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EVALUATION OF SUSTAINABILITY AND MANAGEMENT CHALLENGES OF SMALL SCALE IRRIGATION PROJECT, IN CASE OF AMIBA GARNO IRRIGATION SCHEME

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FACALITY OF CIVIL AND WATER RESOURCE ENGINEERING

HYDRAULICS ENGINEERING

MSc THESIS ON

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By

Bayesh Maru Elfineh

A thesis submitted to the School of Graduate Studies of Bahir Dar Institute of Technology, Bahir Dar University in partial fulfilment of the requirements for the degree of Master of Science in Hydraulic engineering in the Civil and Water Resource Engineering

Advisor: Chalachew Abebe (PhD)

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Bahir Dar University

DECLARATION

This is to certify that the thesis entitled Evaluation of Sustainability And Management Challenges Of Small Scale Irrigation Project, In Case of Amiba Garno Irrigation Scheme, Central Gondar Zone, Ethiopia, is submitted in partial fulfillment of the requirement for degree of Master of science in Hydraulic Engineering in the Faculty of Civil and Water Resource Engineering ,Bahir Dar Institute of Technology ,is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation has been duly acknowledged.

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LIST OF ABBREVIATIONS

DA	Development Agent
EIA	Environmental Impact Assessment
Eq	Equation
FAO	Food and Agricultural Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GTP	Growth and Transformation Plan
GZAO	Gondar zuria agricultural office
HH	House holds
IFAD	International Food and Agricultural development
m.a.s.l	Meter Above Sea Level
MoA	Minister of Agriculture
MoWR	Ministry of Water Resource
ODA	Overseas Development Administration
O and M	Operation and Maintenance
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
SSI	Small Scale Irrigation
WUAs	Water User Associations
WUC	water user committee

ABSTRACT

The development of irrigation systems has long been recognized as an important tool to encourage economic growth and rural development in Ethiopia, as well as a foundation for food security and poverty reduction. Irrigation development receives a lot of attention, but little attention is paid to its sustainability. This study assesses the sustainability of Amiba Garno small scale irrigation scheme, located in Gondar zuriya woreda. This study aims to identify sustainability level of the scheme from socio-cultural, environmental, physical, economical and institutional aspect. To achieve these objectives, structured household survey questionnaires, semi-structured interviews, group discussions, field observations and literature were used. Physical and technical performance indicators, maintenance indicators, stability of the system, environmental protection, productivity of the scheme and institutional management structure were also selected to indicate scheme operation and management practices. Based on the Yes or No answers of the sampled households, sustainability rated scales of each category were calculated. Finally, the average value of all categories was considered the scheme sustainability index. From the data analysis, shortage of irrigation land is the first problem for the farmers. The unequal distribution of irrigation water to their plots is also a major issue. Siltation of the head work and apron damage is also a series issue that needs immediate solution. Generally, the scheme's sustainability index was 1.53, a value approaching unsustainable condition. This is due to poor institutional and management structures and low scheme maintenance. To improve the economic and environmental sustainability of the scheme, institutional support, training of farmers on improved crop production and water management issues, regular supervision and monitoring of scheme activities are essential.

Key Word: - Sustainability, Irrigation, Indicator

1. INTRODUCTION

1.1. Back ground

In Ethiopia, under the prevalent rain-fed agricultural production system, the progressive degradation of the natural resource base, especially in highly vulnerable areas of the highlands together with climate variability have aggravated the incidence of poverty and food insecurity (Bishaw et al., 2013). Agriculture, the mainstay economic sector of Ethiopia, is mainly based on rainfall which is highly variable both spatially and temporally (Suryabhagavan, 2017). In many parts of the country, agricultural development and performance is weak position by occurrence of due to droughts both in frequency and severity. An extended drought in the country can lead to crop failure that aggravates food shortages and poverty (Miyan, 2015). To solve this problem, the Ethiopian government proposed irrigation to minimize the crop failure and drought risks based on the water resources availability (Awulachew & Merrey, 2007).

Irrigation development has been recognized as a key tool to promote economic growth and rural development, and it is considered as a basis for food security and eradicating poverty in Ethiopia (Hagos, 2009). The country has huge land and water resources potential for irrigation development. Awulachew (2010), estimated that total irrigable land potential in the country is 5.3 Mha, including 1.6 Mha through rain water harvesting and ground water potential, while the current reporting of irrigation schemes in the country is about 640,000 ha including small, medium and large schemes (Awulachew, 2019). But due to technical, financial, management and other problems the country hasn't utilized its potential very well up to today. However, there has been concern regarding the development of performance and management of existing irrigation schemes, but the result is not satisfactory (Uysal & Atış, 2010).

Apart from valued efforts by the Government of Ethiopia and other stakeholders improving agricultural water management, some constraints held back the progress, among the challenges the Government policy, institutions and technologies capacity, infrastructure, and market issues can be mentioned (Awulachew, 2019). Overcoming these constraints is critical to achieve sustainable growth and accelerated development of the sector in promising manner (Awulachew, et al.2011). Even though irrigation infrastructure expansion in the country is promising, little effort is being made towards the sustainability of constructed schemes (Elias 2011).

FAO (2013), Defined sustainability as a means of ensuring human well-being without compromising the capacity of the earth’s ecosystems to support life. In addition, this sustainability defined as the well-being of future generations and in particular with incomparable natural resources as opposed to the gratification of present needs (Hoover, 2012). Sustainability of the scheme is ensured through good management and periodical operation and maintenance of the physical structures of the scheme. However, sustainability of the schemes can be measured by using indicators. Indicators are used to measure sustainability and give information for decision making in water resources management (Cai, et al 2001) . An indicator is some number or qualitative that describes the level of actual sustainability in respect of one of the objectives of irrigation to benefit the community over the long run.

Amba Garno irrigation scheme is one the community managed irrigation schemes found in Debisan Tikara Kebele, which is used for irrigation purpose. It has greater discharge for one season irrigation at the proposed point and downstream even if it is diverted on upstream part with limited expansion. When one observes the physical structures and water delivery performance of the scheme, a question on sustainability of scheme is raised. As well known for scheme sustainability the operation and maintenance activities are very important which highly affect the performance of the scheme. The main focused of this thesis is to evaluate the sustainability of the Amiba Garno scheme by using selected sustainability indicators and to identify the management challenges that affect the sustainability of the scheme.

1.2. Statement of the problem

Though Ethiopia has abundance of land and water resources potential for irrigation development, this potential is still untouched .For example, Wassie, (2020)and MOA, (2011) estimated only about 10- 12% of the total potential is currently under production using traditional and modern irrigation schemes while Awulachew, (2010) also estimated the current irrigation coverage in the country is about 0.7 Mha, and the performance of the existing schemes is not well studied. This shows that more attention was given to irrigation development by the government of Ethiopia to use and utilize this vast irrigation potential to overcoming the problem of food insecurity and eradicate poverty (MoWR, 2004).

Lined up with the Federal government policy and strategies, the regional government of Amhara is also giving more emphasis to irrigation development to increase productivity and ensure food security in the region (Awulachew et al., 2005). But even tangible achievements were made in the region for irrigation development the performance is not satisfactory; some of the constructed schemes have totally failed while some are performing below their capacity (Lambisso 2008). Amiba Garno irrigation scheme is among the community managed schemes in the region. The hydraulic performance of this irrigation scheme is becoming poor and the maintenance requirement of the scheme is significant. This is due to weak institutional set up, poor maintenance of conservation structures that cause siltation and damage to the physical structure, absence of equity between tail and head users in water distribution, poor water management, poor irrigation scheduling, lack of proper operation and maintenances that grounds low hydraulic performance of the scheme.

However, many researchers have been done on community managed irrigation scheme; but most of them were focused on performance of physical, technical and socioeconomic evaluation of the scheme. Since sustainability of irrigation system is evaluated from selected indicators and factors affecting the sustained use of this irrigation scheme were neglected in the study area. Therefore, the major focused area of this study was to evaluate sustainability of the scheme from physical, technical, management and institutional, economic, social and environmental aspect and to generate location specific data on sustainability of irrigation scheme.

1.3. Objectives

1.3.1. General objective

The general objective of this study is to evaluate sustainability and identify management challenges of small scale irrigation by using selected sustainability indicators.

1.3.2. specific objectives of the study:

- To identify the scheme management challenges that are threatening sustainability of the scheme;
- To assess the source of conflict and resolution mechanisms by irrigation water users;
- To evaluate the sustainability of the scheme by using selected indicators.

1.4. Research Questions

- What are the management challenges that affect the sustainability of the scheme?
- What are the mechanisms used to solve conflict among the water users?
- What is the sustainability level of the Amiba Garno irrigation scheme by using selected sustainability indicators?

1.5. Significance of the Study

In the development of policies and strategies of the country starting from past few years and currently under Growth and Transformation Plan, the government gives more concentration to sustainable development. Sustainability is simply an idea about what is going to be happen in the future by using past data as point of reference and observation of what is happening in the present. With this as input, the outcome of this study will contribute to improve the information gaps between institutions and WUAs regarding the performance and the management practices to ensure sustainability and the major problems of sustainable irrigation management.

Therefore, the outcome of this study may make a bit difference to serve as a source of additional information for use by policy makers, irrigators, WUAs, planners and by local community to know the sustainable level of the scheme during the planning of irrigation scheme management plan to ensure sustainable scheme.

1.6. Scope of the Study

The study was conducted on Amiba Garno community managed irrigation scheme intended to evaluate the sustainability level of the scheme by focusing on selected sustainability indicators such as physical performance indicator, technical performance indicator, stability of the system, institutional structure and management system, maintenance indicator, productivity and profitability of the scheme, environmental protection indicator. The study finally makes evaluation of the sustainability level and analysis of the challenges related to irrigation system that affect the sustainability of scheme and recommends the remedial measures investigate the sustainability.

2. LITERATURE REVIEW

2.1. History of Irrigation development in Ethiopia

2.1.1. Land and water resources

Ethiopia contains 112 million hectares (Mha) of land. The potential cultivable land area estimates vary between 30 to 70 Mha(Awulachew, 2019). Form this potential currently the existing cultivated or irrigated area, is estimated to be about 4 to 5 percent, with existing equipped irrigation schemes covering about 640,000 hectares (Awulachew 2010).

Ethiopia has also 12 river basins with an annual runoff volume of 122 billion m^3 of water and an estimated 2.6 - 6.5 billion m^3 of ground water potential, which makes an average of 1575 m^3 of physically available water per person per year (Awulachew, et al. 2007). However, due to lack of water storage infrastructure and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year (Cosgrove & Loucks, 2015).

2.1.2. Irrigation development

Irrigation is practiced in Ethiopia since ancient times producing subsistence food crops (Kassie, 2020). However, modern irrigation systems were started in the 1960s with the objective of producing industrial crops (sugar and cotton) on large-scale farms by private investors in the Awash area (Gebul, 2021).while local farmers had already been practicing traditional irrigation during the dry season using water from river diversions for subsistence crop production (Awulachew 2010). Modern small-scale irrigation development and management started in the 1970s initiated by the Ministry of Agriculture (MoA) in response to major droughts, which caused wide spread crop failures and food insecurity (GURARA, 2017).

The development of irrigation and agricultural water management holds significant potential to improve productivity and reduce vulnerability to climatic instability in any country(Schilling et al., 2020). Although Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation (Yosef & Asmamaw, 2015). The majority of rural residents in Ethiopia are among the poorest in the country, with limited access to agricultural technology, limited possibilities to diversify agricultural production given underdeveloped rural infrastructure, and little access to agricultural markets and to technological innovations (Salami et al., 2010). These issues, combined with increasing degradation of the natural resource base, especially in the highlands, aggravate the incidence of poverty and food insecurity in rural areas (Stephens et al., 2012). Improved water management for agriculture has many potential benefits in efforts to reduce vulnerability and improve productivity (Awulachew 2010).

The irrigation potential of the country is estimated to be about 3.7 million hectares (Ugalahi et al., 2016). Of the total potential, until now only about 20 to 23% of this potential is put under irrigated agriculture up until now (both traditional and modern irrigation systems). Recent estimates indicate that the total irrigated area under small-scale irrigation in Ethiopia has reached to 853,000 ha during the last implementation period of PASDEP – 2009/10 and the plan set for development of small-scale irrigation is 1850,000 ha, which is planned to be achieved by the end of the five years (Tesfaye et al., 2019).The existing irrigation development in Ethiopia, as compared to the resources potential that the country has, is not significant and the contribution of irrigation sub-sector is not satisfactory (MOA 2011).

2.2. Sustainability and sustainable development

2.2.1. Concept of sustainability

The word sustainability is not new concept started today while is a broad concept and multidimensional. Sustainability is a concept on which social and natural scientists, and philosophers and many scholars from all disciplines have expressed their views from time to time (Meppem & Gill, 1998). Today, however, sustainability is almost always seen in terms of three dimensions: social, economic and environmental (Belete 2006).

2.2.2. Concept of sustainable development

Sustainable development has a broad concept and various definitions have emerged over the past few decades (Barkemeyer et al., 2014). Economic, social and environmental changes are inherent to development. Even as development aims to bring about positive change it can lead to conflict. In the past, the promotion of economic growth as the motor for increased well-being was the main development thrust with little sensitivity to adverse social or environmental impacts (TARAFA, 2020). The need to prevent adverse impacts and to make sure long-term benefits led to the concept of sustainability. This concept becomes vital feature of development if it enhances well-being and greater equity in fulfilling basic needs to meet for present and without undermining future generation's well (FAO ,1995).

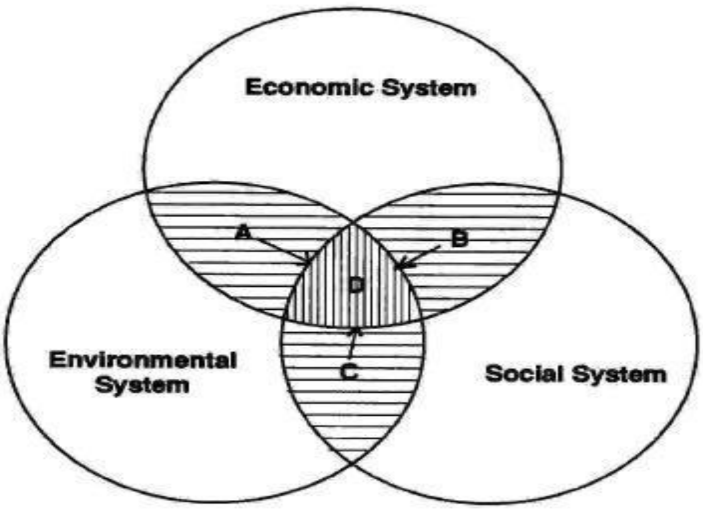

Figure 2-1 the three spheres of sustainability

(Source: Adapted from Barry Dalal-Clayton, (1993), cited on (Elias, 2011)

Sustainable development should be environmentally bearable, socially equitable, and economically viable that expresses sustainability denoted by A, B, C, and D figure above respectively. The sustainable projects aim at contributing to environmentally sound water-management for the control of salinity, water-logging and depth of water-table in agricultural land thus enhancing soil conservation and sustainable land use (www.waterlog.info/articles.htm).

