SUSTAINABILITY OF SMALL SCALE IRRIGATION SCHEMES: A CASE STUDY OF NEDHI GELAN SEDI SMALL SCALE IRRIGATION IN DEDER WOREDA, EASTERN OROMIA

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Title

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LIST OF ABBREVIATIONS

ADLI	Agricultural Development Lead Industrialization
CSA	Central Statistical Agency
DA	Development Agent
EIA	Environmental Impact Assessment
FAO	Food and Agricultural Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FTG	Farmer Training Group
FHH	Farmer Households
GDP	Grows Domestic Production
GPS	Global Positioning Systems
GTP	Growth and Transformation Plan
IFAD	International fund for Agricultural Development
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
m.a.s.l	Meter Above Sea Level
MoWR	Ministry of Water Resource
OBFED	Oromia Bureau of Finance and Economic Development
ODA	Overseas Development Administration
OIDA	Oromia Irrigation Development Authority
O and M	Operation and Maintenance
OWEMRB	Oromia Water Energy and Mineral Resource Bureau
SEAGA	Socio economic and Gender Analysis Programme
SSI	Small Scale Irrigation
WUAs	Water User Associations
SDPRP	Sustainable Development and Poverty Reduction Program
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
SSA	Sub-Saharan-Africa

Glossary of Local Term

Abba Ganda	Village Leader
Abba Affosha	Community associations leader
Malaqa	Community water association leader for water distribution
Qanyur	Red Ants
Hamarkots	Special Khat Stimulant Cash Crops Found in the Area
Fagee	Improved maize variety
Mangudo Bishaani	Committee of elders represent able for irrigation water
Bulchinsa fi Haqa	Administration and Justice
Shango	the three justice committee
Kert	Local unit of measurement equivalent to 0.125 Ha

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Abstract

Irrigation development has been identified as an important tool to stimulate economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction in Ethiopia. While a lot of effort is being exerted towards irrigation development, little attempt is being made toward the sustainability of already constructed schemes. This study is an attempt to show whether already constructed scheme is sustainable or not, in the case of Nedhi Gelan Sedi SSI scheme in Eastern Oromia Region, Deder District, which was selected purposively. Therefore, the major concern of this study is to identify sustainability of the scheme from socio-cultural, environmental, physical, financial, institutional and community empowerment aspect .To realize these objectives, structured household survey questionnaires, semi-structured interviews, group discussions, field observations and literature were used. For household survey questionnaires a total of 88 sampled households were randomly selected.

Physical stability , efficiency of the scheme, environmental protection, productivity, equity, collective action system resilience and relevance are those categories' that are selected to indicate 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. Categories are further expressed by around 36 indicators. By using the computed Yes or No response of the sampled household, rated scale of each category was calculated from rated scale of indicators. Finally, average value of all categories was taken to be the sustainability index of the scheme.

The study indicates that, the approach of intervention was not participatory. The communities did not participate during study and construction period and no handing over of the project to the community. Elected committees were not representative of all villages and at this time water distribution, mass mobilization for maintenance and conflict resolutions were handled by traditional water leader Malaqa that are limited in their own village. Equality in water distribution is non-existence. Even if IFAD did the demonstration, the result was not satisfactory. Land scarcity is number one problem in the area. Siltation of head work and damage of column of flume is also a series issue that needs immediate solution. Watershed management must be practiced in the area. 92 percent of sampled households are not paid and willing to pay operation and maintenance costs, water fee costs and project recovery costs, which show weakness of financial viability of the project.

As a result, the key findings of the study reveal that the sustainability index of the scheme was 1.31 which shows value approach to unsustainable condition, an outcome of lack of equitable resource distribution, which create lack of collective action towards the scheme sustainability issues, especially for operation and maintenances that harm stability of the physical capital by minimizing the efficiency of the scheme, coupled with low protective action of the environment, aggravate the problem and finally systems are no longer to deliver their benefit and the people are also no longer to devote necessary efforts to key activities and sustainability of the system become under question even for this generation.

The supports from IFAD would have been more rewarding, if it is coupled with improvement of the condition of physical stability of the scheme with maintenance and establishment of representative WUA. Moreover, to improve the economic and environmental sustainability of small scale-irrigation schemes, institutional support (input supply, output marketing and credit services), training of farmers on improved crop and water management issues, regular supervision and monitoring of scheme activities are crucial.

Chapter 1

Introduction

1.1 Background

In sub-Saharan Africa, agriculture accounts for approximately 70% of the economically active population and it remains a very important social and economic sector. In this part of the world, rain-fed agriculture is largely dominant: food security and income of rural populations are vulnerable to rainfall variability, and food production is often less than the requirements of growing population. The volatile rains and soil degradation partly explain the stagnation of agricultural yields, one cause of the chronic food deficit (FAO, 2006).

According to FAO, irrigation increases yields of most crops by 100 to 400% and over the next 22 years, 70% of gains in cereal production are expected to come from irrigated land (FAO, 2003,I).This indicates that the contribution of irrigated agriculture to food security throughout the world is undeniable. In developing countries, up to 85% of the available water is used for agriculture (FAO, 2003,29). The average rate of irrigation development of the sub-Saharan Africa countries from 1988 to 2000 was 43,600 ha/year. If this rate is continued, then an additional 1 million hectares of land will be brought into irrigation by the year 2025 (FAO, 2003).

Ethiopia is one of the SSA countries characterized by low standard of living and widespread poverty. Agriculture is the mainstay of the rural population and the sector plays a vital role in the national economy. The sector contributes almost 41% of the gross domestic product (GDP); 90% of the foreign exchange earnings and employs, almost 85% of the total population living in rural and agricultural sector (FDRE, 2010). Improving this sector ensures food security, improves livelihoods and alleviates poverty of the rural community in the country.

It has been clearly and loudly stated that if Ethiopia is to feed its ever increasing population, lessen risk of catastrophes caused by drought, continuous and extensive effort need to be made towards developing irrigated agriculture and intensifying agricultural production. That is why, in addition to existing schemes, the government prepared a 15 years water sector plan to develop 471,862 ha of irrigation farm out of which 225,763 ha is small scale and 246,099ha is large scale (MoWR , 2002).

Similarly, to enhance the use of country's water resources under 5 year plan of Growth and Transformation Plan (GTP) at this moment, expansion of small scale irrigation will be given priority while due attention will be given to medium and large scale irrigation to the extent possible (FDRE, 2010).

When one observes the substantial development of irrigation in the country as compared to the status of the developed one in the past, a question on sustainability of existing irrigation schemes is raised.

According to IWMI working paper inventory out of 193 SSI projects, only 6 are underutilized, 108 project functioning, 9 under design, 38 projects actual command area, 32 project design area are not available (Awulachew .et.al , 2006).

The situation in Oromia is not different. The analysis made by OIDA in its annual report, in 2000, is quite worrying concerning the future of modern irrigation schemes. It states that:

- ✓40% of the irrigation schemes managed by a Water User Association are under exploitation in Oromiya region.
- ✓The cultivated area under irrigation represents 50% of the area from irrigation infrastructures.
- ✓15 irrigation schemes, equivalent to about 2,112 ha are totally abandoned (IODA, 2000).

1.2 Statement of the problem

Even if Ethiopia has a substantial potential for irrigated agriculture assessed both from available land and water resource view point, the bulk of this potential is still untouched .For example, the developed irrigable land was 2.5 % of the potential land for irrigation and in 2014/15 the plan target will be 7.5% by taking 2009/2010 as base line data (FDRE, 2010).This shows that concerted effort is underway by the government of Ethiopia to expand irrigation of all categories including rain-water harvesting with the prime purpose of overcoming the problem of food insecurity, extreme rural poverty, and to promote economic dynamism(FDRE, 2010).

In line with the development objective of the country, the regional government of Oromia is also promoting SSI development, so as to increase and stabilize food production in the region. It is with this aim that Nedhi Gelan Sadi small scale irrigation was developed from traditional water use to modern scheme in Nedhi Gelan Sedi PA, Deder District, East Harerghe zone of Oromia Region with the budget from International Fund for Agriculture and Development (IFAD) in 2001. The command area and beneficiaries are 75 ha and 375 household (HH) respectively (OIDA, 2001).

The analysis of project design papers reported that, improving farmer welfare can be achieved, if schemes are designed properly, constructed properly and managed according to specific set of key management objectives, which must be achieved within the context of effective organizational coordination and farmer participation (OIDA, 2001). But, the afformitioned farmer participation and effective organizational coordination is not actualized.

Due to these, even if some technical changes are effective at the end of the construction, still there are gaps between intended and actual result of the project. For example, weakness of the institutional set up, weak economic condition, lack of environmental conservation that cause siltation and damage to the physical structure , absence of equity between social in water distribution, poor water management, lack of irrigation scheduling according to design paper, lack of proper operation and maintenances that brings low performance of the systems and cause food insecurity in the area, that indicate the output was not as expected and production of the scheme is not so much different from the traditional use.

One of the pressing challenges of the intervention in SSI development made in Ethiopia in general and in Oromia in particular, focused only on improving and expansion of the physical structure of existing traditional small-scale irrigation schemes. That is why sustainability of existing small scale irrigation schemes is not as anticipated as the planning and appraisal stages (Leliso, 2008).

This is a dilemma for professionals in the water sector that the country's limited resources are allocated to reduce the chronic food security problem, but could not result in the desired change.

Eventually, this is an area of concern regarding what should be done and what type of strategic plan to be developed in the future.

Many researchs have been done on performance evaluation of small scale irrigation project; but most of them were in central part of the country and focus on physical and technical evaluation of the scheme. Since irrigation system varies depending on the prevailing practice, environmental and social condition, factors affecting the continued use of irrigation projects in the background of limited resources are not adequately and systematically studied in the study area.

Hence, it is clear that there is a lot to be done in search for some set of institutional, social, environmental and economical practices under which we feel confident that, the system will continue to exist and function, at least for the time intended during the planning stage of the project by understanding the past and current situation of the scheme. Therefore, this specific research is designed to generate location specific data on sustainability of irrigation scheme in the area and this is the driving force for this research.

1.3 Objectives of the study

The general objective of this research is to study the sustainability of Nedhi Gelan Sedi small scale irrigation scheme in Deder Woreda, Eastern Oromia.

The specific objectives are:

- To assess the situation of irrigation system of the site under study.
- To find out financial sustainability of the scheme.
- To assess technical and socio-cultural sustainability of the scheme.
- To see environmental sustainability of the scheme.
- To see the role of community participation in sustaining the system.

1.4 Research questions

The specific questions are:

1. What is the existing status of irrigation scheme in the area?
2. What are the conditions of the scheme from environmental sustainability?
3. What are the conditions of the scheme from socio-cultural sustainability?
4. What are the conditions of the scheme from financial and physical sustainability?
5. Which threat we want to avert is most important?
6. What are the roles of community participation in sustaining the system?

1.5 Significance of the study

In the development policies and strategies' of the country starting from SDPRP, PASDEP and currently under Growth and Transformation Plan (GTP), sustainable development is a core issue. Any statement about sustainability is simply an opinion about what is going to be happen in the future. Our opinions about future are likely to be better if they are supported by sound data about what is happening in the present and has happened in the recent past. From such a data base, policy makers or managers may get early warnings of changes or trends that may indicate weakness of sustainability.

This shows that, learning from the past is crucial and therefore, this particular research make a bit contribution to existing stock of knowledge and practice on sustainability of SSI schemes in Nedhi Gelan Sedi Area. Thus, Local Government, NGOs involved in the promotion of SSI development in the area and communities in particular, are expected to gain some valuable information for future use. Beside the above advantage, since there is no any research which was undertaken in the study area on SSI development, it generates some of literature of SSI sustainability of Deder Woreda in Ethiopia. The study also paves the way for other researchers to do more comprehensive research in the area.

1.6 Scope and limitation of the study

The study specifically focuses on assessing sustainability condition of Nedhi Gelan Sedi small scale irrigation schemes in Deder Woreda. It is delimited to Nedhi Gelan Sedi small scale irrigation schemes. Hence, the results and finding on the problem and improved situation are the reflection of the study area which may be difficult to replicate to other areas of the regions.

Besides, sustainability of irrigation scheme is a multidimensional and dynamic concept, which is the result of interaction of various factors over a long period of time; it was difficult to carry out in-depth investigation. Household level survey output and input data of only one-year period (2009/10) was used for the analysis. Therefore, this one year survey data might not be enough to capture the intertemporal variations that would happen through time to see the stability of natural capital and physical capital as well as the production yield of the area.
Therefore, further research for better understanding will have great importance. Despite these limitations, the study is expected to generate valuable information which may be of great use to different stakeholders.

1.7 Organization of the thesis

The remaining chapters of the thesis are structured as follows. Chapter two review of theoretical and empirical literature related to irrigation schemes and agriculture are presented. Chapter three and four deal with the research methodologies and description of the study area respectively. Chapter five provides research finding about sustainability of Nedhi Gelan Sedi irrigation scheme. Finally, chapter six summarizes the main findings of the study and draws the conclusion and recommendation.

CHAPTER 2: LITERATURE REVIEW

In this chapter, conceptual, theoretical, review of previous work and analytical frame work was organized as follows.

*2.*1 Definition and Concept Related to Irrigation Technology

2.1.1 Irrigation

Irrigation is defined as the artificial application of water onto cropland for the purpose of satisfying the water requirements necessary for growing different crops and plays a key role in stabilizing food production in a number of countries by either supplementing or replacing the need for natural precipitation for the purpose of food production (FOA, 1997:7).

Again, FAO (1997) defines irrigation modernization as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation systems combined with institutional reforms, with the objective to improve resource utilization (labor, water, economic, environmental) and water delivery service to farmers (FAO, 1997 in FAO, 2003:5).

From the above discussion one can understand that, irrigation facility is the physical structure that bring social and environmental component together for bringing sustainable development.

2.1.2 Small Scale Irrigation System

Irrigation systems can be classified according to size, source of water, management style, degree of water control, source of innovation and type of technology. In terms of management there are: governmental managed, farm managed and jointly managed irrigation scheme in Ethiopia (Yusuf and Tena, 2007). Similarly Angelle, (2007) puts as traditional irrigation schemes, modern small-scale irrigation scheme, modern private irrigation and public irrigation depending on the size and type of technology, type of management, degree of water control and size of the land (Angela, 2007:28-29).

Small-scale irrigation may be defined as irrigation, usually on small plots, in which private farmers have the major controlling interests, and which uses a level of technology that farmers can effectively operate and maintain themselves. An important objective in the promotion of small-scale irrigation has been to increase farmer's involvement in the design, implementation

and operation and maintenance of irrigation systems. Indeed, small-scale schemes are defined as schemes that are controlled and managed by the users themselves (Carter and Howsam in Turner, 1994:251).

2.2 History of Irrigation Development

Over 5000 years ago, runoff irrigation was practiced in Yava, Palestine. At the same time, so-called hydraulic societies developed in large river valleys, such as the Yangtse in China, Indus in India, Euphrates in Iraq and Nile in Egypt. Laws and by-laws regulated the distribution of irrigation water, which dominated the life cycle of farmers and citizens alike. Some 1500 years ago, the Marib dam in Yemen raised the water level of a non-perennial river to divert floods for irrigation purposes (FOA, 1997/98/99:1).

According to Kloos (1990) cited in Andarge, (2009), irrigation in Ethiopia probably predates the arrival of Sematic speaking immigrants from Yemen and possibly agriculturalists from Sudan. Both groups may have introduced seed/plough cultivation and irrigation to Northern Ethiopia in the area of the later Axum Empire between 1000 B.C. In the 15^{th} and 16^{th} centuries, the Portuguese missionaries Alvarez and Almelda reported the use of irrigation in various localities in the northern high lands, and among the Afars in the lower Awash Valley (Kloos, 1990 in Andarge, 2009:13).

From the above, one can understand irrigation is an age-old art, perhaps as old as civilization. Nevertheless, the increasing need for crop production due to growing population in the world is necessitating a rapid expansion of irrigated agriculture throughout the world especially small-scale irrigation.

2.3. Irrigation Development in Oromia Region (The project site)

According to the study conducted by Oromia Economic Study Office (1999), the land suitable for surface irrigation in Oromia is estimated to be 1.7 million hectares of which only 97,185 ha (5.5%) has been developed so far. Out of these developed areas, the share of community irrigations constitute 66,224 ha of which 10,820 ha were developed with the help of regional

government, 6588 ha were developed by NGOs and 48,816 ha were developed traditionally. The amount of water used for the purpose of irrigation is only 1.5 % of the total 58 billion cubic meters obtained from mean annual runoff generated in the Region and 2.1 billion cubic meters of groundwater.

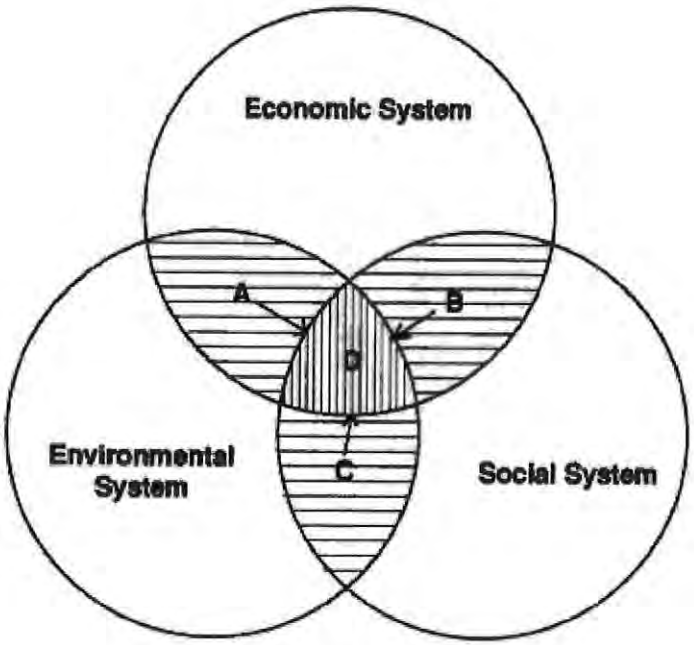
According to the data from Eastern Hararghe Zone WEMRO, the small-scale irrigation developed in the Zone from 1993/4-2002/3 was 58 projects of which 18 are unfunctional, 8 under construction and 32 are functional with no indication of its sustainability. Out of the above indicated schemes 5 schemes are found in Deder Aana where Nedhi Gelan Sedi is in the account.

2.4 Survey of Thought on Sustainability and Sustainable Development

Sustainability is a concept on which social and natural scientists, and philosophers have expressed their views from time to time. The word sustainability is derived from the Latin sustinere (tenere, to hold; sus, up). Dictionaries provide more than ten meanings for sustain, the main ones being to "maintain", "support", or "endure". However, since the 1980s sustainability has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability and sustainable development, that of the Brundtland Commission of the United Nations on March 20, 1987:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Figure 1: The three spheres of sustainability



Source: Adapted from Barry Dalal-Clayton, (1993), Where A denotes viability, B denotes equitability, C, denotes bear ability, D Denote sustainability

As the definition of sustainable development which is given by Barron, (2006:12), the development is sustainable if it ensures inter-generational equity (passing to future generation as much as the present enjoys) and intra-generational equity (sharing what there is between all groups) which is also stated on the Rio Declaration on Environment and Development under an important guide for public policy. Most definitions stress and recent discussion has crystallized around this and that of Brundtland Commission's notion.

