not in watershed development. a_{xi} Vector of explanatory variables assumed to determine the likelihood of watershed development users participation in livelihood outcome activities. β_{xj} is a vector of unknown parameter in participation equation. Y is a dependent (response) variable that takes the value one if a watershed users participates in WSD and zero otherwise. And u_x, u_{xi} Random disturbance term that captures all unmeasured variables and that are independently and normally distrusted with zero mean and constant variance.

The equation of rural farm household participation in the developed watershed for their livelihood diversification and generate their annual income could be formulated as Heckman

second stage model which could be analyzed employing the specification of regression equation denoted as Heckman (1979):

$$Y_{2i} = \beta_0 + \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + \ldots + \beta_n X_n + Z_n \lambda_j (X_i B)_j + \varepsilon_j ; \ \varepsilon_j \sim N(0, \delta^2)$$

Where: Y2i is estimated outcomes. Xj is exogenous variable in the second stage. βj is vectors of unknown parameters (to be estimated and measures the effects of independent variables on household's decision) in participation equation. λj (Xiβ)j is the inverse Mills ratio derived in the first stage/probit/ regression. Z_n is shows the influence of participation on outcome activities. And εj is stochastic term in the second stage that is independently and normally distributed with zero mean and constant variance.

Propensity score matching: The study is also utilized Propensity Score Matching Method (PSM) in order to estimate the average effect of watershed development on livelihood of rural farm household status. Treatments are heterogeneous in the population (Hackman et al., 1997). Robin (1997) developed a framework that each household has two potential outcomes; an outcome when participating in the program (y_1) and not participating (y_0). If we let the participation status d, d=1 for program users and d=0, for non-users, then it is possible to write the observed outcome y of the household livelihood performance as a function of the two potential outcomes as $Y = dy_1 + (1-d)\, y_0$

The causal effect of watershed development participation on its observed outcome y is the difference between the two outcomes (y_1-y_0). But because of the realization, the potential outcomes are mutually exclusive that is only one of the two outcomes has been observed at a time (Nguezet *et.al*, 2011). It is also impossible to measure the individual effects of program participation in any household. However, it can be possible to estimate the mean effect of watershed development participation on a population household. Such mean parameter is called average treatment effect (ATE) (Imben and wooldridge, 2009).

$$\text{ATE} = \frac{1}{n}\sum_{i=1}^{n} \frac{\text{di} - (\text{p(xi)yi}}{(\text{p(xi)}(1 - \text{p(xi)})}$$

Where n is the sample size, $n_1 = \Sigma di$, is the number of treated variables which is the number of watershed development participant households and p (xi) is a constant estimate of propensity score evaluated at x. It is possible to use logistic regression to estimate the propensity score. Propensity score matching pursues a targeted evaluation of whether participating in the program cause households to improve household's livelihood.

There will be a problem of avert and hidden biases and deal with the problem of non-compliance or indigenous treatment variable. In order to remove such biases, use ignobility (conditional) assumption which postulates, the existence of a set of covariate x, which

controlled for renders the treatment outcomes (y_1 and y_0). The estimation using the conditional independent assumption or they are based on a two-stage estimation procedure, conditional probability of treatment called propensity score.

3.9. Estimating the Propensity Scores

The first step in PSM method is estimate the propensity scores using logit regression model. Caliendo and Kopeinig (2008) noted that the logit model which has more density mass in the bounds could be used to estimate propensity scores, P(x) using a composite characteristic of the sample households and matching will then be performed using propensity scores, p-score, of each observation. Matching algorism will be selected based on the data to be collected after undertaking matching quality test. Overlapping condition or common support condition will be identified, estimating the average treatment effects of both outcomes (ATE1 and ATE0) after estimation of the propensity scores, seeking an appropriate matching estimator is the major task.

There are various matching estimators, which include the nearest neighbor matching, caliper or radius matching, stratification or interval matching, kernel and local linear matching and difference–in-difference matching (Caliendo and Kopeinig, 2008). However, with this study mainly utilized four types of matching techniques Kernel Matching (KM), Nearest Neighbor Matching (NNM), Radius Caliper Matching (RCM) and Stratification Matching (SM).

Nearest Neighbor Matching: It is the most straight forward and frequently used matching estimator, where the individual from the control group is chosen as a matching partner for a treated household with the closest propensity score (World Bank, 2010). Several variants of nearest neighbor matching are proposed, e.g. NN matching 'with replacement' and 'without replacement'. Matching with replacement means that the same non-participant can be used as match for different participants. Through matching replacement, the bias and variance will decrease and increase respectively and enhance the average quality of matching will increase.

Caliper Matching: To avoid the problems of bad matches resulted from the Nearest Neighbor matching; economists impose a threshold or tolerance level on the maximum propensity score distance (caliper). This procedure consequently involves matching with replacement only among propensity scores within a certain range and a higher number of dropped non-participants are likely, however, potentially increasing the chance of sampling bias (World Bank, 2010). The benefit of this approach is that it uses only as many comparison units as available within the caliper and therefore allows for usage of extra (fewer) units when good matches are (not) available.

Stratification or interval matching: This procedure partitions the common support into different strata (or intervals) and calculates the program's impact within each interval. And also, specifically, within each interval, the program effect is the mean difference in outcomes between treated and control observations (World Bank, 2010). A weighted average of these interval impact estimates yields the overall program impact, taking the share of participants in each interval as the weights.

Kernel Matching: With Kernel matching, all treated groups will be matched with a weighted average of all control groups with weights that are inversely proportional to the distance between the participant and non-participant propensity scores (Becker and Ichino, 2002). But the matching algorithms discusses have in common that only a few observations from the comparison group will be used to construct the counterfactual outcome of a treated individual.

The drawbacks of kernel matching are that only a small subset of non-participants will ultimately satisfy the criteria to fall within the common support and thus construct the counterfactual outcome (World Bank, 2010). And also, it describes that, a nonparametric matching estimator such as kernel matching uses a weighted average of all nonparticipants to construct the counterfactual match for each participant. If *Pi* is the propensity score for participant *i* and *Pj* is the propensity score for nonparticipant *j*, and if the notation in TOT psm followed, the weights for kernel matching are given by;

$$w(i,j)km = \frac{k(\frac{pj-pi}{an})}{\sum k(\frac{pk-pi}{an})}$$

Where K (·) is a kernel function and *an* is a bandwidth parameter.

Treatment effect on the treated: To estimate the contribution of watershed development program on livelihood of rural farm household indicators, can be specified as:

$$\tau_{ATT} = Y_i(d_i = 1) - Y_i(d_i = 0)$$

Where τ_i is treatment effect due to participating in the program, Y_i is the outcome on household$i$, d_i is whether household i has got the treatment or not (i.e., whether a household is WSDP user or non-user). However, one should notice that $Y_i(d_i = 1)$ and $Y_i(d_i = 0)$ cannot be observed for the same household at the same time. Depending on the position of the household in the treatment either $Y_i(d_i = 1)$ or $Y_i(d_i = 1)$ is unobserved outcome (counterfactual outcome). Due to this fact, estimating individual treatment effect τ_i is not possible and one has to shift to estimate the average treatment effects of the population than the individual one. Two treatment effects are most frequently estimated in empirical studies

(Dillon, 2008). The first one is the population Average Treatment Effect (ATE), which is simply the difference of the expected outcomes after participating in the program or not:

$$\Delta Y_{ATE} = E(\Delta Y) = E(Y_1) - E(Y_0)$$

This measure answers the question what would be the effect if households in the population were randomly assigned to the program. But this estimate might not be of importance to policy makers because it includes the effect for which the intervention was never intended (Dillon, 2008). Therefore, the most important evaluation parameter is the so-called Average Treatment Effect on the Treated (ATT), which concentrates solely on the effects on those for whom the interventions are actually introduced. In the sense that this parameter focuses directly on those households who are beneficiary in the WSDP, it determines the realized impact of undertaking WSDP and helping to decide whether participation on the program is successful or not. It could be given as:

$$\tau_{ATT} = E(\tau/d = 1) = E(Y_1/d = 1) - E(Y_0/d = 1)$$

This answers the question, how much did households benefit from the program compared to what they would have experienced without participating in the WSDP. Data on $E(Y_1/d = 1)$ are available from project users. An evaluator's classic problem is to find $E(Y_0/d = 1)$). So the difference between $E(Y_1/d = 1) - E(Y_0/d = 0)$ cannot be observed for the same household. Due to this problem, one has to choose a proper substitute for it in order to estimate ATT. The possible solution for this is to use the mean outcome of the comparison individuals, $E(Y_0/d = 1)$ as a substitute to the counterfactual mean for those being treated, E (Y0/d=1) after correcting the difference between user and non-user households arising from selection effect. Thus, by rearranging, and subtracting $E(Y_0/d = 1)$ from both sides, one can get the following specification for ATT.

$$E(Y_1/d = 1) - E(Y_0/d = 0) = \tau_{ATT} + E(Y_0/d = 1) - E(Y_0/d = 1)$$

Both terms in the left-hand side are observables and ATT can be identified, if and only if E $E(Y_0/d = 1) - E(Y_0/d = 1)$ i.e., when there is no self-selection bias. This condition can be ensured only in social experiments where treatments are assigned to units randomly i.e., when there is no self-selection bias (Caliendo and Kopeinig, 2008; Dillon, 2008). There are two assumptions in the non-experimental studies to solve the selection problem.

Assumption of conditional independence:

Conditional independence is also called unconfoundedness which states that given a set of observable covariates X that are not affected by treatment, potential outcomes Y are

independent of treatment assignment T. If Y_1 represents outcomes for participants and Y_0 outcomes for nonparticipants, conditional independence implies

$$(Y_1, Y_0) \perp {}^{d}/_{X}$$

It implies that uptake of the program is based entirely on observed characteristics (World Bank, 2010).

The possible outcomes are autonomous of the treatment status, given X. Or, which means after controlling for X, the treatment assignment is "as good as random." The conditional independence assumption (CIA) is crucial for correctly identifying the impact of participation, since it ensures that, although treated and untreated groups differ, these differences may be accounted for in order to reduce the selection bias. This allows the untreated units to be used to construct a counterfactual for the treatment group (Heinrich *et al*., 2010).

Assumption of common support

This assumption rules out perfect predictability of d given X. That is

$$0 < p\left(d = {}^{1}/_{x}\right) < 1$$

This equation implies that the probability of receiving treatment for each value of X lies between 0 and 1. The interpretation of the formula is: the proportion of treated and untreated individuals must be greater than zero for every possible value of X (Caliendo and Kopeinig, 2008; Heinrich *et al*., 2010). And also, it is known as overlap condition, because it ensures sufficient overlap in the characteristics of the treated and control groups to find adequate matches (or a common support). When these two assumptions are satisfied, the treatment assignment is said to be strongly ignorable (Rosenbaum and Rubin, 1983).

Given the above two assumptions, the PSM estimator of ATT can be written as:

$$\tau_{ATT} = E(Y_1 - Y_0/d) = 0, P(X)) = E(Y_1/d) = 1, P(X)) - E(Y_0/d) = 0, P(X))$$

Where P(X) is the propensity score computed on the covariates X. Equation is explained as; the PSM estimator is the mean difference in outcomes over the common support, appropriately weighted by the propensity score distribution of participants.

3.10. Description and measurement of variables

The study used participation in the program as a treatment that classified sample households a control and treatment group. Age of household, education level, family size, dependency ratio, cultivated land size, number of livestock, distance from the market and formal source of credit are matching variables to develop common support among treated and control groups.

Whereas, livelihood indicator variables including; total household income, diversification and household income from irrigation are taken as outcome variables.

3.10.1. Matching Variables

Age of household head: Age of household head is important variable that can determine participation in the program and that enable the study to develop common support among treated and control groups. It is a discrete variable that refers the number of years starting from birth date of each household head. It is assumed that asset and capacity of rural households would increase parallel to increase on their age. Hence, an increase on age of household head is expected to show positive relationship with more income with increased probability to livelihood sustainability.

Years of schooling: importantly education level of a household is another determinant to easily understand and take part program activities as per the expectation level. Education status of household heads was used in two ways in different regression analysis models. As a discrete variable, an increase on education level of a household head was expected increase his/her probability of income generate for livelihood sustainability. As a dummy variable where illiterate = 0 and literate =1, literate households were expected to have generate less income per adult equivalent which hypothesized positive association of literacy and livelihood unsustainability. It will capture as discrete variable and hypothesized to show positive correlation with income generates to improve livelihoods. The above hypothesis is made based on the assumption that, educated households will more willing to actively participate in the program and utilize improved technologies and have knowhow about how to improve their livelihood.

Household size: the size of family members is important variable to determine livelihood at household level. It refers the number of peoples who are living in a single household and it can be expressed in terms of adult equivalent size. For the purpose of this study, simple count of family members was used as discrete independent variable.

Land holding: It refers to the size of land owned by the household. Land holding was measured in terms of the standard unit hectare for analysis purpose. Land is among important asset and factor of production in the rural areas where a household who has larger adult equivalent farm size has better opportunity of obtaining more income and hypothesized to show a positive impact on livelihood diversification.

Livestock holding: Household's livestock holding refers the total owned animals in terms of TLU (Tropical Livestock Unit). The converted TLU value of livestock takes continuous form

where the study examined its impact on household income and livelihood analysis as independent variable. Households with higher livestock holding will lead to higher probability of getting excess livestock for selling and hence generating additional income, particularly the owner of improved varieties of livestock will earn higher income. Livestock are the source of income and expected to show significantly positive relationship with livelihood diversification of rural farm household.

Adult Equivalent: An adult equivalence scale is defined as the proportionate increase in income per adult necessary to maintain a certain level of household living standard given some change in demographic circumstances. Adult equivalence of the sample households in the sample watersheds is a powerful characteristic to determine the total income and livelihood diversification of the households as well as to observe other characteristics since it shows the size of the family as per the standard equivalence scale. Values for such scales might be obtained in any of a number of ways.

Dependency ratio: It is a continuous variable which refers the number of dependents (children < 15 years plus old peoples > 64) per economically active (between 15 to 64 years) members of the family. The existences of a large number of children under age of 15 and old age of 65 and above in the family expected to affect the household income negatively. Households with less dependency ratio expected to have more income and livelihood sustainability.

3.10.2. Outcome variables:

Livelihood diversification: it is defined as the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living. Development strategies seek to provide farmer populations with access to new or expanded non-farm opportunities for livelihood diversification therefore tend to focus on eliciting increased access to and use of modern inputs and technologies, improving markets and agribusiness opportunities, and developing skills and support for individuals and groups to engage in non-agricultural self-employment or wage employment (USAID, 2017). Hence, able to generate various type source of income and livelihood diversification is measured in two ways. The first diversification index is the Baerger-parker index, which is developed in the form of ($1 \leq D \leq N$), where N is the

maximum possible number of income activities available in the areas and D is the maximum number of income activities (source of income) that the household undertake.

The second method of diversity measurement is Simpson Index**;** it is the most suitable index for measuring livelihood diversification in a particular watershed.

$$\text{Simpson Index (SI)} = 1 - \sum_i^N pi^2$$

Where, N is the total number of income source and Pi = Ai / Σ Ai is the proportion of the i^{th} activity in the program. It's value between 0 & 1. If SI is near zero, it indicates that the program is near to the specialization in growing of a particular income source and if it is close to one, then the program is fully diversified in terms of income source.

Household income: Household income is a major outcome variable where the watershed development program initiated to attain on-farm, non-farm and off-farm activities for livelihood of rural farm households. It is netted using annual income from each type of activities engaged by each household. The study assumes that the watershed development approach has significant impact on total annual income of rural farm households.

On-farm income: is income gained from either through farming own-land or land acquired or accessed by cash or share tenancy, and income from livestock production. The study expected that the effect of watershed development approach has significant impact on on-farm income of rural farm households.

Irrigation based income: Agricultural production in Ethiopia is primarily rain-fed; so, it depends on erratic and often insufficient rainfall, and there are frequent failures of agricultural production. So, irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall (Abebaw *et al.*, 2015).

In watershed development soil and water conservation is a common practice to control soil degradation and to improve ground water resources. Therefore, Irrigation through stream diversion and other water harvesting technologies are widely utilized for the cash crop production in the watershed. It is measured using a continuous variable, where amount of irrigation income valued in terms of ETB. Hence, those households who have access to irrigated plots expected to have more income than others. The study expected that it has significant impact to increase rural farm household income.

Off-farm income: income generated from those activities which helps to receive cash money from agricultural wage employment that households participate whether they own their land or work for a wage, in a secondary or additional job away from his or her own plot of land, non-agricultural wage employment, self-employment and other income such as capital

earnings and pensions. Income from Off-farm activities is used to supplement the farm income of the poor and reduce livelihood problem in rural farm households. it provides vital income diversification and access to cash at key moments, where the risks of farming are high and other rural farm services are poorly provided or not available. It is also generated when there is surplus labor on On-farm, during farm-based risks, during the agricultural off-season, and when farming fails. Hence, households who are generate income from off-farm activities are expected to show significantly positive relationship to treated households for their livelihood than for control farm households because the relative return from off-farm activities greater for the control than the treated households.

Non-farm income: income generated from comprising all those non-agricultural activities which are include various ventures like handicrafts, small-scale manufacturing, construction, mining, quarrying, repair, transport, extractive, commercial, and direct services either through waged work or in self-employment but of course in the designated rural areas for their livelihood. Non-farm income is an income generating from diversified livelihood portfolio. It is a vital income access to cash at crucial moments, where the rural farm households earn more income and make capital accumulation from on farms, transform to non-agriculture activities for additional income. Hence, households who are generating more non-farm income are expected to show significantly positive relationship to more total income generating and livelihood.

3.10.3. Treatment variables

Participation in watershed development: Watershed is defined as any surface area from which runoff resulting from rainfall is collected and drained through a common confluence point. A watershed is made up of the natural resources in a basin, especially water, soil, and vegetative factors. At the socioeconomic level a watershed includes people, their farming system (including livestock) and interactions with land resources, coping strategies, social and economic activities and cultural aspects.

Watershed can be classified as micro-watershed, sub-watershed, broader/critical watershed, major watershed, sub-basin and basin watershed (MORAD, 2015). To response the watershed development concerns further decentralization of the programs circumstances and the strengthening of local mechanisms, capacity for delivery, implementation and productivity enhancement and livelihoods along with conservation measures. Therefore watershed

development program allowed for larger program areas (cluster approach) comprising clusters of micro-watersheds of average size from 1,000 to 5,000 hectare (GOI 2008).