2.3. Sustainability evaluation of irrigation schemes

Spatial and temporal variation of rainfall in the country makes irrigation the best way to enhance food production to ensure food security at national level. However, irrigated agriculture radically changes land use and is a major freshwater consumer and also has impact on the environment (FAO 1995). In addition to large water use and low efficiency, environmental concerns are usually considered the most significant problem of the irrigation sector (Cai, et al. 2001). Accordingly, there may be environmental problems include excessive water depletion, water quality reduction, water logging, and salinization (Scanlon et al, 2007).

In addition, excessive diversion of river water for irrigation has brought environmental and ecological disasters to downstream areas, and groundwater pumping at continuous rates as contributed to the lowering of ground water tables (Luo et al, 2021). So, sustainability of irrigation development is threatened by unfettered surface and groundwater development, lack of watershed and environmental management that aggravates land degradation which negatively affects productivity capacity of the soil (Awulachew, 2010).

A guiding rule for sustainable irrigation water management is to minimize the interference of the irrigation system with the associated environment system. Therefore, the sustainability of irrigation scheme is not only evaluated from its' negative impact on the environment but, also evaluated from physical performance, technical, economic, socio-cultural and the like by using indicators (Burton, 2010).The sustainability index level of an irrigation system is calculated from actual value of one or several parameters that are chosen as indicators of the system goals. The cause of the unsustainable indicators has been occurred due to limitation of the technical, financial, managerial, social, and/or institutional causes (Bos et al., 2007).

2.4. Sustainability Indicators and Methods of Measuring Sustainability

2.4.1. Methods of Measuring Sustainability

Sustainable development has been getting more attention in the past few years worldwide as main agenda. Considerable attention has been paid to align the development targets with environmental consciousness (Organization, 2015).Indicators can provide crucial guidance for decision-making in a variety of ways. They can translate physical and social science knowledge into manageable units of information that facilitate decision-making (Giupponi et al., 2006).

Kellett (2005) and Rogers et al., (2012) ,Revealed that to assess the sustainability of an irrigation system and stated that sustainability indicators must have the following attractive functions:

- ✓ Gauge sustainability of system elements like social, cultural, economic, environmental, and institutional.
- ✓ Gauge sustainability of system attributes, for example groundwater and crops and processes of deep drainage and cultivation that make system elements; and
- ✓ Gauge sustainability at a range of spatial scales (field, catchment, district & scheme) According to (Fanadzo & Ncube, 2018), sustainability of the irrigation scheme is threatened by inadequate access to irrigation water, inadequate knowledge and skills on sustainable agriculture production practices leading to poor crop yield performance and environmental degradation; poor irrigation designs, high debts, poor market environment and inadequate skills in business management. Also, irrigation scheme sustainability is affected by social and environmental constraints. The improvements of the social and environmental constraints to maintain soil fertility, water quality and

reducing land degradation for better productivity are some of the main indicators that ensure sustainability of the irrigation scheme(Khan & Hanjra, 2008).

In addition, (Khan & Hanjra, 2008), Waas , et al (2014)stated sustainability indicators can be powerful decision supporting tools that encourage sustainable development by addressing three sustainability issues and categorized sustainability indicators as Descriptive vs. normative; Quantitative vs. qualitative; Objective vs. subjective; Community vs. expert and Ex-ante vs. ex-post.

On the other hand, Elias (2011) cited on (Thapa et al., 2017) studied sustainability of the Nedhi Gelan Sedi SSI Scheme in Deder woreda, Eastern Oromia in Ethiopia and identified about eight categories of sustainability indicators like Relevance of the project for the farmer, stability, collective action, productivity of the project, efficiency of the project, resilience of the system, equity and protection are chosen.

Similarly Cai, et al. (2001), also categorized sustainability indicators in irrigation water management as water supply reliability, reversibility and vulnerability, environmental system integrity, equity in water sharing and economic acceptability.

While Lebacq, et al. (2012) categorized sustainability indicators of livestock farming into three main categories: Environmental, Economic and Social sustainability, and divided them into various themes, based on sustainability indicators. To measure sustainability of the schemes, many researchers first collect data of individual indicators and then category of indicators is judged and then sustainability index of single value are calculated according to their categories.

A number of studies have used the above systems to study the sustainability of certain systems. For instance, (Delai& Takahashi, 2011) use productivity of the systems, stability, efficiency, durability, compatibility, and equity as categories of sustainable agricultural systems and apply so many direct and indirect indicators that are able to express the categories and then find the sustainability index from the average of the total. According to Talukder et al., (2018), in a study on sustainability of agricultural systems, they used 52 indicators and For the sustainability analysis, all indicators were divided into 14 categories, where each category was supposed to reflect the sustainability of one major part of the farm system and finally the indicators were rated on a scale of 1, 5 and 10, where 10 indicated a sustainable condition, 5 indicated a medium sustainability, and 1 indicated a condition that was not considered sustainable.

2.4.2. Selected categories of sustainability indicators

Indicator selection is an important step in all indicator-based assessments since it influences results and conclusions. The use of a well-defined procedure to select indicators is thus necessary to enhance credibility and acceptability of the evaluation (Ferede et al., 2020). Indicators selection is based on available data since the indicator must be quantifiable. Therefore, the data needed to quantify the indicator must be available or measurable. But for this study the following categories of indicators were selected and categorize.

Technical performance indicators: From technical performance; water conveyance efficiency of main canal is the main indicators selected for the study(Checkol & Alamirew, 2008).

Conveyance efficiency: Significant volume of water is lost by the networks of the conveyance canals due to seepage and evaporation depending on the nature of the soil and afro-climatic zone in which the canals are located. Conveyance efficiency is defined as the ratio of the amount of water delivered at the turnouts of the main irrigation conveyance network to the total amount of water diverted into the irrigation system or simply it is the ratio of outflow rate to inflow rate of a system (Gorantiwar & Smout, 2005).It is one of closely related and commonly used output measures of performance that focus on the physical efficiency of water conveyance by the irrigation system.

According to Leliso (2007), the conveyance efficiency for long unlined canals (>2000 m), have been reported as 60, 70, 80% for sand, loam, and clay soil respectively; for medium length unlined canals (200-2000) as 70, 75, 85% for sand, loam and clay soil respectively; and for short canals (<200 m) as 80, 85 and 90% for sand, loam and clay soil respectively. Losses of irrigation water occur during the transit from the head of a canal up to the farm plot.

Maintenance indicators

Maintenance is the basic activities for scheme sustainability. It enables the keeping of water control infrastructure in good working condition to minimize seepage and sustain canal water level, so that the design water level and water delivery performance are maintained (Farley & Trow, 2003). Where there is proper periodic maintenance, the only losses occur due to elevation differences across structures (water level difference between upstream and downstream of structure) in irrigation canals is the single most important factor disrupting the intended delivery of irrigation water. The maintenance indicators will be evaluated by the following selected hydraulic performance indicators adopted from literature are the relative change of water level and effectiveness of infrastructure (Poulin & Kane, 2021).

The relative change of water level (RCWL):

This indicator indicates the impact of sedimentation and erosion problems on the physical irrigation scheme. If there is a rise or drop of the water surface elevation, which shows that maintenance are being required (Bruijnzeel, 2004). It is ratio of the actual water depth from the canal bottom and comparing it with the design water depth at the same position in the main canal or the change of water depth from the intended level (Canals et al., 2006).

Effectiveness of infrastructure (EI)

The computed values of the ratio (percentage), performance were classified according to Mamuye & Mekonnen (2015) as 'operative', 'nearly operative' and 'inoperative'. The effectiveness of infrastructure shows the extent to which the system manager is able to control water. As the deviation of effectiveness of infrastructure more than 5% would signal the need for repair or rehabilitation of the physical structures (Mekonnen et al., 2022).

Physical Performance indicators

The sustainability of irrigation schemes were evaluated from physical performance. For this study relative irrigation area and beneficiaries target performance indicators were selected.

Relative irrigated area: this term is quantify by ratio of the total area under irrigation versus total designed command areas of already implemented irrigation projects during a particular year or averaged over years of the scheme (Awulachew, 2010), (Mamuye&Mekonnen, 2015)**.** Within the irrigated area, a number of negative impacts (water logging, salinity and water shortage due to competitive use) cause a reduction of the actually irrigated area (Kijne, 2006). A further reduction of the irrigated area is related to population growth and urbanization, road construction, etc.

Beneficiaries target performance*:* This is the ratio of actual number of beneficiaries using irrigation schemes and planned or targeted number of beneficiaries. This is applicable mainly to community-owned schemes (Awulachew, 2010), (Mamuye&Mekonnen, 2015)**.**

The stability of the system

It is a useful indicator for assessing the sustainability of irrigation system and data required will be collected through observation and semi-structured surveys. Soil fertility and productivity of the land, water availability and land scarcity were assessed to check stability of the system in view of sustainability (Corbeels et al., 2000). Checking the operation and functionality of structures in continuity of water supply and ability to deliver intended water from head work and conveyance systems of the scheme, scarcity of resource (land and water) and their continuity were assessed (Fischhendler & Heikkila, 2010).

Institutional structure of management system

Irrigation development and management is a community practice in which different stakeholders work together to make irrigation system effective, efficient and sustained. The main institutional indicator in an irrigation scheme is water user association (Gany et al., 2019). They are formed from the members of water user as its name indicates. Poor performances of government owned and operated irrigation systems have compelled a number of countries to transfer rights and responsibilities for management of irrigation systems from government agencies to private or local persons or organizations.

Productivity and profitability of the scheme

Profitability is one of the primary indicators of agricultural sustainability, the issue being to ensure that agriculture is profitable without negatively affecting the environment, and to recognize that farm profitability might be increased by preventing environmental degradation. Irrigated agriculture must be economically viable in order to be sustainable, ensuring not only adequate profitability for farmers, but also a positive contribution to national/regional income. The purpose of using irrigation plot is to produce cash crops or subsistence crops; production trend is increasing or decreasing, satisfaction level of users about production, income level of users were selected as indicators under this category.

Environmental indicators

Now day environmental issues become high agenda over the world. Climate change, decline of flow (fluctuation of discharge of water), assessment of time dependent variation of adverse effects like water logging, salinity, flooding etc. are important environmental indicators for monitoring a system's physical sustainability. Sustainable irrigation system should balance in the human, social and natural environments where it is located, maintaining and enhancing the health of this environment. Watershed management activities in the study were assessed by observation and survey.

3. MATERIALS AND METHODS

3.1.Description of the study area

3.1.1. Location

Gondar Zuriya woreda is located at 12^{0}7'23"N-12°39'24"N and 37°24'24"E-37°45'43"E and its total area is 1286.76 km^2. Being part of the central Gondar Zone from Amhara Regional State, Gondar Zuriya woreda is bordered on the south by the south Gondar Zone, on the southwest by Lake Tana, to the west by Dembiya, to the north by Lay Armachiho and Gondar town, to the northeast by Wegera. The cities in Gondar zuriya woreda include Degoma, Enfraz, and Maksegnit.

Maksegnit is the capital town of the Gondar Zuriya woreda, which includes 37 kebeles and have 10 perennial rivers. Amiba Garno is a community managed small scale irrigation scheme located in Debisan Tikara kebele of Gondar Zuriya Woreda. It is located at 56 km south of Gondar city and 18km from Makisegnit. The rest 6km is a footpath crossing a number of private farmlands. The head work site is located at351991E and 1359062N with an elevation of 2016m.a.s.l.The altitude indicates that it is in the range of 1995-2804 m.a.s.l, which means that it is in the Tropical Humid agro-ecological zone. Figure3-1 below shows the study area location map.

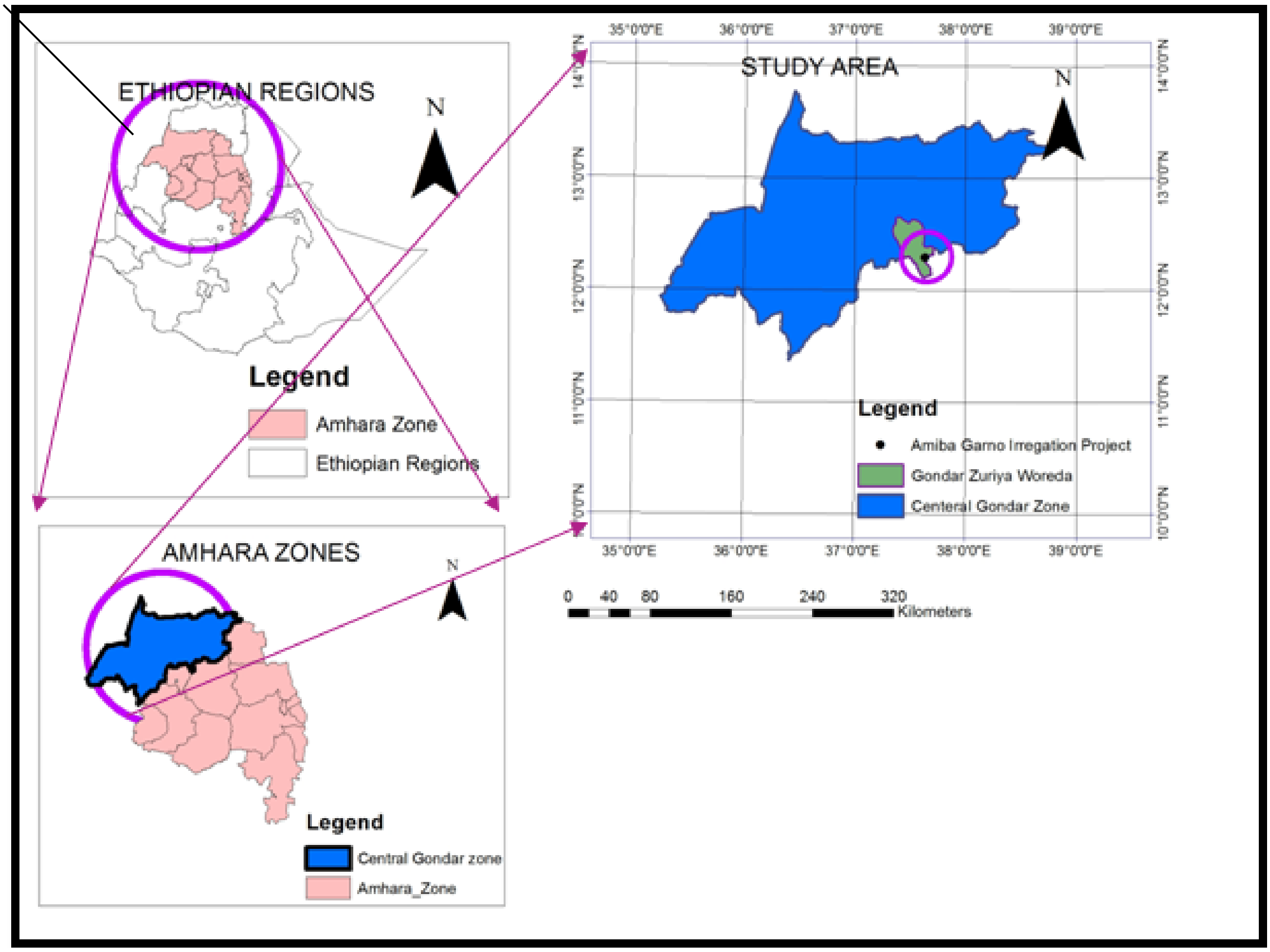

Figure 3-1 Location map of the study area.