Most of the time, some scholar use sustainability and sustainable development interchangeably but according to Barrow, (2006:12), sustainability is the quantification of status and progress of (economical, social or environmental) and it is the goal of the sustainable development process. Thus, the above stated meaning give the overall definition of the term sustainability and sustainable development and now it is a time to see scale and context of the meaning of the term.

2.4.1 Scale and Context

Sustainability is studied and managed over many scales (levels or frames of reference) of time and space and in many contexts of environmental, social and economic organization. The focus ranges from the total carrying capacity (sustainability) of planet Earth to the sustainability of economic sectors, ecosystems, countries, municipalities, neighborhoods, home gardens, individual lives, individual goods and services, occupations, lifestyles, behavior patterns and so on(Dalol, 1993).

Here Dalol, 1993 understands sustainability as a result of *"the relationship between technologies, inputs and management used on a particular resource base within a given socio-economic context"* that have three aspects of systems. Namely; spatial level like starting from global, regional, farm, field and individual plants and microscopic which seen in relation to a certain time period with taking social, economical and environmental dimension in to consideration.

2.4.2 The Concept of Sustainability of Small Scale Irrigation Schemes

In any assessment of sustainability, an essential first step is to set out a broad vision of what is meant by sustainability in that situation. Then, starting with this broad definition, many follow up questions can be asked in order to develop a useful strategy.

The concept of sustainability of SSI can be defined at different levels and in various contexts depending on the condition we want to sustain. According to Abernethy, (1994) sustainability of small scale irrigation system is 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 the sort of time-span (say 20-30) that constitutes a horizon for this kind of prediction. Here from policy perspective the researcher believe that it is sound and then only focus on practices on the ground. More over the management aspect is what he needs to sustain.

Whereas, according to Tom et.al. (1999), Stephen,(2002) cited in Yusuf and Tena, (2006), Sustainability concept, when viewed within the context of SSI development generally refers to the long-term ability of the beneficiaries to operate and maintain their schemes profitability with

little or no external intervention other than the normal extension services. This shows that the structure must be simple to operate and maintained by the farmers themselves which is the design aspect.

Similarly, according to Shah et al., (2001) cited in Teshome, (2009) viability includes the ability of the scheme to generate sufficient income to satisfy the household income expectations of the irrigations and cover basic operational maintenance costs of the irrigation infrastructure, while not undermining the natural resources (soil and water) and viability was assumed similar to sustainability in this context.

In social case Buydens, (2000), stress that, projects that keep the poor in their misery, while protecting the environment and promoting economic growth, cannot be defined as sustainable development.

2.4.3 Indicators and Measuring Sustainability

In the past few years, considerable attention has been paid to bring into harmony the targets of development on the one hand with the consciousness about the environment on the other hand. In the following paragraphs a brief description is presented on some general reflections, and indicators of sustainability and sustainable development was forwarded as follow.

According to Abernethy (1989), clarity, equity, flexibility, transparency, compliance with rules, conflict resolution, autonomy and decentralization are the eight principles which appear to be strongly correlated with sustainability, especially regarding water resources.

In similar manner, Ximing .et.al. (2001), in the context of arid or semi-arid basins where irrigation is the dominant water use, sustainability in irrigation water management can be indicated by water supply reliability, reversibility and vulnerability, environmental system integrity , equity in water sharing and economic acceptability.

Again, according to Garry et.al (2005:64-65), productivity of the systems, stability, efficiency, durability, compatibility and equity are indicators of sustainable agricultural systems. Similarly,

existence in the normal environmental state, effectiveness, freedom of action, security, adaptability, coexistence and physcological needs are indicators of sustainability of one system (Hartmut, 1999). Here there are many arguments in favors of having one combined or a set of many indicators or an intermediate approach to measure the sustainability of the systems (Garry et.al. 2005:60).

To measure sustainability of the systems, many researcher first collects data of individual indicators (perhaps 40-50) and then category indicators are judged from the former (typically 6) and then sustainability index of single value are calculated from the categorical indicators as it is shown in Figure 3 (Garry et.al. 2005:96). Accordingly, Garry et.al. (2005:), Campbell et al. (1997:), (Letroy et al. 1999:), Meermam et al. 1996:) and Sara et al. 1999 in Campbell et al. (2003:) use the above procedure to study sustainability of agricultural systems in different country.

For example, Sara at al. (1999 :) in Campbell et al. (2003 :), they use in total, 52 indicators on the environmental and socio-economic sustainability were used in the study. 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.

In similar manner, Maintenance and Rehabilitation project (REMR), has developed a number of function-based condition indexing procedures to determine the condition of large, multi-function, multi-element structures, (Andersen and Torrey, 1995; Bullock, 1989) as stated in ODA (1997:). The principal elements of an asset are assessed using a standard questionnaire requiring a YES or NO response to each question and the questions are all formulated such that a YES response indicates a defect, a NO response implies no defect. The condition index (CI) is the score associated with the element in worst condition.

Table 1 Condition index

Condition Index	Status
100-81	Good- A yes response returned for a question(s) related to a minor fault. No significant structural deterioration or 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.
51-69	Poor- A serous loss of function and /or some risk to the structural integrity. Action needs to be taken to prevent.
<50	Very Poor- effective failure

Source: (ODA, 1997)

2.5 Related Empirical Studies on Irrigation

Currently, the issue of irrigated agricultural practice by smallholder farmers is one of the development topics in developing countries. This is due to its contribution to increase agricultural yields and food production, income and food security. Thus, in line with this study some related empirical studies on irrigation are discussed below.

In the study designed to assess the economic linkages of smallholders' irrigation development and issues of community management in East showa administrative Zone of Oromia Regional State, Lemma *et al.* (2004) concluded that community irrigation practices that integrate food crop, cash crop and livestock production can help to tackle the existing chronic food security problem and can become sources of employment and income generation for the local people.

Wagnew (2004) conducted a case study using formal survey on socio economic and environmental impact assessment of four community based small-scale irrigation in the Upper Awash Basin of Ethiopia, concluded that, rural credit systems, institutional support, monitoring of irrigation schemes, training in water management, marketing and general crop production, empowerment of local communities, economic evaluation of optimal plot size, cropping patterns, agronomic practices and resources utilized in the irrigation schemes were necessary conditions for viable and sustainable irrigation schemes. Further he added that NGO's that are involved in irrigation development should come up with a clear, transparent and completed handing over of up-graded or newly developed small-scale irrigation schemes to farmers. The establishment of a

system of water user fees, which underwrite and reinforce the value of the resource and provide individual motivation for wise use should be promoted.

2.6 Conceptual Framework

Starting from the observation of the failure of a lot of projects cited in the conclusion of the first part, and the importance of irrigation development given by Ethiopian government, the follow up of such actions seems to be important.

The concept of sustainable development is an integrating idea and a bridge between conservation and development. Depending on the above definition, developing and expressing the clear definition of sustainability of SSI scheme was a crucial steps.

Accordingly, from the above discussion on definitions and constraints of sustainability of SSI scheme for the purpose of 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 the time-span of 20-30 years. Here, from policy perspective the researcher believe that it is sound and then only focus on practices on the ground.

This is to mean that, any sustainable SSI scheme is the one that empower the community, socially acceptable, economically viable both in generating sufficient income to satisfy the household income expectations of the irrigations and cover basic operation and maintenance costs, environmentally protective which means not undermining the natural resources (soil and water), the physical structure have stable and that have good institutional strength. This will form the following six pillar of sustainability of SSI scheme.

Figure. 2 The six pillars of sustainability of SSI

Source: Adopted from literature

Having put out a conceptual statement, a second step is to further refine and expand the overview to set out more specific areas that require investigation. According to this research this specific areas are called categories. The third step is then to choose appropriate indicators within these categories, then work together to provide a description of the total situation.

In general, to study sustainability of the Nedhi Gelan Sedi SSI Scheme about eight categories are chosen and they are operationilized as follows.

Relevance of the project for the farmer: it refers to whether the project is important to the beneficiaries' or not and it is hypothesized that if the people have interest and reliance on the project and the purpose of using irrigation plot is to produce cash crops as well as the constructed scheme is simple to operate, maintain and manage besides the multipurpose of the project and land tenure security, the project will be important for the community.

Stability of the physical constructed structure and natural resources like land and water, soil fertility from interview, productivity of the land after participation in irrigation and its stability are assessed from both direct observation and survey. Here stability is a practice that underway

in the area which requires routine record of data but with this respect due to time, finance and data shortage, the study only limited to investigating operation and function of facility in continuity of water supply and ability to deliver intended water from head work and conveyance systems of the scheme, scarcity of resource (land, water) and their continuity are assessed.

Collective Action: If there are collective action towards operation and maintenance of irrigated water and irrigation infrastructure, stability of system facility will be ensured. This means, from the very beginning the design and study process should be holistic in approach. That is, in the process of intervention, the approach must permit to clarify the problems in a collective manner and not to start with the proposed development solution to supposed problems.

Productivity of the project: It can be assessed by survey questionnaires that indicate whether farmers' livelihoods are improved after intervention or not, which depend on intensification and ability to generate sufficient income for the households.

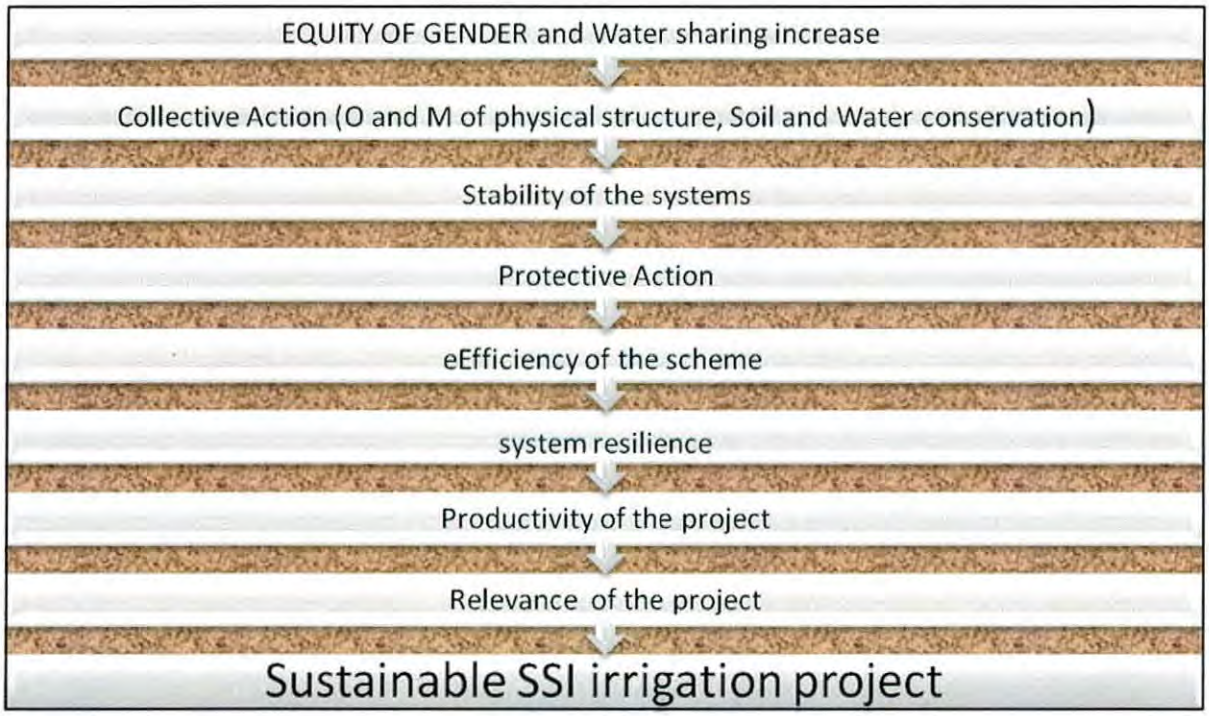
Efficiency of the project: These parameters have been subdivided and defined in a multitude of ways as well as named in various manners. Some of them are conveyance efficiency, Distribution efficiency, field efficiency, application efficiency and project efficiency. For this particular research, efficiency was only focused on conveyance and overall project efficiency of main canal. The conveyance efficiency was measured on the main canal by measuring discharges at two different points. The discharges were calculated from the velocities of the water flowing in the main canal using floating materials. The method of discharge measurement is called floating method as floating materials were used for velocity measurement. For this particular research the measurement of discharge was conducted only on the main canal because of absence of secondary and tertiary conveyance systems. Since the main canal had a rectangular lined section for part of the system, the test site was ideal for flow measurement.

Resilience of the system: the resilience of a system is the rate at which its performance can recover after an adverse event. Traditional systems may be more resilient than modern design s, since they have evolved specific responses to cope with the threats that are most often experienced in their environment (Abernethy, 1994).Thus, in this aspect the above idea are assessed based on the situation in the scheme.

Equity: rules that ensure each member's contributions and benefits are in balance is the main focus of this Category. But with this particular research disparity in water distribution, gender issue was assessed that influence the issue of collective action.

Protection: Sustainable irrigation system should fit in the human, social and natural environments where it is located, maintaining and enhancing the health of this environment. Is there watershed management and environmental impact assessment part in the study and design document of the project? Project area soil and water situation and the physical part and future threats are assessed.

Figure 3: Categories' interdependency



The aim was to give an image of the sustainability at scheme and plot level qualitatively, and then to use the results to point out the parts or practices of the irrigation systems in which there were deficiencies in the sustainability, and where the farmers and concerned GO's or NGO's could work in order to improve the sustainability. This will form a basis for the design of an in-

depth, more data-intensive study that will facilitate a full application of the frame work on the entire scheme, which is currently beyond the scope of this paper.

The categories were chosen to reflect the conditions of the scheme, socio-economic and environmental, that are thought to promote sustainable irrigation system. In total, 8 categories on the environmental and socio-economic sustainability were used in the study. For the sustainability analysis all categories were elaborated by about 36 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 36 indicators are collected using survey questionnaires, FGD and Key Informant interviews with the relevant stakeholders and analyzed after inserting the data in to SPSS. Then, depending on the result of the percentage of the respondents', the researcher determine condition index which shows the status of the selected indicators' goalposts. 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 apply Equation 1 to get numerical scale value of sustainability that are rated on a scale of >1, 1-2, 2-3 and 3-4, and 4-5. Where 4-5 indicated a highly sustainable condition, 3-4 indicated 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= $\frac{(Actual\ value - minimuim\ value)}{(Maximuim\ value - minimium\ value)} * 5$

(Adopted from Garry et.al. (2005)

Table 2: Condition index, status and scale of sustainability rating

Condition Index(categories of actual value)	Status	Scale of sustainability rating
91-100	Good .	4-5
81-90	Fair- indicates partial loss of function and / or some risk to the integrity of the structure. Action not immediately urgent.	3-4
71-80	Poor- A serous loss of function and /or some risk to the structural integrity. Action needs to be taken to prevent.	2-3
61-70	Very Poor- effective failure/approach to unsustainable	1-2
<60	Condition that was not sustainable	>1

Source: (Adapted from Garry et.al. 2005 and ODA, 1997)

CHAPTER 3, METHODOLOGY

3.1. Sample Size and Sampling Procedure

The selection of the study area Deder district and the scheme site is carried out purposively, because of relative accessibility of the district and the site. In the sampling design, distance was taken as a base for HH selection for interview since the view of user is different throughout the schemes locality. Thus, stratification of the scheme user in to three groups was done .Also, the researcher took command area into consideration, and since right command area is larger than the left canal and the distance of the two canals more or less equal, stratifying the 3.8km in three equal places depending on the distance of the users' villages from the head work. Out of 375 HHs 28,30 and 30 household head was selected randomly from the list of head user, middle user and tail user respectively from each group and in the total 88 HHs out of which 5-10% of this was women headed HHs. For FGD and key informant interview purposive sampling was used.

3.2. Method of Data Collection

In the study, both primary and secondary data was utilized by employing quantitative and qualitative methods. Instrument used in this research for primary data collection were the survey structured questionnaires for the sample HHs, and semi-structured questionnaires for the FGD and scheduled interview.

3.2.1 Household Survey

To collect Primary data, both closed and open-ended questionnaires on socio-economic, organizational and institutional situation of the users, on household assets, activities, income, and demographic information was collected from sample households using structured interview questionnaires. The interview questionnaires were pre-tested among the non-sample respondents of matching characteristics and depending on the results of the pre-test; some modification was made in the lights of suggestions received. In conducting the interview, four enumerators who have knowledge about the area and well acquainted with the culture and language was recruited and trained before commencing the work of filling questionnaires.

3.2.2 Focus Group Discussion

FGD using semi-structured questionnaires with six participant which can be selected purposively as one water user committee and two traditional water leader, two women and a youth in the irrigation users' community .

3.2.3 Key Informants Interview

Interview using scheduled interview was carried out with ten Key informants. The informants for the researcher were Development Agent (DA) working for Gelan Sedi PA, District officials pertinent to irrigation issues (irrigation desk officer, head for cooperative promotion office, from woreda administration a person in charge of economic and rural development, eastern Hararghe Zonal head for Water Resource Development Department, from irrigation extension service, Zonal Agricultural bureau and cooperative bureau) and NGO like IFAD. Generally different stakeholder on their integration toward sustainability of the scheme was assessed.

3.2.4 Observation

Functionality of irrigation schemes, structures design system, carrying capacity (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 was observed at the field and photographs was taken as aiding tools. Grid coordinates was collected using GPS (Global Positioning System) for the purpose of preparing map of the study area and to calculate area under irrigation and rain-fed with the help of Global Mapper and Auto-Cad software.

3.2.5 Secondary Data

Secondary data was gathered from various sources like zonal and district bureau of agriculture and rural development, NGOs serving in the area IFAD, Regional water bureaus, Finance and Economic Development, Bureau of Agriculture and Rural Development, Cooperative, Land management and natural resources). Similarly to enrich information research publication and other published and unpublished sources were consulted.

3.3. Method of Data Analysis

The analysis of qualitative data is made both during and after data collection. A descriptive analysis from qualitative, quantitative and personal observation was used to explain the different socio-economic, institutional, environmental, cultural and political aspect of sustainability of the schemes. The principal elements of an asset are assessed using a standard questionnaire requiring a YES or NO response to each question in order to see the presence or absence of a defect regarding socio-economic, institutional, environmental and physical aspect of the scheme. Then, Statistical Package for Social Sciences (SPSS) software was used for the analysis of quantitative data. Finally, outputs of the statistical analysis were discussed using tabulation, cross-tabulation, means, frequencies and percentages. These include mean, percentage, frequency of occurrence and range and data will be summarized by using tables, charts, graphs etc. Then using this percentage, try to show the condition index of the situation under. Take the limit of condition index (CI) in Table 2 which is the score associated with the element in worst condition .Use Equation 1 to calculate sustainability rated scale of chosen indicators. Take average value of calculated rated scale of indicators to get rated scale of each category and then take the average of whole category to get sustainability index of the scheme.

Data collected from key informant interviews, group discussions and observations were qualitatively analyzed. At the same time, open-ended type questionnaires, discussion with different stakeholders and individuals' was summarized and discussed. Finally, data from different sources was triangulated to get reliable information.