Through Developed watershed (Economic Development Phase) the watershed users diversifies their livelihood and generate better income from uses of specialized production, generate income from woodlots, use of improved technologies including farm tools, Beginning of shaping the farming system, Beginning of small-scale processing, packaging and marketing, grouping and marketing, establishment of watershed institution, establishment of producers cooperatives, Availability of strong rural finance, Plantation on farmlands and around homesteads (agro-forestry), Well organized rural transportation, Well-functioning rural infrastructure; roads, market, off-farm and non-farm activities. It is measured in binary form, where a household laved as 1 if he/she participated in watershed development program and considered as treated group, while non-participant households took 0 and considered as control groups.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1. Descriptive Analysis on Socio-Demographic Characteristics of the Study

The total population of the study area is 16,560 households where 2,500 (15%) are female headed households. Passing through multi-stage sampling procedures, the study involved a total of 322 sample households randomly selected from six Kebeles which constitute three developed and three undeveloped micro-watersheds. Of the total, 322 surveyed household 29.81%, 36.96% and 33.23% from dega, woyena-dega and kolla respectively. Of the total samples male headed households account 94.4%, while female counter parts are only 5.59%. The agro-climatic situation of the study area can be classified under three agro ecological zones (Dega, Woyna-Dega and Kolla). The study area has 86 identified micro-watersheds, where the development progress of these micro-watersheds labeled in three different stages of watershed development (initiation, rehabilitation and economic development). Of the total 86 micro-watersheds only 11 micro-watersheds are under stage three, which is economic development stage referred as developed watersheds.

Table 4. 1. Distribution of sample household across sample micro-watersheds

household head		Sample watersheds						
		Dega		W/Dega		Kolla		
		Chenetaly	Eliene	Zagera	Misheg	S_quante	F_quante	Total
Male	Freq.	32	60	49	60	55	48	304
	%	96.97	95.24	85.96	96.77	96.49	96	94.41
Female	Freq.	1	3	8	2	2	2	18
	%	3.03	4.76	14.04	3.23	3.51	4	5.59
Total	Freq.	33	63	57	62	57	50	322
	%	10.25	19.56	17.7	19.25	17.7	15.53	100

Source: Computed from own survey, 322. Freq. = frequency, % = percentage

Age of respondent: The mean age of households is 43.70 ±11.34 and 46.88±11.32 years for participants' non participants in the watershed development (Table 4.2). The study clearly showed that there is a significant age difference among watershed development participants and non-participant households as tested using two group sample t-test (t= 2.506). This could be attributed to the fact that younger households are more likely to engage in watershed development initiatives than elders. Besides, the case could be also linked with better awareness of younger households about possible benefits of watershed development program

to earn more income and enhance their livelihood options developed via actively partaking in awareness campaigns, mass media and extension services. The minimum and maximum age of respondent households ranges form 23- to - 75 years for program users and from 27-to-80 for non-program users.

Table 4. 2 The mean age of watershed-users and Non-users (Two group-sample t test)

Participation in the WS	Obs	Mean	stad. Err.	Std.Dev.	Min	Max
Non users (0)	175	46.88	0.85	11.32	27	80
Program Users (1)	147	43.7	0.93	11.34	23	75
Combined	322	45.43	0.63	11.42	23	80
Diff		3.17	1.26			
diff = mean (0) - mean (1)					t= 2.506	

Source; own survey result, 2020

Household size and dependency ratio: Without converting to adult equivalence scale, the average family size of the households under the study is 5. Literarily speaking control households seems to have higher family size, 5.11 compared to treated household headed which is 4.86; however the family size difference is not significant as tested using two-group sample t-test (t= 1.24). Besides, the average number of dependent household members in watershed development program participants and non-participants is 1.39 and 1.79 respectively. Furthermore, the ratio of dependents with respect to working age population with in a family of both treated and control households is more or less similar, where the difference is found to be insignificant as tested using two-group sample t-test. Family size and dependence ratio result for both watershed development program participants and non-participants tell us that, the average family size in the study area is more or less similar with the regional young and old age dependency ratios are 0.937 and 0.077 respectively and the general age dependency ratio 1.014 (ADSWE, 2016). Meanwhile, the family demography between treated and control households doesn't show significant difference since both of them have shared culture to rare children and consider them as future assets to help the family and a destiny for households at the age of retirement.

Table 4. 3 Average household size and dependency ratio

participation in watershed	Freq.		Household size	Number of dependents	Dependency ratio
Control (0)	175	Mean	5.114	1.79	0.687
		Std.Err.	0.131	0.099	0.048
		Std.Dev.	1.744	1.309	0.611
Treated (1)	147	Mean	4.863	1.86	0.692
		Std.Err.	0.153	0.114	0.053
		Std.Dev.	1.860	1.39	0.649
Total	322	Mean	5	1.826	0.689
t value			t= 1.2442	t= -0.4617	t= -0.068

Source: Computed from own survey, 2020. Freq. = frequency

Adult equivalent family size: Adult equivalence of the sample households in the sample watersheds is a powerful characteristic to determine the total income and livelihood diversification of the households as well as to observe other characteristics since it shows the size of the family as per the standard equivalence scale.

Table 4. 4 Adult equivalent household size of treated and control households

Participation in WS	Obs	Mean	stad. Err.	std.Dev.	Minimum	Maximum
Control (0)	175	4.437	0.118	1.568	0.82	8.5
Treated (1)	147	4.129	1.29	1.571	1	9.08
Total	322	4.296	0.087	1.574	0.82	9.08
Diff		0.307	0.175			
diff=mean (0) – mean (1)				t= 1.7514		

Source: Computed from own survey, 2020. Freq. = frequency

Based on the result of the study, the average adult equivalent family size for both treated and control group is 4.296. Similarly, average adult equivalent family size for control and treated watersheds is 4.437 and 4.129, respectively. The minimum family size of sample households per adult equivalent is 0.82 and the maximum stretched to 9.08. Adult equivalent family size result reflects that rural households in the study area have relatively higher proportion of working age population with lower composition of dependents, which is also a good indicator

to generate considerable household income subjected to the existence of labor force with in the family.

Marital status of the households: The marital status of household head is one of the main factors, which has an economic meaning as a determinant of household welfare status through watershed development**.** Among the total sample households, 93.79% are married, 2.8% are widowed and 3.42% are divorced. Focusing on marital status of female headed households, widowed heads are high and accounts, 50% of female headed households followed by divorced, 38.89%. Almost all male headed households are married, 98.68%, while only 1.32% heads are in state of divorce. This reveal that the tendency of male headed households to lead their house without partner is very low compared to their counterparts which could be linked to many socio-cultural factors.

Table 4. 5 Marital status of sample households

Sex of farm household head	Marital status of farm household heads				
		Married	Widowed	Divorced	Total
Female	Freq.	2	9	7	18
	%	11.11	50	38.89	100
Male	Freq.	300	0	4	304
	%	98.68	0	1.32	100
Total	Freq.	302	9	11	322
	%	93.79	2.8	3.42	100

Source: Computed from own survey, 2020. Freq. = frequency, % = percent

Education status of sample households: Many studies usually threat educational level of the respondent as key variable since it can play major role to determine the socio-economic situation of a given society. Meanwhile, education level of the household head is a key variable to determine the development of watershed that can enhance total household income and the tendency to diversify livelihood options so as to improve overall livelihood status of a given rural farm household. Among sample households, 36.65% are illiterate, while 57.76% are able to read and write only, others, 5.59% are literate which refers formal education up to technical and vocational college. On the other way, 38.98% watershed users and 61.02% of non-users are illiterate.

On the other hand, among sample households, 4.76% and 5.14% completed their primary education at WSD-users and Non users respectively, while only 0.68% of watershed users and 0.57% of Non-users have academic background of secondary & above school complete.

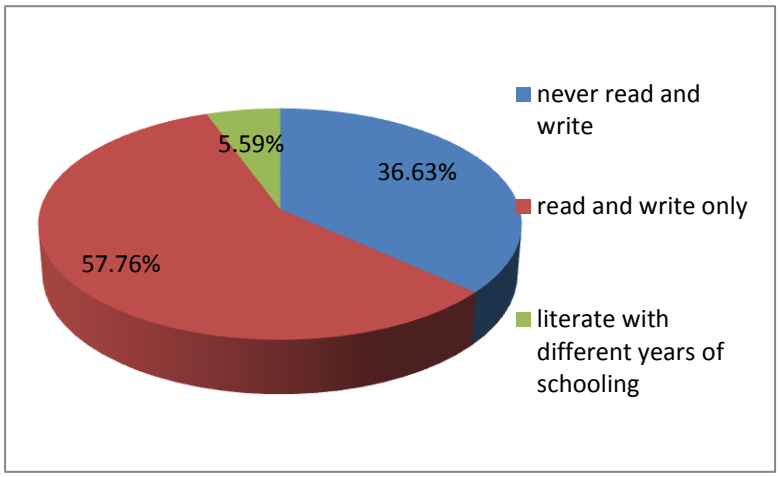

Figure 1 Educational status of sample households

4.2. Description on Economic Variables

Economic variables and rural farm household's resource ownership like land holding, house ownership, livestock ownership, on farm activities, participation in off-farm and non-farm activities or additional livelihood meanness, cultivating through crop shared/rented system are crucial factors in household income and livelihood diversification analysis, where this part of discussion is focused on major economic and resource ownership status of sample households.

House ownership: In rural farm household, owning a house is common for all income status, while the type, quality and size may differ across different areas. Many households are successful to build large sized corrugated iron sheet houses in their life span. In recent times, there is high demand of households to own a house made of corrugated iron sheet than thatched roof houses due to the fact that building thatched roof houses become difficult due to lack of specific grass types to thatch the roof caused by natural resource degradation.

Of the total sample households, 99.07% have own corrugated iron sheet, while the remaining 0.93% have thatched roof house. This indicates that a corrugated iron sheet house become a priority for rural households. In certain circumstances, owning a house made of large sized

corrugated iron sheets could be considered as indicator of wealth in the community. Thus, 44.1% of households own a house with greater than and equal to 70 corrugated iron sheets.

Table 4. 6 Amount of iron sheets of houses owned by sample households

Sex of farm household head		amount of iron sheet					Total
		0	20 sheets	20-42	42-70	≥70 sheet	
Female	Freq.	0	1	4	9	4	18
	%	0	5.6	22.22	50	22.22	100
Male	Freq.	3	9	24	130	138	304
	%	0.99	2.96	7.89	42.76	45.39	100
Total	Freq.	3	10	28	139	142	322
	%	0.93	3.11	8.7	43.17	44.1	100

Source: Computed from own survey, 2020. Freq. = frequency, % = percent

Total land holding: The average land holding of all sample households is 1.135 hectares which is more or less similar with the regional average land holding per household, 1.10 hectares (Birhanu Adenew and Fayera Abdi, 2005). And it is in lined with Yenesew *et., al*. (2015), the overall average private land size of the sample respondents was 1.4 hectares. The land holding difference of female and male households is insignificant. This could be attributed to the land distribution made on 1997 and land use police which provide relative emphasis for gender right that enable women to secure equivalent land size with male counterparts. The survey clearly revealed that households have an experience of cultivating additional land through crop sharing and renting system in order to augment their farm income. In the last production season, an average of 0.932 hectares of land was cultivated through crop sharing and renting system by sample households. On the other hand, land holding size per adult equivalence is an important characteristic to provide further insight on land holding of households with respect to their adult equivalent family size. The mean land holding size per adult equivalence of the study area is 0.294 hectares. It is also similar with the revealed that Melaku Yegizaw, (2016), owned land holding size per adult equivalent is low, 0.30 hectares.

Table 4. 7 Land holding per adult equivalence (Two-sample t test with equal variances)

sex of farm household head	N	Mean	stad. Err.	std.Dev.	Min	Max
Female (0)	18	1.222	0.196	0.835	0.25	3.5
Male (1)	304	1.13	0.035	0.62	0	4
Total	322	1.135	0.035	0.633	0	4
Diff		0.092	0.153			
diff = mean (0) – mean (1)						t= 0.5995

Source: Computed from own survey, 2020.

Livestock ownership: In most agrarian communities including the study area, livestock are considered as assets where the local community utilized their power to plow and transport various farm products as well as human beings. Animals also serve as source of food and cash for the family. Beyond this, the local community considered livestock ownership as measurement of wealth status. Accordingly, livestock ownership is considered to be vital factor to determine the income status of the household. The survey revealed that major animals kept by rural households of the study area include: cattle, donkey, mule, horse, sheep and goat as well as poultry. In order to come up with standard unit for different livestock, the researcher utilized TLU (Tropical Livestock Unit) conversion factors.

Of the total 322 sample respondents, 320 (99.38%) possess different livestock. The average livestock ownership of households in the study area is 4.414 TLU with standard error of 2.856 and zero and 16.845 TLU minimum and maximum livestock unit respectively. The difference of livestock ownership among watershed participant and non-participant households is insignificant as tested using two group sample t-test.

Table 4. 8 Livestock ownership of sample households (two group sample t-test)

Participation in WS	Freq.	Mean	stad. Err.	std.Dev.	Minimum	Maximum
Control (0)	175	4.331	0.218	2.893	0	16.845
Treated (1)	147	4.513	0.232	2.819	0	12.19
Total	322	4.414	0.159	2.856	0	16.845
Diff		-0.181	0.319			
diff = mean (0) – mean (1)					t = -0.5668	

Source: Computed from own survey, 2020.

Off-farm and non-farm activities: Engagement of the household on different off-farm and non-farm activities has greater contribution to improve the livelihoods of the rural farm household through generating additional income. Only 2.17% and 1.86% of the total sample households are engaged in off-farm and non-farm activities respectively. The result indicated that households in the study area have low experience to be engaged in off-farm and non-farm activities.

4.3. Access to Resources and Different services

Household's access to utilize different resources and services like irrigation, agricultural extension, credit, market information and cooperative services play pivotal role to enhance rural household income and diversify livelihood options. Some of the services could enhance the production and productivity while others can provide information for farmers to sell their produce with actual market price rather than losing their profit.

Access to irrigation: Irrigation farming has great potential to increase farm household income and enhance livelihood diversity. Of the total 322 surveyed households, 42.55% have access to irrigation, while the remaining didn't have access to the resource. Of the mean land holding size of 1.135 hectare per household, 0.151 hectare is irrigated. Similarly, the mean land holding of households who have land in the watershed is 1.068 hectares, of which 0.128 hectare is irrigated land. Table 4.9 disclosed that there is no significant difference among watershed development participant and non-participant households regarding to their total irrigable land holding as well as with in the watershed development areas. The survey clearly revealed that households have an experience of cultivating additional land through irrigation system in order to augment their farm income.

Table 4. 9 Mean irrigable land holding (total and within watershed development areas)

participation in the watershed	Freq.		Total house hold land	Total irrigation land	household land in the ws	Irrigation land in the ws
Control (0)	175	Mean	1.121	0.55	1.05	0.14
		Std.Err.	0.045	0.015	0.039	0.013
		Std.Dev.	0.597	0.211	0.528	0.175
Treated (1)	147	Mean	1.151	0.147	1.09	0.113
		Std.Err.	0.055	0.21	0.049	0.014
Total		Std.Dev.	0.675	0.255	0.603	0.165
	322	Mean Total	1.135	0.151	1.068	0.128
diff = mean (0) – mean (1)			t= -0424	t= 0.303	t= -0.638	t= 1.445

Source: Computed from own survey, 2020. Freq. = Frequency

Access to market: Household's access to market was taken based on hours taken to walk on foot from their residence to the nearest market where they can access market information, sell their product and buy goods and services as per the need of their family. Average time taken to travel from main market place to the residence of sample households is 1.528 hours with standard deviation of 0 .556 and the minimum hours is registered as 0.4, while the maximum is 2.3 hours. And the mean hours needed to reach kebele centers from the home of sample households is 0.67 with standard deviation of 0.242 and the minimum time is registered as 0.1 hours while the maximum is 1.3 hours.

Table 4. 10 Average hours taken from households' home to nearest market and Kebele centers

	Freq.	Mean	Std.Dev.	Min	Max.
Hours from market to home	322	1.528	0.556	0.4	2.3
Hours from Kebele Centers	322	0.67	0.242	0.1	1.3

Source: Computed from own survey, 2020. Freq. = Frequency

Access to agriculture extension service: All of 322 valid respondent households replied that, they accessed agriculture extension services at least once in the last production season. The frequencies of extension agent's visit vary from household to household, where 34.16% explained that they were visited once in a week, 59.94% once in a month and the remaining 5.9% received the visit once in a year. This shows that agriculture extension service provision has shown tremendous progress.

Access to credit service: Access to credit service is a crucial factor for the households to start or scale up their farm production and productivity and it has also important role to smooth the consumption of the family at times of food shortage. Hence, respondents were asked to tell whether they had regular saving and taken any form of loan from any type of sources in the last major production season. As indicated on table 4.11, 63.04% (n=322) have regular saving and only 37.58% households accessed credit services from different formal and informal institutions. Male headed households have more opportunities of credit services than female households, where 33.33% female and 37.83% male headed households received credit service in the last one year.

Table 4. 11 Regular saving and access to credit service of rural farm households

Sex of the household head		Regular saving		Access to credit service		Total
		No saving	Have saving	No access	Have access	
Male	Freq.	114	190	189	115	304
	%	37.5	62.5	62.17	37.83	100
Female	Freq.	5	13	12	6	18
	%	27.78	72.22	66.67	33.33	100
Total	Freq.	119	203	201	121	322
	%	36.96	63.04	62.42	37.58	100

Source: Computed from own survey, 2020. Freq. = Frequency

Access to improved agricultural input: Result of the study revealed that 54.23% program users and 45.77% non-users have accessed improved agricultural input. This shows that watershed development participants' households are motivated to use a wide-range of agricultural inputs compared to non-user households.

Household's source of fuel: Energy is a key element to maintain and extend life with in the ecosystem. Based on survey result, households mainly used fire wood as source of fuel. This tells us that majority of the communities in the study area have been using non-renewable energy sources which has direct impact on deforestation and environmental degradation.