3.1.2. Topography and climate

Gondar Zuriya woreda elevation varies from 1507 to 3022 m a.s.l, and falls into two agro-ecological zones. The two agro-ecologies are Weynadega (1500-2300 m a.s.l) and Dega (2300-3200 m a.s.l.). In the woreda, the temperature ranges between 14-20°C, with a mean annual temperature of 17.9°C. Rainfall ranges between 1030-1223 mm with a mean annual rainfall of 1100 mm. Crop covers 56.5% of the area, pasture 14.7%, forests and shrubs 10%, settlements 5.3% and the rest 13.5% is miscellaneous land and(GZWARDO, 2013 annual report).Based on data obtained from the woreda agricultural development office, the woreda almost flat land.

3.1.3. Demography and population

The majorities of the woreda population live in the rural area of the district, where they are dependent on crop production and livestock rearing to sustain their livelihood. The woreda has an estimated total population of 264,920 (of whom 130,796 are males and 134,124 are females). About 10.24% of its population is urban dwellers, which is less than the zone average of 14.1%. The rural area consists of 40,551 households. With an estimated area of 1,286.76 square kilometres, Gondar Zaria woreda has an estimated population density of 205.9 people per square kilometre. This is low compared to the zone average of 60% (GZWARDO, 2005, annual report). The total population in the Amiba Garno small-scale irrigation project command area is estimated to be 5,000.

3.1.4. Land Use and Land Cover

Based on data obtained from the Agricultural Development Office of Gondar Zuriya woreda and the project kebele, the main land use and land cover of the woreda and the kebele includes cultivated land, arable land, rock, shrub and fallow lands, grass land, grazing lands, water bodies, and others (villages or construction areas, waste lands and rock land).

Table 3-1 Land use pattern of the study area

Land use/cover	Hydrological condition	Area (%)	WCN-II	WCN-III
Cultivated	Poor	36.02	84.03	92.86
Grass Land		54.38		
Shrub and Bush Land		8.66		
Forest Land		0.94		
Total		100		

(Source፡ Gondar Zuriya agricultural office)

3.1.5. Water resources and description of the irrigation system

The main drainage basin of the project area is the Lake Tana basin, and the watershed area covers around 26.62 km^2.The designed and current irrigable command area measure 82 ha and 64 ha respectively. According to the design document, the weir height is 2.04 m and the stream length is 10961.39 km. The major surface water resource in the project area is the Amiba Garno River. There are also many perennial streams that join the river system upstream and downstream of the head work site. Amiba Garno River is perennial having base flow of 120 l/s from design document and currently 105 l/s measured by floating method in the dry season. Amiba Garno small scale irrigation project is an upgrading scheme by expanding the existing command area and increasing productivity with the same amount of irrigation water flow which applying in the case of traditional activity. This project is designed to use this water potential effectively and efficiently to increase the income of the farmers living around the area without affecting the water balance. According to the design report, the length of the main canals from the diversion head work to the last project beneficiary users extends about 1.8 Km. The irrigation system conveyance structure consists of 1.2 km of lined canal, 2 flumes, 4 road crossing culverts, 4 vertical drops, 10 turnouts, 3 box culverts, 12 division boxes and other earthen canals was commissioned The diversion weir of the project is shown in Figure 3-2.

Figure 3-2 Amiba Garno irrigation headwork structure

(Source: Photo taken on December 22/2023 during field survey)

3.1.6. Crop production and soil

Permanent intensive cropping is the current farming pattern in the study area, with low technology input and without adequate soil erosion control measures. Crop production is the main stay of the households of the project kebele. Almost all of the cultivable lands of the kebele other than mountainous and other waste lands are under cultivation. It is also starting point for in depth irrigation activities and production for the kebele. Based on the data collected at Gondar Zuria Woreda Agricultural Development Office, the major crops grown in the study area are wheat, teff, onion, garlic and pea. Barley and sunflower are the two minor crops grown in the area. Gondar Zuria woreda agricultural development report indicates that the major soil type of the proposed command area is clay soil.

3.2.Materials

Materials used to conduct this study are listed in the table below.

Table 3-2 materials used for this study

No	Material type	Purpose
2	Stopwatch or clock	To record time
3	Tape meter (50m)	To measure the length of the main canal
4	Handle GPS (Garmin72)	To collect coordinate points and track actual irrigated area
5	Stakes	To fix the measuring place when the floating method used
6	Floating object	Dry leaf (Flow velocity measurement)

3.3. Method of Data Collection

Data were collected for some set of physical structure, institutional, social, environmental and economic aspects under which we feel confident that, the scheme will continue to exist and function, at least for the design period by understanding the past and current situation of the system. In this study, both primary and secondary data were collected using quantitative and qualitative methods. Tools used in this research for primary data collection were the survey using structured questionnaires for the sample HHs, and the semi-structured questionnaires for the FGD and programmed interview.

3.3.1. Primary data collection

Household Survey

To gather primary data, both closed and open-ended questionnaires on the socio-economic, organizational and institutional situation of the users, household assets, activities, income, and demographic information were collected from sample households using structured interview questionnaires. The interview questionnaires were pre-tested among non-sample respondents of similar characteristics and, depending on the results of the pre-test, some modification was made based on hints received. In conducting the interview, four enumerators who know the area and are well familiar with trained before filling questionnaires were taken.

Sample Size and Sampling Procedure

It is difficult to collect data from the entire study area population due to time constraints and limited budgets. Due to this, it is critical to determine sample size and identify sampling techniques. Probability and non-probability sampling methods were used in this study. To sample respondents from the targeted households (HH), systematic sampling was used for HH interviews, while in Focus Group Discussions (FGDs) the stratified method of sampling was utilized for the water user association committees (WUAs), Development Agents (DA) and women users of the irrigation scheme.

The current irrigation water user HH are 85 and 70 were selected for this study. A single population proportion formula and purposive sampling techniques were applied to sample selection.

$$n = \frac{N}{1+N(e^2)} \text{--- Eq. (1)}$$

Where: n = the number of required sample of irrigation scheme (sample size); N = total households of irrigation scheme (population size); e = confidence level (0.05) of precision.

The list of water user members is obtained from WUA. By informal communication with other HHs, the non-user number of all HH beneficiaries is obtained. Stratifying sampling was used for selecting HH head from three equal places depending on the distance of the user's village from the head work that is 25,30 and15 household head was selected from the list of head user, middle user and tail user respectively. For FGD and key informant interview purposive sampling was used

Focus Group Discussion

The focus group discussion was done with representative farmers who are the first during irrigation design and young irrigators having farm plots at the head, middle, and tail. This was done to get all the information about management activities. Specifically, for semi-structured questionnaires six participants were selected, including one water user committee, two traditional water leaders, two women and one youth in the irrigation user's community. The discussion was based on irrigation water sustainability, water diversion mechanism, irrigation schedule, water distribution and challenges faced in all irrigation activities starting from water diversion from main source to field plot and agricultural seed plants.

Key Informants Interview

Key informant interview were conducted with development agents, relevant Woreda irrigation experts and WUA and role model farmers. Conversation was conducted based on all activities of irrigation management. This included water conveyance system, sustainability of the irrigation scheme, the major problems faced and improvement opportunities of the irrigation scheme. In general, the sustainability of the scheme was assessed by combining different stakeholders.

Discharge measurement

Discharge measurement is one of the main activities of data collection. It helps to know the conveyance efficiency. Discharge measurement takes place in main canal using area-velocity method. This was done as it was difficult to use Par shall flume as the canal is too large.

Measuring tape, stakes, stopwatch, and floating object are the materials that are used to measure the discharge.

There are eleven steps as listed below used to measure and compute the discharge. It includes:

Step 1 10m long straight section of the canal section is selected. The shape of the canal along this section is regular;

Step 2: Two stakes are putted, one each side, at the upstream end of the selected portion of the canal. They should be perpendicular to the centerline of the canal;

Step 3: measure10 meter along the canal;

Step 4: Two stakes at the downstream end of the selected section is placed, which are perpendicular to the centerline of the canal;

Step 5: The floating object is placed on the center line of the canal at least 5m upstream of point and begin the stopwatch when the object reaches point where first stakes at the upstream end are placed;

Step 6: Stop the stopwatch when the floating object reaches point of downstream stakes place, and record the time in seconds;

Step 7: Step 5 and 6 is repeated for five times in order to determine the average time necessary for the object to travel from one point to another point. The object should not contact the canal embankment during the trial, but if it does the operation is repeated and the time for the bad trial is not included.

Step 8: The canal cross sectional area and wetted perimeter is calculated.

Step 9: The surface velocity(Vs) is calculated using the equations Vs = L / t, where t is the average travel time in seconds, based on the average of five clear runs of the floating object, and Average velocity (V)= 0.75*Vs , where 0.75 is a constant velocity reduction factor (FAO, 1985).

Step 10: The wetted area of the cross-section A in $m^2$is calculated

Step 11: The total discharge, Q, in the canal, is then obtained as: Q = V * A Where Q in m^3/s

Observation

The other method of collecting primary data was by transect walk and analysis of the situation by observing the functionality of irrigation schemes structures, carrying capacity of the canal (actual), damage, condition of distribution structures, problem of flooding, erosion, siltation of canal, weed growth in the canal and on farm, water logging, salinization, total area proposed, irrigation practices and type of crop grown and other relevant data. Photographs are also taken at selected locations. Grid coordinates are collected using hand GPS (Global Positioning System) to prepare a map of the study area and delineate actual command area under irrigation**.**

3.3.2. Secondary Data collection

Secondary data are collected from different sources like institutions involved in the development of irrigation schemes such as the Bureau of Water Resources Development, Bureau of Agriculture, Regional Meteorological agency, Woreda Office of Agriculture, kebele Administration office, district and zonal irrigation offices, and Rural Development workers. And also, literatures, both published and unpublished, were explored based on the required data. The collected secondary data were related to type of crops cultivated, designed command area, and designed features of the scheme, management structures, and by-laws of water user association.

3.4. Method of Data Analysis

A descriptive analysis method such as frequency, percentage, mean and standard deviation from qualitative, quantitative and personal observation was used to describe the different socio-economic, institutional, environmental, cultural and political aspects of sustainability of the schemes. Qualitative data analysis is prepared during and after data collection. The principal elements of an asset are assessed using a standard questionnaire, requiring a YES or NO response. This is used to see the presence or absence of a defect and analyze socio-economic, institutional, environmental and physical aspects. Then, the Statistical Package for Social Sciences (SPSS) software was used for quantitative data analysis. After all, outputs of the statistical analysis such as the mean, percentage, frequency of occurrence and range were summarized using tables, charts, graphs etc. Then, the sustainability situation under this percentage condition is analyzed. Take the limit of condition index (CI) in Table 3-3 which is the score associated with the element in worst condition. Using Eq. (1), the sustainability rated scale of the selected indicators is calculated. Take the average value of calculated rated scale of indicators to get rated scale of each category. Then, the average of the whole category is calculated to get sustainability index of the scheme.

Data gathered from key informant interviews, group discussions and observations were qualitatively analysed. At the same time, open-ended questionnaires and discussions with different stakeholders and individual responses were summarized. Finally, data from different sources was triangulated to get reliable information. According to these finding, primary field or other data were collected and the data are processed by standard methods and get value of indicators to calculate categories to get sustainability index of the condition under study.

The categories were selected to reflect the conditions of the scheme, socio-economic and environmental, that are thought to promote sustainable irrigation system. In total, 7 categories on the environmental and socio-economic sustainability were used in the study. For the sustainability analysis all categories were elaborated by about 22 individual indicators, where each of them was supposed to reflect the sustainability of one major part of the irrigation systems.

Thus, to gain the above condition, primary data about 22 indicators are collected using survey questionnaires, FGD and Key Informant interviews with the relevant stakeholders and analyzed after inserting the data in to SPSS software. Then, depending on the result of the percentage of the respondents', the researcher find out condition index which shows the status of the selected indicators' goalposts. For the literacy case, it is clear that the goalpost values should be 0 and100 percent respectively. But in this study 50 percent was taken as lowest value of goalposts and maximum value is 100 percent. Then apply Equation 1 to find numerical scale value of sustainability that are rated on a scale of >1, 1-2, 2-3 and 3-4, and 4-5 as indicated in table 1. Where 4-5 show highly sustainable condition, 3-4 show sustainable in most aspect, 2-3 stand for partially sustainability and 1-2 approach unsustainable conditions and >1 indicated a condition that was not considered sustainable.

Sustainability scale= $\frac{\text{Actual value} - \text{minimum value}}{\text{Maximum vaue} - \text{minimum value}} * 5$ --------------------------------------- Eq (1)

Adopted from (Elias, 2011).

Table 3-3 : Condition index (CI), status and scale of sustainability rating

condition index (categories of actual value)	Status	Scale of sustainability rating
81-100	Good –No significant structural deterioration or	3-5

	loss of hydraulic function	
70-80	Fair indicates partial loss of function and /or some risk to the integrity of the structure Action not immediately urgent	2-3
51-69	Poor a serious loss of function and/or some risk to the structural integrity. Action needs to be taken to prevent	1-2
<50	Very poor effective failure/approach to unsustainable	<1

Source: (Adopted from Garry et.al, 2005).

3.4.1. Selected sustainability indicators

Sustainability is a very broad and complicated concept that has been used in many ways and various contexts the last decade and at present time. The use of this research became to study the sustainability of irrigation systems in the case of Amiba Garno from environmental, financial, social, and socio-economic points of view. This was to be done with a systematic approach by using structured qualitative interviews together sustainability indicators primary data from the beneficiaries supported by direct observation and secondary data support.

Researchers and scholars have developed many indicators to evaluate irrigation scheme sustainability and categorize them in to group. But, to study the sustainability of the Amiba Garno community managed irrigation scheme about nine categories of sustainability indicators were chosen. The criteria for selecting these indicators are their effectiveness, relevance, and they are clear and easy to measure and selecting the criteria of addressing the central pillars of sustainability of the scheme i.e. physical, technical and management aspect, economic, socio-cultural and environmental aspect were addressed, and they are described as follows.

Physical performance indicators

A. Relative number of area (RA)

This indicator allowed investigating the change in area actually irrigated against the planned in terms of ratio and give valid reasons for such variation. Thus, the actually irrigated area was estimated by tracking using handle GPS (Garmin 72), whereas planned command area was obtained from the design document of study area. Then, the RA of area was computed using eq 2.Ifthe value of RA of the scheme is equal and/or close to 1.00, it implies that the irrigated area is keeping its design state, similarly, the RA value greater than one indicates that the expansion of cropped (command) area. However, if the RA value less than one, it indicate the irrigated area is reduced compared to the intended; hence rehabilitation or repair requirement of the system is required.

RA = AC/ AD --------- Eq. (2)

Where, RA is the relative number of area, AC is the actual total command area (ha), and AD is the designed command area (ha).

Taking 50 percent the lowest limit and 100 percent the largest limit, the sustainability rated scale is calculated by.

$$\frac{\text{Actual command area} - \text{Minimum}}{\text{Maximum} - \text{Minimum}} * 5$$

B. Beneficiaries target performance (BTP)

The BTP is an indicator in which people discussed their own life situation, identified their problems, and planned for future. This indicator require developers to focus on creating situation and finding out what to do with its inadequacies, planning for collective action to transform whatever is undesirable, acting to change their life and finally identifying failures and successes from action taken so that it transforms the nest plan of action. Beneficiary members are a rich source of knowledge about their community and energy and commitment to that community. Actual participation by community members, including youth is the key for sustainability of project.