Several studies employed the above systems to studies sustainability of certain systems. For instance, Garry et.al (2005:64-65), use productivity of the systems, stability, efficiency, durability, compatibility and equity as categories of sustainable agricultural systems and use so many direct and indirect indicators that able to express the categories and then find the sustainability index from the average of the total. Sara at al. (1999 :) in Campbell et al. (2003 :), in study on sustainability of agricultural systems, they use 52 indicators. 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.

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.

Chapter 4

Description of the Study Area

4.1. Location

Deder district is one of the 19 districts of East Hararghe administrative zone of Oromia Regional State. Geographically, Deder district is located in eastern part of Oromia Regional State between $9^0$09'N – $9^0$24' N latitude and $41^0$16'E – $41^0$32'E longitude. It is bordered by Meta district in east, West Hararge zone in west; Malkabalo district in south and GoroGutu in north Figure 4. The capital town of the district, Deder town, is located to the west of Harar town, at a distance of 112km from Harar and about 12 km from the main asphalt road that takes from Addis Ababa to Harar.

4.2. Topography and Climate

Vast area of the district is characterized by undulated and rugged landscape. Agro-climatically, the district encompasses highland (33%), midland (50%) and lowland (17%) with altitude ranging from 1200 to 3138 meters above sea level. Annual average rainfall ranges from 600mm in the lowland to nearly 1200mm in the highland. The district gets biannual rain fall- the belg (short season, from the end of February to the middle of May) and Meher (long season, from July to the end of September). The average precipitation is generally considered adequate for rain fed agriculture. But uneven nature of its distribution, especially in the lowland and midland of the district, has resulted in frequent crop failure. The temperature of the area ranges from 14°C (min.) to 29°C (max.) (*District* Agricultural Office, 2011).

4.3. Demography and population

The majorities of the population of the district live in the rural area of the district and depend on crop production and livestock rearing to support their livelihood. Rural population of the district is predominantly Oromo in ethnic origin and Islam in religion. Population from Amahara ethnic origin also lives in rural area of the district. Total population of the district is estimated to be more than 236,236. Of these populations, about 90.5% live in rural area while the remaining lives in urban area.

4.4 Natural Resource and Irrigation

There are three rivers in the district: Gallan Sadi, Laga Gaba and Burqa Galleti. They are tributaries of Ramis River, but during dry season they are used for irrigation within the district except for Burqa Galleti which serves other districts also. Dader District is also endowed with different types of minerals of which iron ore is the dominant source. According to sources of district Agricultural office land use pattern of the district is summarized in Table 3.

Table3. Land use pattern of Deder

Type of land use	Area in Ha	Percentage
Cultivated land	26,531	39.7
Forest land	1,992	3
Bush and Shrubs	2,270	3.4
Residence and others	9,826	14.7
Rugged and mountains	26,288	39.3
Total	66, 907	100

Source: District Agricultural Offices

The soil type of the district are 5% sandy, 20% loam and 75% sandy loam with 75% black color, 20% reddish brown and others 5% (WAO, 2011).

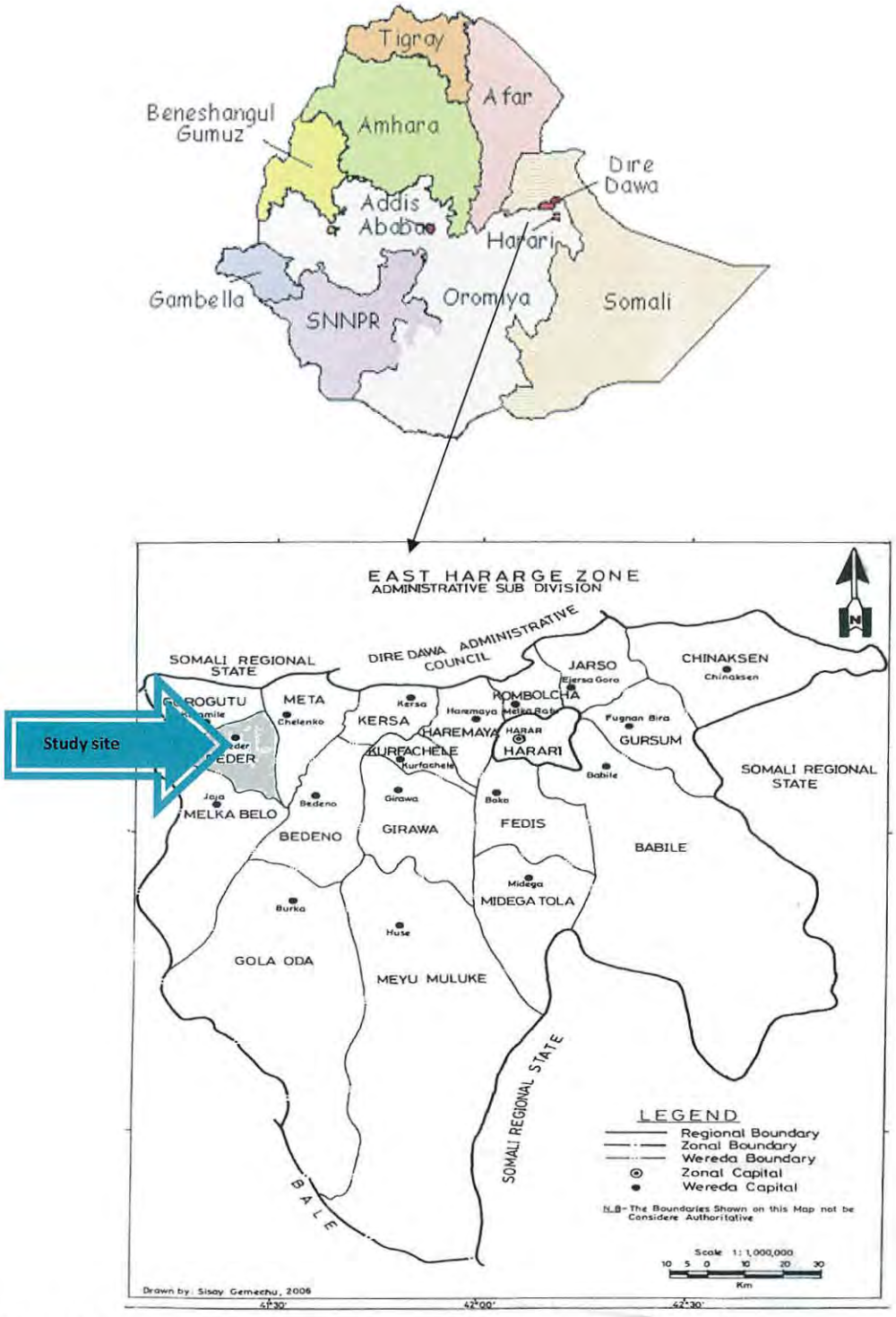


Figure 4: Regional Map of Ethiopia, Study Region and Study Site.

Source: East Hararghe Zone, Finance and Economic Development office (2006)

4.5. Agriculture

Agriculture is the major economic activity in the rural area, mixed farming system being a common practice in all agro-climatic zones (highland, midland and lowland). Accordingly, crop production and livestock rearing are the main source of livelihoods of rural population. Maize is a staple crop in the district followed by sorghum. Wheat and barley are also the second major category of food crops produced in the highland part of the district. Legumes such as haricot bean and horse bean are grown usually intercropped with maize and sorghum. But during a year with abnormal rainfall, growing sweet potato is a common practice in the rural of the district.

Chat and coffee are the two dominant cash crops grown in the district. *Chat* grows almost in all agro-climatic zones of the district while coffee is in the midland but mostly dominating in the low land. For that matter, Deder is among major coffee producing districts in the East Hararghe zone. Deder is also known for its special type of *chat "Hamarkoot"* which is among the dominant source of income and known for its good performance even during dry season.

4.6 Condition of Social Service

The District have 1 hospitals, 4 health centers, 4 clinic and 39 health station with 2 health extension workers in each Peasant Association. Regarding Animals health station, there are about 1 type B animal clinic, 2 types C, 3 types D and around 8 others.

4.7 Description of the Irrigation Schemes

There are about five communally operated modern irrigation schemes found in the District and most of them are implemented by the Budget from IFAD and at this moment additional one scheme is under construction that increases the number of modern irrigation in to six in the District. The total area irrigated by these schemes is about 354 ha with 1976 number of beneficiaries (IODA, 2001).

The geographical location of the project sites is located longitudinally 14°23'E and 9° 16' N latitudinal with altitudinal range of 1640-1600 m.a.s.l. It is found in the Wabi Shebele River Basin and the stream name is Gelan Sedi River with discharge of 100 l /s and total area of 100 ha with 75 ha under irrigation and 25 ha under rain fed with total number of beneficiaries 375 HH (OIDA, 2001).

Nedi Gelan Sedi irrigation project was implemented by the budget from IFAD in 2002 and the construction was ended in 2004 E.C and now it is about seven to nine years. The system of extraction is open canal gravity flow. According to the design report, the length of the canals from the diversion head work to the last project beneficiary users extends about 3.8 Kilometers.

The design and construction of this scheme were carried out by the former OIDA (Oromia Irrigation and Development Authority) and its eastern branch offices. The source of the water for the project is from Gelan Sedi River which is emerged from mount Dima at upstream and the abstraction system is gravity for the whole community. Using GPS (Global Positioning System) the location of the weir is 37 p 0765297, 1021881 UTM and with elevation of 1641m a.s.l. The total discharge of Gelan Sedi River measured by floating method was equal to 175.4 l/sec, which is higher than the discharge calculated on the design document of the project (100 l/sec) and this is because of last year rainfall was good and the upstream user did not begin to utilize fully when this measurement was taken. The conveyance structures found on the canals are 329.5m of lined canals, 4 flume, 4 inclined drops, 20 vertical drops, 54 turn out, 12 turn out with drop, 3 box culverts, 2 chutes, 4 pipe culverts, 3 culverts with check dam and other earthen canals.

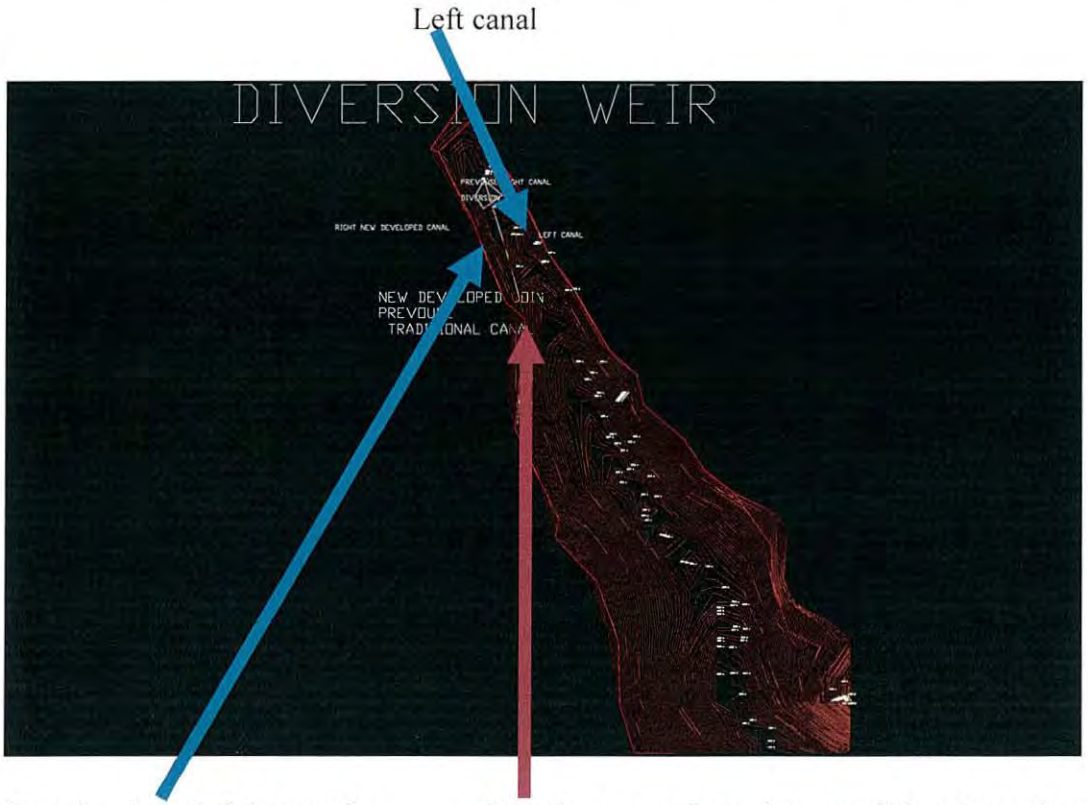
The project benefit around three PA .These are Nedhi Gelan Sedi PA,Golu and Yatu PAs. At the head users in Nedhi Gelan Sedi PA ganda ,Hajji, some parts of Ganda Woldaya are located on the right canals and Ganda Ittu on the left canal with Ganda Kore of Golu PA. At middle users Ganda:Woldaya, Ganda Ali. Whereas at tail users Ganda: Gilboo, Ala are the boundary of modern irrigation but the traditional canal were extended beyond these and benefit Ganda:Qu'ii, Darbii, Dadhii,Roba,Ramis and Dhumuga.

Table 4: Household Distribution of Nedhi Gelan Sedi Irrigation Schemes Users in 2011

Name of village	Number of users(HH)		Total
	male	Female	
Waldaya	71	13	84
Haajii	37	3	40
Jilboo	79	15	94
Ittu	7	1	8
Korre	40	5	45
Ali	15	1	16
Total	249	38	28

Source: DA of the PA

Figure.5. Schematic view of traditional and new developed diversion weir and canals



New developed right canal **Junction area of previous traditional canal and new**

Source: Direct observation and other field data

4.8 Household Characteristics

The mean age of the respondents HH head is about 37.02 year with standard deviation of 9.139.The maximum age of the household head is estimated to be 65 years and the minimum - age is 18 years. With regard to the household members' labor contribution condition as indicated in Table 5; it was found that 45.7 percent of the sample HH members are 14 and below and only 0.2 percent is above 65. By considering HH members below 14 years are too small for work and those members above 65 years are too old and are not potential contributor of labor for the family, the dependency ratio accounts about 46 percent in the areas.

Table 5: Age distribution of Sample HH members

Age distribution	No	Percent
≤14 years	249	45.7
From15-32	188	34.5
From 33-65	107	19.6
>65	1	0.2

Source: HH survey December 2010.

From the survey data indicated in Table 6, 79.5 percent of sampled HH are male headed and 20.5 percent are female headed household. The average family size of the sample households is 6 and 100% of the respondents belongs to Oromo ethnic and Islam Religion. Regarding marital status, 76.1% are married, 3.4% are single, 1.1% is divorced, 18.2% are widowed and 1.1% is polygamy. Here female headed households are supported by their adult's son, relatives, and or by their neighbors in the process of crop production. As indicated in Table 6, household survey result shows that, 33% respondents are illiterate, 9.1% can read and write, 54.5% have attended primary school, 1.1% was attended secondary school and 2.3% have special skill training.

Regarding house type of the sample respondents 96.6% have corrugated iron touched roof, 2.3% grass touched roof and 1.1% has both grass touched roof and iron touched roof house.

Table 6: Demographic characteristics of the Sample HH

Demographic characteristics	*Frequency*	**Percentage**
Sex		
Male	70	79.5
Female	18	20.5
Marital status		
Married	67	76.1
Single	3	3.4
Divorced	1	1.1
Widowed	16	18.2
Polygamy	1	1.1
Religion: Islam	88	100
Ethnic: Oromo	88	100
Education		
Primary school	48	54.5
Secondary school	1	1.1
Special Skill training	2	2.3
Read and write	8	9.1
Illiterates	29	33 %
Average Family size	6	

Source: HH Survey December 2010.

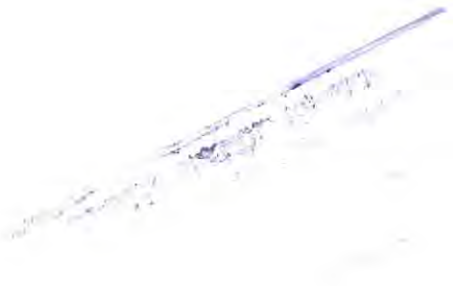
4.9. Resource Ownership and Farm Characteristics

The survey result shows that, the mean land holding of the sample HH under rain fall agriculture and irrigation are 1.33 and 1.51 *kert* respectively. 98.9% of the sampled household gets the land through succession from their parent and only 1.1% is obtained during reform of the government in *derg* time. About 50% of the command area is covered by Chat and 62.5% of the sampled

household use irrigation land for producing both cash crops and food crops, 21.6% only for cash crops,15.9% are use the irrigation land for food crops production.

Regarding the fertility of the irrigation farm, 58% of the respondents says good, 36.8% very good, 3.4% bad and 1.1.% of respondent says very bad, which shows the 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 labor force to perform farming activities. The perceptions of the household on the land holding size are 35.2% very small, 45.5% small and 19.3% sufficient. This confirms the scarcity of land in the area.



CHAPTER 5

Sustainability of Nedhi Gelan Sedi SSI Scheme

Sustainability is a very wide and complex concept that has been used in many ways and various contexts the last decade and at present time. The purpose of this research became to study the sustainability of irrigation scheme systems in the case of Nedhi Gelan Sedi PA from environmental, financial, social, and socio-economic points of view.

This was to be done with a systematic approach by using structured qualitative interviews to collect sustainability indicators primary data from the beneficiaries supported by direct observation and secondary data support.

The categories were chosen to reflect the conditions of the scheme, socio-economic and environmental, that are thought to promote sustainable irrigation system. In total, 8 categories on the environmental and socio-economic sustainability were used in the study. For the sustainability analysis all categories were elaborated by about 36 individual indicators, where each of them was supposed to reflect the sustainability of one major part of the irrigation systems.

Relevance of the project, stability of the system, collective action toward the system, protective action, system resilience, productivity of the system, efficiency of the project and equity were Categories.

Under relevance of the project: importance of the project for the farmer, benefit of the project ,interest and reliance of the farmer on the project, land tenure security, purpose of using irrigation plot and simplicity of structure to operate, maintain and manage were chosen as indicators .

Similarly, to show the stability, functionality (of head work, road crossing, flood crossing, turn out, lined canal and earthen, drop structure), soil fertility, productivity of the land whether it is decreasing or increasing, water availability and land scarcity from time to time were analyzed from the study.

Regarding collective action: sense of owner ship, participation of the beneficiaries, management transfer, establishment of legitimate WUA/WUC, capacity to organize and enforce rule, integration of stakeholder, ability of the beneficiaries to generate operation and maintenance cost and construct new facility were chosen.

Productivity of the project were expressed by 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 labor in the area.

Conveyance efficiency and maintenance performance in terms effectiveness of infrastructure which were collected from direct observation was analyzed as direct indicators of efficiency of the system.

Resilience of the systems: livelihood diversification and contribution of traditional systems for the scheme was analyzed.