4.4. Descriptive analysis on household income and livelihood iversification

Major livelihood options of respondent households: Recently, income inequality among households became widen from time to time and the effect of this inequality has been observed across rural households. Consequently, the diversity of livelihood options is also important in rural areas where the study tried to capture major livelihood options among WS user and non-user household groups.

The study revealed that, 88.2% of both watershed development user and non-user households are engaged on on-farm activities as major source livelihood Options. Considering other livelihood options, 2.72% participant and 4% non- participant engaged in petty trade, 4.57% participant and 2.72% non- participant used horse cart as source of income, 1.14% participant and 1.36% non- participant are also engaged in hand craft as means of life. On the other hand, of the total non-participant households 1.75% are engaged in charcoal production, while none of watershed development participant households are involved which implies that deforestation is high in undeveloped watershed areas than the

developed one. On the contrary, 0.68% of participant households used seedling production as source of income, while none of watershed development non-participants are engaged in such activities. This also indicates that, watershed development participant households have the awareness and practice on the importance of tree plantation as well as used the opportunity to generate additional income compared to undeveloped watershed areas.

Livelihood Diversity Comparative analysis: Households diversify because of returns to their income endowed in agricultural production decrease in relation to the returns from using them in activities outside agriculture and for additional investment. This implies that the ability to diversify highly depends on the access to the different types of assets, physical, human, and social capital. Diversity of livelihoods is highly important to ensure livelihood sustainability at household level where a household who has diversified source of income has sustainable livelihood. Besides, diversifying livelihood opportunities can be considered as source of income. It also addresses livelihood sustainability analysis where households with diversified livelihood options have better potential of income.

The study measured household's livelihood diversity in two ways. The first is a simple number that count the total number of income sources and developed an index using the maximum number of livelihood sources of the area as denominator. The second is a Simpson Index (SI) which was developed using the share of each source of income from the total annual income of the household. Thus, the result of the study revealed that, the mean source of income for watershed participant households is 3.05 and non-participant households have on average only 2.64 sources of income. The difference in source of income among participant and non-participant households is significant at (t=3.426), which implies that watershed development user households have relatively better number of income compared to their counter parts.

Table 4. 12 Source of income across watershed development participant and non-participants

Participation in the WS		No. of income sources		Simpson Index			
	Obs	Mean	Std.Dev.	Mean	Std.Dev.	Min	Max
Non-users	175	2.640	1.120	0.35	0.21	1	6
Users	147	3.054	1.032	0.43	0.14	1	6
Total	322	2.829	1.099	0.39	0.18	1	6
Diff		-0.414		-0.07			
diff mean(0) – mean (1)		t = -3.426		t = -3.7644			

Source: Computed from own survey, 2020.

The difference in livelihood diversification among watershed development participant and non-participant households is also significant as measured using Simpson Index. The average Simpson Index of watershed participant households is 0.43 and 0.35 for non-participant households. Diversification index among participant and non-participant households is significant at (t= -3.76) which ensures that households in developed watershed areas have relatively diversified livelihood option compared to undeveloped watershed residents.

Total annual household income and expenditure: The study tried to capture every dimensions of annual income and consumption expenditures (food expenditure, non-food expenditure and farm expenditure) using multi-dimensional survey questions. In order to generate reliable annual income and consumption expenditure data, household income generated from different activities and household consumption expenditure paid by others and consumption without any form of payment were included beyond focusing on consumption from own resources.

Findings of the study revealed that, the mean annual income of the sample households in the study area is Birr 127,019 with minimum and maximum annual income of Birr 3050 and 1,097,000, respectively. Similarly, the mean annual expenditure of sample households is Birr 30,760.56 with minimum of Birr 8,680 and maximum of Birr 314,370. On the other hand, the mean annual income of the non-participant households is 87,536.6 and their mean annual expenditure is Birr 50,022, while watershed development participant households have relatively higher mean annual income of Birr 174,021.9 and Birr 54,333.02 mean annual expenditure.

Table 4. 13 Mean annual household income and expenditure of rural households

Participation		Annual household income				Annual household expenditure			
in the WSD	N	Mean	std. Dev	Min	Max	Mean	std. Dev	Min	Max
Non-users	175	87,536.60	78,955.74	3050	705,000	50,022	25,088.68	8,680	314,370
Users	147	174,021.90	165,713	20,350	1,097,000	54,333.02	36,322.42	13,520	181,420
Total	322	127,019	133,156.70	3050	1,097,000	51,990.07	30,760.56	8,680	314,370
Diff		-86485.3				-4311.0			
diff mean(o) – mean (1)			t = -6.127			t = -1.254			

Source: Computed from own survey, 2020.

The two-group sample mean test revealed that watershed user households have higher annual income compared to non-users and the annual income difference among user and non-user households is significant at (t= -6.127). Similarly, household expenditure of user households is greater than non-users; however, the difference is not significant. This result reflects that

watershed user households have a diversified source of income generation schemes and relatively reduced expenditure, which can be linked with existence of improved household saving culture due to regular awareness campaigns and training programs conducted by local government offices.

Disaggregating amount of annual income based on source categories, the mean annual on-farm income of households is Birr 122,461.3 birr with minimum and maximum annual income of Birr 23,100 and 1,107,220 respectively. Similarly, the mean annual on-farm income of the non-participant household is Birr 87,536.6, while the figure increased to Birr 187,682.7 for watershed development users. The difference on on-farm income among watershed development participant and non-participant households is significant at t = -6.248. It implies that the production and productivity of on-farm activities in developed watershed areas is promising compared to undeveloped areas.

Proceeding further, households' mean annual income from irrigation based farm is Birr 2,181.5 with minimum and maximum annual income of Birr zero and 33,900 respectively. With similar fashion annual irrigation based income of watershed participant households is Birr 2,370.17, while the mean irrigation based income of non-participants is Birr 2,023.029, however, the difference among the two household groups is insignificant (t = -0.745). This implies that irrigation farming practices are not adequately adapted in watershed development areas as required where both participant and non-participant households generate more or less similar amount of income from irrigation.

Moreover, the mean annual income households from off-farm and non-farm sources is Birr 4,539.13 with minimum and maximum annual income of Birr zero and 286,400 respectively. Here also the mean annual off and non-farm income of watershed development participants is Birr 6,301.36, while the income of non-participant households is only Birr 3,058.857.

Focusing on expenditure side of the household, the mean annual food consumption, non-food and farm expenditure of sample households is Birr 21,636.68, 13,310.86 and 17,042.53 respectively.

The annual food consumption expenditure of per adult equivalent is Birr 13,310.86 with standard deviation of 10,742.53 and the minimum and maximum food consumption expenditure per adult equivalent is Birr 1,740 and Birr 108,000 respectively. Mean annual non-food consumption expenditure of watershed user households is Birr 13,626.65, while the expenditure lowered to Birr 13,015.60 in case of non-user households. Non-food

consumption expenditure of watershed development participant and non-participant households is significant. On the hand, the mean annual farm expenditure of sample households under the study is Birr 17,042.53. The mean farm expenditure of program users and non-users is Birr 19,982.5 and 14,572.97 respectively. Still farm expenditure is high for watershed development households compared to non-participant households. And the difference is significant at t=2.348. It implies that watershed user households expend more on farm activities, technologies and inputs which is important to increase their production and productivity which ultimately enhance their annual income.

4.5. Estimates of factors affecting watershed development

Heckman's two-stage regression and logistic regression models are used to investigate factors that determine watershed development and household's participation in watershed development programs.

Logistic regression result: logit regression model revealed that how the log odds in favor of the dependent variable (participation of a household in the watershed development) as the determinant variable changes by a unit. The coefficients returned from a logistic regression model are log-odds ratios. It tells us how the log-odds of a household's participation in the program change with a one-unit change in the independent variables. Before proceeding to describe about the relationship of explanatory variables with the watershed development user status in terms of log-odd ratio, it is important to check the model for goodness to fit.

Goodness to fit test: Though there are many controversies, the study utilized Hosmer-Lemeshow (HL) test in order to check how far the model fit the data. After conducting logit regression, Hosmer-Lemeshow test was made and the result shows that Hosmer-Lemeshow chi2 (8) = 7.64 and Prob> chi2 = 0.4695 which indicate that the model is correctly specified since p-value of chi2 is greater than 0.05 (5% significance). Meaning the null hypothesis is accepted by rejecting the alternative one. The maximum log likelihood value of the fitted model is -151.029 and the total valid observation is 322. The probability of $>chi^2$ is 0.0000 which shows that at least one explanatory variable is not equal to zero, which refers all independent variables have non-zero value.

Table 4. 14 Heckman Two-Step Estimates on factors that determine watershed development and logistic regression model on factors that determine household participation.

	Logistic regression model			Heckman two stage regression model		
Variables	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Household size	0.962	0.48	0.045	0.713	0.293	0.016
Adult equivalent	1.231	0.541	0.023	0.902	0.333	0.007
Dependent ratio	-0.656	0.322	0.042	-0.511	0.203	0.012
Years of household head schooling	-0.13	0.066	0.050	-0.004	0.010	0.693
Age of household head	-0.018	0.015	0.240	-0.088	0.041	0.032
TLU of livestock	0.051	0.054	0.348	0.031	0.036	0.397
Total land hold	-0.134	0.418	0.748	-0.337	0.246	0.171
Topography gradient	-	-	-	0.55	0.125	0.000
culture of free grazing	-1.79	0.336	0.001	-0.648	0.202	0.001
lack of awareness	-0.433	0.300	0.149	-0.20	0.183	0.273
population pressure	-	-	-	-0.126	0.182	0.488
lack of properly livestock management	-0.95	0.397	0.001	-0.535	0.182	0.003
poor land use	-1.055	0.309	0.001	-0.424	0.181	0.019
Week implement land admin. Policy	-1.04	0.317	0.001	-0.654	0.203	0.001
political situations	-1.695	0.319	0.000	-0.931	0.192	0.000
rain fall precipitation	-	-	-	-0.405	0.197	0.040
low government facilitation	-	-	-	-0.802	0.201	0.000
land slop	-	-	-	0.604	0.194	0.002
total land hold in the watershed	0.605	0.481	0.209	0.191	0.162	0.236
lack of technique and farm technology	-1.365	0.345	0.000	-0.484	0.208	0.020
_cons	6.296	0.974	0.000	2.740	0.636	0.000
Lambda				-0.008	0.068	0.911
Number of obs		322				322
Prob > chi2		0.0000				0.0407
LR chi2(13)		141.89		wald chi2(20)		32.25
Pseudo R2		0.3196		Rho		-0.045
Log likelihood		-151.0298		Sigma		0.169

Source: Computed from own survey, 2020.

Based on this by using p-values, household size and lack of technique and farm technology are statically positive significant effect and adult equivalent ratio, dependent ratio, years of household head schooling, culture of free grazing, lack of proper livestock management, poor land use, week implement land administration policy and political situations are statistically significant variables and have negative effect on likelihood of household to participate on watershed development program.

On the other hand, household size, livestock holding and total land holding of a household have positive effect on household's participation on watershed development. Of these variables, household size is significant to determine the participation of the household in watershed development which implies that households who have large family size have higher probability to participate in watershed development activities.

Heckman two-sage regression result: Results of the study indicated that factors affecting the watershed development are obtained through the Heckman two-stage econometric regression model with sample selection. The first model is the choice model it shows that whether the sample households are watershed development users or not. The second analysis is the investigation of the effects of the independent variables on the watershed development. Inverse Mill's Ratio (λ) is calculated and included in the second stage Heckman selection model to estimate how much the watershed is developed. The overall joint goodness of fit for the second stage Heckman selection estimates is assessed based on the maximum likelihood method. The model chi-square test while applying appropriate degrees of freedom shows that the overall goodness of fit for the second stage.

Based on the empirical data results on table 4.14, Wald value of the model is 32.25 and the P value is 0.0407, which indicates that it rejects the original hypothesis and the entire model is valid. From the Probit estimates, the Inverse Mill's Ratio (Lambda) is calculated and included in the second stage of the Hackman model in order to estimate the factors affecting the watershed development. Further from the results, rho (ρ) is negative, an indication that the unobservable factors are negatively correlated with each other. Therefore, the standard interpretation of the estimates in the regression analysis is that a unit change in the predictor, while all the factors affecting watershed development are held constant, results in the respective regression coefficient to change the estimated value of the developed watershed.

In the second stage selection model, fourteen predictor variables using p-values, Heckman two stage model regression revealed that household size, topography gradient and land slop are statistically significant variables and have positive effect on watershed development and adult equivalent, dependent ratio, age of household head, culture of free grazing, lack of proper livestock management, poor land use, week implement land use policy, political situation, rainfall precipitation, low government facilitation, and lack of techniques and technologies are statistically significant variables and have negative effect on watershed development.

Topography gradient and land slop parameters positively affect watershed development at less than 1% level of significance. This tells us that when topography gradient and slop of land is increases, the development of watershed will be better. This means that watershed development activities are highly performed on highland and sloppy land areas to overcome soil and water degradation problem. As shown in the model result, a unit increases on topography gradient and slope of the land, the watershed development index increased by a coefficient of 0.550 and 0.604 respectively assuming that other variables held constant. Hence, the topography gradient and land slop are the major factors to determine the watershed development.

Lack of proper livestock management and culture of free grazing are statistically significant variables and have negative effect on watershed development at less than 1% significance level. Therefore, existence of poor livestock management and free grazing will reduce watershed development index by 0.535 and 0.648 respectively. It implies that rearing of poor genetic livestock, poor veterinary services delivering and high livestock pressure as poor livestock management system and prevalence of free gazing significantly determine watershed development. Therefore improvement of livestock management and control of free grazing culture can be taken as important measures to improve the watershed development.

Week implementations of land administration policy and poor land use have negative effect on watershed development at less than 1% level of significance. Existence of week implementations of land administration and poor land use could degrade watershed development progress by a coefficient of 0.654 and 0.424 respectively. The government set farm land policies for endorsement and Land-use certification activity to overcome the problem of land management and suitability. Land owners are responsible to conserve and manage his/her land resources properly. In this regard, conservation works on cultivated land need to be planned together by land users that cultivate a given sub-watershed area. This is believed to strongly support the current participatory watershed development initiative. It is hypothesized that if land policy is strongly implemented, rural farm households can manage their land properly and governed by the policy. The result show that week implementation of land administration policy and poor land use has significant negative effects on watershed development.

Low government facilitation and political situation has negative effect on watershed development. Low level of government facilitation and existence of volatile political situation can reduce watershed development index (measure of watershed development levels where

approaching to 1 indicates well developed watershed and approaching to zero shows low level of watershed development) by a coefficient of 0.931 and 0.802 respectively. It means that contribution of government facilitation on watershed development is highly demanded that can also enable watershed user's to develop sense of ownership and manage watershed development activities properly. At times of political instability, natural resources are subjected to damage due to low awareness level of the community that watershed development initiatives are from the people to the people. Accordingly, committed and stable political situation and strong government facilitation are important factors for watershed development programs.

Ethiopia is one of among the least developed and most venerable countries to climate change (World Bank, 2010), due to its geographical location and low adaptive capacity of watershed development. Findings of the study revealed that rainfall precipitation negatively affect watershed development at less than 1% level of significance. It indicates that an increase of rainfall precipitation could bring degradation of watershed development with a coefficient of 0.405. This implies that at times of high rainfall, natural resources are subjected to degradation due to erosion.

On this study lack of farm technology and techniques has negatively effect on watershed development with a coefficient of 0.484 at less than 1% level of significance. It implies that, lack of using appropriate faming technologies and techniques would significantly reduce watershed development progresses. Therefore, lack of farm technology and techniques is one of the factors that determine watershed development.

4.6. Estimation of WSD impact on livelihood of rural farm household using PSM

As discussed on chapter three, the study focused on Propensity Score Matching (PSM) method and Hackman two stage regression models to estimate the contribution of watershed development program to enhance improvement of livelihoods at rural farm household level in the study area.

In order to proceed and measure the effect, balancing property must be satisfied before matching the treated with control groups/households. This results in generation of propensity scores to be used for matching procedure. Hence, balancing property satisfaction is investigated and propensity score graphs for program participants and non-participants are generated as well. After all, average treatment effect on the population (ATE) and average

treatment effect on the treated (ATT) are measured using nearest neighbor, radius matching, stratified matching and kernel matching techniques.

4.6.1. Propensity Score Matching Analysis

The first stage of algorithm to estimate the propensity score is constructing propensity score for each variable and matching starts from each treated case's propensity score and tries to find a control case with a similar propensity score to use as a match. Logistic regression comes first and followed by propensity score estimation and identification of the block which can satisfy the balancing property.

As showen table (4.15), the logistic regression result indicates that the estimated model appears to perform well for the intended matching exercise since Pseudo R^2= 0.0379 and it is significant at <1%. Propensity score for each household for both treated and control groups are developed and the optimal number of blocks is identified as block 4, where this block ensures the mean propensity scores are not different for treated and control groups. Hence, the balancing property satisfied at block 4.

Table 4. 15 Logistic regression to estimate propensity scores

Participation in the watershed	Cosf.	Std.err.	Z	P>|z|
Household size	0.655	0.362	1.81	0.07
Adult equivalent	0. 866	0. 410	2. 11	0.035
Dependent ratio	-0. 264	0. 244	-1.08	0.28
Age of household head	-0. 022	0. 012	-1.83	0.067
Years of hhh schooling	-0. 052	0. .051	-1.02	0.306
Total land hold	0. 289	0. 208	1.39	0.165
Tlu of livestock	0. 048	0. 043	1.1	0.27
_cons	1.075401	0. 565627	1.9	0.057
Log likelihood = -213.56884		Prob > chi2 = 0.0187		
Number of obs = 322		Pseudo R2= 0.0379		
LR chi2(8)= 16.81				

Source: computed from own survey, 2020

4.6.2. Checking for common support among treated and control groups

After estimating values of propensity score for program participants and non-participants the next step in propensity score matching technique is checking common support condition. Only observations in the common support region matched with the other group considered and others should be out of further consideration. Once the region of common support is identified, sample households that fall outside this region have to be dropped and the

treatment effect cannot be estimated for these sample households. The estimated propensity score of non-participant households (control) is within the range of 0.196 to 0.736 with a mean score of 0.434. The estimated propensity score of participant households (treated) rages between 0.274 and 0.774 with mean score vale of 0.484.