If implemented correctly, community participation can be effective for a number of reasons. Communities have different needs, problems, beliefs, practices, assets. Getting community involved in construction and implementation helps ensure that strategies are appropriate for and acceptable to the community and its youth. Community participation promotes shared responsibility by service providers, community members and youth themselves. This indicator can be quantified by Eq. (3)

BTP = AB/ PB---------------Eq. (3)

Where, BTP is the beneficiaries target performance, AB is the actual number of beneficiaries, and PB is the planned number of beneficiaries.

Taking 50 percent the lowest limit and 100 percent the largest limit, the sustainability rated scale is calculated by.

$$\frac{\text{Actual BTP} - \text{Minimum}}{\text{Maximum} - \text{Minimum}} * 5$$

Technical performance indicators

Technical performance indicators estimated through the calculation of conveyance efficiency (EC) of the main canal. For the determination of EC in the main canal, as it is too large for the partial flume, area-velocity method was used. The first canal section considered for discharge measurement had 5 meter length and straight reaches of the canals. Floating material (dried leaf) was put on the upper end of this canal section and the time it took to reach the 5 meter mark was recorded by using stop watch.

Figure 3-3: Measuring canal length and floating material on the upper canal section

(Source: Photo taken on December 22/2023 during field survey)

This test was repeated five times and the average time it took was taken to calculate the discharges. The cross sectional area of the canal was also evaluated by measuring the average depth and width of this same canal section. The average velocity and the rate of flow (discharge) were calculated by dividing the distance (5 m) with the average time, and by multiplying the cross sectional area with the average flow velocity, respectively. Then, using continuity equation ($Q = A \times V$) the discharge of canals was calculated.

Figure 3-4 Measuring canal width and depth on the upper canal section

(Source: Photo taken on December 22/2023 during field survey)

The second measurement was taken starting from the 0+00 m mark downstream from the first test site for a distance of 500m, so that the amount of conveyance loss could be known and the conveyance efficiency is determined. The criterion for choosing the sections for discharge measurement was the availability of lined sections rectangular straight channel shape to measure the flow. The discharge in the canal was determined using area velocity method following the steps described in the above Section. After determining the amount of water delivered by the conveyance system and total inflow into the conveyance system, the EC was calculated using Eq. (4).

$$EC = (Q\ out / Q\ in) * 100 \quad \text{Eq. (4)}$$

Where, Q out is the amount of out flowing water from the canal (l/s) and Qin is the amount of inflowing water (l/s). Loss (LC) is the difference between the amount of water inflow and the amount of water out flow from the canal.

Stability of the system

Stability of the structures, soil fertility, and productivity of the land, water availability and land scarcity were addressed by questionnaires. Then the stability rated scale were calculated by using Eq. (1).

Institutional structure and management system

Sense of ownership, participation of the beneficiaries, management transfer, establishment of legitimate WUA/WUC, capacity to organize and enforce rules, integration of stakeholders, ability of beneficiaries to generate operation and maintenance cost and construct new facility were chosen as an indicators under this category.

Maintenance Indicators:

A. The relative change of water level (RCWL)

The term RCWL provides to estimate the impact of sedimentation and erosion problems on the main canal of the irrigation system. Measurement of water level of the main canal during irrigation season was considered at the head, middle and tail reach of the system. At each reach of the main canal, the actual data were taken at every ten meter distance intervals along the main canal up to the entire length. The actual water surface depth from canal bottom was measured by using staff gauge and measuring tape meter.

If there is up or down of the water surface elevation, which indicates that maintenance are being required. It was computed by taking the actual water depth from the canal bottom and comparing it with the design water depth at the same position in the main canal.

$$RCWL = \frac{\text{change of depth}}{\text{Design or intended depth}}$$ ------------- Eq. (5)

Efficiency of infrastructure (EI)

The evaluation of the effectiveness of infrastructure was focused on the physical structures in irrigation system apparatus. It is the ratio of functional structure to total number of structures primarily installed. Under this parameter, the level of maintenance requirement of the system was evaluated by computing the ratio of actually functional structures and total number of structures initially installed. To determine the affectivity of the infrastructure of the irrigation system, all the infrastructures including diversion weir, head regulator, the drop structures, the division boxes and main canals off take gates (gates closure) which were positioned on the main canal were monitored during the field observations.

EI= (Number of functioning structures) / (Total number of structures) ---------- Eq. (6)

Table 3-4: Effectiveness of infrastructure

No	Name of structure	Installed	Functional	Non-functional	EI (%)
1	Weir	1	1	0	100
2	Flume	2	2	0	100
3	canal regulator gate	1	1	0	100
4	Turn out gate	5	3	2	60
5	Drop structure	4		4	0
6	Division box	12	8	4	67
7	Road crossing culvert	2	2	0	100
8	Division box gate	26	15	11	58
9	under sluice gate	1		1	0
10	Turn out	10	6	4	60
Total		64	38	26	59.38

Productivity and profitability

Productivity of the land whether it is decreasing or increasing, water availability and land scarcity from time to time, whether the community generate sufficient income for the household using irrigation, improvement of livelihood of the farmer, intensification of the crop, increasing of annual production after modernization and availability of farm labour in the area were analyzed from the study.

Environmental protection

Strictness of soil erosion, cropping pattern, watershed management and EIA main streaming during planning of the project and current status and change of the environment due to intervention were selected as indicators.

3.5. Flow chart of the thesis

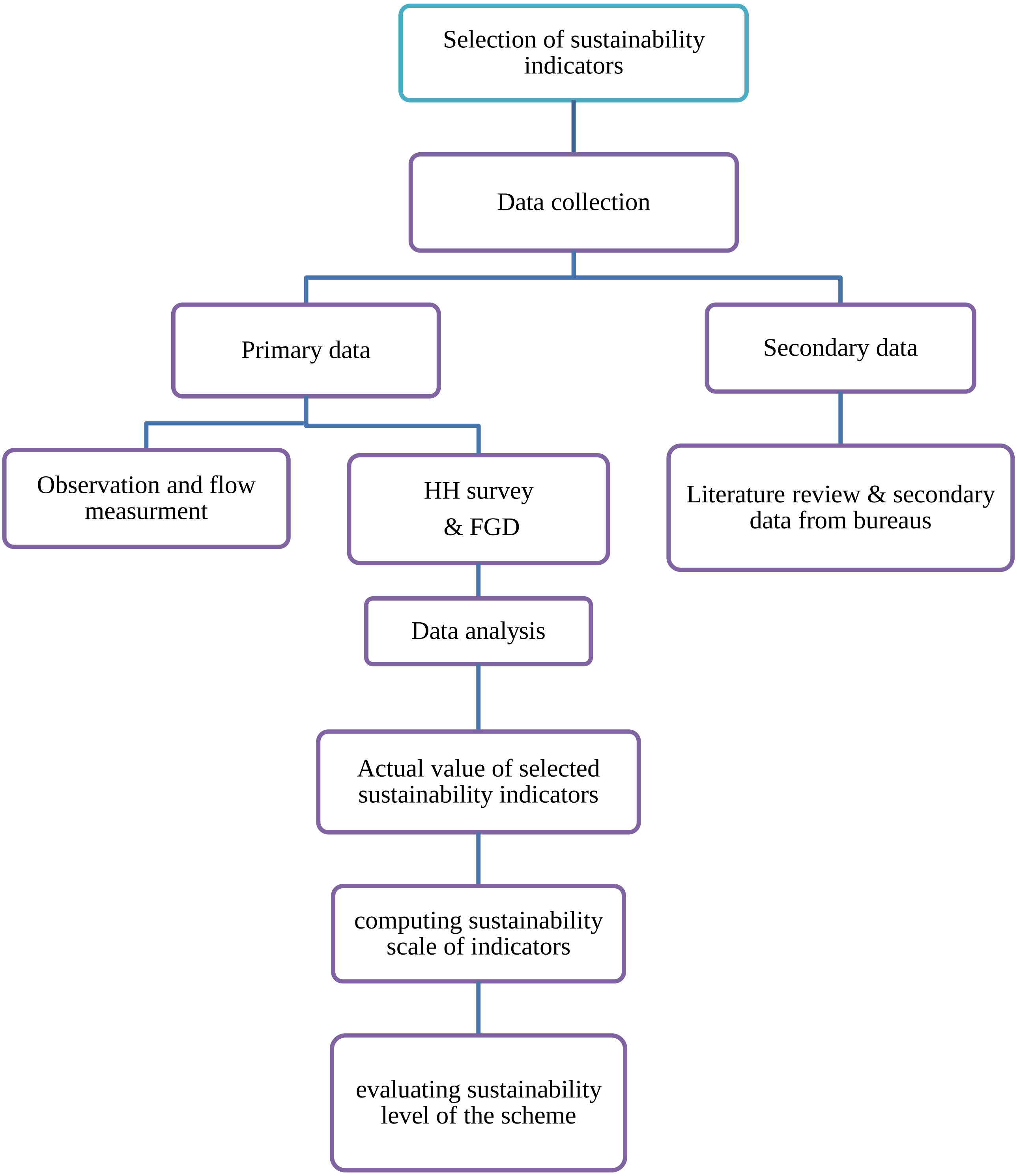

Figure 3-5 Flow chart diagram

4. RESULT AND DISSCUTION

4.1. Household Characteristics

According to Table 4-1; it was found that 54.3 % of the sample HH are 14 and below and only 1.4 % is above 65. By considering sample HH below 14 years are too small for work and those above 65 years are too old and are not potential contributor of labour for the family, then the number dependency is increase in the areas.

Table 4-1: Age distribution of sample HH

Age distribution	No	Percent
≤14 years	38	54.3
From15-32	27	38.6
From 33-65	4	5.7
>65	1	1.4

(Source: HH survey December 2015 E.C)

From the survey data, 85.7 percent of sampled HH are male headed and 14.3 percent are female headed household. Here female headed households are supported by their adult's son, relatives, and or by their neighbours in the process of crop production. The average family size of the sample household is 6.

Table 4-2: General Demographic status of the sample HH

Demographic characteristics		Frequency	Percentage
Sex	Male	60	85.7
	Female	10	14.3
Marital status	Married	57	81.4
	Single	3	4.3
	Divorced	1	1.4
	Widowed	9	12.9
Religion	Christian	61	87.1
	Muslim	9	12.9
Ethnic	Amhara	70	100.0
Education	Primary school	16	22.9
	Secondary school	1	1.4
	Special Skill training	2	2.9
	Read and write	19	27.1
	Illiterates	32	45.7
Average Family size		6	

Source: HH Survey December 2015 E.C

Regarding the soil fertility of the irrigation farm, 71.4% of the respondents say good, 18.6% very good and 0.1% bad which shows the soil fertility of the land is good since the farmers also use mulching and traditional way of improving the fertility of the soil. Here, 100% of the respondents use labour force to carry out farming activities. The perceptions of the household on the land holding size are 35.7% very small, 42.9% small and 21.4% sufficient. This confirms the scarcity of land in the area.

4.2. Sustainability of Amiba Garno SSI Scheme

The categories were chosen to reflect the conditions of the scheme, socio-economic and environmental, those are thought to support sustainable irrigation system. In total, 7 categories for sustainability were used in the study. For the sustainability analysis all categories were detailed by 22 individual indicators, where each of them was supposed to reflect the sustainability of one major part of the irrigation systems.

Technical performance indicator, physical performance indicator, stability of the system, maintenance indicator, Institutional structure and management system, environmental protection indicators and productivity and profitability of the system were Categories.

4.2.1. Technical Performance Indicator

The conveyance efficiencies under normal flow conditions were calculated using Equation 4. Therefore the conveyance efficiency of the canal is 88% for the lined main canals at the head (LMCH) and 63%for the unlined main canal at tail. This result is somewhat lower than the value of conveyance efficiency suggested for unlined canals, which was 70% (MOAFS, 2002). Here there is no secondary and territory canals developed by the project and measurement was taken only from main canals .The average conveyance efficiency during water delivery from main canal to field plot was 75.55%.The efficiency of lined canals has been reported in the order of 95% for all canal length. With this respect, 88% for lined canal are lower than 95%. But in this case there are no any secondary and tertiary canals systems, so that much amount of water were lost due to most of canals are unlined, growing of grasses and weeds be there in the canal during the site observation.

Figure 4-1 Growing of grasses and weeds on the canal

(Source: Photo taken on December 22/2023 during field survey)

The reasons of these losses in the main canal also mainly the sedimentation problem and seepage be there in the canal during the site observation. Another reason is unauthorized water turn out by the farmers into their farm. Theft of water and illegal water abstractions, and the peoples who lived around the main canal used canal water for domestic purpose; for washing their body, for drinking animals, clothes and used the river for water supply purpose as indicated figure below

Figure 4-2 Seepage loss on the main canal

(Source: Photo taken on December 22/2023 during field survey)

Figure 4-3 Unauthorized water turns out by farmers

(Source: Photo taken on December 22/2023 during field survey)

In general, to have sustainable irrigation scheme all the required resources for irrigation should be used in a way that is not wasteful, but maximizes output per unit input especially water.

Table 4-3 : Conveyance Efficiency of lined and unlined main canal.

canal section	Average depth(m)	Width (m)	Length (m)	Time elapsed (sec)	Area (m^2)	Average Velocity (m/sec)	Discharge (m^3/sec)	Ec (%)
ULMC	0.13	0.36	50	77	0.0468	0.4870	0.022792	88
LLMC	0.12	0.4	50	90	0.048	0.4167	0.020000	
UUMC	0.11	0.6	55	160	0.066	0.2578	0.017016	63
LUMC	0.1	0.4	60	167	0.04	0.2695	0.010778	

In sum, taking 70 percent for minimum value and 95 percent maximum value for medium (200-2000 meters) canal, sustainability rated scale for conveyance efficiency of the project is shown in Table 4-4.

Table 4-4: Conveyance efficiency sustainability rated scale value

Category	Indicators	Actual value of indicators in percent	Sustainability rated scale	Remark
Technical performance of the scheme	Conveyance Efficiency	75.5	1.11	Move towards unsustainable condition

According to table 3-3, scale of sustainability rate 1-2, the status is poor and there is some risk to the structural integrity. The current state of the scheme was shown under this category .In general, from technical performance of the scheme, the research indicates that poor conveyance efficiency was observed.

4.2.2. Physical performance indicators:

A. Relative number of area

Based on the design document, the proposed command area that a scheme could potentially irrigate is about 82ha.However, the actual irrigated area in a cropping season is 64 ha. Hence, the relative number of irrigation area is found to be 78% using equation 2. This indicates that the actual irrigated area in a cropping season was remains 78% of the design/ intended command area. According to table 1 the current state of the scheme was shown under 70-80 category.

Therefore, irrigated area of the scheme was reduced by 22% compared with the planned. These were happening due to, natural drainage, and water shortage and soil fertility degradation. In the irrigation schemes' flooding were happen and damages the farmer's field by loading stones on the field and affects the soil fertility. The flood erodes the fertile soil of the field and also it causes valleys that are not important for irrigation. This leads to reduction of irrigation area. Taking 50 percent the lowest limit and 100 percent the largest limit, the sustainability rated scale becomes 2.8 this result laid between 2-3 and the status is fair, indicates action is not immediately urgent.