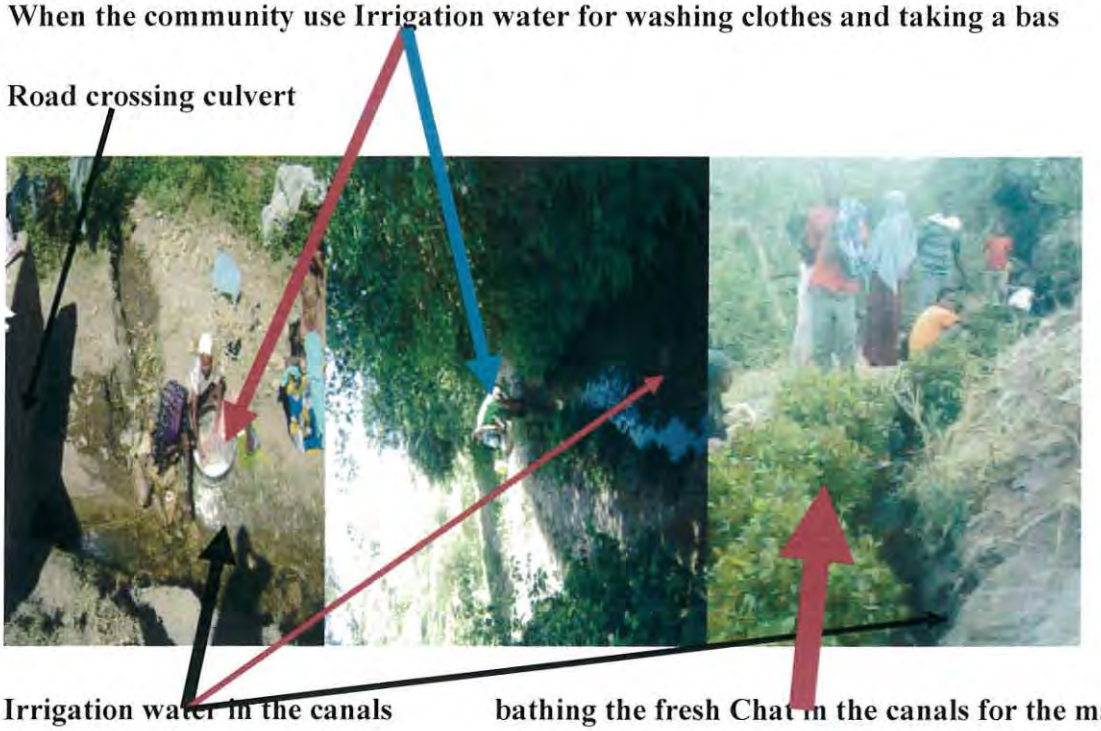
In terms of equity, equity of water distribution and gender fairness issues were selected as indicators.

Similarly, under protection of the environment, severity of soil erosion, cropping pattern, water shade 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.

5.1 Relevance of the Project

According to the survey, 88.6% of the respondents believe that the benefit of the irrigation project is multiple purpose and 11.4% respondents said that the benefit of Nedhi Gelan Sedi irrigation is only for irrigation purpose. For example, washing the clothes on the canals, using the water in the canals for cattle watering purpose, taking a bass in the canals and using the water in the canals for cleaning equipment near the villages where the canals cross and bathing the chat to improve freshness, are some of the multiple purpose of utilizing the irrigation project as indicated in Figure 6. There is no any watering structure or trough for livestock that is why farmers are using irrigation canals for this purpose which was an opportunity of damaging the structures.

Figure 6: Multi-pupose benefit of irrigation water in the canal



Source: Nedhi Gelan Sedi Right Main Canal, December **10,2010**

Similar, 62.5% of the sample respondent said that, the irrigation project is very much important, 35.5% said normal whereas 2.3% of the respondents said that, the project is not that much important for them. Land tenure security is 100% as the irrigation land belongs to them. Similarly, most of the Head and middle user use irrigation water and land to generate cash crops which is 62.5% of the respondents. At the same time the respondent's perception on land size under irrigation as indicated above illustrate that the intensification of the agricultural activities is the only way to improve the livelihood of the community.

Simplicity of constructed structure to operate, maintain and manage also increases the relevance of the project to the community. In line with this, 93.2% of the respondents said that, the structures are simple to operate, maintain and manage.

In general, the relevance of the project indicates contribution of the system to affected systems. That is the existing traditional systems. As a result, from FGD held with two traditional water leader, one water committee, two women and one youth in Woldaya village and key informant

discussion (DA of the area), the relevance of the project for the farmers is perceived in different ways across the canals with respect to the location of the field from the head works.

Most of the middle user which is found on the right canals produces vegetables like onions, tomatoes and carrots. About 62.5% of respondents are those who use irrigation to harvest cash crops and belong to this right canals middle user. An elderly at Woldaya village of Nedhi Gelan Sedi PA, for example, described the relevance of the project in terms of the change of the production systems as:

> *I have a big plot here in Woldaya out of this irrigation project but under traditional irrigation from upstream diversion. But under this project even if the land size is small we learn production of fagee (improved seed of maize with straight rows) after IFAD did demonstration trials on some plots of selected farmers and now our production were increased but the land does not respond without fertilizers at this time. I haven't sown vegetables yet, but now I try to plough Onions this year.*
>
> ***Source: FGD, December, 2010.***

Similarly, one of the beneficiaries that interviewed during direct observation when he and his friends were perform desilting the head work intake gate as indicated in figures 7 said:

> *The right canal head user which is found up to 500m especially criticize the project by saying after the intervention, we lost the traditional irrigation systems, which come from another diversion point from upstream. Because the new canals developed by intervention give benefits for us before the head work was silted up. But, especially after 2008, since the weir was totally silted up and it is above our capacity to maintain it, it become burden on them to desilt it. Now as you see we are trying to disilt only from the gate and nobody collaborate with you to do this but only those who need the water.*
>
> ***Source: Direct observation and interview, December, 2010.***

Figure.7. Condition of main gate

The Left canal gate **Right canal gate and the condition of the silt**

Source: Photo taken from Nedhi Gelan Sedi Irrigation Project on December 10/2010

On the other hand, all the left side beneficiaries were share condition of Figure 7, after the weir was silt up. But due to the existence of long flume on the left canal that was constructed by this project, the relevance of the project was viewed with respect to the benefit of this flood crossing structure.

From the above discussion, it can be concluded that, the relevance of the project for the farmers is perceived in different ways across the canals with respect to the location of the field from the head works and community had awareness about advantages of irrigation.

Hence, 96.6% of the respondent said that their life was changed after they started using modern irrigation and indicators of households' life change after they start to use modern irrigation was shown in Table 7.

Table.7: Indicators of life changed after using modern irrigation.

Indicators of life change		Frequency	Percent
	Construction of new house	3	3.6
	sending children to school	2	2.4
	food variety	20	23.8
	income increase	27	31.1
	construction of new irrigation facility	1	1.1
	Construction of new house, sending children to school, food variety and income increase	28	33.3
	Sending children to school, food variety and income increase	2	2.3
	Speed Up water in the canals	1	1.1
	Total	84	100

Source: Fieldwork, December, 2010.

In sum, taking 50 percent minimum value and 100 percent maximum value regarding the presence of relevance indicators like importance of the project to the community, benefit of the project, interest and reliance on the project, land tenure security, purpose of using irrigation plot and simplicity of irrigation structure to operate, maintain and mange , from the actual value percentage in Table 8, the rated scale of sustainability for each indicators were calculated using Equation 1 and the result are shown in Table 8 too.

Table 8: Summary of result of relevance of the project

Category	Indicators	Percentage of actual value at plot or scheme level	Rated scale of sustainability	Remark
Relevance of the project	a. Importance of the project for the farmer	98 (both at plot and scheme level)	4.8	Good
	b. Benefit of the project to the farmer	88.6	3.86	
	C .Interest and reliance on the project	75 (plot level)	2.5	Different depending on the location
	d. Land tenure security	100 (plot level)	5	Good
	e. Purpose of using irrigation plot	62.5 (plot level)	1.25	Those use for cash crop or vegetables
	f. Simplicity of the structure to operate, maintain and manage	93.2	4.32	

Source: Household survey, December 2010

Relevance average= (4.8+3.86+2.5+5+1.25+4.32)/6=3.62

This value shows, condition of sustainable aspect in terms of relevance of the intervention to the community, one steps to ensure sustainability of the scheme.

5.2 Condition of Physical structures and technical aspect of the scheme

According to the design report of the project, there are two traditionally used and constructed diversion weirs located at 950m apart from each other on the same river course, of which each did have one canal commanding left and right of the river course and the design avoids the downstream diversion weir and brings these two canals into one diversion weir that have height of 1.35m (head works). But of total 3.81km right canal only 0.95km is new canal which was

introduced or implemented by this project and after 0.95km they merged to previously existing traditional canal which is diverted from traditional diversion point.

During the field work the calculated actual discharge at intake point for the right main canal was equal to 30 l/ sec (current abstraction) 43.4% of the design capacity, similarly current abstraction of water on the left main canal was 28.8 l/sec (94.11%) of the design capacity. Here the head work (weir) was totally silted up by the flood during 2008 so that, its water storage capacity is zero and the gate of intake was buried by the silt together the weir except the two guide and wing wall as indicated in Figure 8 and at the same time previous canal depth (LMC) was 0.4m but now about 0.1m is silt up and the actual depth above the silt is 0.3m.

Generally, there are major difference between as built document and actually constructed scheme on the head work area.

Farmland near the river were destroyed by the flood during rainy season every year in spite of the farmer effort at their farm level individually and due to this, the scheme command area are decreased from year to year and farm land loss by the flood is the main problem as interview certain farmer during the observation and as it was seen in Figure 16.

One informant, named Asha Umare Hajii (50) from Ittu village in Nedhi GelaN Sedi PA said that "Previously my farm is not only this much, it was about 6 kert but now I have only half of kert. It is the flood which make like this. Beside this, look at the canal on the top of my farm that seep the water to the field and make marshy as you see the land".

Moreover, according to key informant from Woreda and Zonal expert Karam and Zegeye Tesfaye, whenever there are a rain, there are flooding in the area due to lack of watershed management at upstream and there is no collaboration between different stakeholders of the GO and NGO's in the project area to solve the problem of the area in holistic approach at this time.

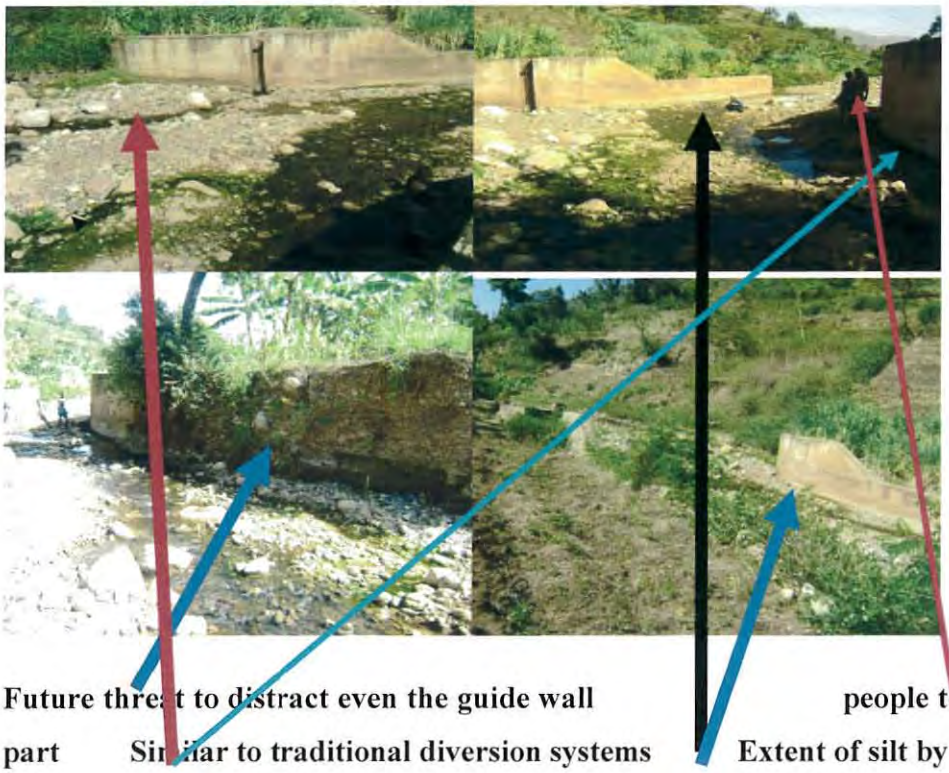
Similarly, on the left side of the canal, one column of the flume was totally destroyed by the flood last year (2010) and not maintained until now as indicated in Figure 15. Only two turn out have the gate and the other are destroyed and stolen as it was observed on the field and also understand during FGD which was held with Water Committee in Woldaya Village of Nedhi Gelan Sedi PA.

The survey result revealed that, 70% of irrigation users responded that, the structures were mostly damaged by siltation during high rainfall due to flood and erosion, weeds and other plant growth but the abandon of turn out by the community pave the way to destroy the iron gate and change to farm equipment due to vandalism.

On the other hand, sample respondents were also asked about their view and feelings on irrigation scheme structure ownership. 5.7% responded that, scheme structure belongs to the government and 94.3% responded that, the scheme structure belongs to the community. Still there is a tendency of considering irrigation scheme structure as government's property and farmers' understanding was that the government and the implementing non-governmental organization are responsible for every matter of the irrigation scheme as the researcher understand during FGD with the selected group of Elderly traditional water rule in Gilboo village of Nedhi Gelan Sedi, even if it show ownership in survey interview. Moreover, the views of the respondents to the physical structure are different across the location and type of the canals as mentioned in the above part under relevance of this project.

Those found in the right canals did not express the filling of ownerships regarding the head works, due to the head work (weir) was totally silted up by the flood during 2008, so that, its water storage capacity is zero and the gate of intake was buried by the silt together the weir except the two guide and wing wall as indicated in Figure 8. At the same time, those found on the right side still use their traditional diversion point which still withstand the adverse flood that silt up the modern irrigation systems, which invite other research topics with respect to system resilience.

Figure 8: Current condition of head work



Source: Pictures taken from Nedhi Gelan Sedi Scheme on December 10,2010

5.2.1 Physical Stability of the Scheme

Under this subtopics, stability of the physical structure and natural capital (water and land) were investigated with indicators like functionality of physical structure(head work weir, road crossing structure, Flood crossing structure, turn out, lined canal, drop structure), siol fertility, productivity of the land, water avaialbility and land scarcity that indicate stability of the systems to ensure sustainability of the system.

To see physical stability of the system effectivenes of infrustructure were culculated which indicate the functionality of the sytems.

Effectiveness of Infrastructure= (Number of functioning Structure/Total number of structure) = (42/108)*100= 38.9%

Taking 50 percent the lowest limit and 100 percent the largest limit stability rated scale were shown in Table 9.

Table 9: Rated scale of stability of the systems

Indicators	Variables	Actual value Condition index percent	Rated scale	Remark
Stability of the systems	a. Functionalities/Effectiveness of infrastructure	38.8	-1.11	Poor value
	b. Soil fertility	94.8 %	4.48	Good(HHs Survey)
	c. productivity of the land	79.1%	2.91	Fair (HHs Survey)
	d. water availability	63.9 % Average of plot and scheme	1. 39	Unfunctionality and poor water resource management problem affect it (HHs survey)

Source: Field data, December, 2010.

From Table 9, stability average rated scale is equal to (-1.11+4.48+2.91+1.39)/4=1.719=1.72 which shows the condition of very poor and approach to unsustainability and need immediate action.

5.2.2 Efficiency and Effectiveness of the scheme

Effectiveness of Irrigation refers to benefits earned from irrigation by the target communities or beneficiaries in a broader sense that can be explained in terms of the change in the quality of life of rural households. Change in quality of life, in turn, can be explained by better housing, increased number of meal in quantity and quality, asset possession in terms of livestock and other households.

Regarding this, 86.4% of the respondents said that overall annual crop production is increased and 13.6% of the sample beneficiaries said that the overall production is not increased. The FGD members participated in Gilbo and Woldaya village also confirm that, there are substantial

improvements regarding overall production in the area by saying we did not take any aid as a food from any organization in our history. The housing condition of the respondents shows that, 3.4% live in grass touched roof house, whereas 96.6% live in iron touched roofed housing in the study area. As the data of household survey shows that, 33% of the respondents' number of meals per day in their household is three times per day, 64.8% two times per day and 2.2% are one times per day. At the same time, 86.4% of the respondents reports that their livestock are benefiting from the irrigation project directly from residual and open access to the water in the canal even if the canals are destructed by the livestock.

To see conveyance efficiency of the main canals, the first canal section considered for discharge measurement had 5 meter length and straight reaches of the canals. Floating material (dried sugarcane leaf) was put on the upper end of this canal section and the time it took to reach the 5 meter mark was registered. This test was replicated five times and the average time it took was taken to calculate the discharges. The cross sectional area of the canal was also estimated 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 each canals was calculated.

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 conveyance efficiency was, then, calculated as:

$Ec = V_d/V_c$

Where, Ec is the conveyance efficiency (%),

Vc is water flowing in the canal (l/sec) and,

Vd is water flowing out of the canal end (l/sec),

The measurements for both positions were taken once and only at normal flow and the conveyance efficiencies under normal flow conditions were calculated using the above Equation.

Thus, in this case, to see conveyance efficiency water supplied by the conveyance system at left and right canal was measured and accordingly the result was, 28.8 l/sec and 30 l/sec respectively. Then at 500m from the above point again the measurement was taken and the result of the discharge of the canals became 20.46 l/sec for the left canals and 25.54 l/ sec for the right canals. Therefore the conveyance efficiency of the two canals is 71.04% for the left canals and 85.13% for the right canals and then by taking the average of the two canals the conveyance efficiency of the project is equal to 78.09%.Here there is no secondary and territory canals developed by the project and measurement was taken only from main canals. From the above calculation, from the left main canal 8.34l/sec was lost and within 24 hours 720,576 liters of water which is too much if it is utilized. This is similar for right canals too.

According to Brouwer and Prins, (1989), sited in 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. The efficiency of lined canals has been reported in the order of 95% for all canal length. With this respect, 78.09% for lined canal are lower than 95%.

Similarly, to see distribution efficiency and field application efficiency there must be extension of service including secondary and territiary canals systems. But in this case there are no any secondary and territiary canals systems, so that ample amount of water were lost due to lack of proper facility as indicated in figure 8 under the traditional systems.

Figure 9: Jump of water from main canal to irrigation field

Source: Picture taken from Nedhi Gelan Sedi on December, 2010

Shows falls of water from main canals to secondary that did not have drops and gates and proper canals or water ways even in the traditional systems.

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.

In sum, taking 70 percent 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 10.

Table 10: Conveyance efficiency sustainability rated scale value

Category	Indicators	Actual value of indicators in percent	Sustainability rated scale	Remark
Conveyance efficiency of the scheme	Conveyance efficiency	**78.1**	**1.62**	**Approach to unsustainable condition**

Source: field work, December, 2010.

In general, from physical condition of the scheme, current state of the scheme were shown under this subtopics and the research indicate that, poor effectiveness of infrastructure and poor conveyance efficiency was observed.

5.3 Financial Sustainability of the project

The financial viability of an irrigation scheme is closely related to the financial viability of the members' households. It also depends on the sense of ownerships and commitment that members feel towards maintaining and sustaining the scheme (SEAGA, 1998 :). For the needs of the farm family and to satisfy local food requirements, any sustainable agricultural system must be capable of producing good yields. similarly, any production systems that results in excellent yields and profits, but gradually or even precipitously destroys the resource on which it is based, is equally unacceptable and unsustainable (Garry et.al. 2005:107).