Table 4. 16 Distribution of propensity score estimate for treated and control groups

Participation in WSD	Mean propensity score	SD	Min	Max
WSD Non-users	0. 434	0. 117	0. 196	0. 736
WSD-Users	0. 484	0. 101	0. 274	0. 774
Total	0. 457	0. 113	0. 196	0. 774

Source: own survey, 2019

The common support region would then lie between 0.274 and 0.736 it excludes treated units whose propensity is higher than 0.736 and control groups whose propensity score is less than 0.274. Therefore, households whose estimated propensity scores less than 0.274 and larger than 0.736 are not considered for the matching exercise.

Graphical presentation was also another way of checking common support where histogram of propensity scores of the treatment group vs the control group shows the presence of enough overlaps among project participant and non-participants.

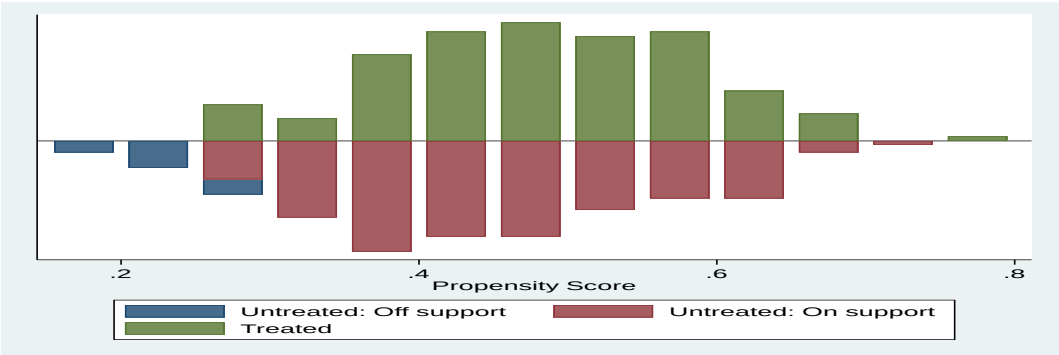

Figure 4.1. Propensity score distribution graph
Source: computed from own survey, 2020

Figure (4.1) revealed that majority of propensity scores of treated groups concentrated from 0. 274 - to- 0. 736 and this case is the same for control groups which indicates the presence of enough common support to conduct matching algorithms.

4.6.3. Mean unmatched and ATT value of outcome variables

The next step focused on comparision of average value of outcome variables before matching and average treatement on the treated where the difference indicate positive or negative contribution of the treatment on the treated. The unmatched values on table (4.17) tell us that the average result of each outcome variable both for treated and control gropus beforematching. The ATT indicates that the average value of each outcome variable both for treated and control group after matching.

Table 4. 17 Average value of outcome variables before and after matching

Variable	Sample	Treated	Control	Difference	S.E.	T-test
livelihood diversification	Unmatched	0.382	0.33	0.052	0.02	3.43
	ATT	0.382	0.317	0.065	0.02	3.19
Total annual income	Unmatched	174021.92	87536.6	86485.34	14116	6.13
	ATT	174021.9	86530.88	87491.05	15772	5.55
On-farm income	Unmatched	167700.2	84460.6	83239.57	13231	6.29
	ATT	167700.2	84084.63	83615.54	14791	5.65
Irrigation income	Unmatched	2370.17	2023.03	347.14	464.8	0.75
	ATT	2370.17	2024.49	345.68	550.4	0.63
Off-farm income	Unmatched	4543.54	2659.43	1884.11	2140	0.88
	ATT	4543.54	4457.14	86.39	2558	0.03
Non-farm income	Unmatched	1757.82	399.43	1358.39	1319	1.03
	ATT	1757.82	1224.49	533.33	1592	0.33

The total annual income score before matching was 174,021.92 and 87,536.6 birr for treated and control groups respectively Table (4.17). The ATT difference among treated and control groups is significant (t = 5.55), which confirmed that watershed development program had a significant impact to enhance household's total annual income which ultimately address the positive contribution of the program to improve sustainable livelihood status of program beneficiaries. And also, On-farm income score before matching is Birr 167,700.17 and 84,460.6 for treated and control groups respectively. There was significant effect on ATT difference among treated and control groups (t = 4.65), this implies that watershed development program has a significant impact to enhance rural farm household's on-farm income which ultimately address the strong positive contribution of the program than irrigation based income, off-farm and non-farm income to improve sustainable livelihood status of the treated household. Besides, the irrigation-based income before matching is 2,370.17 and 2,023.03 for treated and control groups respectively. The ATT difference

among them is insignificant with t= 0.63. It implies that watershed development program has insignificant impact on irrigation-based income.

The study indicates that the difference of average treatment on the treated off-farm and non-farm income score before matching is 6,301.36 and 3,058.86 for treated and control groups respectively. There is no significant ATT difference of treated and control groups (t = 1.37) where the watershed development program has positive impact to increase off-farm and non-farm income score of the program; however, it was not significant.

4.6.4. Testing the balance of propensity score

Before trusting ATT estimation, it is mandatory to check the balancing whether the matching is effective to create good control groups or not. Basically, the balancing result yield percent of bias using average treatement on the trated value of each matching variable followed by summary of mean bias. In the standardized bias before and after matching the formulae from Rosenbaum and Rubin (1985) indicates that the mean bias after matching should be less than 5%.

Table 4. 18 Mean bias of each variable before and after matching

Variable	Unmatched matched	Mean		%bias	%reduct |bias|	t - test	
		Treated	Control			t	p>|t|
Household Size	U	4.864	5.114	-13.9		-1.24	0.214
	M	4.864	5	-7.5	45.7	-0.63	0.527
Adult equivalent	U	4.130	4.437	-19.6		-1.75	0.081
	M	4.130	4.234	-6.7	66	-0.58	0.565
Dependent ratio	U	0.692	0.687	0.8		0.07	0.946
	M	0.692	0.650	6.6	-765.3	0.31	0.754
Age of household head	U	43.707	46.886	-28		-2.51	0.013
	M	43.707	44.129	-3.7	86.7	-0.34	0.737
Years of hhh schooling	U	2.6259	3.12	-20.9		-1.86	0.063
	M	2.626	2.565	2.6	87.6	0.23	0.818
Total land hold	U	1.152	1.122	4.7		0.42	0.672
	M	1.152	1.132	3.1	33.2	0.27	0.787
TLU of livestock	U	4.513	4.332	6.3		0.57	0.571
	M	4.513	4.479	1.2	80.9	0.11	0.912

* if variance ratio outside [0.72; 1.38] for U and [0.72; 1.38] for M. Source: Own survey result, 2020.

Table 4. 19 Mean Bias after matching for all variables

Sample	PsR2	LRchi2	P>chi2	Mean Bias	Med Bias	B	R	%Var
Unmatched	0.038	16.95	0.018	13.5	13.9	46.7*	0.71	0
Matched	0.006	2.45	0.931	4.5	3.7	18.4	1.46	0

* If B>25%, R outside [0.5; 2]. Source, Computed from own survey, 2020

Reduction of biasness comparing before and after matching scenario for each variable is observed (Table 4.18), while the mean bias of all maching variables reduced to the standard and acceptable level which is 4.5 % which below the standard 5% (Table 4.19) and ensure that the balancing is good to proceed for further nalysis.

4.6.5. Impact of watershed development on livelihood diversification

Livelihood diversification is an important survival strategy for the rural households in the developing countries (Dilruba Khatun and B.C. Roy. 2012). The reasons that individuals and households pursue diversification as a livelihood strategy are often divided into two overarching considerations, which are necessity or choice (Frank Ellis, 2000). Livelihood diversity could be taken as proxy measure of livelihood sustainability and it can be used as indicator of livelihood by itself. It is believed that a household with diversified livelihood options has relatively more income enhance higher degree of livelihood. There are various indicators, and indices are there to measure livelihood diversification like number of income sources and their share, Simpson index, Herfindahl index, Ogive index, Entropy index, Modified Entropy index, Composite Entropy index (Shiyani and Pandya, 1998), etc. In this study Simpson index is used to evaluate the impact of watershed development on livelihood diversification.

From the different incremental options of adapted local context and circumstances, livelihood diversification has vital role for increase probabilities of livelihood sustainability. In this section Simpson index is used to evaluate the impact of WSD on livelihood diversification because of its computational simplicity, robustness and wider applicability. In order to strengthen and triangulate the impact of watershed development on rural farm household livelihood diversification analysis by using Simpson index, the analysis involved four different types of matching techniques to estimate average treatment effect of the WSD program on the treated. Number of sample household indicates the number of WSD program user and non-user households whose propensity scores exactly matches as per the matching

assumption each method. The t-value indicates the significance of average treatment effect of the program on the treated.

Watershed development index is used as a key variable to estimate the impact of watershed development on the selected outcomes by Heckman two stage regression models. The key indicators that can help to determine the watershed development status at a particular time has Different mechanisms which are used to define these parameters or indicators (Gete zeleke, 2014). Therefore economic development stage activities or income generated from other rehabilitation activities (developed watershed indicators): establishment of watershed institution, soil and water conservation, stream development, Area closure and gully rehabilitation, plantation, off-farm and non-farm activities and pasture development and livestock variety improvement are the key indicators including their measurement will be identified by periodic performance assessment.

Table 4. 20 Matching analysis to estimate the impact of watershed development on Livelihood diversification using Simpson index.

	Livelihood diversification			
	PSM		Hackman two stage	
	ATT	t-value	coefficient	P>|z|
Nearest Neighbor Matching	0.066	2.482	-	-
Stratified Matching	0.078	3.807	-	-
Kernel Matching	0.081	3.386	-	-
Radius Matching	0.075	2.456	-	-
Simpson diversity index				
WSD index	-	-	0.138	0.016
Household size	-	-	-0.066	0.055
Dependent ratio	-	-	0.054	0.013
Adult equivalent	-	-	0.071	0.077
Age of household held	-	-	0.003	0.024
Years of hh head schooling	-	-	-0.004	0.442
Total land hold	-	-	-0.003	0.861
Tlu of livestock	-	-	0.007	0.083
-cons	-	-	0.396	0.000
WSD index				
Culture of free grazing	-		-0.724	0.000
/mills				
lambda	-		-0.016	0.741
rho	-		-0.129	
sigma	-		0.126	
Wald chi2(8)	-		21.12	
Prob > chi2	-		0.007	

Source: Own survey STAT result, 2020

As a result of propensity score matching analysis, Watershed Development program has positive impact on livelihood diversification (Table 4.20). The Nearest Neighbor Matching (NNM) revealed that treated households have on average 0.066 greater diversified score than non-program users, it is significant at t = 2.482 value. Consistent with NN matching, the Stratified Matching(SM), Kernel Matching (KM) and Radius Matching (RM) techniques also disclosed that program-user households have on average 0.078 (t = 3.807), 0.081 (t = 3.386) and 0.075 (t = 2.456) higher diversified scores than non-users households respectively for matching methods.

Heckman two stage regression model reveal that Watershed development index had a significant positive effect on livelihood diversification. One additional unit of watershed development index results in a 13.8% increase in livelihood diversification Simpson index. In the context of agriculture being subsistence, and off-farm income and non-farm income opportunities being limited in rural areas of the study area, the positive association of watershed development and livelihood diversification should be expected. There was the possibility that more developed watershed is a source of livelihood diversity at the off-farm and non-farm farm level. According to Owusu et al. (2014), off-farm activities, besides being a valuable source of income for rural farm households in developing countries, also helps in smoothing incomes, which in turn smoothens consumption over long periods. The finding is in convergence with the current study finding. Therefore, formal employment (on-farm, off-farm and non-farm) in the developed watershed exerts a positive and robust effect on livelihood diversification and hence leads to increased household income.

As a result, the findings of the study on livelihood diversification using Simpson index assert that the watershed development program in the study area has brought positive impact on livelihood diversification score of treated households this ultimately indicates that the program has contributed to enhance diversification of participant households that ensure livelihood sustainability of the rural farm household. And also the relationship between income and the progression of watershed development structural change towards more diversified rural farm household income. At low income levels rural farm households engaged on survival strategies, while they began to diversify their livelihoods in order to cope risk and generate more additional incomes. The significance of the impact could be due to the implementation of the program which is completed under the right track to attain its objective. This finding is similar with the study conducted by USAID (2017) there is general agreement in the academic literature that more livelihood diversification is typically good for individuals and overall economic growth in SSA.

4.6.6. Impact of watershed development on Household income

Based on WSD principle the possibility and merit of incorporating different activities in to the income portfolio of the rural farm households, in addition to farm level risk mitigation strategies for livelihood sustainability, households also engaged in various forms of income diversification.

Watershed development facilitates in reducing the vulnerability of farm income to weather induced shocks in rain-fed lands. it is a reflection of improvements in the employment pattern and income of rural farm households, due to changes in cropping patterns and cropping intensities more. Stability in livelihoods is assessed in terms of the security of the income sources and diversification of income generating activities. Income can be derived from various livelihood activities: on-farm, off-farm and non-farm activities at the household level. During the economic development stage of the watershed development program, more soil and water conservation structures as well as income generating opportunities were created. Implicit in the support for the non-farm and off-farm income generating activities are the assumption that the development of these alternatives would indirectly reduce pressure on the natural resources base and provide increased income and enhance livelihood sustainability for rural farm households.

Table 4. 21 Different matching analysis to estimate the impact of WSD on annual household income.

	Annual household income			
	PSM		Heckman two stage	
	ATT	t-value	Coefficient	P>|z|
Nearest Neighbor Matching	84,240.17	5.246	-	-
Stratified Matching	79,076.8	5.200	-	-
Kernel Matching	78,818.57	5.336	-	-
Radius Matching	67,659.77	4.266	-	-
Annual household income				
WSD index	-	-	204,824	0.003
Household size	-	-	141,646.8	0.000
Dependent ratio	-	-	-123,132.4	0.000
Adult equivalent	-	-	149,786	0.000
Age of household held	-		-3,266.676	0.006
Years of hh head schooling	-	-	3,963.548	0.420
Total land hold	-		26,955.16	0.159
Tlu of livestock	-		26,076.62	0.000
Cons	-		-13,985.45	0.847
WSD index				
Plantation	-		2.251	0.000
/mills				
lambda	-		51,107.07	0.035
rho	-		0.384	
sigma	-		132,944.38	
Wald chi2(8)	-		92.24	
Prob > chi2	-		0.000	

Source; Own survey result, 20120

The impact analysis shows that watershed development program has positive and strong significant contribution to increase household annual income score on average by 84,240.17 using Nearest Neighbor Matching (t = 5.246), 79,076.798 in case of Stratified Matching at (t = 5.2), 78,818.57 through Kernel Matching (t = 5.336 and 61,659.771 using Radius Matching (t = 3.543). Positive contribution of the program on household annual income is significant and consistently asserted by the four matching techniques, which ensure validity of the result. Thus, the result of this study confirmed that WSD program has a significant positive contribution to increase household annual income score of program-user households as proxy measure of access and utilization of income which ultimately indicates enhancement of livelihood sustainability.

Accordingly Heckman two stage regression model results, however Watershed development index, the developed watershed had a significant positive effect on total household income of watershed development users. One additional unit of watershed development index results in 204,824 birr increase on annual household income of the treated household.

In a sense of improving total annual income, rural farm households who pursue agriculture as source of income for their livelihood are highly probable to implement conservation measures in their farmlands as intensification of agriculture is the survival option and they should work hard to improve agricultural production (Gatbel Chot *et al.,* 2018). Therefore, the result of the study revealed that, watershed development program exerts a positive and robust effect on income generating activities and hence leads to increased household income.

The result of the current study is in line with the previous studies for example; Getnet and Anulo, (2012) result confirmed that the effect of cooperative services was in favor of household income. That was the use of cooperative services positively influenced the income generated by farm households from crop sales in particular. They forwarded higher prices paid by cooperatives for service users' products and farmers' improved crop yield from extension services provided by cooperatives as possible explanations for increased total income. Assan and Beyene (2013) similarly found a positive but statistically insignificant impact of Tree Gudifecha' ecological conservation project on total household income with the possible explanation of income diversification. Moreover, the works of Zerihun and Prowse (2013) found a negative significant impact of PSNP on farm income due to the decline in labor force to be engaged in agricultural activities as PSNP demands higher labor force in public works and negative insignificant impact on non-farm income which contradicts the result my thesis. However, they found a positive significant impact of PSNP on off-farm income due to the dependence of activities exacerbating environmental degradation.

Yenesew *etal.,* (2015) result confirmed that the household survey witnessed that almost all average net annual income (88.9%) of the households were obtained from agricultural crop production and animal husbandry sources; and only 11.1% of the household's average net annual income are obtained from a combination of non/off farm activities. This is in consistent with national estimate of the country, where more than 80% of the rural peoples' livelihood income gained from agriculture activities (CSA, 2010). Nguezet *etal.,* (2011) also confirmed that impact of improved rice seed used on household income, the result shows that while there is a significant difference between the gross incomes of adopters and non-adopters, there was no significant difference in the amount spent per head by both groups.

Gatbel Chot, *etal.,* (2019) have seen that soil and water conservation depicted that there is income level difference between two groups of households (SWC practiced and non-practiced) though the difference is not statistically significant. Thus, the null hypothesis that there is no income level difference between SWC practiced and non-practiced households

could be rejected while the alternative hypothesis that there is income level difference between SWC practiced and non-practiced households could be accepted.

K. Palanisami and D. Suresh Kumar (2009) confirmed that Impacts of Watershed Development Programs intervention was found to help the rural farm and non-farm households in enhancing their income level. The rural labor households in the treated villages were found to derive Rs 28732 as compared to Rs 22320 in control village, which was 28.73 percent higher in Kattampatti watershed. Similarly, the per capita income was also higher among households of treated watershed villages.

K. Palanisami and D. Suresh Kumar, (2002) have made an attempt to assess the overall impact of watershed development activities through benefit coast ratio (BCR) and net present value (NPV). The size of BCR depends on the magnitude of benefits accrued due to the watershed development activities which in turn critically depend on the rainfall. The result also revealed that the BCR works out to more than 2 in around 9% of watersheds. About 91% of watersheds have a BCR less than 2. Similarly, about 45.45% of watersheds exhibit an Internal Rate of Return (IRR) of less than 15%; 52.27% of watersheds have an IRR between 15 and 30% and only 2.27% of watersheds have an IRR higher than 30%.