Beneficiaries target performance

Actual number of beneficiaries of Amiba Garno irrigation scheme is 70. According to FGD information the number of beneficiaries decrease from planned number of beneficiaries due to different reasons; by sell their cultivate land those migrate from rural to urban, conflict from upstream user, and move outside of the country. Generally the actual beneficiaries target performance is 82.4% and the sustainability rated scale evaluated by Taking 50 percent the lowest limit and 100 percent the largest limit is 3.24. There for the beneficiaries target performance was under good sustainable conditions. Then the physical performance indicator is 3.02 then under sustainable condition but strengthening activities still lack.

4.2.3. Stability of the Scheme

Under this category, natural resources (water and land) were investigated with indicators like soil fertility, productivity of the land and water availability that indicate stability of the systems to ensure sustainability of the system. According to Garry et.al. (2005), for the literacy case, it is obvious that the goalpost values should be 0 and 100 percent respectively.

But in this study 50 percent was taken as lowest value of goalposts and maximum value is 100 percent. Then Taking 50 percent the lowest limit and 100 percent the largest limit stability rated scale were shown in Table 4-5.the remark status is given based on table 3-3.

Table 4-5: Rated scale of stability of the system

Indicator	Variables	Actual value Condition Index percent	Rated scale	Remark
Stability of the systems	A) soil fertility	71.4%	2.14	Fair (HHs Survey)
	B)productivity of the land	84.3%	3.43	Good(HHs Survey)
	C)water availability	62.8 %	1.43	Unfunctionality and poor water resource Management problem influence it (HHs survey)
Average rated scale of stability			2.333	

(Source: Field data, December, 2015 E.C)

From Table 4-5, the stability average rated scale value shows the condition of stability of the scheme According to Garry et.al(2005), scale of sustainability rate 2-3, fair- indicates partial loss of function and some risk to the reliability of the structure. Action not immediately urgent.

4.2.4. Productivity and profitability of the scheme

Farmers in rain-fed areas extremely concerned with the capture and effective utilization of limited rainfall. Where an additional supply is available as in supplementary irrigation, as in the case of Amiba Garno, it is important to maximize their income from this small amount of additional irrigation.

The land does not respond without the supply of fertilizer and due to these farmers doesn't intense additional crop in the area in now there are shift of practice by augmenting application of fertilizer with compost and manure.

Taking 50 percent the lowest limit and 100 percent the largest limit, productivity rated scales were shown in Table 4-6. According to table 3-3 the sustainable condition is very good but strengthening activities still lack.

Table 4-6: Productivity of the scheme

Category	Productivity Indicator	Actual value of Respondents answers in percent	Rated scale	Remark
Productivity	a) produce sufficient income for the households	88.5	3.85	Good
	b) upgrading of the living standard of the farmers	84.3	3.43	Good
	c) increase production of dominant crop in the area)	68.5	1.85	Poor
	d) Increasing of annual production after upgrading of the scheme	87.1	3.71	Good
	e) accessibility of farm labor	82.8	3.28	Good
Average		82.24	3.2	

(Source of data: HH survey)

4.2.5. Organizational structure and management system

WUAs are legal bodies which are made-up to have full control over the irrigation infrastructure in their scheme. One of the major parts for a successful and sustainable irrigation management is establishing a strong organization system. Sustainable management of farmers-managed irrigation systems requires well established rules that assurance the interest of all farmers.

Establishment of Legitimate WUA/WUC

The key organization structure in irrigation system is water user association. They are formed from the members of water user as its name indicates. According to Amhara National and Regina State (ANRS) water, irrigation and energy development bureau central Gondar zone water, irrigation and energy department, the election of WUA can be takes place by existing three selective members.

The establishments of legal WUA in the schemes respondents are asked whether they know or not know water organization established in the area. Accordingly, 82.8%of the respondents said “not know any water organization” whereas 17.2% said they know establishment of water use association.

From key informant interview of the kebele development agent said that:

The establishment of water user association was carried out by electing water committee only from one got which is found at the upstream user. Still they tolerate the name of water committee even if the beneficiaries did not accept them.

Key informant interview

Even if the committee with 8 members was established, they lack transparent, accountability, and lack of commitment to users although it is one of the essential factors for good irrigation management.

According to the information from FGD held with elderly traditional water leader, the setup of the WUC in the study area previously initiated for the purpose of fulfilling the criteria set by Amhara National and Regina State (ANRS) water, irrigation and energy development bureau to get post-construction support especially during demonstration period and still these people are actively participate in the leadership in the committee while the down steam users' village did not aware them. From the HH survey, 90% of the respondents decided that they are not the member of the irrigation users' association and only 10% are member of the irrigation user's association. Some of the reasons for being not the member of the irrigation user's association in the survey result shows lack of participatory approach during election period of the committee, lack of confidence in its importance and un-affordability to pay the contribution for the membership.

The committee has no role for scheme maintenance except canal cleaning. Thus, the committee must be accountable and transparent for all villages of beneficiary, have finances and must have clear objective. Sustainable management of farmers-managed irrigation systems requires healthy established rules that ensure the interest of all farmers.

Therefore, if the WUC are not practical how you manage the system in previous time and who manage the system now was the question forwarded for the respondents.

Table 4-7: Response of respondents for existing management system

Management system	Frequency	Percent
community alone	1	1.4
WUA	2	3
NGO alone	0	0
GO	3	4
Traditional leader alone	15	21.4

All in teamwork	42	60
GO and Traditional leader	4	5.7
Community, WUA and Traditional leader	3	4
Total	70	100

(Source of data: HH survey, December, 2015 E.C.)

From Table 4-7 the issues of existing WUC are insignificant and the PA administration and the traditional leader play a great role in management of the scheme.

Ability of the beneficiaries for Maintenance condition

Maintenance activities within a village covering small areas are done by the block or team members and coordinated by the Community water association leader. But according to FGD and key informant interview, the most important maintenance tasks are to remove silts two times per year from the canals only on behalf of their villages. But the beneficiaries do not cooperate and even shows willingness to maintain destroyed part of the scheme structure like weir, flume and part of stolen and abandoned turn out structures. It is possible to say that there is no maintenance of the irrigation infrastructure. The Community water association leader is responsible for the mobilization of resources required for maintenance activities and for the scheduling of maintenance of the main canal only for removing the silt, compacting internal canal part to minimize the seepage and removing weeds that minimize canal carrying capacity and retard the speed of water. Out of the 70 HHs selected for interviews 4.3% of them are women headed HHs from which12.9% of them are widowed and 81.4% of them with their husband. Under the participation of the community, women participation plays a great task to ensure sustainability of the systems. According to survey result 91.4% of the respondents believe that there was no women participation in irrigation activities before the project and after project too. Focus Group Discussion indicated that women headed household who are single, widowed and owning agricultural land are parts of their schemes enjoying similar benefits to that of men. Among the seven member of the nominally elected water committee, two of them are women. This was done only to fulfill the criteria. According to the respondents, 70% of the community was not participating during planning, construction and post construction and 30% of the community was participated.

Construction of new facility

Sustainability of irrigation systems also depends largely depend upon the construct new facility after construction of the irrigation structure and the relationships that establish farmers and their organization with external players that is market traders, input providers, extension services, irrigation agencies and with relevant stakeholders.

According to the district agricultural office after construction, demonstration navigator were carried out by IFAD for three consecutive years and intended it was adopted by the beneficiaries. At that moment, IFAD make some correction on irrigation scheduling, but after demonstration stopped, the downstream users force the upstream head user to use previous traditional water right distribution systems. From this demonstration, the scheme users benefits and learn how to cultivate which means to plough in a row, have improved seed and able to produce twice a year. After demonstration take, the result of distribution was not that much satisfactory according to key informant interview from woreda extension expert.

According to respondents' response, 10% of them are the ability and willingness to pay cost for new facility construction and 90% of them haven't ability and willingness to pay cost for new facility construction. In general rank the severity of absence of post construction support was the question forwarded to the sample farmers in the selected study areas. Accordingly, 41.4% said that the post construction support was less, 20% said that it was modest while 38.6% said that post construction support was present.

Sense of ownership

For sustainability of the scheme, one of the important steps in irrigation system design has been farmers' participation in all stages of the project phase. However, the government has been making vast investment in irrigation scheme design and construction without participation of the community in the area. This lead to dependency on the government which decreases farmer's sense of ownership and responsibility for operation and management.

As far as capacity building for the users is concerned, only 14.3% agreed that they are gets training and the rest 85.7% responded that they are not getting trainings regarding irrigation scheme management.

Handing over of irrigation systems to farmers, upon completion of construction, has been a standing procedure in small-scale irrigation development.

Here institutional structure of the scheme was summarized by taking actual value. from sub-topic: Establishment of Legitimate WUA/WUC, Key informant interview from Participant beneficiaries, Ability of the beneficiaries for Maintenance condition based on their capacity, Construction of new facility and Sense of ownership

Assuming 50 percent minimum and 100 percent maximum value of condition index, the rated scale of each indicator was calculated and the result was found in Table 4-8.

Table 4-8: The average value of organizational structure and management system

Indicators	Variable	Condition index	Rated scale	Remark
Organizational structure and management system	a. Ability and willingness to pay costs and make new facility construction	10	-4	90%say no pay
	b. Participation of the beneficiaries	30	-2	Very poor
	c. Establishment of legitimate WUA/WUC	17.2	-3.28	Very poor
	d. capacity building	14.3	-3.58	Very poor
	e. Post construction support	38.6	-1.14	Very poor
	f. Sense of owner ship	85.7	3.57	Good (with their Locality)
Average			-1.07	

From Table 4-8 the average value of Organizational structure and management system is -1.07. The negative value shows the worst case for sustainable of the system. In general, in this research absence of organization structure and management system in water distribution bringing worst condition of sustainability for the systems.

4.2.6. Environmental Sustainability of Amiba Garno SSI project

The area was known by practicing irrigation for a long period of time under traditional method and irrigation has added to increase food production. Similarly, socio-economic difference, social distraction and environmental degradation are among the impact that irrigation brings on the environment. To maximize the positive impact of irrigation and if possible resist or minimize the negative one, mainstreaming the environmental impact assessment in every project that has likely difficult impact on environment is a must. Thus, even if the beginning of SSI project in this area has a number of social and economic benefits which are thought to be the crop of the objectives, investigating the other side is critical and with this respect, information was collected concerning plot fertility, human and animal disease occurrences due to functioning of irrigation schemes in the area and condition of natural disaster and scarcity of natural resource which delay the sustainability of the physical structure facility.

100% of the respondents believe that, farm destruction by flood and sediment accumulation of weir is the major natural factors that reduce the sustainability of irrigation scheme in the area. 92.9% of the respondents said that; land scarcity hold the first rank during ranking scarcity of resource in the irrigation area. The land scarcity problem noted by farmers is the result of population increase 78.6%, irrigation expansion 5.7%, infrastructure expansion 1.4% and flooding problem 20%.Similarly, 91.4% of the respondent said that soil erosion is the environmental problem in the area. The soil erosion observed on farm land caused by irrigation water management problem 55.7%, and flooding from upstream that destruct nearby farm accounts 35.7% of the respondents‟ response. About 81.4% of the respondents said that, the productivity of the land do not decrease where as 18.6% said that the productivity of the land decreased from time to time because without fertilizer there are no any production from our plots. The water logging and salinity problem is not significant since the land is sloppy in nature but next to the river side needs attention as observed through field visits.

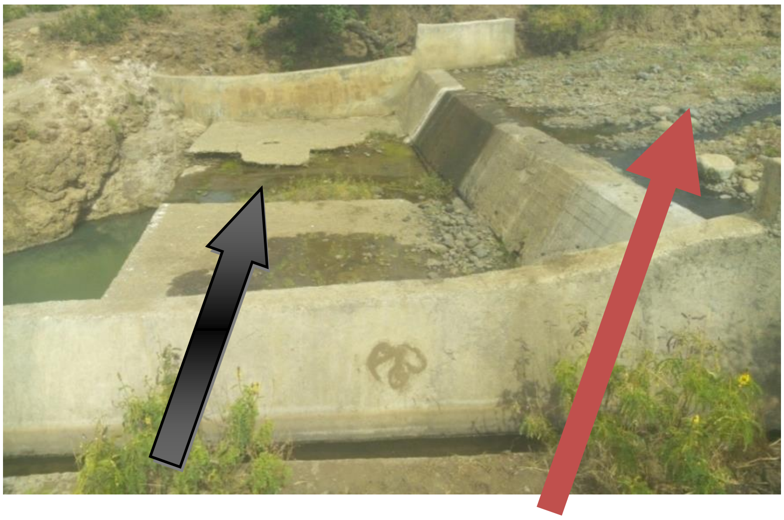

Figure 4-4 Flooding problem on apron structure and sediment accumulation

(Source: Photo from field observation at Amiba Garno SSI December 2015 E.C)

Most of the respondents in the area did not specify an incidence of human or animal diseases after the implementation of the irrigation schemes. Additionally, for crops ‘are there any pest infestations due to irrigation implementation?’ was the question forwarded to the respondents. Accordingly, 94.3% of the respondents said ‘no’ while only 5.7% said ‘yes’ for the above question. Therefore,” what is the reason of crop failure?’ are another question to the respondents.

Thus, 42.9% of the respondents those who said there is crop failure responded that, the reason for crop failure are existence of crop diseases and pests , water shortage due to insufficient of scheme structure and poor cultural practice as a reason. Concerning the stability of water availability, 54.3% of the respondents said that climate change has effect on availability of irrigation water whereas 45.7% of respondents said that they do not know the connection of this thing.

Generally, some of observed problem in the area are flooding, land slide, soil erosion which result land degradation in the area. Population increase is another area, which needs attention for the future in the area. Siltation is the main barrier for the irrigation structure sustainability on the head work diversion while for cross-drainage structures damage by flooding is the main factors. Here, the protective action of the scheme is also considered to study the environmental stability of the project. Similarly taking 50 percent as minimum value and 100 percent as maximum value, protective action to bring environmental sustainability of the project was summarized in Table 4-9.

Table 4-9: Summary of results for protection action rating scale

Indicators	Variable	Condition index	Rated scale	Remark
Environmental Protection for sustainability of the scheme	Absence of soil erosion	20	-3	92 % said yes erosion is severe)
	Cropping pattern for protection of soil fertility	51.4	0.14	(no crop rotation and fallow to protect soil fertility due to land scarcity
	Watershed mgt. And EIA consideration during planning and current practice	0	0	Key informant interview
	Change in environment due to intervention	92.8	4.28	(12.9 % said yes)
Average			1.42	

(Source: Field work, 2015 E.C)

From Table 4-9 average value for protection of environmental indicator is 1.42 according to Table 3-3 between1-2. This shows the unsustainable condition of the systems. Therefore, the study shows that due to irrigation structure, there are no environmental changes. But due to lack of protective measure that ensures sustainability of natural resources that affect the project, environmentally the project is in the condition of unsustainable condition.

4.2.7. Maintenance Indicators

The relative change of water level (RCWL)

This parameter is defined by measuring the ratio of change of the water level in the canal to the intended (designed) level as shown above. The design or intended value of the water level (H) when the main canal was 0.46 m. whereas the actual level (height) measured was 0.21 m. This makes change of water depth to be 0.25, the value of relative change of water level to be 54.34 percent. If a value is greater than one it would expected to indicate an erosion problem or overcapacity of a canal resulting from inaccurate dreading or cleaning activity. While, if the value of water surface elevation ratio is less than one, then there is a probability of rising canal bead level due to sedimentation or siltation and weed incidence in a canal (MOGISO, 2020). When the value of water surface elevation ratio is equal to or close to one, this implies that the main canal is keeping of water conveyance and distribution system in good working condition.