Thus, under this sub-topics, crop production patterns, productivities and production inputs and food security situation was assessed qualitatively and quantitatively to indicate financial condition of the scheme and the productivity of the project indirectly from selected indicators.

5.3.1 Crop Production patterns and productivities

According to the design document and Key Informant interviewed during the study time, irrigated agriculture is the main means of income generating for existence of life at the area due to shortage of rainfall for 10 months per year. That is why 96.6% of the respondents confirm that, the crop yield from rainfall is not enough for them. Thus, implementation and introduction of intensive agricultural system by increasing cropping intensity per year is the only solution to ensure food security of the area and the data collected from the household interview of selected schemes shows that 87.5% are able to produce two times per year, 9.1% three times and 3.4% produce one times per years. Even if the design document was propose 161.3% per year as cropping intensity and under improved irrigation system, still the dominant existing cropping pattern were maize and sweet potatoes and this was what they said two times per year.

Table 11. Proposed crops and cropping calendar for Nedhi SSI scheme

Crop under full irrigation	Ha	Month	Crop proposed under supplementary irrigation	Ha	Month	Proposed perennials under improved irrigation system	Ha
Onion	7	Oct-Feb	Maize	14	Feb-June	Papaya	4
Potato	6	"	Haricot bean	7	March-June	Sugarcane	2.8
Maize	5	Sept-Jan	Beet root	3	"	Chat	40.4
Tomato	3	"	Potato	3	"	Banana	1.8
Pepper	3	"	Cabbage	3	Feb-APril		
Carrot	3	"					
Sweet potato	3						

Source: Design document of Nedhi Gelan Sedi 2001

Even though, the above cropping pattern was proposed by the project, by now the dominant crops of the head users are sugarcane, Sweat potatoes, maize, onion, and tomato while chat is only produced on the land of downstream users due to soil and pests problem on the head and middle user in the valley according to the user's discussion during FGD held on Gilbo Village of Nedhi Gelan Sedi PA. To confirm the above statement, 55% of the respondents said that they follow proposed cropping calendar, 38.2% said not followed whereas 6.8% said that they follow the proposed cropping calendar sometime. But 86.4% of the respondents said that their annual crop productions were increased and 13.6% said "not increased" which is due to introduction of fertilizers and improved seeds.

Table12: Average improvement of crops production after irrigation development.

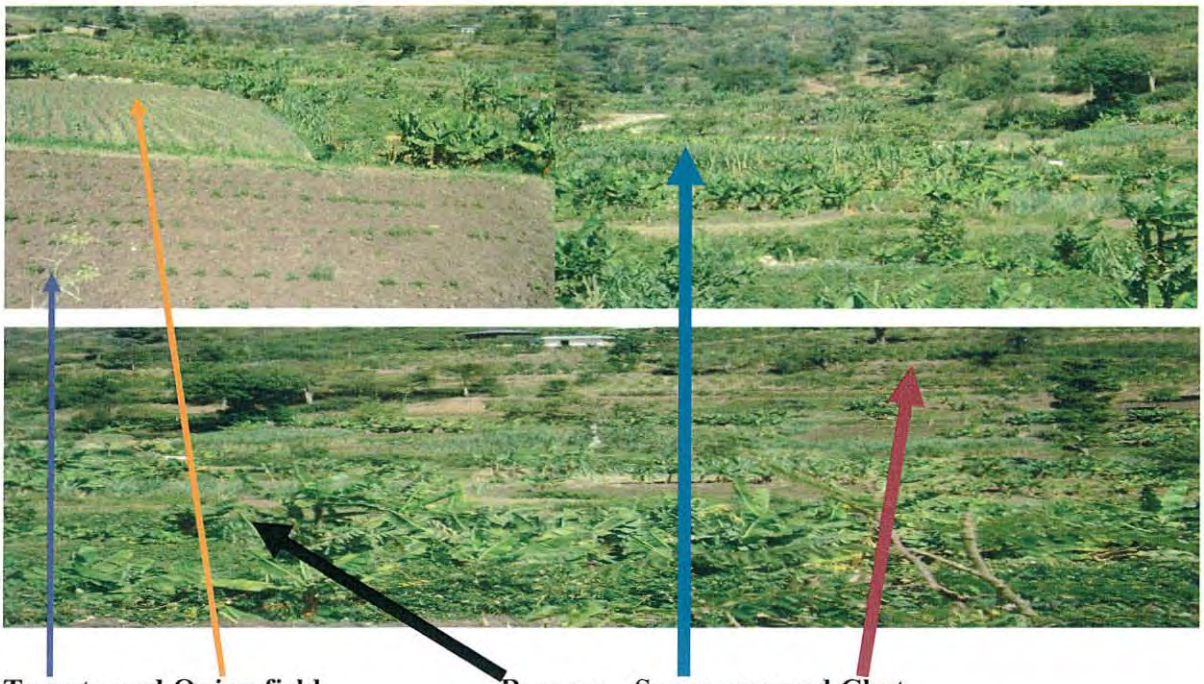
Type of Crop	Agricultural land(In kert)	Previous Production/ ke-rt	New Production/ kert
Maize(supplementary)	1.33	2 quantal	3-5 quantal
tomato	0.25	Not practiced	400 Birr
onion	0.25	Not practiced	350 Birr
Sugar cane	0.2	high	Low due to flooding
Banana	0.2	high	Low due to flooding
Chat	1	1000(Birr)	3000Birr (depend on the condition of the time(specially the tail end user have too much chat under the schemes
Coffee	0.03125	high	Low(it is replaced by chat)

(Source: Household survey)

100% of the consulted households confirm that, maize, sweet potato and sorghum are cultivated using rainfall. Regarding grain crops maize is the dominant crops, and 50% of the command area was occupied by Chat, but within the boundary of this project, it is found at the downstream of the area out of the Gelan Sedi PA which is Yatu PA according to FGD and direct observation.

The sample respondents said that, they mostly grew maize, because it is staple food crop; its irrigation water application is easier and provides large stalk for animal feed. On the other hand, farmers also grow sweet potato, because, it is less perishable, it fills food shortage gap with high carbohydrate content, easy to harvest and transport, it requires less water with wide irrigation interval, withstands drought and diseases and also provides large leaves for animal feed.

Figure 10: Major crop grown under Nedhi Gelan Sedi irrigation project



Source: Pictures taken from Nedhi Gelan Sedi Scheme on December 10/2010

As indicated in table 13, 52.3% of the respondents' choice crops with respect to better prices of the crops.

Table 13: Perception of the respondents of the crops type grown

	Reason for selection of crops	Frequency	Percent
	Better price for production	46	52.3
	easy for operation and good production	4	4.5
	Traditional preferred for household demand	3	3.4
	High disease tolerance and adaptation	3	3.4
	Seed availability	3	3.4
	All the above stated	6	6.8%
	Better price ,easy for operation, high disease tolerance and seed availability	1	1.1.%
	Better price, traditionally preferable, high disease tolerance and seed availability	24	27.3%
	Total	88	100

Source: Households survey December 2010

In general, the objectives farmers assign to irrigation play a great role for productivity and sustainability of the scheme. With this respect ,100% 0f the respondents relate the importance of irrigation with Chat since it does not require too much labor as that of vegetables that is why the upstream users always blame the downstream people those who have chat by saying the project was only constructed in our PA but it benefit to much the tail users PA. This is one of the bottlenecks for sustainability of this scheme.

5.3.2 Input Utilization

The intensification and production of cash crops especially vegetables are only limited to the right canals head and middle users on the plot of certain people under the project of IFAD support at this time and they are testing the benefit of this project at this time as the participant said during FGD.

About 79.1% of the respondents said that, the productivity of the land does not decreased where as 20.9% said that, the productivity of the land decreased from time to time because without fertilizer there are no any production from our plots. That is why 92% of the respondents use fertilizers and improved seeds as well as pesticides.

Even if the design document proposes use of chemical fertilizer, improved seeds and use of protective chemicals with its method of application, there is not any average application of the above stated inputs in the area. But, 92% of the respondents said that, they use fertilizers and improved seeds especially for maize that are not according to the recommended rate of design document.

5.3.3 Productivity status of the irrigation farm

Farmers in rain-fed areas, especially in the arid areas, are 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 Nedhi Gelan Sedi, it is important to maximize income from this small amount of additional irrigation.

As indicated above since the land does not respond without the supply of fertilizer, now there are shift of practice by augmenting application of fertilizer with compost and manure.

5.3.4 Household's Food Security Situation

The traditional irrigation in the area has been started at the area since 100 years ago by the man called Hajji Barkale by whom the main right canal (Woldaya) was constructed. Since then, a lot of agricultural crops such as sugarcane, sweet potato, banana, coffee, chat and maize have been produced by using traditionally constructed irrigation structures (IODA, 2001).

As discussed above, due to intervention the community learns to cultivate Faagee (improved maize variety) and especially those found on the right side middle canal now practicing production of cash vegetables like onion, tomato and potatoes as indicated in Table12.

The survey result shows that, 96.6% of the respondents agree that after the intervention their life is changing. Regarding food security condition, 58% of respondents said that they produce available food for home consumption, whereas 42% said not. The major area of concern among the rural farming community is the availability of food at household level and 33% of the respondents' number of meal per day is 3 times, 64.2% said 2 times per day and 2.3% said their number of meals is 1 times per day.

Accordingly, 62.4% of the respondents believe that crop production have dual purpose which include the production of both food crops for household consumption and cash crops for sale and used to purchase consumption food items. 96.6% of the respondents said that even if they produce available food for home consumption, most of the time the produced foods crops for home consumption are not enough to feed them all round the year and they purchase food item. About 42% have off-farm income other than agriculture. However, the area always face problem of seasonal food shortage after the end of April, June and specially September and October, were large member of families are exposed to disaster and famine. According to key informant DA of the area, nevertheless, farmers do have a traditional coping mechanism to the above vulnerability situation. Some of them are: grain borrowing among themselves, money credits, eating sweet potatoes, reducing the amount and the number of food taken per meal. For instance, the amount of meal taken in January (threshing time) is different from the amount of meal taken in May (no harvest).

As supplementary activity, rearing of livestock's also supports families to satisfy their day to day needs as the respondents of FGD and key informants interview of the area stated in the discussion held with them at Koree village of Nedhi Gelan Sedi PA. Similarly, 87.5% of the respondents said that, the irrigation practices change their livelihood positively whereas 11.5% said not that much.

5.3.5 Productivity of the scheme

Taking 50 percent the lowest limit and 100 percent the largest limit productivity rated scale were shown in Table 14 and productivity average of the scheme were (3.8+3.9+0.5+3.5+3.4)/5 = 3.02 which shows sustainable condition in most aspect but intensification activities still lack.

Table 14: Productivity rated scale

Category	Indictors of productivity	Actual value of respondents answers in percent	Rated scale	Remark
Productivity	a. Generate sufficient income for the households	87.5	3.8	Good
	b. Improvement of the livelihood of the farmer	88.5	3.9	yes
	c. Intensification (maize and sweet potatoes rotation were dominant in the area)	55	0.5	poor
	d. Increasing of annual production after modernization	86.4	3.5	Good
	e. Availability of farm labor	83.9	3.4	Very good

Source: Field data, 2010.

Here, the main point of this subtopic is to see the financial sustainability of the scheme by discussing the financial viability of the members' households. Even if the scheme is relevance and productive for the households, absence of commitment feeling towards maintaining and sustaining the scheme, brings lack of condition which ensure financial viability of the scheme. Because of this, 92 percent of the sampled households are not paid and willing to pay operation and maintenance costs, water fee costs and project recovery costs, which show poor financial viability of the project.

5.4. Institutional Aspect of the scheme

Irrigation development and management is a social process in which different stakeholders interact to make irrigation system effective and efficient. Disappointing 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 (World Bank, 1998)

According to Pant (2000:15) in Wageningen (2008:18) Ostroms provides an analytical framework of institutions for governance of irrigation systems, with three nested sets of rules which are necessarily for the effective functioning of the irrigation system. The operational rules govern the daily use of monitoring water activities of others and rewards and sanctions for the combination of action and outcomes. Collective choice rules confirm how schemes should be operated and managed. Constitutional choice rules determine who is able to participate in a scheme and who will draw up the operational and collective choice rules (Ostrom in Pant, 2000:15, in Wageningen, 2008:18)

To bring this Poven (2004) pointed that WUAs are the most frequently recommended organizational form for management of irrigation schemes. WUAs are legal entities which are supposed to have full control over the irrigation infrastructure in their scheme.

Establishing a strong irrigation organization is one of the major aspects for a successful and sustainable irrigation management. Sustainable management of farmers-managed irrigation systems requires well established rules that ensure the interest of all farmers.

5.4.1 Establishment of WUA

According to IFAD key recommendations from the evaluation of SCP II, Sustainability of SSI project depends on site selection in relation to markets; establishing or strengthening sound social structures; study and design which takes account of local knowledge; and post-construction support services.

From the above suggestion to see establishment of WUA in the schemes respondents are asked whether they know or not know water organization established in the area. Accordingly, 85.2%

of the respondents said "not know any water organization" whereas 14.8% said they know establishment of water use association.

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

> *The establishment of water user association was carried out by electing water committee only from one village which is found at the right canals of middle block. Still they bear the name of water committee even if the community did not accept them.*

Key informant interview: Decemeber, 2010.

Even if the committee with 8 members was established in 2004, no change has taken since then. According to the information from FGD held with elderly traditional water leader in Ittu village of Nedhi Gelan Sedi PA, *the set up of the WUC in the study area previously initiated for the purpose of fulfilling the criteria set by IFAD organization to get post-construction support especially during demonstration period and still these people are actively participate in the leadership in the committee* while the left side and down steam users' village did not even recognize them. From the HH survey, 96.2% of the respondents agreed that they are not the member of the irrigation users' association and only 3.8% are member of the irrigation user's association. Some of the reasons for being not the member of the irrigation user's association as indicated in the survey result were lack of participatory approach during election of the committee, lack of confidence in its importance and un-affordability to pay the contribution for the membership. All respondents confirmed that the existing WUA committee has no by-law. Beneficiaries and the committee have no role in scheme maintenance except canal cleaning.

Thus, the committee must be representative of all villages, have finances and must have clear objective. Sustainable management of farmers-managed irrigation systems requires well established rules that ensure the interest of all farmers.

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

Table 15: Response of existing management system

Management systems	Frequency	Percent
community alone	1	1.1
WUA	2	2.3
NGO alone	0	0
GO	0	0
Traditional Leader alone	20	22.7
All in collaboration	3	3.4
GO and Traditional leader	57	64.8
Community, WUA and Traditional leader	1	1.1
WUA and traditional leader	2	2.3
Community and traditional leader	1	1.1
NGO,GO and traditional leader	1	1.1
Total	88	100

Source: HH survey data

Accordingly, from Table 15 the issues of existing WUC are insignificant and the PA administration and the traditional leader play a great role in management of the scheme.

5.4.2 Water Allocation and Equity of distribution

According to FAO, (2006), in most of African communities' water is frequently seen as a common good, a gift of nature or of God, linked to strong cultural values that forbid men to appropriate water. The absence of historically established water rights makes water distribution a new and difficult objective for irrigation development. Since the intervention, farming communities have been trying with more or less success to craft socially acceptable and applicable water distribution rights (FAO, 2006, 18). Fairness and equity, rational use of resources, non-discrimination and transparency and participation are among the principle of the institution to bring socially acceptable and equitable water distribution system.

In the case of Nedhi Gelan Sedi SSI project, 99% of the control gates of turn out were not functional even if the structure of masonry are there, the community still use traditional turn out to the field and to secondary canal too. The criteria for determining when to irrigate is not according to design document and there is no any operation and maintenance manual.

Table 16: Traditional and current irrigation scheduling at scheme level which is rotational system.

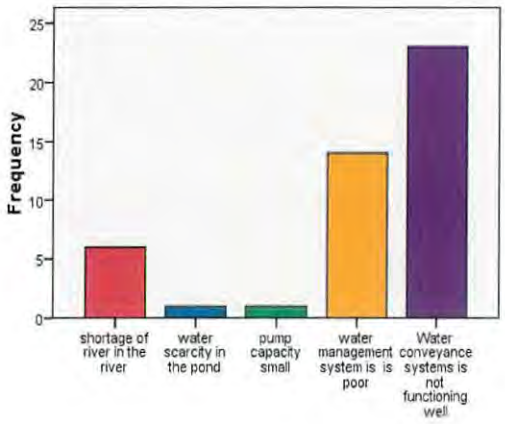
Name of village	Number of users(HH)		Total	Water distribution according to villages	Block
	male	Female			
Waldaya	71	13	84	From Monday-Friday before noon and Saturday and Sunday 24 hours	Head and middle user
Haajii	37	3	40	"	"
Jilboo	79	15	94	Except Saturday and Sunday always after noon	Right canal tail users
Ittu	7	1	8	"From Monday-Friday before noon and Saturday and Sunday 24 hours	Left canals head and middle user
Korre villages	40	5	45	"	"
Ali villages	15	1	16	Except Saturday and Sunday always after noon	Left canals tail users
Yatu (PA) (excluded from the improved development but, still keep their previous water sharing quota				Every night Except Saturday and Sunday	Both right and left canal

Source: FGD with traditional water leader in the study area

At the scheme level water distribution is fixed rotational system according to the above table. But at village level since every village have their own *Malaqa,* mode of water distribution vary

depending on his experience and the prevailing cropping pattern of the village. From Figure 10, 35.2 % of the respondent said that, decision of *Malaqa* govern who get water in the area, where as 50 % of the respondents agree that mode of water distribution depends on the crop type and land size. Which mean, depending on the condition of the crops and land size, the *Malaqa* know the time required to irrigate the field from his accumulated traditional skill.

Regarding availability of water during the interview, 87.5% of the respondents said that irrigation water is enough for the project. Whereas 12.5% said that, it depends on the condition of the rain. But when the respondents was asked the extent of water availability at plot level, 47.7% of the respondents said 'yes' it is available, whereas 52.5% respond 'no'.



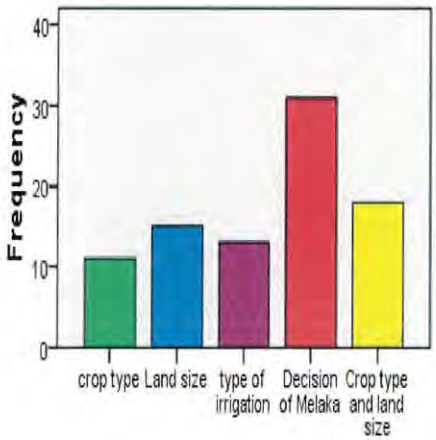


Figure 11: Reason for Scarcity

Figure 12: Mode of water distribution

From Figure 11 and 12, more than 20% of the respondents agree that unfunctionality of the conveyance structure was the main reason of shortage of water at plot levels. The mode of irrigation water distribution of the Nedhi Gelan Sedi irrigation project were still under the traditional leader called *Malaqa* which as shown in Figure 12 in which decision of *Malaqa* accounts for more than 30 percent of water distribution.