The watershed intervention helped the rural farm and nonfarm households to enhance their income level (K. Palanisami and D. Suresh Kumar, 2002). Evidence showed that the rural labor households in the treated villages derive Rs 28,732 when compared to Rs 22,320 in control villages, which is 28.73% higher in the Kattampatti watershed. Similarly, the per capita income is also relatively higher among households of watershed treated villages.

4.6.7. Impact of watershed development on on-farm, off-farm and non-farm income

On-farm activities as a primary source of income has failed to guarantee sufficient livelihood for most rural farm households in the study area, and Watershed development program have largely produced little improvement. It is being real in the study area rural farm households are longer remain confined to crop production, livestock-rearing, forest management, apiary, poultry and combine range of farm occupations to construct a diverse portfolio of activities to enhance their livelihood.

In the study area the rural farm households are practiced more annual crop production which is highly dependent on the rain fed agricultural production systems. Furthermore, due to the insufficient land resource to absorb the household's full labor force and the rain fall pattern variability, the rural farm households are becoming unable to assure their livelihood

sustainability. As a result, they are engage in low return daily labor works, firewood selling, charcoal production, petty trading, and hand craft activities to supplement their fragmented land based livelihoods and to cope up with the agricultural risks.

Mixed farming which is practiced more is, mainly crop production and animal husbandry is the major source of rural farm household livelihood. Agricultural practice is predominantly rain fed; this makes the livelihood of smallholder farmers at mercy of nature. Though their contribution is less, non-farm activities are supplementary sources of livelihood for a greater proportion of households. Although having source of income from non-agricultural economic activities has been integrated with agricultural activities, the contribution of such economic activities to the overall income of households is very limited. The prominent non-farm economic activities practiced in the study area are petty trading, casual daily laborer, handcrafting of different forms and selling local liquor which demands less skill and entry capital.

Table 4. 22 Different matching analysis to estimate the impact of watershed development on on-farm, off-farm and non-farm income

Means of annual household income estimation with propensity sore matching						
	On-farm income		Off-farm income		Non-farm income	
	ATT	t-value	ATT	t-value	ATT	t-value
Nearest Neighbor Matching	81,202.76	5.433	1,300	0.492	1,757.82	1.274
Stratified Matching	76,248.02	5.331	1,497.60	0.639	1,334.62	0.932
Kernel Matching	75,857.68	6.08	1,635.394	0.67	1,329.75	1.031
Radius Matching	66,113	4.398	-903.427	-0.478	2,441.86	1.049
estimate with Heckman two stage						
Means of income	Coefficient	P>|z|	Coefficient	P>|z|	coefficient	P>|z|
Watershed development index	112,497	0.044	0.299	0.078	0.047	0.52
Household size	109,968.30	0.000	0.195	0.050	-0.019	0.648
Dependent ratio	-113,128.10	0.000	-0.086	0.186	0.001	0.976
Adult equivalent	112,851.30	0.002	0.190	0.098	0.027	0.573
Age of household held	-2,657.67	0.017	-0.002	0.578	-0.001	0.476
Years of hh head schooling	3,818	0.402	0.014	0.342	0.013	0.032
Total land hold	16,771.35	0.340	-0.014	0.802	-0.011	0.624
Tlu of livestock	25,429.99	0.000	0.00	0.984	-0.009	0.076
Cons	76,001.90	0.216	0 .269	0 .269	0.04	0.618
Watershed development index	Poor land use		Lack of awareness		Lack of awareness	
	-0.778	0.000	-0.377	0.018	-0.377	0.018
/mills						
lambda	-19,873.98	0.492	0.156	0.123	-0.005	0.908
rho		-0.164		0.403		-0.031
sigma		120,842.9		0 .388		0 .158
Wald chi2(8)	88.01		11.7		9.08	
Prob > chi2	0.000		0.165		0.336	

Source; Own survey result, 20120

On farm income: The impact analysis shows that watershed development program has positive and strong significant contribution to increase household on-farm income score on average by 81,202.755 using Nearest Neighbor Matching (t = 5.433), 76,248.022 in case of Stratified Matching at (t = 5.331), 75,857.68 through Kernel Matching (t = 6.08) and 66,113.002 using Radius Matching (t = 4.398). Heckman two stage regression model also illustrate that the results, yet Watershed development index, the developed watershed had a significant positive effect on on-farm income of the program users. One additional unit of watershed development index results in 112,497 birr increase on on-farm income of the treated household. The result of this study suggested that WSD program has a significant and positive influence to increase household on-farm income score of program-user households as proxy measure of access and utilization of income which ultimately indicates enhancement of annual household income.

Off-farm income: As presented on table (4.22) the impact of watershed development on off-farm income is estimated with different matching analysis is insignificant. And also it has similar results in Heckman two stage regression model. This implies that in the study area rural farm households have not engage more on off-farm activities. Therefore, rural development facilitators and stockholders have to give attention on the adoption of Off-farm activities to improve the participation of rural farm households during off time season to engagement of additional income. This result in lined with Yenesew *etal,* (2015) reported that From the total sample households, only 36.5% of the households participated in off-farm activities while 63.1% households did not participate in any one of the off-farm activities. Again, from the total off-farm participants' majority (55.9%) of the households engaged in agricultural wage labor activities.

Non-farm income: The impact of watershed development on non-farm income was estimated with different matching analysis (table 4.22) and Heckman two stage regression model analysis. However, the result indicated that Watershed Development program has insignificant contribution to increase household non-farm income score of program-user households as proxy measure of access and utilization of income.

This also indicated that in the study area no more engagement on non-farm activities. Therefore, in the watershed development program income generating activities beside to on-farm activities planned and implemented as multiple income generating activities to increase household incomes and to minimize natural resource depilation that rural farm households done day to day activities to improve their livelihoods.

This result is in line with other studies. For example Amogne Asfaw*eta,* 2017 on the study of determinants of non-farm livelihood diversification implied that Households engaging solely in non-farm activity were very low (4.2%) which is a considerable proportion of smallholder farmers earned a substantial proportion of their income from such activities besides agricultural activities. This also implied that the need to consider economic status of smallholder farmers in designing development intervention schemes which would provide opportunities for the poor and marginalized segments of the population. Meanwhile, it was found in that farm size had negatively and significantly influenced the probability of livelihood diversification into non-farm activities at 10% probability level. The marginal effect of −0.221 showed that a unit increment in farm size could result in decreasing the probability of smallholder farmers' engagement in non-farm economic activities by 22.1% holding other things constant. Farmers with large farm size are less likely to diversify the livelihood strategies into non-farm income sources. That means, farmers having more land size depend on crop production than to go for non-farm in order to satisfy basic needs.

4.6.8. Impact of watershed development on irrigation-based income

From those on-farm activities estimating the impact of watershed development on irrigation based income is desirable. Water harvesting is an integral part of watershed development and key factor to improve community's livelihood through providing opportunities for irrigation based income generate. But, in most developing countries, only 20–50% of total surface runoff is controlled and effectively used (MORAD, 2005). Ethiopia is among them as topography; inadequate farming practices, lack of conservation hamper water, moisture retention and its efficient use and suffers from what is referred as a "recurrent wastage of most of its rainwater". When rainwater infiltrates rapidly it also has a high probability to recharge water-tables and make ground water available for small-scale irrigation or supply springs for various uses. Depletion of water resources is directly linked to the disappearance of vegetative cover and then household income.

Table 4. 23 Different analysis to estimate the impact of WSD on irrigation income.

	Irrigation based income			
	PSM		Hackman two stage	
	ATT	t-value	coefficient	P>|z|
Nearest Neighbor Matching	263.707	0.484	-	-
Stratified Matching	430.00	0.901	-	-
Kernel Matching	414.821	0.828	-	-
Radius Matching	182.239	0.292	-	-
Irrigation based income				
Watershed development index	-	-	612.765	0.763
Household size	-	-	-860.3086	0.475
Dependent ratio	-	-	-456.1988	0.562
Adult equivalent	-	-	1021.462	0.465
Age of household held	-	-	-.5055599	0.991
Years of hh head schooling	-	-	-251.5062	0.146
Total land hold	-	-	437.781	0.515
Tlu of livestock	-	-	2.619325	0.985
Cons	-	-	5033.149	0.029
Watershed development index				
Lack of techq. and farm technology	-		-.6136923	0.000
/mills				
lambda	-		-2374.521	0.062
rho	-		-0.49793	
sigma	-		4768.7499	
Wald chi2(8)	-		5.860	
Prob > chi2	-		0.6626	

Source; Own survey result, 20120

As presented on table (4.23) the impact of watershed development on irrigation-based income is estimated with different matching analysis and was non-significant. And Heckman two stage sample selection model regression result estimate that the same scenario with those of different matching analysis. It implied that rural farm households have not gave attention for irrigation based income generating activities because of lack of awareness, interests and irrigation technologies. And they engaged more on rain fed agricultural activities. The result is in line with the study of K. Palanisami and D. Suresh Kumar, (2009) the perennially of water in the wells inspected during the sample survey was found to have improved as the establishment of watershed programs in the study area contribute to the improvement of water level in the wells. It indicated that the result of recuperation rate after watershed development program intervention the recharge rate had increased in the range of 16 to 39 percent. This increased the gross irrigated area by 13.6 percent. Due to the groundwater recuperation in the nearby wells had increased e the irrigation intensity increased from 115.74

percent to 122.73 percent in Kattampatti watershed and from 101.45 percent to 102.01 percent in the Kodangipalayam watershed.

4.7. Result of key informant analysis

To supplement the results of the study based on the data collected from respondents through questionnaire, individuals have been interviewed in relation the impacts of WSD on the livelihood of rural farm households in Bure Zuria district. First the contribution of natural resource conservation activities through watershed development program in the study areas to households' agricultural productivity was explained by watershed development program committee members Azimeraw and Mekonene as follows. "*The program prepares annual plans and implementation strategies to soil and water conservation. This benefited the community in terms of prevention of soil from erosion. As a result, our Agricultural production and productivity has been increased as compared to the previous years. For example, maize production has increased from 18-25 to 45-60 quintals per hectare".*

In this regard, program participant household heads Endalew and Bosenna were interviewed and forwarded their idea as follows. "*We know the advantage of WSDP because it gives training on how to implement green manuring activities and natural fertilizers like compost to increase agricultural productivity".*

Agricultural productivity is expressed by Tilahune, Mulat and Zerfie as follows: "*To some extent, agricultural productivity on our plot of land is increased after implemented natural resource construction through WSDP.*

The impact of WSDP on agricultural productivity is also well acknowledged by district soil and water conservation and development expert by stating that "*Watershed development program implements farm land treatment and initiate the farm household's involvement in different income generating activities. These activities improve agricultural productivity and annual household income*".

The watershed development participant household heads; Haymanot, Bosena, Kindie and Mammo expressed the impacts of WSDP on their income level as follows. "*as WSDP gives training and awareness creation activities income generating activities like fattening of animal by cut and carrying system, forage development and tree and fruit seedling preparation so that our total annual income is increased by the intervention of the program*."

Other interviewees Azimeraw, Haymanot, Animaw and Worku stated the impacts of WSD as *"our income is increased after WSDP gives some extension services. For example after we*

have taken training which was given by stockholders on how to prepare potato storing house we store the potato for seed purpose and sell with high price". In addition, Azimeraw said *that "WSD introduces a new forage development technology which is called densho grass which is used for forage and has additional advantage that after the end of the year I sale 10 birr per sod and I get Birr 7,000 to Birr 16,000 per year."* And development agents who facilitate the program in the kebele states the impacts of the program by stating as *"the program works intensively on different income generating activities like fattening, seedling preparation and introduction of cash crops to increase household incomes of the community. As a result, the program increases the income level of participant household."*

To sum up the interviewees and experts stated that the positive impact of WSDP on livelihood of rural farm households, which supports the result that was found from the empirical evidence.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

In the study area, the majority (57.76%) of respondents' educational background was able to read and write. The average land holding of all sample households is 1.135 hectare which is more or less similar with the regional average land holding per household, 1.10 hectare. The majority of respondents had regular saving and credit services from different formal and informal institutions that helped through purchasing on farm inputs and equipment to increase their on farm income. The study revealed that most of the watershed development participants are improved agricultural input users.

Based on watershed development indexes, topography gradient, culture of grazing, poor land use, poor livestock management, in stable political situations, low government and stockholder facilitations and lack of appropriate farm technologies were significant factors affected watershed development. On the same way, Household participation parameters; Household size, Adult equivalent, Dependent ratio, culture of free grazing, lack of properly livestock management poor land use and land administration policy had significant effect on the watershed development.

The result revealed that the mean land hold of sample households, per adult equivalent and the mean irrigable land of farm households are minimal. While the mean family size of sample households is 5 in number and also per adult equivalent is 4.296. Therefore there is left-over time for additional work on off-farm and non-farm activities in addition to their on-farm activities to mitigate risks of on-farm activities, for a better livelihood diversify and generate more income to enhance their livelihood.

Watershed development program in the study area has brought positive impact on livelihood diversification score of program user which ultimately indicated that the program contributed to enhance diversification of participant households for better livelihood. The more livelihood diversification resulted better rural farm household income.

Watershed development program in the study area has positive and significant impact on annual income of the participants which implied the interventions of the program had positive contribution on: soil and water conservation, pasture development, livestock breed

improvement, crop productivity improvement and afforestation. Similarly, the intervention has also change on a cropping pattern variation as a result of increment of irrigation potential.

On the other side, watershed development had no significant effect on irrigation-based income, off-farm and non-farm income which was due to lack of awareness creation and lack supply of agricultural technologies. And also; there were no significant differences on total irrigable land holding between watershed development participant and non-participant households. Participants in the study area were engaged at minimal level on off-farm and non-farm activities. Crop and livestock production was the major source of livelihood in the study area. Land holding size per adult equivalent was low which reduced the potential of irrigation farming system and rain fed crop production potential.

5.2. Recommendations

The study illustrates that, Convergence of various rural development programs in and around the watershed is ensured to promote the holistic development of watersheds enhancing rural farm household's livelihood. However, to its continued success, the watershed development program should be designed economically efficient, financially viable, technically feasible and socially acceptable while ensuring livelihood of rural farm households. These results have some policy implications to be recommended as follows.

- The study revealed that, land policy implementation affects watershed development program by 65.4%. Therefore to ensure the watershed development the government should implement land policies wisely without any political intervention and Watershed development program should have its Owen strong institution which is led by watershed users
- The study area has different income generating potentials like irrigation schemes which was not yet fully exploited. Therefore, watershed development program should focus on income generating diversification through irrigation scheme implementation.
- The study revealed that, only 2.17% and 1.86% of the total sample households are engaged in off-farm and non-farm activities respectively. Despite the fact that the study used different econometric regression analysis the net annual income generating from off-farm and non-farm activities is insignificant. Therefore in in the watershed development program different income generating options like off-farm and non-farm activities should be implemented to minimize the pressure on natural resources and should introduced updated and news technologies, scale up best practices and

alternative livelihood strategies with practical training should be appropriately designed and implemented.

- In the study area most of the sample farm households were not participated in non-farm and off-farm livelihood diversification strategies. Therefore watershed development Policy makers should incorporate strategies and promote households participation in off-farm and non-farm activities by providing adequate infrastructure, formal credit facilities and other necessary services needed by the farm households.
- Through watershed development program to consider as an alternative livelihood diversification strategy, special package program should be designed so as to promote off-farm and non-farm activities and need to be incorporated in the rural development policies and technical as well as financial supports should be given in rural extension programs. Government organizations and other stockholders should also support these strategies especially women and youths as well through watershed development program to minimize the natural resource depletion.
- In the study area the compatibility of watershed development program should be established and the methods of policymaking must be refined. Therefore, Policies and strategies that aim at watershed development must have been welfare-oriented and their primary goal should be designed to increase livelihood of farm households.
- Policy makers and other government stockholders should have to focus in strengthening the role of different rural extension agents providing livelihood diversification option to the marginalized WS portion of the farm households. Entrepreneurial training, skill development and infrastructure development would probably enhance the participation of smallholder farmers in off-farm and non-farm activities.
- The study revealed that, 88.2% of sample households are engaged on on-farm activities as major source of livelihood Options. Therefore, Rural-based institutions should integrate off-farm and non-farm diversification as part of their program. Moreover, targeted interventions should be focused for youths and female-headed households to participate in off-farm and non-farm economic activities.
- Finally, watershed development programs should be fully operated by the community with support of the government and other stack holders. Policy-makers and stakeholders should be widely encouraged in planning and implementation.