Taking 50 percent the lowest limit and 100 percent the largest limit sustainability rated scale 0.434, this value is greater than 0 and less than 1. This indicates that the intended water level in the main canal has not been achieved due to growing of weeds, grasses and sediment accumulation in the canal as observed during on site visit. Hence, less discharge is delivered per unit time there for, maintenance is required.

Efficiency of infrastructure (EI)

Effectiveness of infrastructure was estimated using equation 6. According to the design document, the total number of structures initial installed in the irrigation scheme was 64, however only 38 structures are currently functional. Therefore, the value of effectiveness of infrastructure is found to be 59.38%. This value indicates that more than 40.63% of initially installed structures were non-functional because of scouring, sedimentation, silt accumulation and the physical irrigation infrastructure in this system has decline over time. It was happing due to absence of regular repair of the irrigation system components

Taking 50 percent the lowest limit and 100 percent the largest limit then the sustainability rated scale became 0.938 based on the formula. As the deviation of effectiveness of infrastructure more than 5% would signal the need for repair or rehabilitation of the physical structures (Mekonnen et al., 2022).

In this study the maintenance indicator the average of the two indicators (The relative change of water level and efficiency of infrastructure) which is 0.686.

4.3. Challenges of Amiba Garno SSI and level of impact on sustainability of the system

The major irrigation management challenges are forces which threaten the sustainability of irrigation structure. Identifying these threats should be the solution to various protective actions by managements. Siltation at head work is one trouble and factors that cause system unsustainable. Eventually, it becomes impossible to supply the dependent command area with water. Siltation in the canals is moderate but in some area it needs desilting.

Figure 4-5 Siltation at head work

Source: Photo from field observation at Amiba Garno SSI December 2015 E.C

Regarding for the loss of soil fertility, it is good if the combination of composite and fertilizer application as well as manure application would implemented as reported from key informant to ensure the stability of the productivity of the farm land.

The other problems that are threatened related to water resource availability and agricultural land scarcity such as drought, sedimentation, too small land holdings and farm land inundation due to flooding will be endangered in the future but application of integrated watershed management is the solution to it. As observed during site visit, weed growth in the canals and in the farm is another important physical constraint which decreases efficiency of the canals and productivity of the farm respectively.

Figure 4-6 Weed growth in the canals

(Source: Photo from field observation at Amiba Garno SSI December 2015 E.C)

According to design document, the irrigation water distribution per each irrigation has been directed by community elders who have its own problem to irrigate water stress sensitive crops such as vegetables. Therefore, such problem can be easily solved by establishment of strong water users committee under improved systems (GZAO, 2010). Absence of establishing representative WUC or strengthening of the existing structure was the main institutional threats of the area.

Key informant of GZAO engineer, Gebru Zemene, there are great problem of integration of stakeholders, overlap of duties and responsibilities and institutional instability. According to him, in development of irrigation due attention was given to construction of physical part only and at this moment, there is no operation and maintenance department as well as no regular monitoring and evaluation trend in the office. Finally, the respondents asked to rank the major challenges that reduce their irrigation development at present. The results are shown in Table 4-10.

Table 4-10: Major factors which decrease irrigation development at present and their rank

Challenges	degree of challenges in percent			Rank
	Less	Modest	Severe	
poor technology choice	14.28	25.71	60	2
lack of market information	5.7	35.7	58.6	3
Very Small land holding	8.58	4.28	87.14	1
lack of training on irrigation technologies	45.7	10	54.3	4
poor infrastructures such as roads, lack of adequate credit service and extension packages	61.4	24.3	10	7
lack of irrigation structure maintenance	21.4	34.3	44.3	5
Water scarcity	60	14.3	25.7	6

The survey result showed that 52.9% of the respondents said that irrigation water use can create conflict, those conflicts are raise due to, scarcity of water, water theft and problem of water management as the main reason for conflict as shown in Table 4-11.Whereas 47.1% of the respondents believe that there is no conflict

Table 4-11: Reason for conflict

Source for conflict	Frequency	Percentage
Scarcity of water	21	30
Illegal abstraction of Water	8	11.4
Lack of enforcement of by low(Problem of water management)	35	50
Unequal maintenance contribution	6	8.6
Total	70	100

4.4. Sustainability level of Amiba Garno SSI

In this study, sustainability of SSI scheme can be defined as, the search for some set of policies and practices under which we will feel confident that the system should continue to exist and to function, at least for time-span of 20-30 years. Here, from policy perspective the researcher only focus on practices on the ground. From technical, physical, socio-culture, environmental and community participation different practice were discussed under each topic as indicated above and understand the condition of each aspect. Now, let us see the level of impact of each condition on sustainability of Amiba Garno scheme.

According to Abernethy (1994), cited by Elias (2011), there seem to be three major ways in which systems may lose sustainability, because they are no longer delivering their benefits, they are not performing the eternal part of the structure as well, they are damaged by different factors, and beneficiaries haven’t responsibility to hard work for urgent activities.

Before categorizing the scheme to the above three criteria, combining of values for individual category are done as follows:

- Stability average rated scale =2.33
- Technical performance average rated scale =1.11
- Physical performance average rated scale =3.02 that means the average of its indicator
- Productivity average rated scale =3.2
- Environmental Protective average rated scale =1.42
- Institutional structure average rated scale=-1.07
- Maintenance indicator average rated scale =0.686 that means the average its indicator

Hence, the sustainability index of Amiba Garno was the average of the above values, and itbecame1.528. According to this value, the scheme is on the verge of becoming unsustainable.

The result indicated that, it is useful to organize an impact study on the irrigation systems that causes unsustainability. Number one factor is the absence of well-organized institutional structure towards the scheme sustainability which resulted mainly from low value of establishment of legitimate WUA, resulting low value of maintenance performance. Similarly, very low value of environmental protective average rated scale, lack of protective means to overcome any threat against the distraction of conveyance system and natural resources of this project.

In this regards, development of Amiba Garno SSI scheme was relevant for the community and also increase their productivity that explained by value between fair and good.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The aim of this research is to study the sustainability of Amiba Garno SSI scheme. To answer the specific question of the study, primary data were collected from sampled households using survey questionnaires. FGD with elderly traditional water leader, water committee, women and youth, direct field observation, measurement and key informant interview also carried out. Secondary data were also collected from design document, literature and published books. More of primary data was used in this study.

The study was done to give an image of the sustainability at scheme level. The spatial scale comprised the farm and scheme and the time scale at least for the time intended during the planning stage of the project that is 20 years and now it was 6 year after construction. The objective was to give level of the sustainability of condition index by concerning selected indicators.

Generally, good productivity and physical performance indicator of the scheme with fair stability is balanced by poor technical performance, poor Institutional structure Poor Maintenance indicator , poor protective action and resilience of the systems which affect the sustainability of the scheme in aggregate.

The results are described using table and charts. Important indicators of sustainability of SSI scheme were selected based on theories of sustainable SSI found in the literature and then primary data for each indicator was collected using survey questionnaires and condition index was set depending on the response of respondents. At the same time, scale rating was assumed for each condition index and goalpost was assumed. Taking the average of each indicators value was the final steps to determine the sustainability index of the systems.

The total length of the main canal of the scheme is 1008m. From this, 858m is concrete lined and 150m is earthen canal. Average conveyance efficiencies were 88% and 63% for lined rectangular and earthen canal, respectively.

Maintenance performance indicators were considered by the parameter of relative change of water level and effectiveness of infrastructure. As a result the maintenance performance of the system was very poor.

Using the qualitative and quantitative information obtained from household interview, key informants, FGD and direct observations, households socio economic characteristics, technical performance, physical performance, stability of the system, institutional structure, maintenance indicator, environmental protection, productivity of the system and challenges and sustainability of the SSI scheme were analyzed and methodically discussed.

In the case of this project, an outcome of lack of equitable resource distribution, which create lack of institutional structure towards the scheme sustainability issues especially for operation and maintenances which damage the stability of the physical performance by minimizing the conveyance efficiency of the scheme coupled with low environmental protective action aggravate the problem and finally systems are no longer to deliver their benefit and the beneficiary are also no longer to give necessary efforts to key activities and sustainability of the system become under question. Then to use the results to point out the parts of the irrigation scheme in which there were shortage in the sustainability, and where the farmers and concerned body could work in order to improve the sustainability.

5.2. RECOMMANDATIONS

The following recommendations are believed to contribute for improving the sustainability of Amiba Garno SSI scheme:

- Bottom-up approach is best for irrigation development treating farmers as owners and not as beneficiaries of the projects. So, farmers should involve throughout the project planning, implementation and evaluation phases.
- Creating representative water user association is fundamental for irrigation scheme sustainability. Hence, water user association of Amiba Garno irrigation scheme has to be strengthened. Effort should also be made to bring all beneficiaries of the irrigation scheme under water user association
- Training in water management, and marketing and general crop production for farmers and extension workers ,Institutional support and regular monitoring and evaluation of irrigation schemes is necessary to provide feedback and information important for the future planning of management of new schemes and maintenance of old schemes.
- Finally, promote research and development activities that indicate standard indicators of sustainability of SSI scheme to assess and monitor the scheme in the light of these indicators.
- Although the success of implementing new irrigation facilities, equal attention should also be given to sustainability of already constructed irrigation schemes.

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Appendix

Table 0-1: Name of selected water committee Amiba Garno SSI scheme

No	Name	Sex	Age	Village (gote)	Year of establishment
1	Mandae Takele	Male	45	AmibaGarno	2011
2	Awoke Mandefro	Male	39	AmibaGarno	2011
3	Misganaw Chekole	Male	41	AmibaGarno	2011
4	Megabiyaw Sisay	Male	33	AmibaGarno	2011
5	Alamirew Kasse	Male	48	AmibaGarno	2011
6	Setegn Mola	Male	40	AmibaGarno	2011
7	Deneblal Kasse	Female	28	AmibaGarno	2011
8	Ageritu Abate	Female	33	AmibaGarno	2011

Questioners for sampled house hold, focus group and key informant

Bahir Dar University Institute of Technology

School of Civil & Water Resource Engineering

School Graduate studies

Hydraulics Engineering Department

A questioner designed for sampled farmers

Dear respondents,

The main objectives of this questionnaire is to identify challenges and level of sustainability in case of Amiba Garno small scale irrigation project in central Gondar zone Gondar zuria woreda, such studies on the community based small scale irrigation are useful to the planers and decision makers to sketch the most suitable irrigation development plans, which are based on food security, farmers needs and priorities.

You are kindly asked to give an answer freely and openly. The questionnaires are abundant for the academic research purpose, any information you present will be kept confidential. Thus, your cooperation is very necessary to achieve the desired goal of the study.

Thank you for your support in advance

Bayesh Maru the survey coordinator

SECTION I

Questionnaires for Beneficiary Households

1. **General information**

1.1. Site of research

Woreda-------------------------

Scheme ------------------------ code ------------

Full name of interviewer ----------------------

Date of interview --------------------------------

1.2. Household Head:

1. Full name ………………………………
2. Sex: 1, male 2, female
3. Age: …………years 1, ≤14 years 2, from15-32 3, from 33-65 4,>65
4. Marital Status: 1, married 2,unmarried 3,divorced 4, Widowed

1.3. Ethnic background: 1, Amhara 2, Other, Specify --------------

1.4. Educational status 1,Reading and writing 2, primary school 3,secondary school 4, special skill training, 5 illiterate

1.5. Religion background1,Christian 2, Islam 3,Catolic 4,Protestant 5,Others(specify)__________

1.6. Family size: How many family members do you have? Male------Female----Total---

1.7. What type of irrigation system you have? 1 .Gravity 2. Pump 3. Both

2. Land resources and operation

2.1. Do you have land for production and other activities?1. Yes 2. No

2.2. If yes, provide the following information: 1. Homestead 2. Irrigation land 3. Private Pasture 4 .Common grazing 5. Other/specify

2.3. For what purpose have you used your irrigation land? 1. Seasonal crop 2. Food crops 3. Grazing land 4. Cash crop 5. Any other specify_______

2.4. What is the soil fertility of land on which you are irrigating?
1. Very good 2. Good 3. Bad 4. Very bad

3. A. Significance of the project

3.1. Did your irrigation land (farm) belong to you? 1. Yes 2.. No

3.2. If no, to whom belongs this irrigation plot/farm? ....

3.3. If you are using irrigation how do you see the size of land holding you have under irrigation? 1. Very small 2. Small 3. Sufficient 4.Large

3.4. What are the main purposes of using irrigation? 1. To generate cash income 2.To produce food for the household 3. Produce livestock feed 4 others (specify__________

3.5. What do you think is the benefit of Amiba Garno irrigation project? (Multiple answer is possible)

- **For human:** For home consumption 2. Market (Income increase) 3. Job opportunity 4.Other, Specify _______________
- **For livestock:** 1. Forage production increase 2. Easy access to water 3. Crop residue for livestock 4.Other; specify_________

3.6. Is this irrigation project significant to you?1. Very much 2. Normal 3. Not that much 4. Completely not

3.7. Is your life changed after you begin to use modern irrigation? 1. Yes 2. No

3.8. If yes what are the indicators?1. Construction of new house 2. Sending children to school 3. Food variety 4.Income increase 5.Constructions of new irrigation facility 6.Other, specify ________________

3 B Community contribution

3.1 Who begin the construction of the scheme in your area? 1. Government 2. NGO 3. Community 4. 1&2 5 1&3 6 All in collaboration

3.2 Has the scheme been constructed full participation of the target beneficiaries? 1) Yes 2) No

3.3 If your answer to Q3.2 is yes at which stage of the intervention process you have participated?1) Preparation 2. Construction 3)Post-Construction 4)1&2 5)2&3 6)1&3 7)in all phases 8)others (specify)

3.4 If your answer to Q3.3 is participated, what is your contributions?1)initiative 2) only free labor 3)IN cash 4)Food for work 5)Cash for work 6) Supply of local materials

3.5 Is there women involvement in irrigation activities before and after scheme upgrading?1) Yes 2) No

3.6 If the answer is yes for Q3.5 how they participated?

3.7 Are the numbers of beneficiary decrease or increase after modernizing the irrigation system? 1 decrease 2 increase

3.8 Is the management system put in place for developed scheme after intervention?

1) Yes 2) No

3.9 I f your answer to Q 3.8 is yes, who manage the system now?1)Community alone 2) WUA alone 3) NGO alone 4) Government alone 5)Traditional leader alone 6) All in Collaboration(multiple answer is possible)

3.10 Is the management body adequately performed its duties and responsibilities?1)Yes 2)No

3.11 If your response to Q3.10 is no what do you think the reason? --------------------

3.12 Do you have sense of owner ship to the developed scheme?1) Yes 2) No

3.13 What do you think should be done by the community to improve the sustainability of the scheme?

4. Productivity of the project

4.1. What seems your production pattern and productivity?

4.2. How many times do you produce in a year? _________

4.3. Do you think that currently the productivity of your land has decreased?

1. Increase 2. Decrease

4.4. If you say decrease to the above question what is/are the main reasons?

1. Ageing of land 2. Loss of nutrients 3 . Little or no use of following

4.5 What is the indicator for you the irrigation system is productive? 1 produce sufficient income for the households 2 upgrading of the living standard of the farmers 3 increase production of dominant crop in the area 4 Increasing of annual production after upgrading of the scheme 5 accessibility of farm labor