Regarding equity of water distribution, about 77.1% of the respondent feels that they did not share equally, where as 22.9% of the users feel as they share equal amount of water with every user of the scheme. The reason of inequality was shown in Table 17.

Table 17: Reason of inequality in water distribution

Reason of inequality	Frequency	Percent
Management of water canal	2	3.1
Nearness to the main canals and diversion point	51	78.5
Political powers and others	12	18.5
Total	65	100.1

Source: Fieldwork, December, 2010.

Table 17 shows that, nearness to the main canals and diversion structures, play a great role in getting water. Similarly, 77.3% of the respondent said that, people found at headwork and middle user get more water than people found at tail or end user. This shows that, there was in-equality in water distribution which hinders issue of collective action toward sustainability of the scheme.

But, when water scarcity is high, the *Malaqa* decided water distribution on negotiated request. Thus, from FGD and key informant interview held on the site, traditional leader which are elected by local community is the man in charge to distribute water but every village has its own *Malaqa* and there are no any coordination among them. When the respondent asked the extent of water availability at plot level, 47.7% of the respondents said yes, whereas, 52.5% responded there is scarcity. The factors that contribute for scarcity of water for irrigation also depicted in Figure 9 of which problem of conveyance systems weigh more.

5.4.3 Organization of the Irrigation Scheme Users

As indicated in the above part, the existence of WUA and WUC are insignificant. Thus, it is important at this stage to evaluate the strategies implemented by the farmers to adapt their practices to the conditions, and the collective agreements that permits to adapt the formal frame to the specific situation. Formal frame are a framework of irrigation schedule existing before

implementation of the project under traditional systems. Generally, the traditional arrangement to adapt formal frame of the scheme are shown in Figure 13.

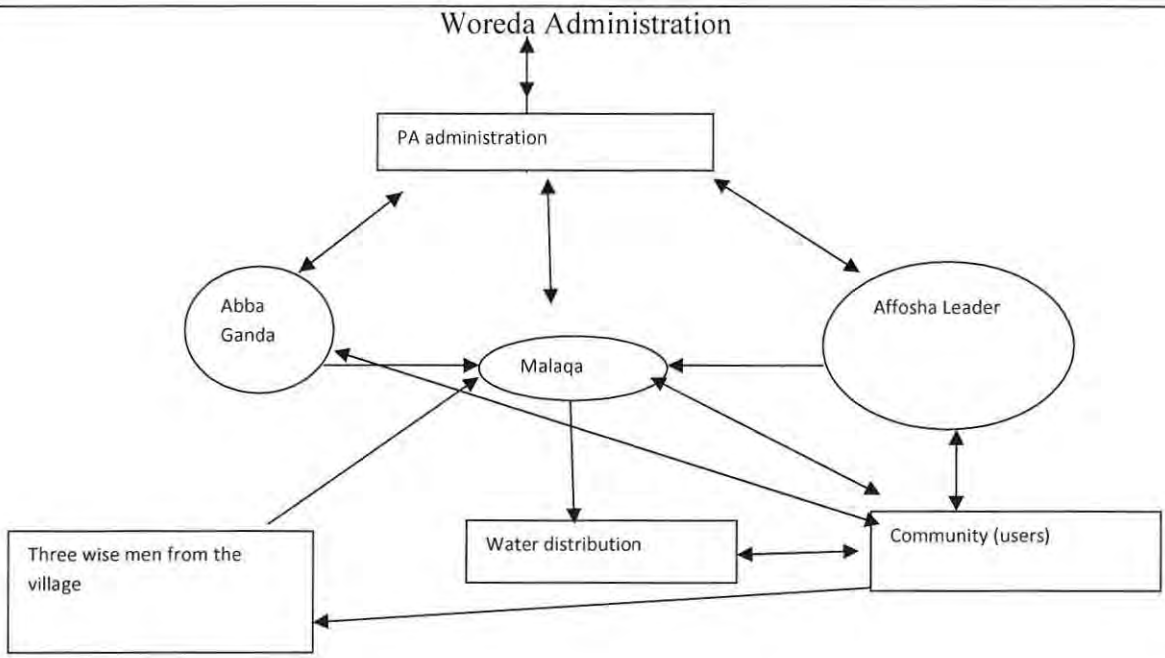


Figure 13: Formal and current schematic organizations of scheme user

According to FAO, (2006) in rural Africa, villages are the most important social units. In the case of Nedhi Gelan Sedi PA, villages are the most important social units too. The community of one village organize themselves and is a key unit for water management. A certain number of days of water is accorded to it and has to be shared between the different users. It is also the unit for collective structure maintenance organization. In each cluster, a water committee is elected, composed by one *malaqa* and three mangudo bishani.

The *malaqa* is elected by the users among the villagers. If there is not particular problem, he can stay *malaqa* during several years. If there are too much conflict between Malaqa and the other users, another has to be elected. He is responsible of water since its entrance in the part of canals that corresponds to his unit until the repartition in the plots. He has the knowledge of the

individual rights and the schedule and he is in charge of its application. Practically, the farmers themselves open and close the different canals when their turn arrives. In case of conflict, the *malaqa* is called to see and record the evidences. He has to be informed of all exchanges of water turn. He is witness for all agreements and he can foresee the calendar changes. He is also in charge of organising the works for canal maintenance. He is also the one who represents the Village in negotiations involving different villages. The mangudo bishani are three wise men chosen inside the community for water problems resolution. They are responsible of the *malaqa* and the users. In case of problem, they are the ones who judge. If the *malaqa* doesn't completing his work properly, they have power to fire him.

Another current problem is the water robbery in the upstream part, when the downstream people are supposed to use it, especially during the night. In this case of conflict that implicates people from different villages, the traditional judgment takes place in presence of the *malaqa* and *mangudo bishani* for the two different units. In case of disagreement, it is possible to resort to the kebele administrative tribunal. The person in charge of these problems resolution is the *bulchinsa fi haqa* and the three judges are the *shango*. The sentence risked is a few days in jail. This process is frequently used to resolve problems involving people from different clusters or conflicts between *malaqa* and users than cannot be resolved by traditional system. In case of big problems, it is also possible to ask the District administration tribunal but this is very uncommon. The division of the area in seven clusters permits a functional management of water. A general water distribution schedule is negotiated between their representatives. The *malaqa* is then in charge of the water sharing and the operation and maintenance organization inside his unit,. This defined a formal frame necessary for a distribution of the water for irrigation activities.

Here, the above stated statement was applied at different extent with respect to the type of the canals. The left canals did not have any combination with the right canals. This is the main constraint that the researcher observes during FGD with the traditional water leader of each group and key informant interview with DA of the PA. Development Agent (DA) was the structure that comes at this moment and guides the *malaqa* by improving the capacity and creating written program of irrigation schedule depending on his decision.

The survey result showed that 42% of the respondents said that irrigation water use can create conflict whereas 58% of the respondents believe that at this time since there is good intervention

from PA administration to combat the conflict there is no conflict. Those who said there are conflicts raise, scarcity of water, water theft and problem of water management as the main reason for conflict as shown in Table 18.

Table18. Reason for conflict

Reason for conflict	Frequency	Percent
Scarcity of water	4	18.9
Problem of water management	2	5.4
Water theft	3	8.1
all	20	50.1
Scarcity of water and water theft	5	13.5
Problem of water management and water theft	3	8.1
Total	37	100

Source: Survey Result 2010

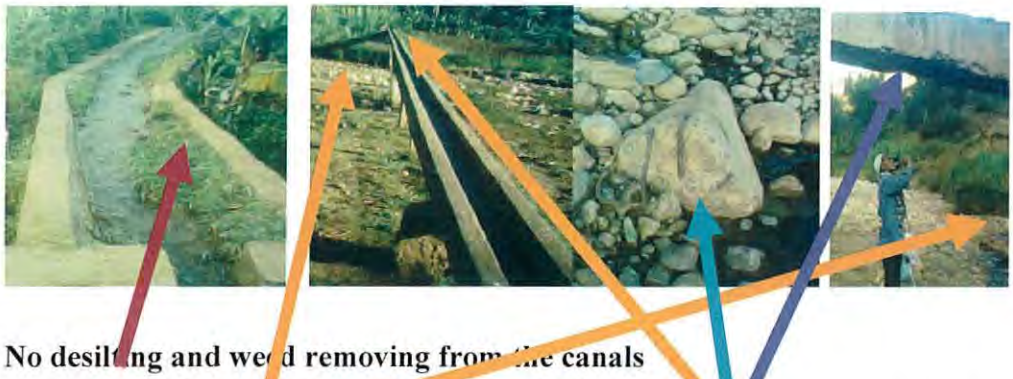
Informant respondent from tail end user's Mohamed Nadi Abdurahman said that, *"During water theft especially when the head users take the water without their turn, always it is difficult for the downstream user to protect their right since the downstream turn is always at night. But now after PA involve on this issue there are good improvement regarding this issues"*

5.4.4 Maintenance Condition

Maintenance activities within a village covering small areas are done by the block or team members and coordinated by the *malaqa*. 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 as discussed in the above part. It is possible to say that there is no maintenance of the irrigation infrastructure. The *malaqa* is responsible for the mobilization of resources required for maintenance activities and for the scheduling of maintenance of the primary, secondary and tertiary canals only for removing the silt, compacting inner canal part to

minimize the seepage and removing weeds that minimize canal carrying capacity and retard the speed of water.

Figure 14. Condition of the lined canals and flume on the left side canals



No desilting and weed removing from the canals

Golu Flood ways **Destroyed column of flume on the left main canals by floods**

Source: Pictures taken from Nedhi Gelan Sedi Scheme on December 10/2010

WUAs are effective in the management of water allocation and distribution but often maintenance and especially investment activities are not regularly performed (Agarwal, 2000; Vermillion, 1999). But in the case of Nedhi, no established WUAs and the nominally established WUC are not representative of all villages and operation and maintenance activities was not according to the design document which hinder the stability of functionality of systems in sustainable manner.

5.4.5 Post Construction Support

Sustainability of irrigation systems also depends largely upon the post construction support 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 water office after construction, demonstration pilot 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 oblige the upstream head user to use previous traditional water right

distribution systems. From this demonstration, the scheme users benefits and learn how to cultivate Fagee which means to plough in a row, have improved seed and able to produce maize twice a year, but only for Woldaya village where the pseudo committee were elected which means the approach of demonstration was not participatory. After demonstration seize, the result of dissemination was not that much satisfactory according to key informant interview from District's extension expert Wondosen.

From 2009 by changing means of support, again IFAD able to group certain beneficiaries as FRG and FHH groups and provides improved seeds and fertilizers by their money but farm equipment support without payment as aid. During 2010, there were 20 HH under FRG and 11HH under FHH but this year 2011 under FRG the number of HH are increased to 30 HH where as that of FHH are decreased by one and become 10 HH. According to the member of FRG and FHH, they believe that now it is a time of realization of the benefit of the horticultural production.

Wagengew(2004) in Andarge (2009), indicated that, given the complex set of facing smallholder producers, providing access to irrigation water by itself is not enough; smallholders also require a broad range of support service (access to inputs, credit, and output market), knowledge of farming and land tenure that implicate the need of post construction supports. Thus, let us see on by one.

5.4.5.1 Input and Credit Supply

Farmers need credit for purchase of agricultural inputs (fertilizer, improved seed and insecticide), fattening and rearing of animals and promote petty trading. The main institutions that provide credit are District cooperatives and Oromia Saving and Credit Institution (OCSI). The main input supplier in the area is *District* service cooperative. It supplies fertilizer, improved seeds and chemicals. However, 100% of farmers told that due to shortage of credit, supply of inputs during irrigation season is very small at required time. This leads that, fertilizer application to irrigated plot is not a common practice in the scheme. Hence, almost all scheme beneficiaries do not use fertilizer at the right time to increase production except right canal middle user. The case is the same in relation to the utilization of improved crop varieties and seeds too.

5.4.5.2 Market

There are four main market centers for the community. These are *Soqa, Deder,Dire Dawa* and Harar according to design document (OIDA, 1993). Most of the time, farmers sell their outputs to private traders and in Deder the Woreda capital town. In the same manner, there are problem of getting profitable market conditions according to the response of the informant Yusuf Sham of Gilbo village of Nedhi Gelan Sedi PA.

5.4.5.3 Agricultural Extension Service

According to Van Den and Hawkins (1988) in Teshome (2009), the main aim of extension program is to initiate change to bring about sound agricultural development especially on the part of smallholder farmers. It offers them technical advice and also supplies with the necessary inputs and services. Agricultural extension is therefore used as a tool for rural development (Teshome, 2009).

According to the key informant from Woreda Agricultural office extension expert Wondosen, there was no integration between extension department, IFAD and beneficiaries but after 2010 they are working in collaboration with IFAD and DA of the area.

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, 36.4% said that the severity of absence was less, 20.5% said that it was modest while 43.2% said that the severity of absence of post construction was severe.

5.5. Community participation and empowerment

For sustainability of the scheme, one of the important steps in irrigation system design has been farmers' participation in all stages of the project cycle. However, the government has been making huge investment in irrigation scheme design and construction without participation of the community in the area. This leads to dependency on the government which decreases farmers' sense of ownership and responsibility for operation and management. Thus, 100 % of the respondents confirmed that, they do not undertake even minor repairs for the structure.

All respondents confirmed that, the irrigation scheme is very important for them to secure food self-sufficiency. The idea of constructing the irrigation scheme on the site was originally initiated by the government but later agreement was reached between the government and the local community especially those at head and middle user, it was not included all the beneficiaries.

The study and designs for all headwork and irrigation networks were formulated and produced by former OIDA East Hararghe Branch which dissolve in to east and west Water Resource office in 2008 and add Energy and mines office at this time. All respondents confirmed that no attempts were made to encourage participation of the beneficiaries. According to the respondents, 75.9% of the community was not participating during planning, construction and post construction and 24.1% of the community participated. From those participated, 45.5% said that they were participated in planning stage, 9.1% participated during construction stage, 36.4% at both stage and 9% said that they are participated in all phase of project cycle.

As far as capacity building for the users is concerned, only 12.5% agreed that they are getting trainings and the rest 87.5% 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. It is based on a desire to decrease the resource burdens of the government for irrigation operation and maintenance and to enhance the long-term sustainability of irrigation systems through local management and control. However, 77.3% of the respondent said that there is no formal handing over of the project to the beneficiaries and 22.7% said there is formal handing over of the project to the beneficiaries. Moreover, all respondents believe that it is possible to increase economic benefit of the scheme by redesigning the scheme with full participation of beneficiary farmers.

5.5.1 Gender and SSI

Out of the 88 HHs selected for interviews 20.5% of them are women headed HHs from which 88.9% of them are widowed and 11.1% of them have their husband abroad in Saudi Arabia and America.

Under the participation of the community, women participation plays a great role to ensure sustainability of the systems. According to survey result 97.7% of the respondents believe that there was no women participation in irrigation activities before the project and after project too. Focus Group Discussion held at Nedhi Gelan Sedi SSI in Deder District indicated that women headed household who are single, widowed and owning agricultural land are members 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 of donor organization and meet the slogan of women participation in the project as key informant of the District Agricultural office stated during interview.

With regard to the benefit of the irrigation project, gender wise, the respondents in the selected areas said that, they use water in the canals to wash the clothe, clean house equipment that decrease their burden to fetch water that serve for all this activities. Moreover, benefit for livestock forage production, availability of food variety at home and income increase from sugarcane, banana and chat are some of the benefit of Nedhi Gelan Sedi irrigation project for women as confirmed during observation, survey result and from FGD.

5.6. Collective Action, Equity and Resilience of the Project

Here institutional, social and community empowerment condition of the scheme were summarized by taking actual value from sub-topic 4.3, 4.4, 4.5, 4.6, 5.6 and 5.6.1. Assuming 50 percent minimum and 100 percent maximum value of condition index, the rated scale of each indicator was calculated using Equation 5 and the result was found in Table 19.

$$\text{Sustainability scale} = \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}} * 5$$

Table 19: Rated scale for collective action, resilience and equity

Indicators	Variables	Condition index	Rated scale	Remark
Collective action	**a. Ability and willingness to generate O and M costs and make new facility construction**	8%	-4.2	92 % says no paid and no will to pay (HHs susrvey)
	b. Sense of owner ship	94.3%	4.4	Good (with their vicinity)
	c. Participation of the beneficiaries	24.1%	-2.6	Very poor
	d. Management transfer	22.7	-2.7	Very poor
	e. Establishment of legitimate WUA/WUC	14.8%	-3.5	Very poor
	f. Capacity to organize and enforce rules	12.5	-3.6	Very poor
	g. Integration of stake holder	0%	0	Very poor
	h. Post construction support	35.7	-1.43	Average response of credit ,inputs, training, demonstration and monitoring and evaluation)
Resilience of the systems	**a. Livelihood diversification**	64.2 % average of the two	1.4	42%)have off-farm and 86.4% participate in livestock production
	b. Contribution of traditional systems	100	5	(if there are not traditional right canal diversion ,this project is out of service
Equity	**a. Gender fairness issues**	51.2	0.12	
	b. Water distribution equity	27.8	-2.2	72.2 % said no equity

From Table 18 the average value of collective action is (-4.2+4.4-2.6-2.7-3.5-3.6+0-1.43)/8 = -1.7, negative value that shows worst case.

Again for system resilience average value is (1.4+5)/2= 3.2, which shows good value whereas for equity the average value is (0.12-2.2)/2=-1, which indicates worst case of in-equality.

In general, in this research absence of equity in water distribution and gender fairness create low collective action toward bringing sustainability of the systems. Moreover, the approach of intervention was not participatory.

5.7. Environmental Sustainability of Nedhi Gelan Sedi SSI project

The area was known by practicing irrigation for a long period of time under traditional systems and irrigation has contributed to increase food production and the overall socio-economic development. Similarly, socio-economic inequality, social disruption and environmental degradation are among the impact that irrigation brings on the environment.

To maximize the positive impact of irrigation and if possible combat or minimize the negative one, mainstreaming the environmental impact assessment in every project that has likely adverse impact on environment is a must. Thus, even if the advent 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 of coin is crucial and with this respect, information was collected concerning plot fertility, human and animal disease occurrences due to implementation of irrigation schemes in the area and condition of natural catastrophe and scarcity of natural resource which hinder the sustainability of the physical structure facility.