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APPENDICES

Appendix 1 TLU conversion factor for different animals

Animal Category	**TLU**	**Animal Category**	**TLU**
Cow & Ox	1.00	Donkey (adult)	0.70
Horse & mule	1.10	Donkey (young)	0.35
Camel	1.25	Sheep and Goat (adult)	0.13
Heifer & bull	0.75	Sheep and Goat (young)	0.06
Calf	0.25	Chicken	0.013

Source: Adopted from Yilma (2005)

Appendix 2 Determinate factors with logit regression model

Watershed development index	Coef.	Std.Err	Z	P>|v|
Household size	0.962	0.479	2.01	0.045
Adult equivalent	1.23	0.54	2.28	0.023
dependent ratio	-0.656	0.322	-2.03	0.042
years of household head schooling	-0.13	0.066	-1.96	0.05
age of household	-0.018	0.153	-1.18	0.24
Tlu of livestock	0.51	0.054	0.94	0.348
Total land hold	-0.134	0.418	-0.32	0.748
culture of free grazing	-1.079	0.336	-3.21	0.001
lack of awareness	-0.433	0.299	-1.44	0.149
lack of poor livestock mgt	-0.95	0.297	-3.2	0.001
Poor land use	-1.055	0.308	-3.42	0.001
Weak implement land admin policy	-1.04	0.317	-3.28	0.001
political situation	-1.694	0.319	-5.31	0.000
Total land hold in the WSD	0.605	0.481	1.26	0.209
Lack of technique and farm technology	-1.365	0.345	-3.95	0.000
Cons	6.296	0.974	6.47	0.000
Number of observation	32			
LRchi2(15)	141.89			
prob > chi2	0.0000			
Pseudo	0.3196			
Log likelihood	151.02982			

Appendix 3 Determinants of watershed developmnt (Heckman –two stage regression model)

Factors	Coef.	Std. Err.	Z	P>|z|
Topography gradient	0.0296632	0.0316752	0.94	0.349
culture of free grazing	-0.0261116	0.0382651	-0.68	0.495
lack of awareness	0.0190064	0.0329332	0.58	0.564
population pressure	-0.0205057	0.0315979	-0.65	0.516
lack of properly livestock management	0.0356887	0.0369143	0.97	0.334
poor land use	-0.0358382	0.0367588	-0.97	0.33
Week implement land admin. Policy	-0.0097722	0.0400289	-0.24	0.807
political situations	0.0752336	0.0487367	1.54	0.123
rain fall precipitation	0.0519986	0.0342358	1.52	0.129
low government facilitation	0.0251396	0.0464551	0.54	0.588
land slop	-0.0301064	0.0414322	-0.73	0.467
total land hold in the watershed	0.0523457	0.0261928	2.00	0.046
lack of technique and farm technology	-0.0014347	0.0403676	-0.04	0.972
_ cons	0.6682868	0.0778427	8.59	0.00
Topography gradient	0.5496861	0.1246079	4.41	0.00
culture of free grazing	-0.6476378	0.2016444	-3.21	0.001
lack of awareness	-0.2001803	0.1825109	-1.1	0.273
population pressure	-0.1262812	0.1819157	-0.69	0.488
lack of properly livestock management	-0.5353681	0.1820504	-2.94	0.003
poor land use	-0.4236365	0.1805488	-2.35	0.019
Week implement land admin. Policy	-0.6539435	0.2027552	-3.23	0.001
political situations	-0.931428	0.1919525	-4.85	0.00
rain fall precipitation	-0.404803	0.1970212	-2.05	0.04
low government facilitation	-0.8015805	0.2013981	-3.98	0.00
land slop	0.6037218	0.1936761	3.12	0.002
total land hold in the watershed	0.191934	0.1620837	1.18	0.236
lack of technique and farm technology	-0.4839807	0.2080708	-2.33	0.02
_ cons	1.673256	0.4284035	3.91	0.00
lambda	-0.0916106	0.0929727	-0.99	0.324
Rho	-0.50384			
Sigma	0.1818252			

Appendix 4 Matching analysis to estimate the impact of WSD on Livelihood diversification using Simpson index

Type of matching	N(treated).	N(control)	ATT	Std.Err.	T
Nearest Neighbor Matching	147	83	0.066	0.027	2.482
Stratified Matching	147	161	0.078	0.02	3.807
Kernel Matching	147	161	0.081	0.024	3.386
Radius Matching	86	71	0.075	0.031	2.456

Appendix 5 Heckman selection model -- two-step estimates of livelihood diversification

	Coef.	Std. Err.	Z	P>|z|
Livelihood diversification				
WSD index	0.1383618	0.0573007	2.41	0.016
Household size	-0.0656729	0.0342738	-1.92	0.055
Dependent ratio	0.0544904	0.0220236	2.47	0.013
Adult equivalent	0.071132	0.0402604	1.77	0.077
Age of household head	0.0027565	0.0012171	2.26	0.024
Years of hhh schooling	-0.0037314	0.0048523	-0.77	0.442
Total land hold	-0.0032973	0.0188864	-0.17	0.861
Tlu of livestock	0.0069495	0.0040078	1.73	0.083
_cons	0.3955286	0.0655784	6.03	0.000
WSD index				
Culture of free grazing	-0.7248595	0.1659213	-4.37	0.00
Household size	0.3816997	0.2308725	1.65	0.098
Adult equivalent	0.5042054	0.2611434	1.93	0.054
Dependent ratio	-0.1746315	0.1578026	-1.11	0.268
Age of household head	-0.0147116	0.0076974	-1.91	0.056
Years of hhh schooling	-0.0376549	0.032398	-1.16	0.245
Total land hold	0.1602035	0.1284133	1.25	0.212
Tlu of livestock	0.0284705	0.0274999	1.04	0.301
_cons	1.263912	0.3832047	3.3	0.001
/mills				
Lambda	-0.0162188	.0490959	-0.33	0.741
Rho	-0.12875			
Sigma	0.12596764			
Number of obs	322			
Wald chi2(8)	21.12			
Prob > chi2	0.0068			

Appendix 6 Different matching analysis to estimate the impact of WSD on annual household income and Heckman two stage regression model

Type of matching	N (treated)	N (control)	ATT	Std.Err.	T
Nearest Neighbor Matching	147	83	84,240.17	16,057.66	5.246
Stratified Matching	147	161	79,076.80	15,206.80	5.2
Kernel Matching	147	161	78,818.57	14,772.44	5.336
Radius Matching	86	71	67,659.77	15,860.60	4.266

Appendix 7 Heckman selection model -- two-step estimates on annual income

	Coef.	Std. Err.	z	P>|z|
Total annual income				
WSD index	204,824	67,966.99	3.01	0.003
Household size	141,646.80	33,768.18	4.19	0.00
Dependent ratio	-123,132.40	22,140.10	-5.56	0.00
Adult equivalent	149,786	39,083.40	3.83	0.00
Age of household head	-3,266.68	1,182.95	-2.76	0.006
Years of hhh schooling	3,963.55	4,917.67	0.81	0.42
Total land hold	26,955.16	19,128.09	1.41	0.159
Tlu of livestock	26,076.62	4,099.18	6.36	0.00
_cons	-13,985.45	72,644.82	-0.19	0.847
WSD index				
Plantation	2.250685	0.233595	9.64	0.00
Household size	0.8043327	0.273518	2.94	0.003
Adult equivalent	0.9780057	0.310791	3.15	0.002
Dependent ratio	-0.4546695	0.199192	-2.28	0.022
Age of household head	-0.0184749	0.00937	-1.97	0.049
Years of hhh schooling	-0.0162414	0.037544	-0.43	0.665
Total land hold	-0.0114676	0.152142	-0.08	0.94
Tlu of livestock	0.0638004	0.032215	1.98	0.048
_cons	0.4267346	0.414584	1.03	0.303
/mills				
Lambda	51,107.07	24,255.04	2.11	0.035
Rho	0.38442			
Sigma	132,944.38			
Number of ob.	322			
Wald chi2	92.24			
Pro > chi2	0.0000			

Appendix 8 Different matching analysis to estimate the impact of WSD on on-farm income

Type of matching	N(treated).	N. (Control).	ATT	Std.Err.	T
Nearest Neighbor Matching	147	83	81,202.76	14,946.17	5.433
Stratified Matching	147	161	76,248.02	14303.654	5.331
Kernel Matching	147	161	75,857.68	12,476.55	6.08
Radius Matching	86	71	66,113.00	15,033.80	4.398

Appendix 9 Heckman selection model -- two-step estimates on-farm income

	Coef.	Std. Err.	z	P>|z|
Total on-farm income				
WSD index	112,497	55,930.27	2.01	0.044
Household size	109,968.30	31,277.34	3.52	0.000
Dependent ratio	-113,128.10	20,484.77	-5.52	0.000
Adult equivalent	112,851.30	36,233.62	3.11	0.002
Age of household head	-2,657.67	1,117.36	-2.38	0.017
Years of hhh schooling	3,818	4,553.93	0.84	0.402
Total land hold	16,771.35	17,564.13	0.95	0.34
Tlu of livestock	25,429.99	3,772.00	6.74	0.000
_cons	76,001.90	61,394.32	1.24	0.216
WSD index				
Poor land use	-0.7776915	0.1616551	-4.81	0.000
Household size	0.3577384	0.2502599	1.43	0.153
Adult equivalent	0.5052906	0.2835031	1.78	0.075
Dependent ratio	-0.1814604	0.1698355	-1.07	0.285
Culture of free grazing	-0.7345172	0.1782987	-4.12	0.000
Lack of proper livestock _mgt	-0.6223355	0.157962	-3.94	0.000
Lack of technique and farm technology	-0.6629505	0.1810744	-3.66	0.000
Age of household head	-0.0085479	0.0082067	-1.04	0.298
Years of hhh schooling	-0.0656203	0.034934	-1.88	0.06
Total land hold	0.1291884	0.1340693	0.96	0.335
Tlu of livestock	0.0318349	0.0289777	1.1	0.272
_cons	2.529216	0.4572897	5.53	0.000
/mills				
lambda	-19873.98	28,941.06	-0.69	0.492
Wald chi2(8)	88.01			
Prob > chi2	0.000			
rho	-0.16446			
sigma	120,842.95			

Appendix 10 Different matching analysis to estimate the impact of WSD on off-farm income

Type of matching	N(treated).	N (control).	ATT	Std.Err.	T
Nearest Neighbor Matching	147	83	1300	2642.604	0.492
Stratified Matching	147	161	1497.604	2343.085	0.639
Kernel Matching	147	161	1635.394	2440.264	0.67
Radius Matching	86	71	-903.427	1890.47	-0.478

Appendix 11 Heckman selection model -- two-step estimates of off-farm income

	Coef.	Std. Err.	Z	P>|z|
Total off-farm income				
WSD index	0.2993588	0.1697436	1.76	0.078
Household size	0.194698	0.099138	1.96	0.05
Dependent ratio	0.0858601	0.0648627	1.32	0.186
Adult equivalent	0.1903896	0.1149311	1.66	0.098
Age of household head	-0.0019879	0.0035754	-0.56	0.578
Years of hhh schooling	0.0135413	0.0142643	0.95	0.342
Total land hold	-0.0139293	0.0554684	-0.25	0.802
Tlu of livestock	-0.0002341	0.0118827	-0.02	0.984
_cons	0.2688476	0.1903784	1.41	0.158
WSD index				
Lack of awareness	-0.3772619	0.1592489	-2.37	0.018
Household size	0.3033077	0.2434967	1.25	0.213
Adult equivalent	0.4154093	0.2752136	1.51	0.131
Dependent ratio	0.0863189	0.1623147	0.53	0.595
Culture of free grazing	-0.8118025	0.1750038	-4.64	0.000
Lack of proper livestock _mgt	-0.5686025	0.1546753	-3.68	0.000
Lack of technique and farm technology	-0.6345715	0.1756197	-3.61	0.000
Age of household head	-0.0101367	0.0080129	-1.27	0.206
Years of hhh schooling	-0.0365456	0.0341265	-1.07	0.284
Total land hold	0.1369524	0.1330456	1.03	0.303
Tlu of livestock	0.0199878	0.0288692	0.69	0.489
_cons	2.172143	0.4352572	4.99	0.000
/mills				
lambda	0.1563612	0.1013085	1.54	0.123
rho	0.40336			
sigma	0.38765011			
Number of obs	322			
Wald chi2(8)	11.7			
Prob > chi2	0.1651			

Appendix 12 Different matching analysis to estimate the impact of WSD on non-farm income

Type of matching	N (Treated)	N(Control).	ATT	Std.Err.	T
Nearest Neighbor Matching	147	83	1757.823	1379.232	1.274
Stratified Matching	147	161	1334.615	1432.244	0.932
Kernel Matching	147	161	1329.754	1289.625	1.031
Radius Matching	86	71	2441.86	2327.12	1.049

Appendix 13 Heckman selection model -- two-step estimates of non-farm income

	Coef.	Std. Err.	Z	P>|z|
Total non-farm income				
WSD index	0.0466832	0.0724854	0.64	0.52
Household size	-0.0188693	0.0413099	-0.46	0.648
Dependent ratio	0.0007984	0.0270231	0.03	0.976
Adult equivalent	0.0270384	0.0479394	0.56	0.573
Age of household head	-0.0010662	0.0014966	-0.71	0.476
Years of hhh schooling	0.0128124	0.0059604	2.15	0.032
Total land hold	-0.0113278	0.0231405	-0.49	0.624
Tlu of livestock	-0.0087996	0.0049611	-1.77	0.076
_cons	0.040003	0.0801438	0.5	0.618
WSD index				
Lack of awareness	-0.3772619	0.1592489	-2.37	0.018
Household size	0.3033077	0.2434967	1.25	0.213
Adult equivalent	0.4154093	0.2752136	1.51	0.131
Dependent ratio	-0.0863189	0.1623147	-0.53	0.595
Culture of free grazing	-0.8118025	0.1750038	-4.64	0.000
Lack of proper livestock mgt	-0.5686025	0.1546753	-3.68	0.000
Lack of technique and farm technology	-0.6345715	0.1756197	-3.61	0.000
Age of household head	-0.0101367	0.0080129	-1.27	0.206
Years of hhh schooling	-0.0365456	0.0341265	-1.07	0.284
Total land hold	0.1369524	0.1330456	1.03	0.303
Tlu of livestock	0.0199878	0.0288692	0.69	0.489
_cons	2.172143	0.4352572	4.99	0.000
/mills				
lambda	-0.0048838	0.0424545	-0.12	0.908
rho	-0.03092			
sigma	0.15793051			
Number of obs	322			
Wald chi2(8)	9.08			
Prob > chi2	0.3355			

Appendix 14 Different matching analysis to estimate the impact of WSD on irrigation income

Type of matching	N(treated).	N.(control).	ATT	Std.Err.	t test
Nearest Neighbor Matching	147	83	263.707	545.335	0.484
Stratified Matching	147	161	430	476.995	0.901
Kernel Matching	147	161	414.821	500.858	0.828
Radius Matching	86	71	182.239	625.166	0.292

Appendix 15 Heckman two stage sample estimates on Irrigation income

|	Coef.	Std. Err.	Z	P>|z|
Total irrigation income				
WSD index	612.7648	2030.458	0.3	0.763
Household size	-860.3086	1204.112	-0.71	0.475
Dependent ratio	-456.1988	786.5201	-0.58	0.562
Adult equivalent	1021.462	1396.73	0.73	0.465
Age of household head	-0.5055599	43.09772	-0.01	0.991
Years of hhh schooling	-251.5062	173.1944	-1.45	0.146
Total land hold	437.781	672.548	0.65	0.515
Tlu of livestock	2.619325	144.0519	0.02	0.985
_cons	5033.149	2305.68	2.18	0.029
WSD index				
Lack of awareness	-0.6136923	0.1733343	-3.54	0.000
Household size	0.3192153	0.2409282	1.32	0.185
Adult equivalent	0.4453753	0.2724226	1.63	0.102
Dependent ratio	-0.0952595	0.1625287	-0.59	0.558
Culture of free grazing	-0.8002271	0.1729538	-4.63	0.000
Lack of proper livestock _mgt	-0.5815597	0.1536422	-3.79	0.000
Lack of technique and farm technology	-0.0092541	0.0079632	-1.16	0.245
Age of household head	-0.0453986	0.0336425	-1.35	0.177
Years of hhh schooling	0.1321695	0.1315313	1	0.315
Total land hold	0.0271922	0.0284851	0.95	0.34
_cons	1.927697	0.4194626	4.6	0.000
/mills				
lambda	-2374.521	1270.498	-1.87	0.062
rho	-0.49793			
sigma	4768.7499			
Number of obs	322			
Wald chi2(8)	5.86			
Prob > chi2	6626			

Appendix 16 Household Survey Questionaire

Impact of watershed development on livelihood of rural farm household: (in the case of Burie Zuria district, Amhara Region)

Introduction

Dear respondent:
How are you! I am fine Thank you. My name is Tsegaye simachew yehun

First of all thank you for your willingness to be part of the survey. I am a Post graduate student in department of Development Economics, In Bahir Dar University. Currently, I am undertaking a research entitled with *"Impact of watershed development on livelihood of rural farm household."* You are one of the respondents selected to participate in the survey. Please, support me through providing actual information for household income and diversification related questions detailed with the questioner. Your participation is entirely voluntary and the questionnaire is completely anonymous.

Finally, I need to confirm you that the information that you shared me will be kept confidential and only used for the academic purpose. No individual's responses will be identified as such and the identity of persons responding will not be published or released to anyone. All information will be used for academic purposes only.

Thank you again for your kind cooperation and time.

Household Survey Questioner General Information

Name of the district/ Worda: ……..

Name of the kebele: ……

Name of the watershed: …….

Types of the topographic gradient (elevation) 1. upstream, 2. midstream 3. downstream

Name of enumerator: …… signature ……

Mobile No: …….

Enumeration date: ……..

Household ID code: …
…….

Part I - Basic household information

1. List all household members who are living continuously in the household. Please include everybody who usually lives in the household and complete the rest of information.

ID. code household members	Relationship to the household head (A)	Sex M =1 f= 0	Age	years of schooling (B)	Marital Status (C)	Religion (D)	Major activities (E)	Secondary Activities (E)
1								
2								
3								
4								
5								
6								

Code A	**code B**	**code C**	**code D**	**code E**
1=head 2=wife/husband 3=Son/Daughter 4=Mather/father 5=Brother/Sister 6=Servants 7=Others	1= Read and write only 2.=Completed primary 3=complete secondary 4=TVET/college diploma 5=Degree and above 6=Never read and write	1= Single 2= Married 3= widowed 4=Divorced	1=Orthodox, 2=Muslim 3=Protestant, 4=Catholic 5=Others (Specify)____	1= farming , 2= Off-farm activities 3= daily labor 4=petty trade, 5= student 6 = Religious leader(priest) 6=civil servant, 7= Kebele Administration representative 8= private enterprise employee, 9= producer/ service cooperative employee, 10= pensioner 11= domestic worker

1.2. Household dependency ration (number of people living under respondent care and its dependency)

Age group & other measures	Sex		Total	Numbers of family do not earn income	Number of adults
	Male	Female			
Under15 yrs.					
15-65yrs					
Above 65 yrs.					
Total					
Dependency ration	Dependency ratio; number of family members (NFM)<15+NFM>64 divided by NFM(15-64)				

1.3. Type of dwelling, Constructed with: 1. Corrugated iron sheet 2. Thatched roof

If your house is constructed with corrugated iron sheet: 1. 20 sheet 2. 20 -42 sheets 3. 42 – 70 sheets 4. > 70 sheets

Part II- Resource ownership of the household

2.1. **Land Ownership of the Household**

1. Do you have land to plough? Yes=1, NO= 0

2. If your answer is yes, how many hectors of land you have?

Total land size ----------

1. Rain fed land ----------Gezem/gemed 2. Irrigated land ----------Gezem/gemed

3. Forest/woodlot ----------Gezem/Gemede 4. Grazing land ----------gezem/gmede

3. Do you have land in this watersheds Yes =1 no= 0

If your answer is yes, Total land size that you have in this watershed=---------- gezem/gemed

Irrigated --------- gezem/gemed, Rain fed---------- gezem/gemed, Grazing ---------- gezem/gemed, Covered by forest ---------- gezem/gemed and Degraded/not suitable to use----------gezem/gemed

4. Where did you get this land? 1. Gift of land 2. Earth's lead 3. Inheritance of land 4. Possession of land 5 others specify ----------

5. Did you cultivate a land through rent or crop sharing system in the last main production season (Keremt) Yes = 1 No = 0 if your answer is yes, tell me the size of the plot

- Crop shared in = _____ *Timad/Gezem*
- Rented in = _____*Timad/Gezem*

6. The average distance from home to the farm land -------- k/m

5. Are there any irrigation access / irrigable water source in your community? Yes = 1, No=0

If your answer is yes, give the information based on the table list

Plot no	3) Irrigable plot size in *Gemed/Gezem or ---- meter by --- meter*	4) How many times do you produce per year using irrigation	5)Irrigable water source (A)
1			
2			
3			
4			
Code (A) 1=River diversion, 2= spring 3= River using motor pumps, 4= Water well, 5= Pound, other specify --------			

6. If your answer in Q2 is no, what are the main reasons?
1= Lack of water source, 2= Lack of capital, 3= Lack of interest, 4= Lack of technical skill, 5= steeply slope of plots, 6. Others (specify) _____
7. Have you increased your irrigated plot of land after the implementation of watershed? Yes=1 No= 0

If yes, increased amount of land in *Gezem/Gemed* =----------

8. Average distance from the farm land to nearby irrigation water sources --- meter or ---k/m.

9. What is the slop of your farm land? 1. Plane 2. Moderately sleep 3. Steep 4. Very steep

2.2. The number of livestock owned

1. Do you have Owen livestock at present? Yes =1, No =2, If your answer is yes, indicate the number and types of livestock that you owned.