5. Technical performance

5.1. Do you think the Irrigation water is enough for the project? 1. Yes 2. No

5.2. Is there water shortage for your plot? 1. Yes 2. No

5.3. If your answer for question No 5.2 is yes why you do think is the reason? (Multiple answer is possible) 1. There is shortage of water in the river 2. The pump capacity is small 3. Water distribution management is poor 4. Water conveyance system is not functioning well

5.4. What is the water conveyance method from source to field? 1. By Gravity method 2. Motor pump by using electric power 3. Motor pump by using engine power 4. Others

5.5. Do you feel you share equal water with every user in the scheme? 1 .Yes 2. No

5.6. If no, what do you think is the reason for the inequality? 1. Ethnicity 2. Gender 3. Political Power 4. Religion; 5. Crop Type; 6. Management problem; 7. Nearness to the main water canal; 8. Land size; 9.Topography of the plot; 10. Others/Specify

5.7. What are the major challenges in water conveyance system of canals? (your answer may more than one) 1. Poor canal leveling and grading 2.Sediment deposition in the canal 3.Lack of willingness of farmers in canal clearance 4. Seepage 5.weed growth in the canal

6. Maintenance indicator

6.1. Who make maintenance of irrigation system? 1. Government 2. Farmers 3. Nongovernmental organization (NGO) 4. Others

6.2. What is the source of water for your scheme? 1. River 2. Dam 3. Lake 4. Ground water

6.3. Which structure frequently of damage is high? Rank them1 .head work 2. Flume 3. Intake gates of main canal 4. Drop structure 5. Road crossing culvert 6. Earthen canal 7 Others/Specify

6.4. Did you still took guidance on operation and maintenance of the structures and canals? 1. Yes 2. No

6.5. If your answer is yes on Q. 6.4 how many times? 1. Once per irrigation season 2. Once per year 3. As required by the community 4. As planned by the Government 6. Other specify _________

7. Environmental indicator

7.1. Which resource you think is short in your area? 1. Water; 2. Agriculture land; 3. Pasture land; 4. Forest; 5. Other specify

7.2. Why you think it is scarce/short1. Population increase 2. Irrigation expansion 3. Infrastructure expansion 4. Expansion of grazing land 5. Overgrazing 6. Fuel wood consumption 7. Other, specify

7.3. From where are you getting water for your utilization? (Multiple answers are possible)1. Rain fall 2. From Amiba Garno River 3. Ground water from your place 4. Any another, specify_____

7.4. What are the primary uses of water? 1. For Agriculture, 2. For Domestic, 3. For Industrial, 4. Other, specify

7.5. Do you think the climate change has an effect on the water availability? 1. Yes 2. No

7.6. How? ____

7.7. Do you think that soil erosion is an environmental problem in the project area? 1. Yes 2. No

7.8. If your answer is yes for the above Q 7.8, why? Because 1. Irrigation water management problem 2. Irrigation system (flooding) 3.Structure problem 4. Type or irrigation (pump/ gravity) 5. Other,

8. Institutional structure and management system

8.1. Is there any water organization in your irrigation area? 1. Yes 2. No

8.2. If yes, what it is? 1. WUA 2. WUC 3. Other, specify __________

8.3. Do your water organization has written bylaw 1. Yes 2. No

8.4. Are you a member water user association 1. Yes 2. No

8.5. How do you see your water organization? 1. Very Strong 2. Strong 3. Medium 4. Very weak 5. Weak

8.6. What are the challenges in WUAs during water coordination? 1. Low communication between WUs 2. Lack of incentives for WUAs 3. Lack of willingness of WUAs4. Lake of transparency and accountability 5.Other

9. **Major Challenges that threat the sustainability of the scheme**

9.1 Major Challenges that threat the sustainability of the irrigation structure

Challenges	degree of the problem: 1=Less, 2=medium,3=Severe
Very Small land holding	
poor technology choice	
lack of market information	
lack of training on irrigation technologies	
poor infrastructures such as roads, lack of adequate credit service and extension packages	

9.2 Do you think the irrigation water use can create conflict? 1. Yes 2.No

9.3 Why do you think is the irrigation water is the source for conflict? Because of1. Scarcity of water 2. Illegal abstraction of Water 3. Lack of enforcement of by law (Problem of water management) 4. Unequal maintenance contribution 5 others

9.4 . Whom do you think create the conflict will be? 1. among the beneficiaries 2. With D/s users 3. With U/S users 4. With 1 & 2 5. With 1& 3 6. With 1, 2 & 3.

II. Question for Focus Group Discussion (FGD) For Women, Traditional Water Leader, WUA, Youth.

Date------------------------

Name of Irrigation Scheme-----------------------------

Interviewer sex-------------------

1. What it look like the overall maintenance of irrigation structure?
2. What is your skill to construct new facility and to improve the existing irrigation facility?
3. What are the major problems in water conveyance system?
4. What are the sources of conflict in relation to irrigation scheme in the area?
5. Do you have traditional structure on how to allocate water resource, maintain the canal and diversion structure and way of penalty, conflict resolution during traditional irrigation system before intervention and what is your contribution to the sustainability or unsustainability of the schemes from your socio-cultural back ground?
6. Does the irrigation scheme create special benefit to women? What is the benefit?
7. What is your experience on the continuity and availability of irrigation water and irrigated agricultural soil fertility?

8. Is there a water users Association for the scheme? What is their responsibility?
9. What is your relation with the Woreda Agriculture Office and the irrigation expert?

III. Questionnaires to Key Informant

Key informant interview for Gondar zuria woreda Water office and Agriculture Office**.**

Organization________________

Name_____________________

Educational status_________________________________

1. What it seems irrigation water management practice of Amiba Garno irrigation scheme?
2. What is the major management problems related to water conveyance?
3. Do you organize all water management activities in good manner? If no why?
4. Have you ever seen conflict between users or WUA in the scheme? How to solve?
5. What type of medication or action you take to solve the problems in water sharing and conveyance system?
6. What are the duties of WUAs? How many member they have?
7. Is there any special support to female headed households using irrigation?
8. Suggest the possible option to sustain the irrigation structure?

THANK YOU VERY MUCH

ለተመረጡ አርሶ አደሮች ፣ የትኩረት ቡድን እና ቁልፍ መረጃ ሰጭ የተዝጋጀ መጠይቅ

የባህር ዳር ዩኒቨርሲቲ ቴክኖሎጂ ኢንስቲትዩት

የሲቪል እና የውሃ ሀብት ምህንድስና

የድህረ ምረቃ ፕሮግራም

የሃይድሮሊክ ምህንድስና ክፍል

ለተመረጡ አርሶ አደሮች የተዘጋጀ መጠይቅ

ውድ ምላሽ ሰጪዎች፣

የዚህ መጠይቅ ዋና አላማ በማዕከላዊ ጎንደር ዞን ጎንደር ዙሪያ ወረዳ የአምባ ጋርኖ አነስተኛ መስኖ ፕሮጀክትን በተመለከተ ተግዳሮቶችን እና የዘላቂነት ደረጃን መለየት ሲሆን በህብረተሰቡ ላይ የተመሰረተ የአነስተኛ መስኖ ልማት ጥናት በጣም ተስማሚ የመስኖ ልማት ዕቅዶች ለመንደፍ ማለትም የምግብ ዋስትና ለማረጋገጥ እና የገበሬዎችን ፍላጎት ለማሟልት የተመሰረተ በመሆኑ ለፕላን አውጪዎች እና ለውሳኔ ሰጪዎች ይጠቅማል።

የእርስዎ ትብብር የሚፈለገውን የጥናት ግብ ለማሳካት በጣም አስፈላጊ ስለሆነና መጠይቆቹ ለአካዳሚክ ምርምር ዓላማ ስለሚዉሉ መልሱን በግልፀኝነትና በታማኝነት እንድትሰጡ በአክብሮት እጠይቃለሁ።

ለምታደርጉት ድጋፍ በቅድሚያ እናመሰግናለን።

ባየሽ ማሩ የዳሰሳ አስተባባሪ

ክፍል I

ለተጠቃሚ አርሶ አደሮች የተዘጋጀ መጠይቅ

- አጠቃላይ መረጃ

1.1.ጥናቱ የተካሄደበት ቦታ

ወረዳ -------------------------

የመስኖ ግንባታው ስም -------------------------

የተጠያቂው ሙሉ ስም ---------------------------------

ቃለ መጠይቁ የተሞላበት ቀን --------------------------------

1.2 የቤተሰብ ኃላፊ;

1. ሙሉ ስም ....
2. ፆታ: 1. ወንድ 2. ሴት
3. ዕድሜ፡ .... 1. ≤14 ዓመት 2. ከ15-32 3. ከ33-65 4. >65
4. የጋብቻ ሁኔታ፡ 1. ያገባ 2. ያላገባ 3. የተፋታ 4. ባል የሞተባት

1.3 የብሄር ሁኔታ ፡ 1. አማራ 2. ሌላ ይግለጹ ------------

1.4 የትምህርት ደረጃ፡ 1. ማንበብና መጻፍ የሚችል 2. የመጀመሪያ ደረጃ ትምህርት ቤት የተማረ 3 ሁለተኛ ደረጃ ትምህርት ቤት የተማረ 4. ልዩ የክህሎት ስልጠና የወሰደ 5 ያለተማረ

1.5 የሀይማኖት ሁኔታ፡ 1.ክርስቲያን 2. እስልምና 3.ካቶሊክ 4.ፕሮቴስታንት 5.ሌላ ይግለፁ

1.6 የቤተሰብ ብዛት፡ ምን ያህል የቤተሰብ አባላት አሉለዎት? 1.ወንድ------2.ሴት----- ድምር

1.7 ምን ዓይነት የመስኖ ማልሚያ ስልት አለዎት? 1 .የስበት ኃይል 2. የፓምፕ 3.ሁለቱም

2. የመሬት ሀብቶች እና አሠራር

2.1 ለምርት እና ለሌሎች ተግባራት የሚዉል መሬት አለዎት? 1. አዎ 2. የለም

2.2 መልስዎ አዎ ከሆነ የሚከተለውን መረጃ ይሙሉ፡ 1. መኖሪያ ቤት 2. የመስኖ መሬት 3. የግል ግጦሽ 4 .የጋራ ግጦሽ 5. ሌላ ይግለጹ።

2.3 የመስኖ መሬታችሁን ምን ለማልማት ትጠቀሙበታላችዉ? 1. ወቅታዊ ሰብል 2. የምግብ ሰብሎች 3. የግጦሽ መሬት 4. የጥሬ ገንዘብ ሰብል 5. ሌላ ይግለጹ________

2.4 በመስኖ የምታለሙበት የአፈር ለምነት ምን ይመስላል?

1. በጣም ጥሩ 2. ጥሩ 3. መጥፎ 4. በጣም መጥፎ

3. ሀ. የፕሮጀክቱ አስፈላጊነት

3.1 የመስኖ መሬትዎ (እርሻዎ) የእርስዎ ነዉ? 1. አዎ 2. አይደለም

3.2 አይደለም ከሆነ፣ ይህ የመስኖ ቦታ/እርሻ የማን ነው? ....

3.3 መስኖ እየተጠቀሙ ከሆነ በመስኖ ስር ያለዎትን የመሬት ይዞታ መጠን እንዴት ይገልፁታል? 1. በጣም ትንሽ 2. ትንሽ 3. በቂ 4. ትልቅ

3.4 ዋና ዋና የመስኖ ጥቅሞች ምንድን ናቸው? 1. ገንዘብ /ገቢ/ ለማግኘት 2. ለቤተሰብ ምግብ ለማምረት 3. የእንስሳት መኖ ለማምረት 4 ሌላ ይግለጹ

3.5 የአምቢያ ጋርኖ የመስኖ ፕሮጀክት ጥቅም ምን ይመስልዎታል? (ከአንድ መልስ በላይ መመለስ ይቻላል)

- ለሰው፡ 1. ለቤት ፍጆታ 2. ገበያ (ገቢ ማሳደግ) 3. የስራ እድል ለመፍጠር 4.ሌላ ይግለጹ
- ለከብቶች፡ 1. የግጦሽ ምርት መጨመር 2. በቀላሉ ውሃ ለማግኘት 3. ለከብት እርባታ የሰብል ቅሪት 4.ሌላ; ይግለጹ_________

3.6 ይህ የመስኖ ፕሮጀክት ለእርስዎ ጠቃሚ ነውን? 1. በጣም 2. መደበኛ 3. ያን ያህል አይደለም 4. ሙሉ በሙሉ አይደለም

3.7 ዘመናዊ መስኖ መጠቀም ከጀመሩ በኋላ ህይወትዎ ተለውጧል? 1. አዎ 2. አይደለም

3.8 አዎ ከሆነ ማሳዎቹ ምንድን ናቸው?1. አዲስ ቤት ግንባታ 2. ህፃናትን ወደ ትምህርት ቤት መላክ 3. ምግብ በአይነት መጠቀም 4.የገቢ መጨመር 5.የአዲስ መስኖ ግንባታ አቅም ማግኘት 6.ሌላ

3. ለ. የማህበረሰብ አስተዋፅዎ

3.1.የግንባታዉን የገነባዉ ማን ነዉ? 1. መንግስት 2. መንግሥታዊ ያልሆነ ድርጅት 3. ማህበረሰቡ 4. 1&2 5. 1&3 6. ሁሉም በመተባበር

3.2. ግንባታዉ ሲገነባ በማህበረሰቡ /በተጠቃሚዎች/ ሙሉ ተሳትፎ ነው? 1. አዎ 2.አይደለም

3.3.ከላይ መልስዎ አዎ ከሆነ በየትኛው የግንባታ ሂደት ላይ ተሳተፉ?1.በመጀመሪያ/ዝግጅት/ 2. በግንባታ ጊዜ 3. ከግንባታ በኂላ 4.1&2 5.2&3 6.1&3 7. በሁሉም ደረጃዎች 8.ሌላ ይግለፁ

3.4.በግንባታዉ ሂደት ሲሳተፉ ያበረከቱት አስተዋጽኦ ምንድን ነው?1. በተነሳሽነት 2. ነፃ የጉልበት ሥራ ብቻ 3. በጥሬ ገንዘብ 4. ለሥራ የሚሆን ምግብ በማዘጋጀት 5. ለሥራ ገንዘብ 6. ለግንባታ አስፈላጊ ቁሳቁስ በማቅረብ 7. ሌላ ይገለፁ

3.5. ከግንባታ በፊት እና በኂላ በመስኖ ስራዎች ላይ የሴቶች ተሳትፎ አለ?

1. አዎ 2. የለም

3.6. ከላይ መልሱ አዎ ከሆነ በምን አይነት ሰራ ተሳትፈዋል ?

3.7. የመስኖ ሥርዓቱ ከተሻሻለ በኂላ የተጠቃሚዎች ቁጥር እየቀነሰ ነው ወይስ እየጨመረ ነው? 1 መቀነስ 2 መጨመር

3.8.ከግንባታ በኂላ የአስተዳደር ስርዓቱ ለተሻለ እድገት ተቀምጧል?