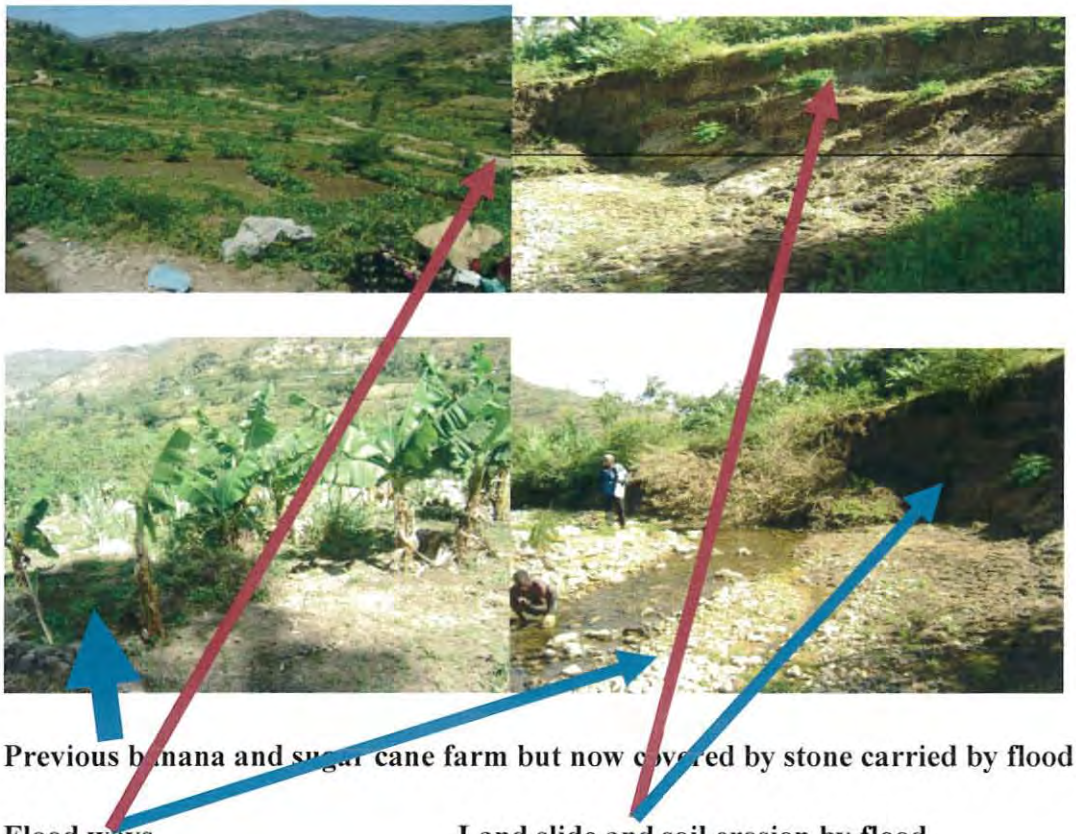
As population increase from time to time, hillside cultivation was the only solution to feed household in the upstream area of the project. 100% of the respondents believe that, farm destruction by flood and siltation of weir are the major natural factors that minimize the sustainability of irrigation scheme in the area. 98.9% 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 84.1%, irrigation expansion 5.7%, infrastructure expansion 1.1%, fuel consumption 1.1% and flooding problem 8%.

Similarly, 92% 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 40.9%, irrigation system used that is graded furrow and some time flooding 10.2%, structure problem which is expressed in the form of adequacy 3.4% and flooding from upstream that destruct nearby farm accounts 35.5% of the respondents' response.

About 79.1% of the respondents said that, the productivity of the land do not decrease where as 20.9% 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 near the river side needs attention as observed during field visits.

Figure15: Flooding problem



Previous banana and sugar cane farm but now covered by stone carried by flood

Flood ways **Land slide and soil erosion by flood**

Source: Photo from field observation at Nedhi Gelan Sedi in 2010

Most of the respondents in the area did not indicate an incidence of human or animal diseases after the implementation of the irrigation schemes. Similarly, for crops "are there any pest infestations due to irrigation implementation?" was the question forwarded to the respondents. Accordingly, 98.9% of the respondents said "no" while only 1.1% said "yes" for the above question. Therefore," what is the reason of crop failure?" are another question to the respondents. Thus, 41.9% of the respondents those who said there is crop failure responded that, the reason for crop failure are existence of crop diseases and pests like the blight of potatoes and tomatoes and stalk bore, red ants(qanyur) and sweets potatoes weevils, water shortage due to insufficient of scheme structure and poor cultural practice as a reason.

Regarding the continuity of water availability, 55.7% of the respondents said that climate change has effect on availability of irrigation water whereas 44.3% of respondents said that they do not know the connection of this thing.

Generally, flooding, land slide, soil erosion which result land degradation in the area are some of observed problem in the area. Population increase is another area, which needs attention for the future in the area. Siltation is the main hindrance for the irrigation structure sustainability on the head work diversion while for cross-drainage structures damage by flooding is the main factors. Unless the upstream watershed are fully protected under the implementation of watershed management which was not included during the scheme project design feasibility document, the physical capital (irrigation scheme), natural capital (soil and water) will be in question even for these generation to give intended benefit for them.

5.7.1 Protective Action

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 20.

Table20: Summary of results for Protection action rating scale

Indicators	**Variables**	Condition index	Rated scale	Remark
Protection	a. Absence of soil erosion	8 %	-4.8	92 % said yes erosion is severe)
	b. Cropping pattern for protection of soil fertility	55%	0.5	(no crop rotation and fallow to protect soil fertility due to land scarcity
	c. Watershed mgt. and EIA consideration during planning and current practice	0 %	0	(IODA, 1993 and key informant interview)
	d. Change in environment due to intervention	94.3%	4.43	5.7 % said yes)

Source: Field work, 2010

From Table 20 average value for protection = (-4.8+0.5+0+4.43)/4 =0.03 this shows unsustainable condition of the systems. Thus, the study shows that due to irrigation structure, there are no environmental changes. But due to lack of protective measure that ensure sustainability of natural capital that affect the project, environmentally the project is in the state of unsustainable condition.

5.8 Main constraint and level of impact of category on sustainability of the scheme

5.8.1 Main Constraint on sustainability of Nedhi Gelan Sedi SSI Scheme

The needs to sustain the irrigation systems imply that there are opposing forces which would otherwise threaten to bring it down. Identifying these threats should be the key to various protective actions by managements.

Siltation at head work is number one problem 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. Water-logging and salinity are not significant threats. Regarding loss of soil fertility the researcher believe that, it is good if the combination of composite and fertilizer application as well as manure application would implemented as reported from some respondents and key informant from PA to ensure the stability of the productivity of the farm land for these generation as well as future generation. Drought, sedimentation and farm land inundation due to flooding will be threatened in relation to water resource availability and agricultural land scarcity in the future but application of integrated watershed management is the only solution to it. Weed growth in the canals and in the farm are another important physical constraints which reduce efficiency of the canals and productivity of the farm respectively. Especially haramazab or feremsis (partenium) is one of the weeds known in this area according to beneficiaries' response during FGD with elderly water user and design document.

According to design document, *the irrigation water distribution per each irrigation has been guided by Malaqa which 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* (IODA, 2001). However, the established water user committee is not representative of the scheme beneficiaries as discussed above and still

everything is similar to previous systems. Thus, the intervention systems lack participation of the end users starting from the very beginning, even though the communities are ok to accept technology and any improvement, especially in the area of irrigation. Absence of establishing representative WUC or strengthening of the existing structure was the main institutional threats of the area.

Similarly, there are great problem of integration of stakeholders, overlap of duties and responsibilities and institutional instability according to East Hararghe Zonal key informant of water resource office Zageye Tesfaye. 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 routine monitoring and evaluation trend in the office.

The other threats are problem of collective action by different stakeholder. Especially, views of irrigation users on ownership of the scheme are different according to location of farm land with respect to head work diversion. Accordingly, all right canals user except those found up to a distance of 500m, which was constructed by the project, the rest did not have feeling of ownerships regarding the diversion weir. They have been using the previous traditional diversion systems and the canal also not new but due to intervention, about three culverts and two flumes were constructed. They think that, these structures have great benefit for them but its maintenance belongs to the government or NGO are what they believe. The left hand sides are those always in problems with the weir, even if it is above their ability to desilt the weir and maintain the destructed column of flume by flood as understood from FGD held in the area with Woldaya village water committee and elderly traditional leader.

Finally, the respondents asked to rank the major factors which most inhibit their irrigation development at present. The results are shown in Table 21.

Table 21: Major factors which most inhibit irrigation development at present and their rank

Problem	Percentage of extent of problem			Rank
	Less	Modest	Severe	
Lack of input availability/ financing	39.8	14.8	45.8	3
Lack of water	59.1	10.2	30.7	5
Lack of the land	1.1	3.4	95.5	1
Lack of credit	0	4.5	95.5	1
Lack of market	2.3	35.2	62.5	2
Lack of access road and transport	45.5	40.9	13.6	7
Crop damage	67	18.2	14.8	6
Competition (between rain fall and irrigation or among the producer)	86.4	5.7	8	8
Lack of training	36.4	20.5	43.2	4

Source: Survey, December, 2010.

From Table 21, lack of land and credit are score rank one in terms of severity, lack of market are the second scoring 62.5% of severity, lack of input availability/financing is third in severity rank, lack of training is the forth and lack of water is the fifth in the rank .

5.8.2 Level of Impact of Category on Sustainability of Nedhi Gelan Sedi

In this research, 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 believe that it is sound and then only focus on practices on the ground. From financial, technical, physical, socio-culture, environmental and community participation different practice were discussed under each topics as indicated above and understand the condition of each aspect.

Now, let us see the level of impact of each condition on sustainability of Nedhi Gelan Sedi scheme.

According to Abernethy (1994), there seem to be three major ways in which systems may lose sustainability:

I. System may lose sustainability because they are no longer to deliver their benefits.
II. System may lose sustainability because, although they are performing well internally, they are injuring other interests.
III. Systems may lose sustainability because people no longer want to devote necessary efforts to key activities.

Before categorizing to the above three criteria, combining values for individual category calculated from Table 8,9,10,14,19 and 20 are now the next steps of the process. Accordingly;

- Stability average rated scale =1.72
- Efficiency average rated scale =1.62
- Resilience average rated scale =3.2
- Productivity average rated scale =3.02
- Protective average rated scale =0.03
- Collective action average rated scale=-1.7
- Relevance average rated scale =3.62
- Equity average rated scale =-1

Therefore, sustainability index of Nedhi Gelan Sedi was the average of the above value.

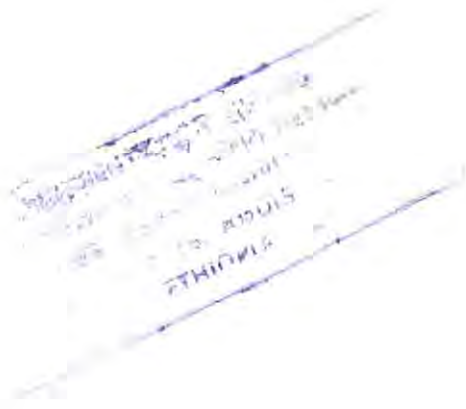
Sustainability index= (3.62+1.62 +1.72 + 3.02 + 0.03 + 3.2 + (-1) + (-1.7))/8 =1.31 which shows value approach to unsustainable situation.

These various factors in Table 8, 9, 10, 14, 19 and 20 do not affect the sustainability of irrigation systems in similar ways. It is useful to classify also the kinds of impacts that irrigation systems may suffer, and that may cause unsustainability. In this regards, development of Nedhi Gelan Sedi SSI scheme was relevant for the community and also increase their productivity that explained by value between fair and good which is also supported by many past research specifically according to Word Bank, (2007), FAO, (1997), (2003), (2007), productivity in irrigated areas is more than twice that in an irrigated areas which support the above finding.

Number one factors are absence of collective action towards the scheme sustainability which resulted mainly from low value of equity of water distribution between beneficiaries. Similarly, very low value of protective average rated scale shows, lack of protective means to overcome any threat against the distraction of physical and natural capital of this project. Generally, fair productivity and relevance of the scheme is balanced by poor equity, poor collective action, poor stability, poor protective action and resilience of the systems which affect the sustainability of the scheme in aggregate.

In the case of this project, an outcome of lack of equitable resource distribution, which create lack of collective action towards the scheme sustainability issues especially for operation and maintenances which harm the stability of the physical capital by minimizing the efficiency of the scheme coupled with low protective action of the environment aggravate the problem and finally systems are no longer to deliver their benefit and the people are also no longer to devote necessary efforts to key activities and sustainability of the system become under question even for this generation.

In this chapter, using the qualitative and quantitative information obtained from household interview, key informants, FGD and direct observations, households socio economic characteristics, relevance of the scheme, efficiency and effectiveness, physical and technical aspect, institutional, financial, environmental, constraint and sustainability of the SSI scheme were analyzed and thoroughly discussed.



CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

The aim of this research is to study the sustainability of SSI scheme based on Nedhi Gelan Sedi irrigation scheme. To answer the specific question of the study, many primary data were collected from 88 households of which 28 from head user, 30 from middle user and 30 from tail user, using survey questionnaires. FGD with elderly traditional water leader, water committee, women and youth, direct field observation and key informant interview also carried out. The descriptive analysis was made using mean, minimum as well as maximum values. In addition, the results are depicted using table, charts and other diagrams.

Depending on literature review, important indicators of sustainability of SSI scheme was selected based on theories of sustainable SSI found in the literature and then primary data for each indicators was collected using survey questionnaires and condition index was set depending on the response of yes or no. 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.

It was to give an image of the sustainability at plot and 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 9 year after construction. The objective was to give an image of the sustainability concerning environmental, institutional, technical and socio economic aspects as a whole, and then to use the results to point out the parts of the irrigation scheme in which there were deficiencies in the sustainability, and where the farmers and concerned body could work in order to improve the sustainability.

Small-scale (smallholder) irrigation has a role to play in agricultural and economic development of Oromia Region, particularly in East Hararghe. The high yields obtained in irrigation, together other benefits such as increased incomes, food security, and drought relief savings and so on, are indication that irrigation can be a vehicle for the long-term agricultural and microeconomic

development without affecting the environment. With water being the scarcest resource especially in the smallholder sector, the need for irrigation development in this sector is quite apparent.

The assessment of the existing irrigation system in the site under study indicated that, the design and construction of this scheme were carried out by the former OIDA (Oromia Irrigation and Development Authority) and its eastern branch offices from 2001-2002. The source of the water for the project is from Gelan Sedi River which is emerged from mount Dima at upstream and the abstraction system is gravity for the whole community. The conveyance structures found on the canals are 329.5m of lined canals, 4 flume, 4 inclined drops, 20 vertical drops, 54 turn out, 12 turn out with drop, 3 box culverts, 2 chutes, 4 pipe culverts, 3 culverts with check dam and other earthen canals. When one observes the effectiveness of the infrastructure out of 106, 66 of the structure become out of use. Thus, in the area there are major difference between as built document and actually constructed scheme on the head work area, one column of the flume and all turn out gate were stolen and the community are still use traditional turn out which shows the physical capital constructed were not in a position to give the intended benefit. Moreover, the natural capital like farm land near the river were destroyed by the flood during rainy season every year in spite of the farmer effort at their farm level individually and due to this the scheme command area are decreased from year to year and farm land loose by the flood is the main problem as interview certain farmer during the observation.

Regarding the condition of the scheme from socio-cultural sustainability, the study showed that, the intervention was relevance to the community even if the farmer perceived the relevance of the project in different ways with respect to the location of the field from the head work. But, 77.1 percent of the respondents said that there is no equity in water distribution systems since people found at headwork and middle user get more water than those found at tail or end user .Absence of equity hamper building of collective action toward systems maintenance and feeling of ownerships. In general, traditional culture of the area in water distribution, system maintenance and conflict resolution is good.

The financial viability of an irrigation scheme is closely related to the financial viability of the member households. It also depends on the sense of ownerships and commitment that members

feel towards maintaining and sustaining the scheme (SEAGA, 1989). In this regard people believe and know the importance of the irrigation to improve their livelihood. But, *the approach of development from the very beginning was top-down approach by the government, which viewed the "target population" primarily as beneficiaries rather than as customers or stakeholders. In turn, "beneficiaries" perceived the government as a "free delivery channel" and consequently no one would be willing to pay for operation and maintenance (Bitew, 2005).* This was the case for this scheme as 92% of the respondents said they were not paid and willing to pay operation and maintenance cost, water fee and recovery costs. Thus, financially the scheme was not viable.

To see the roles of the community participation in sustaining the system, if there are not traditional right canal diversion point, this project was become out of service. Regarding the participation, there was no proper participation of the beneficiaries both during design and construction, which affect the sense of ownerships of the physical capital constructed in the area. Moreover, there were not proper handing over of the scheme to beneficiaries and necessary training were not provided. This indicates lack of one of the key issues to sustainability of the scheme. The researcher believes that, if the beneficiaries had participated in the planning process, they would strongly regard the projects as theirs which support the FAO, (1996) suggestion. Successful implementation requires participation in the planning and implementations process by all stakeholders, in order to create a sense of ownership of, and consequent commitment to, the project (FAO, 1996).

Under institutional sustainability, the study found that, establishment of strong WUA was not the case for this scheme and the traditional *Malaqa* is still the person in charge of water distribution, management and maintenance of earthen canals according to the vicinity to their villages. Every village has their own water turn in rotational manner. The nominal elected water committee is not representative and has no any recognition from the beneficiaries'. Equity in terms of water distribution was not the case in this scheme. Post-construction supports to the community are there by IFAD at this moment under FRG and FHH but not enough. In general, under institutional sustainability ,lack of full consent and keeping interest of members, lack of women participation in all phase of irrigation scheme development, lack of community empowerment,

lack of establishment of representative WUC/WUAs, lack of provision of fair institutional and support services (markets, credits, training , improved seeds on time and fertilizers) and lack of strengthening the existing traditional local water institution and more over, lack of integration among stakeholders were those factors that undermine the sustainability condition of the scheme from institutional aspect, even if the project was still relevant and productive to the beneficiaries.

Regarding environmental sustainability of the scheme, the study showed, land scarcity in the area was number one problem that resulted from population increase and flooding problem and 92 percent of the respondents said that soil erosion is the environmental problem in the area. Most of the respondents believe that, the productivity of their land does not decrease and water logging and salinity problem are not significant in the area. 98.9 percent responds that, there are no pest infestations due to irrigation implementation and 40.9 percent believe that irrigation water management problem caused soil erosion. Again, 55.7 percent of the respondents said that climate change has effect on availability of irrigation water.

Generally, flooding, land slide, soil erosion which result land degradation in the area are some of observed problem in the area. Population increase is another area, which needs attention for the future in the area. Siltation is the main hindrance for the irrigation structure sustainability on the head work diversion while for cross-drainage structures damage by flooding is the main factors. Unless the upstream watershed are fully protected under the implementation of watershed management which was not included during the scheme project design feasibility document, the physical capital (irrigation scheme), natural capital (soil and water) will be in question even for these generation to give intended benefit for them.

The major current constraints of irrigation development in the study area ranked as lack of land and credit are score rank one in terms of severity, lack of market are the second scoring 62.5% of severity, lack of input availability/financing is third in severity rank, lack of training is the forth and lack of water is the fifth in the rank according to the survey result. This shows there is pressure on agricultural land and also lack of post construction support and protection of siltation and flooding are the most important threat we want to sustain.

Moreover, it is important to be aware that the simple numbers of sustainability index obtained, while useful, cannot take the place of detailed qualitative studies in the area. Sustainable

development is obviously a dynamic, not a static concept, as the system and conditions are constantly changing. Hopefully this Study can serve some of the following purposes:

- Information on the constraints with sustainability of Nedhi Gela Sedi SSI scheme was pointed out
- A useful analysis of the situation of Nedhi Gela Sedi SSI scheme that can create ideas on how they can work to improve the sustainability of their irrigation systems was stated.
- The condition of the physical capital and institutional as well as socio-cultural aspect, financial and environmental condition were assessed.
- Information on the practical use of sustainability indicators that can be useful for future development of sustainability indicators in the study area was touched.
- An introduction to the theories of sustainability SSI for students and other persons interested in these issues were applied.