Types Livestock	Ox	Local Cow	mproved cow	Heifer	Bull	Calf	Sheep	Goat	Hen	Bee Hive	Donkey	Horse	Mule
Amount In umber													
Total value at current market													

Part III: Access to different services

3.1. Market access

1. Have you any information about local market? Yes….0, No ….1

If your response is yes, where did you get the information? 1. Development agents, 2.marketing experts, 3. Medias 4. Cooperative experts 4. Others

2**.** Distance to the nearest major market from your home? ----------hours

3. Distance from main road which give service throughout the year? .....hours

4. 2**.** Distance to the nearest town from your home? ----------hours

3.2. Saving and credit access

1. Have you regular saving? Yes---0. No….1 if your answer is yes, where is you save your money? 1. Bank 2. Saving and credit cooperatives 3. ACCI 4. Eqube 5. Others

2. How much did you (respondent only; not household) save in the last One month? _____

3. Have you ever taken any loan from any type of source in last 12 months? Yes=1 No=2,

4. If yes, how many times have you borrowed? ..... round and Total amount ---------- Birr

Describe the details for what purpose? 1. Inputs 2. Consumption 3. Building 4. Health care 5. Ceremonies 6. Animal purchasing 7. Others (describe) ----------

3.3. Watershed development services

1. How long you participated in the watershed development. 1= 5 year, 2=8 years, 3=10 and above years
2. What are the benefits of being a beneficiary of watershed? 1. Increase production and productivity 2. Ecology stability 3. water access 4. Increases different services 5. Others (describe) ----------

3. Did you have had an agricultural extension agent support in the watershed? Yes….0, No…1

4. If your answer is yes, frequency of attendance? 1. Per week 2. Per months, 3. Per year

5. Are you engaged in some kind of new businesses or income generating activity (IGA) in the watershed? Yes = 1 N = 0. If yes, what kind of business you starting? .....

6. Do you get a capacity building training on income generating activity since treated/ involve in the watershed development? Yes…...0, No……...1,

If the answer is yes, please specify the topic of the training 1. Crop production 2. Animal production 3. Seedling production 4. plantation 5. Technology adoption 6. Vegetables 7. Others (describe) ----------

7. Did you use improved agricultural input to enhance your production and productivity? Yes…...0, no……1, if your answer is yes, please specifying it

1. Fertilizers 2. Improved seeds 3. Chemicals 4. Farm machine 5. Others (describe) ----------

3.4. Access of basic service

1. What is the main source of cooking fuel for your home? 1. Wood 2. Charcoal 3, electric 4, solar, 5 Biogas

2. Main source of water supply? 1. Rivers 2. Ponds 3. Hand gadwall 4. Developed & protected spring 5. Traditional/unprotected well water

3. Is there any water scarcity throughout the year? Yes / no

4. Is there any Veterinary services. Yes / no.

If your answer is yes, who is delivered it? 1. Private services 2. Government services 3. Enterprise services 4. Other mentions ----------

5. Is there Farm technologies access? Yes = 1/ no = 0.

If your answer is yes, who is providing it? 1. Private sectors 2. Government 3. Enterprises 4. NGOs 5.Other (mentions) ----------

Part IV: Awareness level and collective action on watershed development initiatives

1. Do you know that watershed development program had been implemented in your village? Yes (1)/ No (O)

If yes, then who were the facilitating agencies? 1. Only government 2. NGO + Gov. 3. Multilateral organizations 4. Only NGOs

2 Is there a watershed institution established in your local area? Yes = 1/ no =0

3. If yes, are you a member in the established watershed the institution? Yes =1/ no =0

If yes, mention your role and responsibilities?

1. Watershed executive member 2, Member as user 3.Other sub-committee member (specify)

4. Did you adapt and implement any of the watershed development activities? Yes / no

If yes, list the activities that you are adopting during the course of the program?

1. Soil and water conservations activities 2. Area closure 3. Plantation 4. Pasture development 5. Stream development 6. Livestock variety improvement

5. Did you get any incentives during implementing those activities? Yes / no

If yes, mention it 1, in cash ---------- Birr/year 2. In kind ---------- kg of wheat --------- litters of oil 3. Others (specify) ----------

Part V: Household Expenditure

1. Food Expenditure (Major) in terms of Birr

Cereals (wheat, teff, barley, maize---) = ----------, Oil =----------, Vegetable (onion) = ---------, Beverage = ----------, Coffee = ----------, Sugar = ----------, Salt = ------

2. Non-food expenditure (Major) for

Health ----------, Education ----------, Different ceremonies ----------
Building purpose --------, Home equipment ---------, Clothes ----------Land rent --------
Inputs (fertilizer --------, improved seed -------, lime -------, chemicals -------- farming tools---------others ------) and others ----------

Part VI. Household source of income and amount

1. Have your different source of income? Yes….0, No…1

If your answer is yes, what is the source of income and how much you got, please fill the following table

S/N	Source of income	Unit	Quantity	Estimated Sold unit price in birr	Total price	Average income
1	**Live stock**					
	Oxen					
	Cow					
	Bull					
	Heifer					
	Calf					
	Sheep					
	Goat					
	Horse					
	Mule					
	Donkey					
	Hen					
	Bee collony					
2	**Animal product**					
	Milk					
	Better					
	Meat					
	Leather					
	Egg					
	Honey & wax					

S/N	Source of income	Unit	Quantity	Estimated Sold unit price in birr	Total price	Average income
Rain fed based						
	Annual Crops					
3	Wheat					
	Barley					
	Milate					
	Maize					
	Teff					
	Oil crops					
	Pea					
	Bean					
	vegetables					
	Gebito					
	Perennial plant					
4	Eucalyptus					
	Gesho					
	Wanza					
	forst Seedling					
	Others					

S/N	Source of income	Unit	Quantity	Estimated Sold unit price in birr	Total price	Average income
Irrigation based						
	Fruit & coffee					
5	Coffee					
	Mango					
	Avocado					
	Apple					
	Banana					
	Papaya					
	Coke					
	Lemmon					
	Orange					
	Others					
	Vegetables					
6	Cabbage					
	Carrot					
	Bitriute					
	Tomato					
	Potato					
	Onion					
	Garlic					
	Crops					
	Spice					
	Others					

S/N	Source of income	Unit	Quantity	Estimated /Sold price in birr	Total price	Average income
	Non- farm income					
	Petty trade					
	Wage					
7	Work own shop					
	Wavering					
	Tailoring					
	Others					
	Off- farm income					
	Carpenter					
	waving					
	lover					
	charcoal production					
8	petty tread					
	Daily labor					
	Beehive					
	hand crafts					
	carte work					
	Others					
9	Rent income					
10	Remittance income					
11	Government transfer					
12	Support from donating/supporting institutions					

Part VII: Common resource utilization in the watershed

1. Is there any open grazing practice in the watershed? Yes= 1 No= 0

If your answer is No, how did the community managed common grazing lands?

1. Cut and carry system 2, rotational grazing 3. Intensive 4. Semi intensive 5. Others (describe) -------

2. If there are water sources for irrigation in the watershed, how is the management practice?

1. Governed by water user association 2. Local administration (with *wuha bat*) 3. Others (specify)

3. What are the current challenges of watershed development? (Possible to choose more than one applicable answers)

1. The culture of free grazing, 2. Lack of awareness, 3. Population pressure, 4. Lack of proper 5. Livestock management, 6. Lack of appropriate technologies and farming techniques, 6. Land use system, 7. Weak to implement land administration policies 8. Political situations 9. Rain fall precipitation 10. Lack of awareness 11. Lack of government or facilitators attention 12. Slop of the land 13. Others specify ----------

4. Major benefits earned and changes observed since the implementation of watershed development in your area

1. Bio diversity rehabilitated 2. Source of water increased, 3. Soil fertility improved, 4. Forest coverage improved, 5. Fodder production enhanced 6. Production and productivity improved,7. Degraded land and gullies rehabilitated.

Part VIII: key Informate questioner

1. What are the results of watershed development?
2. What are the sources of income activities practiced in the watershed development?
3. What is the impact of watershed development on livelihoods rural farm household?
4. What is the total annual income of rural farm households before and after watershed development intervation?
5. While watershed development, the irrigation feriquency on the plot of land increased or not.

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አጠቃላይ መረጃ

የወረዳዉ ስም:----------
የቀበሌው ስም: ----------
የተፋሰሱ ስም: ----------
የአየር ንብረት አይነት 1. ደጋ 2. ወይና ደጋ 3. ቆላ
መጠይቁን የሞላዉ ስም:---------- **ፊርማ፡** ----------
ሞባይል ቁጥር: ----------
መረጃዉ የተሞላበት ቀን: ----------
የቤተሰብ መለያ ኮድ: ----------

ክፍል 1 - መሰረታዊ የቤተሰብ መረጃ

1. በቤት ውስጥ የሚኖሩ ሁሉንም የቤተሰብ አባላት እና አብዛኛውን ጊዜ በቤት ውስጥ አብረዉ የሚኖሩ ሌሎች ሰዎች መረጃ በሰንጠረዡ መሰረት ይዘርዝሩ ።

የቤተሰብ መለያ ሚስጥር	የአባዎራዉ/ የእማወራዋ ያለዉ ዝምድና (ሀ)	ፆታ ወ =1 ሴ= 0	እድሜ	የትምህርት ደረጃ (ለ)	የጋብቻ ሁኔታ (ሐ)	ሀይማኖት (መ)	ዋና ተግባር/የስራ አይነት (ሰ)	በሁለተኛ ደረጃ የሚያከናዉኑት ተግባር (ሰ)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

መለያ (ሀ)	መለያ (ለ)	መለያ (ሐ)	መለያ (መ)	መለያ (ሰ)
1=የቤተሰብ አስተዳዳሪ 2=ሚስት/ባል 3=ሴት/ወንድ ልጅ 4=እናት/አባት 5=ወንድም/እህት 6=የቤት ሰራተኛ 7=ሌሎች ይገለጽ	1= ማንበብና መጻፍ ብቻ ሚችል 2.=የመጀመሪያ ደረጃ ትምህርት የጨረሰ 3=.ሁለተኛ ደረጃ ትምህርት የጨረሰ 4=የሙያና ቴክኒክ/ኮሌጅ ዲፕሎማ ያለዉ 5=ዲግሪና ከዚያ በላይ 6=ማንበብና መጻፍ የማይችሉ	1= ያላገባ 2= ያገባ 3= አግብቶ የሞተበት ሰዉ 4=አግብቶ የፈታ ሰዉ	1=ኦርቶዶክስ, 2=ሙስሊም 3=ጴንጤ, 4=ካቶሊክ 5=ሌላ (ይገለጽ)_____	1= የግብርና ስራ , 2= ከግብርና ዉጭ ተጨማሪ ስራ 3= ከግብርና ስራ ዉጭ የሆነ ስራ 3= የቀን ሰራተኛ 4=አነስተኛ ንግድ 5= ተማሪ 6 = የሀይማኖት መሪ(ቄስ) 6=የመንግስት ሰራተኛ 7= የቀበሌ አስተዳድር ተወካይ 8= የግል ድርጅት ስራ 9= አምራች /አ/ህ/ስ/ማህበር ሰራተኛ 10= ጡረተኛ 11= የቤት ሰራተኛ

2. የቤተሰብ ጥገኝነት ድርሻ (በተጠያቂዉ ቤት ዉስጥ በጥገኝነት የሚኖሩ የቤተሰብ አባላት መረጃ)

የድሜ ክልል/ ሌሎች መለኪያዎች	ፆታ		ድምር	ገቢ የሌላቸዉ/የማያፈሩ የቤተሰብ ብዛት	የጎልማሳ ብዛት
	ወንድ	ሴት			
ከ 15 ዓመት በታች					
15-65 ዓመት					
ከ 65 ዓመት በላይ					
ድምር					
የጥገኝነት መጠን	የጥገኝነት ንፅፅር; ከ15 ዓመት በታችና ከ64 ዓመት በላይ ያሉ የቤተሰብ አባላት ብዛት (NFM)<15+NFM>64) ሲካፈል ከ15-64 እድሜ ክልል ዉስጥ ያሉ የቤተሰብ አባላት				

3. የመኖሪያ ቤትዎ አይነት/የተገነባዉ፡1. በቆርቆሮ 2. ጎጆ /ሳር ቤት

መልስዎ በቆርቆሮ የተሰራ ነዉ ካሉ : 1. 20 ዚንጎ እና በታች 2. 20 - 42 ዚንጎ 3. 42 — 70 ዚንጎ 4. > 70 ዚንጎ

ክፍል II- የቤተሰብ ሀብት

2.1. የመሬት ባለቤትነት

1. የርሻ መሬት አለዎት? አወ =1, የለኝም= 0

መልስዎ አለኝ ካሉ በጠቅላላ ስንት ገዝም/ገመድ /ቃዳ አለዎት? ----------

1. በዝናብ ብቻ ማምረት ሚችል---------- ገዝም/ገመድ/ቃዳ 2. በመስኖ የሚለማ(ቋሚ አትክልትን ያካትታል)----------ገዝም/ገመድ/ቃዳ 3. በደን የተሸፈነ--------- ገዝም/ገመድ/ቃዳ 4. የግጦሽ መሬት----------ገዝም/ገመድ /ቃዳ

2. በተፋሰሱ ዉስጥ መሬት አለዎት? አወ =1, የለኝም= 0

መልስዎ አለኝ ካሉ በተፋሰሱ ዉስጥ ጠቅላላ ስንት ገዝም/ገመድ /ቃዳ አለዎት?----------

1. በዝናብ ብቻ ማምረት ሚችል---------- ገዝም/ገመድ/ቃዳ 2. በመስኖ የሚለማ(ቋሚ አትክልትን ያካትታል)----------ገዝም/ገመድ/ቃዳ 3. በደን የተሸፈነ--------- ገዝም/ገመድ/ቃዳ 4. የግጦሽ መሬት----------ገዝም/ገመድ /ቃዳ 5. በጎርፍ ተጎዳ/ጥቅም የማይሰጥ---------- 6. ለሌላ የዋለ ----------

3. በተፋሰሱ ዉስጥ ያለወትን መሬት ከየት አገኙት? 1. በስጦታ 2. በዉርስ 3. በምሪት/ ከመንግስት/ 4. በይዞታ 5. በሌላ አማራጭ ካገኙት ይገለጽ----------

4. ባለፈዉ ምርት ዘመን በኪራይ ወይም በጥማዶ/በሰብል/ የሰብል ምርት አምርተዋል? አምርቻለሁ=1, አላመረትሁም= 0

መልስዎ አምርቻለሁ ካሉ በጥማዶ/በሰብል/----------እና በኪራይ------- ገዝም/ገመድ /ቃዳ አመረቱ?