1. አዎ 2. አይደለም

3.9.ጥያቄ ቁ 3.8 መልስዎ አዎ ከሆነ የአስተዳደር ስርዓቱ በማን እጅ ነዉ? 1.በማህበረሰብ ብቻ 2.በዉሃ ተጠቃሚዎች ማህበር ብቻ 3.መንግሥታዊ ባልሆኑ ድርጅት 4. በመንግሥት ብቻ 5.የባህል መሪ ብቻ 6.ሁሉም በትብብር (ከአንድ በላይመመለስ ይቻላል)

3.10. የሚያስተዳድረዉ አካል ሥራውንና ኃላፊነቱን በበቂ ሁኔታ ተወጥቷል?

1. አዎ 2. አይደለም።

3.11. ለጥያቄ ቁ 3.10 የሰጡት ምላሽ የለም ከሆነ ምክንያቱ ምን ይመስልዎታል?

3.12. ለግንባታዉ የባለቤትነት ስሜት አለህ? 1. አዎ 2.የለም

3.13. ግንባታዉ ዘላቂነት እንዲኖረዉ በህብረተሰቡ ምን መደረግ አለበት ብለው ያስባሉ?

4. የፕሮጀክቱ ምርታማነት

4.1.የእርስዎ የአመራረት ዘዴ እና ምርታማነት ምን ይመስላል?

4.2.በዓመት ውስጥ ስንት ጊዜ ያመርታሉ?

4.3.በአሁኑ ጊዜ የመሬትዎ ምርታማነት ምን ይመስላል?1. መጨመር 2. መቀነስ

4.4.ከላይ ለተጠቀሰው ጥያቄ ቀንሷል ካሉ ምክንያቶቹ ምንድን ናቸው?

1 .የአፈሩ/የመሬቱ/ ለምነት መቀነስ 2. የመዳበሪያ እጥረት 3. የአተራረስ ዘዴን አለመከተል

4.5. መስኖ ተጠቅመዉ ምርታማ ነን ካሉ ማሳዎቹ ምንድነው? 1. ለቤተሰቡ በቂ ገቢ ማገኘት 2. የኑሮ ደረጃ መሻሻል 3. በአካባቢው የተመደዉን የሰብል ምርት ማሳደግ 4. ግንባታዉ ከተሻሻለ በኋላ ዓመታዊ ምርትን ማሳደግ 5. ለእርሻ ጉልበት አቅርቦት ማገኘት

5. የቴክኒካል አፈጻጸም በተመለከተ

5.1. ለፕሮጀክቱ የመስኖ ውሃ በቂ ነው ብለው ያስባሉ? 1. አዎ 2. አይደለም

5.2. ለእርሻዎ የውሃ እጥረት አለ? 1. አዎ 2. አይደለም

5.3. ለጥያቄ ቁጥር 5.2 መልስዎ አዎ ከሆነ ለምን ይመስላችኋል? (ከአንድ በላይ መመለስ ይቻላል) 1. በወንዙ ውስጥ የውሃ እጥረት ስላለ 2. የፓምፕ አቅሙ አነስተኛ ሰለሆነ 3. የውሃ ስርጭት አስተዳደራዊ አደርጃጀቱ ደካማ ስለሆነ 4. የውሃ ማለፊያ ግንባታዎች በጥሩ ሁኔታ ስለማይሰራ

5.4. ውሃን ከወንዙ ወደ ማሳ ለማድረስ የምትጠቀሙት ዘዴ ምንድን ነው? 1, በስበት ኃይል 2, በሞተር ፓምፕ 3. ሌሎች ካሉ

5.5. ዉሃ ለእያንዳንዱ ተጠቃሚ እኩል ተደራሽነት አለው ብለዉ ያስባሉ? 1 .አዎ 2. አይደለም

5.6. አይደለም ከሆነ ምክንያቱ ምን ይመስልዎታል? 1. የብሔር ልዩነት 2. የፆታ ልዩነት 3. የፖለቲካ ችግር 4. የሃይማኖት ልዩነት 5. የሰብል አይነት 6. የአስተዳደር ችግር 7. ወደ ዋናው የውሃ ቦይ መቃረብ 8. የመሬት መጠን 9. የመሬቱ አቀማመጥ 10. ሌሎች / ይግለጹ

5.7. የውኃ ማስተላለፊያ ቦዮች ዋና ዋና ተግዳሮቶች ምንድን ናቸው?(ከአንድ በላይ መመለስ ይቻላል) 1. የቦይ ደረጃ እና ሙሌት ችግር 2. በቦይ ውስጥ የደለል ክምችት ችግር 3. በቦይ ማጽዳት ውስጥ የአርሶአደሮች ፍቃደኝነት ማጣት 4. ስርገት 5. በቦይ ውስጥ የአረም እድገት

6. የጥገና አመልካች

6.1. የመስኖ ግንባታ ጥገና የሚያደርገው ማነው? 1. መንግሥት 2. መስኖ ተጠቃሚዎች 3. መንግሥታዊ ያልሆኑ ድርጅቶች 4. ሌሎች

6.2. ለግንባታ ፕሮጀክቱ የውሃ ምንጭ ምንድነው?

1. ወንዝ 2. ግድብ 3. ሀይቅ 4.የከርሰ ምድር ውሃ

6.3. ብዙ ጊዜ የሚጎዳው የትኛው የመስኖ ግንባታ ክፍል ነዉ? 1 .የአናት ሥራ /head work/ 2. ፍሉም 3. የዋናው ቦይ መግቢያ በሮች /intake gates of main canal /

4.ደሮፕ እስትራክቸር 5. የመንገድ ማቋረጫ ቦይ 6. ያልተለሰነዉ የቦይ ክፍል 7 ሌሎችን ይግለጹ

6.4. ስለ ግንባታ ክፍሎቹ እና ቦዮች ጥገና መመሪያ ወስደዋል 1. አዎ 2. አይደለም

6.5. በጥያቄ ቁ 6.4 መልሱ አዎ ከሆነ ስንት ጊዜ ጥገና ይካሄዳል? 1. በመስኖ ወቅት አንድ ጊዜ 2. በዓመት አንድ ጊዜ 3. ማህበረሰቡ በሚፈልገው መሰረት 4. በመንግስት መመሪያ መሰረት 6. ሌሎች ይግለጹ.

7. አካባቢያዊ ማሳያ/ **Environmental indicator/**

7.1.በአከባቢዎ እጥረት አለ ብለው የሚያስቡት የትኛው ሀብት ነው? 1.ውሃ 2. የእርሻመሬት 4. ለግጦሽ የሚዉል መሬት; 5. ደን 6. ሌሎች ይግለጹ

7.2. ከለይ በቁጥር 7.1 ያሉት ችግሮች /እጥረቶች/ የተከሰቱት በምን ምክኒያት ነው 1.የህዝብ ብዛት መጨመር 2. የመስኖ መስፋፋት 3. የመሠረተ ልማት መስፋፋት 4. የግጦሽ መሬት መስፋፋት 5. ከመጠን በላይ ግጦሽ ማጋጥ 6. የደን መመንጠር 7. ሌላ ይግለጹ.

7.3. አጠቃላይ ለአገልግሎትዎ የሚዉል ውሃ ከየት ነው የሚያገኙት? (በርካታ መልሶችን መመለስ ይቻላል)1.የዝናብ ዉሃ በመጠበቅ 2. ከአምባ ጋርኖ ወንዝ 3. የከርሰ ምድር ውሃ 4. ሌላ ይግለጹ

7.4. የውሃ ሃብት ጥቅሞች ምንድናቸው? 1. ለግብርና 2. ለቤት ውስጥ 3. ለኢንዱስትሪ 4. ሌላ ይግለጹ፡፡

7.5. የአየር ንብረት ለውጥ በውሃ አቅርቦት ላይ ተፅዕኖ አለው ብለው ያስባሉ? 1 . አዎ 2.አይደለም እንዴት?

7.6. በፕሮጀክቱ አካባቢ የአፈር መሸርሸር ችግር አለ ብለው ያስባሉ? 1 . አዎ 2. አይደለም

7.7. ከላይ በቁጥር 7.6 መልስዎ አዎ ከሆነ ምክኒያቱ ምንድን ነዉ? 1. የመስኖ ውሃ አጠቃቀም እና አስተዳደራዊ ችግር 2. ጎርፍ 3. የግንባታ ችግር 4. የመስኖ ዓይነት (ፓምፕ / ስበት) 5. ሌላ ይግለፁ.

8. የዉሃ ማህበር መዋቅር እና አስተዳደራዊ ሥርዓት

8.1. በአካባቢዎ የውሃ ሃብት መዋቅራዊ አደረጃጀት አለ? 1. አዎ 2. አይደለም

8.2. አዎ ከሆነ፣ ምንድን ነው? 1. የዉሃ ተጠቃሚዎች ማህበር/WUA/ 2. WUC 3. ሌላ ይግለጹ

8.3. የዉሃ ተጠቃሚዎች ማህበር የተቋቋመዉ ህጋዊ እና መመሪያን መሰረት ባደረገ መልኩ ነዉ? 1. አዎ 2. አይደለም

8.4. የውሃ ተጠቃሚ ማህበር አባል ነዎት? 1. አዎ 2. አይደለም

8.5. የውሃ ተጠቃሚ ማህበር አደረጃጀቱን እንዴት ያዩታል? 1. በጣም ጠንካራ 2. ጠንካራ 3. መካከለኛ 4. በጣም ደካማ 5. ደካማ

8.6. በውሃ ተጠቃሚዎች ማህበር ውስጥ ምን ተግዳሮቶች አሉ? 1. በዉሃ ተጠቃሚዎች መካከል ዝቅተኛ ግንኙነት መኖር 2. ለማህበሩ ድጋፍ እና ማበረታቻዎች እጥረት 3. ማህበሩ በፍቃደኝነት አለመስራት 4. ግልጽነት እና ተጠያቂነት አለመኖር 5.ሌላ

9. የፕሮጀክት ግንባታዉን እስከታቀደዉ የጊዜ ገደብ እንዳይደርስ የሚያደርጉ ዋና ዋና ተግዳሮቶች

9.1.የመስኖ አዉታሩን ዘላቂነት አደጋ ላይ የሚጥሉ ዋና ዋና ችግሮች

ተግዳሮቶቹ	የችግሩ ደረጃ፡ 1.ያነሰ 2.መካከለኛ 3.ከባድ
ዝቅተኛ የመሬት ይዞታ	
ደካማ የቴክኖሎጂ ምርጫ	
የገበያ መረጃ እጥረት	
ለመስኖ ቴክኖሎጂዎች አጠቃቀም ዙሪያ ስልጠና አለመስጠት	
መሰረተ ልማቶች ያለመሟላት በቂ የብድር አገልግሎት አለማገኘት እና የኤክስቴንሽን ፓኬጆች እጥረት	

9.2.የመስኖ ውሃ አጠቃቀም ግጭት ሊፈጥር ይችላል ብለው ያስባሉ?

1. አዎ 2. አይደለም

9.3.የመስኖ ውሃ የግጭት ምንጭ የሆነው ለምን ይመስላችኋል? ምክንያቱም 1. የውሃ እጥረት 2. ህጋዊ ያልሆነ የውሃ አጠቃቀም 3. በህግና ደንብ አለመመራት (የውሃ አስተዳደር ችግር) 4. ተመጣጣኝ ያልሆነ የጥገና መዋጮ 5 ሌላ ይግለፁ

9.4.ግጭቱን የሚፈጥረው አካል ማን ይመስልዎታል? 1.ከተጠቃሚዎች መካከል 2. ከአዉታሩ የታችኛዉ ተጠቃሚዎች 3. ከአዉታሩ የላይ ተጠቃሚዎች 4. ከ1 እና 2 5. ከ1& 3 ጋር 6. በ1፣ 2 እና 3

II. ለሴቶች፣ ለውሃ አባቶች፣ ለውሃ ተጠቃሚዎች ማህበር ፣ ለወጣቶች የቀረበ ጥያቄ፡፡

ቀን -------------------

የመስኖ ግንባታው ስም -------------------------

ፆታ -----------------

1. የመስኖ መዋቅር አጠቃላይ ጥገና ምን ይመስላል?
2. አዲስ ግንባታ ለመገንባት እና ያለውን የመስኖ ግንባታ ቀጣይነት እንዲኖረዉ የእርስዎ ሚና ምንድን ነው?
3. በውሃ ማስተላለፊያ ቦይ ውስጥ ዋና ዋና ችግሮች ምንድን ናቸው?
4. ካለው የመስኖ ልማት ጋር በተያያዘ የግጭት ምንጮች ምንድናቸው?
5. ግንባታዉ ከመሰራቱ በፊት በባህላዊ የመስኖ መሰረተ ልማት የግጭት አፈታት ዘዴ እንዲሁም ፕሮጅጀክቱ ከተሰራ በኂላ ቀጣይነቱ እንዲረጋገጥ ያለዎት ሚና ምን ይመስላል?
6. የመስኖ ግንባታ ፕሮጀክቱ ለሴቶች ልዩ ጥቅም ፈጥሯል ብለዉ ያስባሉ?
7. በመስኖ ውሃ እና በመስኖ እርሻ የአፈር ለምነት ቀጣይነት እና አቅርቦት ላይ ያለዎት ልምድ ምን ይመስላል?
8. ለተገነባዉ የመስኖ አዉታር የውሃ ተጠቃሚዎች ማህበር አለዉ? የእነሱ ኃላፊነት ምንድን ነው?
9. ከወረዳው ግብርና ጽ/ቤት እና ከመስኖ ባለሙያው ጋር ያላችሁ ግንኙነት ምን ይመስላል?

III. ለቁልፍ መረጃ ሰጭ ማለትም ለጎንደር ዙሪያ ወረዳ ውሃ ጽ/ቤት እና ግብርና ጽ/ቤት የተዘጋጀ ጥያቄ

የፅ/ቤቱ ስም___________________

ስም_____________________

የትምህርት ደረጃ ___________

1. የአምባ ጋርኖ የመስኖ ልማት ግንባታ ፕሮጀክት የውሃ አስተዳደር ስርዓት ምን ይመስላል?
2. ከውኃ ማስተላለፊያ ቦይ ጋር በተያያዘ ዋና ዋና አስተዳደራዊ ችግሮች ምንድን ናቸው?
3. የውሃ ሃብት አያያዝ ተግባራት በተደራጀ አስተዳደራዊ ስርዓት እየተመራ ነዉ ብለዉ ያስባሉ? ካልሆነ ለምን?

4. በመስኖ ግንባታ ፕሮጅክት ውስጥ በተጠቃሚዎች ወይም በዉሃ ተጠቃሚዎች ማህበር መካከል ግጭት ሲፈጠር አይተዉ ያዉቃሉ? እንዴት መፍታት ይቻላል?
5. የመስኖ ውሃን ከማጋራት እና ማስተላለፊያ ቦይ ያሉትን ችግሮች ለመፍታት ምን አይነት ዘዴ ወይም እርምጃ ይወስዳሉ?
6. የዉሃ ተጠቃሚዎች ማህበር ተግባር ምንድን ነዉ? ስንት አባል አላቸው?
7. ለሴት እማወራ ለሚመሩ ቤተሰቦች መስኖን በመጠቀም ልዩ ድጋፍ አለ?
8. የመስኖ ዉሃ ፕሮጀክት ቀጣይነት እንዲኖረዉ ያለዎትን ሃሳብ ይግለፁ?

ስለትብብርዎ በጣም አመሰግናለሁ