5. የእርሻ ማሳዎ ከቤትዎ ያለዉ አማካኝ ርቀት----------ኪ/ሜ
6. በአካባቢዎ የመስኖ አዉታር/ለመስኖ የሚዉል የዉሃ አካል አለ? አለ=1, የለም= 0

መልስዎ አለ ካሉ እባክዎን በሰንጠረዥ መጠየቅ መሰረት መረጃ ይስጡን

የማሳ ቁጥር	በመስኖ የሚለማ መሬት መጠን በገዝም/ገመድ/ቃዳ ወይም በሜትር	የመስኖ ዉሃ በመጠቀም በአመት ስንት ጊዜ ያመርቱበታል	የሚጠቀሙት የመስኖ ዉሃ መገኛ አይነት (ሀ)
1			
2			
3			
4			
መለያ (ሀ) 1=ወንዝ 2= ምንጭ 3= ሞተር ፓምፕ 4= የዉሃ ጉድጓድ 5= ኩሬ 6. ሌላ ካለ ይገለጽ --------			

7. በመስኖ መልማት ሚችለዉን መሬትዎን አትክልት ካላለሙበት/ምርት ካልተመረተበት ዋና ምክንያትዎ ምነዉ?
1= የመስኖ ዉሃ እጥረት, 2= የመስሪያ ብር እጥረት, 3= የፍላጎት ማነስ, 4= የአሰራር/ችሎታ እጥረት, 5= ያለኝ መሬት ለእርሻ/ ለማልማት ምቹ ስላልሆነ 6. ሌላ ምክንያት ካለ ይገለጽ_____
8. የተፋሰስ ልማት ከተሰራ በኋላ የመስኖ መሬትዎ መጠን ጨምሯል? ጨምሯል=1, አልጨመረም=0

መልስዎ ጨምሯል ከሆነ ምን ያህል ገዝም/ገመድ /ቃዳ ጨምሯል----------

9. በመስኖ ሚለማዉ መሬትዎ ከመስኖ ዉሃ አካል/ወንዝ፤ምንጭ፤ሌሎች) ያለዉ ርቀት በአማካኝ ----------ሜትር --------ኪ/ሜ ነዉ።።

9. ያለዎት አጠቃላይ የእርሻ መሬት ተዳፋትነቱ ምን ይመስላል? 1. ሜዳማ/ለጥ ያለ ቦታ/ 2. ትንሽ ተዳፋትነት ያለዉ 3. ተዳፋት ነዉ/ ተራራማ/ 4. በጣም ተዳፋት/ተራራ/ ነዉ

2.2. የእንስሳት ሃብት መረጃ

1. የእርስዎ እንስሳት ሀብት አለዎት? አለኝ =1 የለኝም= 0 መልስዎ አለኝ ከሆነ እባክዎን በሰንጠረዥ የተዘረዘሩ የእንስሳት አይነትና መጠን በመጠይቁ መሰረት መረጃ ይስጡን

የእንስሳት አይነት	በሬ	የአካባቢ ዝርያ ላም	የተሸሻለ ዝርያ ላም	ጊደር	ወይፈን	ጥጃ	በግ	ፍየል	ደሮ	በንብ የተሞላ ቀፎ	አህያ	ፈረስ	በቅሎ
መጠን በቁጥር													
በወቅታዊ ገበያ የሚኖረዉ ዋጋ													

Part III: የተለያዩ አገልግሎቶች ተደራሽነት

3.1. የገበያ ተደራሽነት

1. የአካባቢ ገበያ ዋጋ መረጃ በወቅቱ ያገኛሉ? አዎ =1 አላገኝም= 0

መልስዎ መረጃ አገኛለሁ ከሆነ መረጃዉን ከየት ያገኛሉ 1. ከቀበሌ ግብርና ባለሙያ 2. ከንግድ ባለሙያዎች 3. ከመገናኛ ብዙሃን/ሬድዮ፤ ቴሌቭዥን/ 4. ከገ/ህብረት ስራ ባለሙያዎች 5. ከሌላ ከሆነ ይገለጽ----------

2. የመኖሪያ ቤትዎ በአካባቢዎ ከሚገኝ ዋና ገበያ ያለዉ ርቀት ስንት ሰዓት ይወስዳል? ----- ሰዓት

3. የመኖሪያ ቤትዎ አመቱን ሙሉ አገልግሎት ከሚሰጥ ዋና መንገድ ያለዉ ርቀት ስንት ሰዓት ይሆናል? ----------ሰዓት

4. የመኖሪያ ቤትዎ በቅርብ ከሚገኝ ከተማ ያለዉ ርቀት ስንት ሰዓት ይሆናል? --------ሰዓት

3.2. የብድርና ቁጠባ ተደራሽነት

1. መደበኛ ቁጠባ አለዎት? አለኝ =1 የለኝም= 0 መልስዎ እቆጥባለሁ ከሆነ ገንዘብዎን የሚቆጥቡበት ቦታ የት ነው? 1. ባንክ 2. የቁጠባ እና የብድር አገልግሎት ማህበራት 3. አብቁተ 4. እቁብ 5. ሌላ ቦታ ከሆነ ይገለጽ----------

2. በባለፈው ወር ውስጥ ምን ያህል ብር ቆጥበዋል?(ምላሽ ሰጭ ብቻ) _____ ብር

3. ባለፉት 12 ወራት ውስጥ ከማንኛውም አበዳሪ አካል ብድር ወስደዋል? አወ = 1 የለም = 0

መልስዎ አወ ከሆነ ስንት ጊዜ ተበድረዋል? ..... ጊዜ እና አጠቃላ የተበደሩት የብር መጠን ---- ብር

የተበደሩትን ብር ለምን ተግባር አዋሉት? 1.ለግዳት ግዥ 2. ለፍጆታ 3. ለቤት ግንባታ/መስሪያ 4. ለጤና እንክብካቤ 5.ለተለያዩ በዓላት ማክበሪያ 6. ለእንስሳት ግዥ 7. ሌሎች (ይግለጹ) ----------

3.3. የተፋሰስ ልማት አገልግሎት

1. በተፋሰስ ልማት መሳተፍ ከጀመሩ ስንት ዓመት ሁኖዎታል 1= 5 ዓመት 2= 8 ዓመት, 3=10 ዓመት እና በላይ

2. ከተፋሰስ ልማቱ ምን ምን ጥቅም አገኙ? 1. የሰብል ምርትና ምርታማነት ጨምሯል 2. ስነ-ምህዳሩ /የአየር ንብረቱ/ ተስተካክሏል 3. የምንጠቀመዉ ዉሃ መጠን ጨምሯል /የመጠጥ፤ የመስኖ/ 4. በቂ የእንስሳት መኖ ማግኘት ተችሏል 5. ከእንስሳት የሚገኘዉ ጥቅም ጨምሯል 6. ተጨማሪ መሬት በመስኖ ማልምት ተችሏል 7. ሌላ ካለ ይገለጽ-------

3. ስለ ተፋሰስ ልማት የቀበሌ ግብርና ባለሙያዎች ሙያዊ ድጋፍ ያደርጉልወታል? አ=1 የለም=0

መልስዎ ድጋፍ ያደርጉልኛል ከሆነ በምን ያህል ድግግሞሽ ነዉ ድጋፉን የሚያደርጉት 1. በሳምንት 2. በወር 3. በአመት 4. በየቀኑ 5. እንዳስፈላጊነቱ 6 ሌላ ካለ ይገለጽ----------

4. በተፋሰስሱ ዉስጥ ከእርሻ ስራ በተጨማሪ ሌላ የገቢ ማስገኛ ስራ ይሰራሉ? አወ=1 አልሰራም= 0

መልስዎ አወ እሰራለሁ ከሆነ ምን የገቢ ማስገኛ ስራ ነዉ የሚሰሩት ይግለጹ .....

5. የተፋሰስ ልማት ስራ ከጀመሩ በኋላ ስለ ገቢ ማስገኛ ስራ የአቅም ማጎልበቻ ስልጠና ወስደዉ ያዉቃሉ? አወ = 1 አልወሰድሁም = 0

መልስዎ አወ ስልጠና ወስጃለሁ ከሆነ በምን ርእስ 1. በሰብል አመራርት 2. በእንስሳት እርባታ 3. ችግኝ አዘገጃጀት 4. ደን ልማትና ችግኝ ተከላ 5. በቴክኖሎጅ አጠቃቀም ዙሪያ 6. በአትክልትና ፍራፍሬ ልማት 7. ከግብርና ስራ ጋር ተጨማሪ ተግባራት 8. ከግብርና ስራ ዉጭ ሌላ ተግባርት 9. ሌላ ካለ ይገለጽ----------

6. ምርትና ምርታማነትን ለማሳደግ የግብርና ግብአት ተጠቅመዉ ያዉቃሉ? ተጠቅሚያለሁ = 1 አልተጠቀምሁም = 0

መልስዎ ተጠቅሚያለሁ ከሆነ 1. የአፈር ማዳበሪያ 2. ምርጥ ዘር 3. ኬሚካል 4. የእርሻ ቴክኖሎጂ 5. ሌላ ካለ ይገለጽ---------

3.4. የመሰረታዊ አገልግሎት ተደራሽነት

1. በቤትዎ ዉስጥ ምግብ ማብሰያ የሚጠቀሙት በምን ነዉ 1. በእንጨት 2. በክሰል 3. በባዮጋዝ 4 በሶላር 5. በኤሌክትሪክ 6. ሌላ ካለ ይገለጽ----------

2. የመጠጥ ዉሃ የሚያገኙ ከምን ነዉ? 1. ከወንዝ 2. ከኩሬ 3. ከጉድጓድ ዉሃ 4. ከጎለበቱ ምንጮች 5. ሌሎች ካሉ ይጠቀሱ ----------

3. በአመት ዉስጥ የዉሃ እጥረት ገጥሞዎት ያዉቃል? አወ = 1 የለም = 0

4. በአካባዎ የእንስሳት ጤና አገልግሎት ይሰጣል? አወ = 1 የለም = 0

መልስዎ ይሰጣል ከሆነ በማን? 1 በመንግስት 2. በግል 3. በተደራጁ አካላት 4. ሌላ ካለ ይገለጽ--

5. የእርሻ ቴክኖሎጂ አቅርቦት አለ? አለ = 1 የለም = 0

መልስዎ አለ ከሆነ በማን ይቀርባል 1 በመንግስት 2. በግል 3. በተደራጁ አካላት 4. መንግስታዊ ባልሆኑ ድርጅቶች 5. ሌላ ካለ ይገለጽ---------

ክፍል IV: የተፋሰስ ልማት ተነሳሽነት ግንዛቤ ደረጃ እና የሚከናወኑ ተግባራት

1. በሚኖሩበት አካባቢ የተፋሰስ ልማት ስራ እቅድ እንደሚተገበር ያዉቃሉ? አወ= 1 አላዉቅም= 0

መልስዎ አወ ከሆነ የሚያስተባብረዉ አካል ማነዉ? 1. መንግስት ብቻ 2. መንግስታዊና መንግስታዊ ያልሆኑ ድርጅቶች 3. የተለያዩ ተቋማት ተቀናጅተዉ 4. በማህበረሰብ ተሳትፎ 5. ሌላ ካለ ይገለጽ---

2. በአካባቢዎ የተፋሰስ ተቋም ተመስርቷል/ተቋቁሟል? አወ = 1 አልተቋቋመም = 0

መልስዎ ተቋቁሟል ከሆነ የተቋሙ አባል ነዎት? አወ = 1 አይደለሁም = 0

የተቋሙ አባል ነኝ ካሉ ሃላፊነትዎና ሚናዎ ምን ነዉ? 1. የተፋሰሱ ባለስልጣን አባል 2, ተጠቃሚ አባል 3. ሌላ ንኡስ ኮሚቴ አባል 4. ሌላ ከሆነ ይገለጽ---------

3. ማንኛውንም የተፋሰስ ልማት ተግባራት ተግባራዊ አድርገዋል? አወ=1 አላደረግሁም =0

መልስዎ አወ ከሆነ በተፋሰስ ልማት ፕሮግራም ዉስጥ የሚያከናዉኗቸዉን ተግባራት ይዘርዝሩ?
1. የአፈርና የውሃ ጥበቃ ተግባራት 2. ከንክኪ ነጻ ማድረግ 3. የደን ልማት 4. የግጦሽ መሬት ልማት 5. የዥረት/ዉሃ አካላት/ ማጎልበት 6. የእንስሳት እርባታ/ዝርያ/ ማሻሻል 7. ሌላ ካለ ይገለጽ
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4. በተፋሰስ ልማት ዉስጥ ተግባራትን ሲያከናዉኑ ያገኙት ማበረታቻ ወይም ልዩ ጥቅም ይኖር? አለ = 1 የለም = 0

መልስዎ አወ ከሆነ ያገኙትን ማበረታቻ/ጥቅም/ ይግለጹልን 1. በጥሬ ገንዘብ ---------- ብር / በዓመት 2. በ ዓይነት ---------- ኪ.ግ -------- ሊትር 3. ሌሎች (ይጥቀሱ) ----------

ክፍል V፡ የቤት ውስጥ ወጪ

1. የምግብ ወጪ (ዋና ዋናዎቹ) በብር

ለምግብ ሰብል(ስንዴ፣ ጤፍ፣ ገብስ፣ በቆሎ...)= ----------፣ ዘይት= ----------፣ አትክልት (ሽንኩርት)= -------, መጠጥ= --------, ቡና= -------, ስኳር= -------, ጨው= ----------ሌሎች --------

2. ምግብ ላልሆነ ወጪ (ዋና ዋናዎቹ) በብር

ለጤና----------, ለትምህርት ----------, የተለያዩ ሥነ ሥርዓቶች/በአላት/ ----------, ለግንባታ----------, የቤት እቃ መግዣ ----------, ለአልባሳት ---------- መሬት ኪራይ ---------- ለግብዓቶች (ማዳበሪያ --------፣ ለተሻሻለ ዘር -------፣ ላይም -------፣ ኬሚካሎች -------- የእርሻ መሣሪያዎች ---- ------) እና ለሌሎች ----------

Part VI. የቤተሰብ የገቢ ምንጭ እና መጠን

1. የተለያዩ የገቢ ምንጮች አሉዎት? አወ = 1 የለኝም = 0, መልስዎ አወ ከሆነ የገቢ ምንጭዎ ምንድን ነው ከዚህም ምንያህል ያገኛሉ፣ እባክዎ በሰንተረዡ ጥያቄ መሰረት መረጃ ይስጡን

ተ.ቁ	የገቢ ምንጭ	መለኪያ	መጠን	ያንዱ ዋጋ በብር	ጠቅላላ ዋጋ	አማካይ ገቢ
	ከእንስሳት ምርት የተገኘ ገቢ					
	በሬ					
	ላም					
	ወይፈን					
	ጊደር					
	ጥጃ					
1	በግ					
	ፍየል					
	ፈረስ					
	በቅሎ					
	አህያ					
	ደሮ					
	በንብ የተሞላ ቀፎ					
	ከእንስሳት ተዋጽኦ የተገኘ ገቢ					
	ወተት					
	ቂቤ					
2	ስጋ					
	ቆዳና ሌጦ					
	እንቁላል					
	ማርና ሰም					

ተ.ቁ	የገቢ ምንጭ	መለኪያ	መጠን	ያንዱ ዋጋ በብር	ጠቅላላ ዋጋ	አማካይ ገቢ
ከመኸር ምርት ተገኘ ገቢ						
3	**ከዓመታዊ ሰብሎች**					
	ስንዴ					
	ገብስ					
	ዳጉሳ					
	በቆሎ					
	ጤፍ					
	የቅባት ሰብሎች					
	አተር					
	ባቄላ					
	አትክልት					
	ሌሎች					
4	**ከቋሚ ተክል**					
	ባህር ዛፍ					
	ጌሾ					
	ዋንዛ					
	የደን ችግኝ					
	ሌሎች					

ተ.ቁ	የገቢ ምንጭ	መለኪያ	መጠን	ያንዱ ዋጋ በብር	ጠቅላላ ዋጋ	አማካይ ገቢ
ከመስኖ ምርት የተገኘ ገቢ						
	ከቡናና ፍራፍሬ					
5	ቡና					
	ማንጎ					
	አቮካዶ					
	አፕል					
	ሙዝ					
	ፓፓያ					
	ኮክ					
	ሎሚ					
	ብርቱካን					
	ሌሎች					
	ከአትክልት					
6	ጎመን					
	ካሮት					
	ቀይስር					
	ቲማቲም					
	ድንች					
	ሽንኩርት					
	ነጭ ሽንኩርት					
	የሰብል ምርት					
	ቅመማ ቅመም					
	ሌሎች					

ተ.ቁ	የገቢ ምንጭ	መለኪያ	መጠን	ያንዱ ዋጋ በብር	ጠቅላላ ዋጋ	አማካይ ገቢ
8	**ከግብርና ስራ በተጓዳኝ የተገኘ ገቢ**					
	አናጢነት					
	ሽምንና ስራ					
	የከሰል ምርት					
	ጥቃቅን ንግድ					
	ዕለታዊ የጉልበት ሥራ					
	የንብ ቀፎ ሥራ					
	የእጅ ሥራዎች					
	የጋሪ ስራ					
	ሌሎች					
7	**ከግብርና ስራ ዉጭ የሆነ ገቢ**					
	ጥቃቅን ንግድ					
	ደመወዝ					
	ሱቅ ስራ					
	ሽምንና ስራ					
	ልብስ ስፌት					
	ሌሎች					
9	የኪራይ ገቢ					
10	የስጦታ ገቢ					
11	የመንግስት ድጋፍ					
12	ከለጋሽ /ድጋፍ ሰጪ ተቋማት ድጋፍ					

Part VII: በተፋሰስ ውስጥ ያሉ የጋራ ሀብት አጠቃቀም

1. በተፋሰሱ ውስጥ ልቅ የግጦሽ ስርአት አለ? አወ = 1 የለም = 0
   መልስዎ የለም ከሆነ ማህበረሰቡ የሚጠቀምባቸዉን የግጦሽ መሬቶች እንዴት ይጠቀማል/ይንከባከባል?

1. አጭዶ በመቀለብ 2. በፈረቃ በማስጋጥ 3. ሙሉ በሙሉ አስሮ በመቀለብ 4. በተወሰነ አስሮ በመቀለብ 5. ሌላ ካለ ይገለጽ----------

2. በተፋሰሱ ውስጥ የመስኖ ውሃ ምንጮች/ወንዞች ካሉ የአስተዳደሩ/አጠቃቀም ዘዴ ምን መስላል?

1. በውሃ ተጠቃሚ ማህበር የሚተዳደር 2. በአካባቢ አስተዳደር (በዉሃ አባት) 3. ሌሎች (ይግለጹ)----------

3. የተፋሰስ ልማት ወቅታዊ ችግሮች/ማነቆዎች ምን ምን ናቸው? (ከአንድ በላይ ተፈፃሚ መልሶችን መምረጥ ይቻላል)

1. ልቅ የግጦሽ ባህል፣ 2. የግንዛቤ እጥረት፣ 3. የህዝብ ብዛት፣ 4. ተገቢ ያልሆነ ጥቅም 5. የእንስሳት አስተዳደር፣ 6. የቴክኖሎጂዎች እጥረት እና የአስተራርስ ዘዴ ችግር፣ 6. የመሬት አጠቃቀም ስርዓት ችግር፣ 7. የመሬት አስተዳደር ፖሊሲዎች አፈጻጸም ችግር 8. የሚመለከተዉ አካልና መንግስት ትኩረት ማነስ 9. ሌሎች (ይግለጹ)----------

4. በአካባቢዎ የተፋሰስ ልማት ሥራዎች ከተተገበሩ በኋላ የተገኙት ዋና ዋና ጥቅሞች እና ለውጦች

1. ስነ-ምህዳሩ ተሻሽሏል 2. የምንጭ/ወንዝ ውሃ ጎልብቷል፣ 3. የአፈር ለምነት ተሻሽሏል፣ 4. የደን ሽፋን ተሻሽሏል፣ 5. የመኖ ምርት ተሸሽሏል 6. ምርትና ምርታማነት ተሻሽሏል ፣ 7. የተጋጋጠና ትቅም የማይሰጥ መሬት ተሸሽሏል/ አገግሟል