Thus, from the analysis, according to the definition of sustainability of SSI scheme which is 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 say 20-30 years, absence of scheme watershed management and EIA consideration during planning, improved cropping pattern, low livelihood diversification, little consideration of local knowledge, lack of developing the sense of ownerships, community participation, management transfer, establishment of representative WUC/WUAs, improve the capacity of the Malaqa or WUA/WUC to organize and enforce rules, lack of integration of stakeholder towards pre and post-construction support, absence of willingness to generate operation and maintenance costs and make new irrigation facility as well as unfunctionality of the scheme that create poor conveyance efficiency and brings scarcity of the water at plot level together lack of intensification culture in the area indicates unsustianability of Nedhi Gelan Sedi scheme. Whereas, multipurpose of benefit of the scheme, interest and reliance on the project, land tenure security and purpose of using irrigation is the practice that brings feeling of confident to ward sustainability of the scheme.

6.2 Conclusion

Nedhi Gelan Sedi SSI which approach to unsustainable situation after 9 years of its construction, unless urgent action toward creating representative water user organization and empower the committee with clear water right and by-laws that ensure equity of water distribution and build

collective action towards operation and maintenance of irrigation scheme as well as participate them in watershed management to overcome land degradation and structural failure due to siltation and flooding, the current relevancy and productivity of the project will not Persist. In general, the study shows that;

- Relevance of the project is different with respect to distance from the diversion point.
- The approach of intervention was top-down approach
- There was lack of holistic approach in design document that do not have environmental impact assessment and Water shade management which affect the environment.
- Institutional, social and community empowerment which was reflected by relevance of the project, Equity Resilience and collective action are crucial and the most factors that affect the stability, productivity, protective and financial viability of the systems and sustainability.
- Hence, productivity and relevance without social equity in water sharing; with out approach which improves collective action by empowering the communities, sustainability of Nedhi SSI does not assured.

Finally, the study demonstrated that, improving and expansion of the physical structure of existing traditional small-scale irrigation scheme must supposes to think about approaches that permit to clarify the problems in a collective manner and not to start with the proposed development solution to supposed problems that also supported by Angele, 2007.

6.3. Recommendations

The following recommendations are believed to contribute for improving the sustainability of Nedhi Gelan Sedi SSI scheme:

- Investments in infrastructure improvements may be ineffective in the absence of continued maintenance, an outcome of weak institutions, inadequate funding, low operational and maintenance charge and lack of sense of owner ships and commitment that members feel towards maintaining and sustaining the scheme which generally resulted from top-down approach of the intervention during the intervention of the project. Thus following a bottom-up approach is ideal for irrigation development, treating farmers as "Owners" and not as "beneficiaries" of the projects. So, farmers should participate throughout the project planning, implementation and evaluation phases. Thus, due attention must be given in creating representative WUC and create clear water use right with the beneficiaries as well as traditional water leader of the area at this moment to bring equitable water distribution between the users so that collective action towards

the systems will be developed and maintaining head work, the flume and destroyed turn out as soon as possible.

- However, lack of watershed management as a part of feasibility document during study together population pressure on forest deforestation and hill side cultivation resulted in sedimentation of the irrigation infrastructure, destroying column of the flume and damaging of banana and sugar cane plantation from river bank farm and farm land loose by the flood and decreasing of water availability due to, too much runoff formation rather than infiltration were exposed the project under stress. With such a situation, there is a need to implement integrated watershed management at the upstream and on farm soil and water conservation in the area as soon as possible to protect the environment and the society. Suggestion has been given to the responsible Government Institution (OWMEB and OADB) and IFAD too.

- The support from IFAD at this time under FRG and FHH must be continued in a way that participate women and the poor and also possible market linkage must be created for these group.

- Study tour, training in water management, and marketing and general crop production for farmers and extension workers ,Institutional support and continuous 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 evaluate and monitor the scheme in the light of these indicators.

- Despite the success of implementing new irrigation facilities, equal attention should also be given to sustainability of already constructed irrigation schemes.

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Chapter 8

Appendix

8.1 Different Tables

No	Name	Sex	Age	Village	Year of establishment
1	Bakri Abdurahman Sano	Male	36	Woldaya	2004
2	Abdi Shafii	Male	35	Woldaya	2004
3	Bakrii Abdulahii	Male	45	Woldaya	2004
4	Abdulaziz Mohamed	Male	34	Woldaya	2004
5	Mohamad Ali Issa	Male	35	Woldaya	2004
6	Riyana Mohamed	Female	39 years	Woldaya	2004
7	Faxuma Abrahim Abdullah	Female	40 years	Woldaya	2004
8	Shamshadin Adame	Male	42 years	Woldaya	2004

Table 21 : Name of selected water committee of Nedhi Gelan Sedi SSI Scheme

Chapter 8

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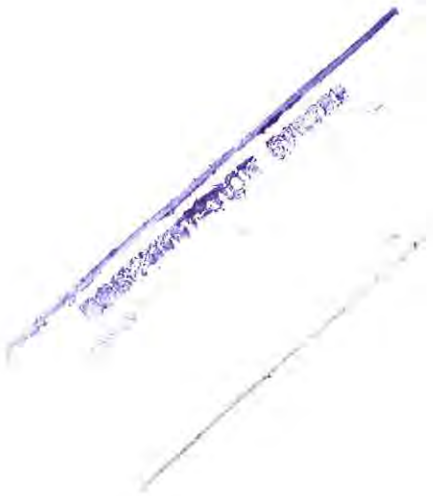
Table 21 : Name of selected water committee of Nedhi Gelan Sedi SSI Scheme



8.2 Research Questioners for sampled farmers and other group

Addis Ababa University

School of Graduate Studies

College of Development Studies

Center of Environment, water and Development **Code___**

A questioner designed for sampled farmers

Dear respondents,

The principal objectives of this questionnaire is to understand sustainability of Nedhi gelan sedi small scale irrigation project in Deder wereda Eastern Oromia. such studies on the community based small scale irrigation are useful to the planers and decision makers to draw the most appropriate irrigation development plans, which are based on food security, farmers needs and priorities. You are kindly requested to give an answer freely and openly. The questionnaires are fully for the academic research purpose, any information you give will be kept confidential. Thus, your cooperation is very necessary to achieve the desired goal of the study.

Thank you for your cooperation in advance

Elias Abdi the survey coordinator.

SECTION I

Questioner for Individual Beneficiary

1. General

1.1. Research Site: Region..... Zone ..... Districts.....
PA.....Village.....Irrigation Block.....

Interviewer full name: ....Date of Interview.....

Time of Interview.....

1.2. Respondent identification number ....
1.3. Household Head:
a) Full name .....
b) Sex: 1) male 2) female
c) Age:.....(years)
d) Marital Status: 1) married 2) single 3) divorced 4) Widowed 5)Polygamy
1.4. Ethnic background
1) Oromo 2)Amara 3)Other, Specify ----------
1.5. Educational status
1 . Reading and writing 2. First cycle 3. Second cycle 4.illitrate 5)Beyond secondary education 6).Special skill training 7) Other, specify.....
1.6 Religion background
1.Islam 2.Orthodox 3,Christian Chatolic 4.Protestant 5.Wkefata 6.Others(specify)_____
1.7.Family Characteristics: How many family members do you have? male------female----------Total

5. Efficiency of the project

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 the above question is yes why you do think is the reason? (Multiple answer is possible)
1 . There is shortage of water in the river 2. There is shortage of water in the pond 3. The pump capacity is small 4. Water distribution management is poor 5. Water conveyance system is not functioning well (specify) which canal (branch, Main, secondary, tertiary)

5.4. What is the mode of water distribution?
1. Crop type 2. Land size 3. Type of irrigation (gravity/ pump)
4. Other, specify -----

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.Do you see the location difference in water allocation? 1) Yes 2) No

5.8. What are the difference observed among the users in getting water due to location difference?

Upstream users get more time in water round than any of users		Code 1= Yes 2=No for all
Upstream and the middle users are more benefited		
All are treated at equal footing except the loss in the canal		
Others/specify		

5.7. Are you able to get the amount of product you planned to get?
1 . Yes 2. No

5.8. If Yes for the above question do you think it is related with water?
1 . Yes 2. No

5.9. How? (for the above question)
1. There was excess water 2. There was enough water 3.Other specify

5.10.Which of the canal system is working well in this project?
1. Primary 2. Main 3. Secondary 4. Tertiary 5. Field canal

5.11.Why do you think this canal is working well?
1. Because it is under the management of Woreda office
2. Because it is under the management of the community
3. Because it is constructed properly
4. Other, specify

6. Physical Structures and technical aspect

6.1. What is the source of water for your scheme? 1. River 2. Dam 3. Lake 4. Ground water 5. Other specify_____

6.2. Which canal type will serve for long time?
1 . Pipe system 2. Geo-membrane lined system 3.Their traditional system 4. Others specify_____

6.3. Which system is vulnerable to damage?
1 . Field canal gate 2. Tertiary gate 3. Secondary canal gate 4. Main canal gate 5. Primary canal gate

6.4. Did you experience lack of water due to structure failure?
1 . Yes 2. No

6.5. If your answer is yes for Q. 6.4 is yes, how many times per one irrigation season? _____

6.6. If your answer is yes for Q. 6.4 is yes, how long it takes to be maintained? _____(days)

6.7. Which structure frequency of damage is high? Prioritize them
1 . head work 2. Pump 3. Flume 4. Intake gates of Primary canal 5. Drop structure 6. Road crossing culvert 7. Earthen canal
1 . __2.__3.___4.___5.___6.___.7___

6.8. Did you ever took training on operation and maintenance of the structures and canals
1 . Yes 2. No

6.9. If your answer is yes for Q. 6.8 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. Economical aspect

7.1 Production pattern and productivity

7.2 How many times do you produce in a year?_____

7.3. Rank the major agricultural crops you produced using irrigation and rain fed in the last two years 2000/2001 and 2001/2002 crops year?

Cereals and legumes	Vegetables and root crops	Perennial crops	Irrigated									Rain fed		
A	b	c	a			b			c			A		b
			Rank	Area (tind)	Yeald(Kuntal/t	Rank	Area (tind)	Yeald(Kuntal/t	Rank	Area (tind)	Yeald(Kuntal/t	Rank	Area	Area
Maize	Onion	Sugarcane												
Sorghum	Tomato	Banana												
Wheat	Carrot	Coffee												
Teff	Cabbage	Chat												
Soybean	Garlic	Mango												
Haricot bean	Sweet potato	Papaya												
Others specify	Others specify	Others specify												

7.4 Why do you prefer to grow crops ranked in the table above?

No	Reason for crop selection	1=Yes	2= No
1	**Better price for production**		
2	**Easy for operation and good production**		
3	**Traditional preferred for household demand**		
4	**High disease tolerance and adaptation**		
5	**Seed availability**		

6	**Others specify**		

7.5. Have you ever faced a problem of crop failure when using irrigation?
1 . Yes 2. No

7.6. If your answer is yes, what was the reason for the failure?

No	Reason for crop failure	1=Yes	2= No
1	**Water shortage**		
2	**Crop disease**		
3	**Poor cultural practices**		
4	**Insufficient scheme infrastructure**		
5	**Over flooding and resulted in soil erosion**		
6	**Others specify**		

7.7. Did you produce enough yields for your household consumption from rain-fed and irrigation during the past Ten years?
1. Yes 2. No

7.8.a) Please list details for Irrigation farming production and cost during 2002 year on plot basis (with irrigation)

Type of crop	Input item		Rain-fed		Irrigation	
			Quantity	Cost(Birr)	Quantity	Cost(Birr)
	Seeds	Improved seed				
		Fertilizers				
		Herbicides and pesticides				
		Others				
	Labour	**Labour cost for all activities**				
		Others				
		Sub Total				

Crop code List: 01 = Maize, 02 = Sweet potato, 03 = Onion, 04 = Tomato, 05 = Cabbage, 06 = Carrot, 07 = Sugarcane, 08 = Banana, 09 =Pepper, 10=Papaya, 11=Chat, 12=Mango, 13=Sorghum, 14=Wheat, 15=Soybean, 16=Garlic, 17=Others specify_____

7.9. Do you have off – farm income source? 1) Yes 2) No

7.10. If yes, provide the income obtained from off-farm activities in 2002?

No	Types of off-farm & other sources income	Income (Birr)	Remark
1	Renting of animals (oxen, pack animals, etc)		
2	Off-farm employment (by member of the household)		
3	Sales of animal dung		
4	Sales of grass		

5	Sales of fire wood/timber		
6	Earnings from family member permanently hired to other household (e.g. herder)		
7	Sale of beverages and food items		
8	Food aid (birr equivalent)/donation		
9	Food for work (birr equivalent)		
11	Renting/sharecropping out land		
14	Small industries (grain mill, oil mill, etc)		
15	Trade		
16	Assistance from relative and friends		
17	Remittance		
18	Compensation		
19	Gift		
20	Others (specify)		
21	Total income		

7.10. What are the main household expenditure (food/non-food) items and its annual amount?

No	Expenditure Items	1=Yes, 0=No	If yes amount (Birr per annum)	
1	Food (Cereals, pulses, Coffee, chat...)			
2	Human health			
3	Education			
4	House maintenance			
5	Clothing			
6	Animal health			
7	Farm tools/Implements			
8	Farm inputs (Fertilizer, seed & chemicals)			
9	Transportation cost			
10	Social ceremonies			
11	Religious ceremonies			
12	Fodder for livestock's			
13	Fuel/ wood/ energy			
14	Taxes/payment			
15	Contribution			

16	Marketing cost			
17	Others / specify			

7.11. Livestock owned: number and value owned during the year 2002

No	Type of animals	No of animals in the year
I	Cattle	
1.1	Calf	
1.2	Young Bull	
1.3	Heifer	
1.4	Cow	
1.5	Draft oxen	
II	Small ruminants and equines	
2.1	Sheep	
2.2	Goat	
2.3	Horse	
2.4	Donkey	
2.5	Mule	
2.7	Bee hives *Traditional	
	* Modern	

Calf = < 1 year, = < 6 months, young bull and heifer = 1-2 year, matured cattle = > 3 years

7.12. What are the major sources of feed for your animals? 01) Grazing, 02) Crop residue that remain in the field 03) straw 04) Fodder 05) hay

7.13. Do you have access to animal health services? 01) Yes 02) No

7.14. How do you herd your livestock? 01) Family Labor 02) Hired Labor 03) Both

7.15. What are the major problems in livestock production? (Rank them in priority order)

01) Shortage of animal fed 02) Diseases & pests 03) lacks of improved breeds

04) Droughts 05) Lack of markets and low price for animals 06) Lack of credit

7.16. Do you think that currently the productivity of your land has decreased,?
1. Yes 2. No

7.17. If you say yes to the above equations what is/are the main reasons?
1 .Ageing of land 2. loss of nutrients 3. little or no use of following 4. Over use

7.18. Are you self-sufficient in food condition? 1=Yes 2=No

7.19. Indicate the number of meals per day in your household.
1. Three times per day

2. Two times per day
3. One times per day

7.20. Does the irrigation change your livelihood positively? 1=Yes 2=No

8. Environmental aspect

8.1. Which resource you think is short in your area? Prioritize

1 . Water 2. Agriculture land 3. Pastor land 4. Forest 5. Other specify _____

8.2 Why you think it is scarce/short

1 . Population increase 2. Irrigation expansion 3. Infrastructure expansion 4. Expansion of grazing land 5. Overgrazing

6. Fuel wood consumption 7. Other, specify

8.3 From where are you getting water for your consumption? (Multiple answers are possible)

1. Rain fall 2. From Gelan Sedi River 3. Ground water from your locality

4. The project 5. Any another, specify_____

8.4 If you give multiple answer for Q. 6.4 prioritize them

1._____ 2._____ 3._____

8.5 What are the primary uses of water?

1. Agriculture, 2. Domestic, 3. Industrial, 4. Other, specify

8.6 Do you think the climate change has an effect on the water availability?

1 . Yes 2. No 4. I don't know

8.7 How? _____

8.8 Do you think the irrigation water use can create conflict?

1 . Yes 2.No

8.9 Why do you think is the irrigation water is the cause for conflict? Because of

1 . Scarcity of water 2. Water Management 3. Water theft 4 . other, specify

8.10 If your answer for Q. 6.20 is yes with whom do you think 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

8.11 Do you think that soil erosion is an environmental problem in the project area?

1 . Yes 2. No

8.12 If your answer for question 6.18 is yes, why ? because

1 . Irrigation water management problem 2. Irrigation system (furrow or flooding) 3. Structure problem 4. Type or irrigation (pump/ gravity)

5 . Other, specify_____

8.13 Whom, do you think; does the water in the river belong to?

1 . To you 2. To Upstream people 3. To downstream people

4 . To all of the above 5. Other, specify _____

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

1. Yes 2. No

8.15 If you say yes the above equations what is/are the main reasons?

1 .Ageing of land 2. loss of nutrients 3. little or no use of following 5. other specify

8.17 Are any pests introduced due to irrigation? 1. Yes 2. No

8.18. If your answer to Q. 8.17 is Yes, mention the name_____

9 Institutional

9.1Is there any water organization in your irrigation area?
1 . Yes 2. No

9.2 If yes, what it is?
1 . WUA 2. WUC 3. WUG 4. Other, specify _____

9.3 Do your water organization has written bylaw
1. Yes2. No

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

9.5 Have you paid membership payment for your water organization?
1 . Yes 2. No

9.6 Have you started to pay project cost recovery?
1 . Yes 2. No

9.7 Do You pay operation and maintenance fee (such as for fuel e.t.c)?
1 .Yes 2. No

9.8 If yes, how do you pay? Based on _____
1 . The land size 2. Crop type 3. Water amount 4. Other, specify_

9.9 How do you get irrigation water? 1 . Gravity 2. From the first pump /Pond 3. From second pump /pond

9.10 Is there water theft (using without turn)?
1 .Yes 2. No

9.11 If your answer is yes for the above question? Is there punishment by the water organization? 1 . Scarcity 2. Management 3, other, specify

9.12 Do you think the punishment is enough?
1. Yes 2. No

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

9.14 The water user organization can manage the project starting from
1 . Headwork 2. Branch canal 3. Main canal 4. Secondary canal 5 Tertiary canal 6. Field canal

9.15 Which of the following canals can you or your WUA can maintain or rehabilitate? 1.Branch canal 2. Main Canal 3. Secondary Canal 4 . Tertiary canal 5. Field canal

10. Major threat

10.1. Rank the following important factors which most inhibit your irrigation development at present?

Factors	**Extent of the problem: 1=Less, 2=Modest, 3=Severe**
Lack of input availability/financing	
Lack of water	
Lack of the land	
Lack of credit	
Lack of Market	
Lack of access road and transport	
Crop damage	
Competition	
Absence post-constructions support	

II. Checklist for FOCUS GROUP DISCUSSION (FGD) with 2 women, Traditional water leader (meleqa), WUA, youth, Traditional community elder.

Date_____

Woreda_____

Name of irrigation scheme_____

1. Is the study and design of this project were take account of your local knowledge?
2. Who initiate irrigation development in your area?
3. What was your contribution in implementing the irrigation scheme?
4. Who owns the irrigation water in your scheme?
5. Is there clarity of boundary and rules about who has rights to water and land?
6. How is water allocated and distributed to users?
7. How is maintenance and rehabilitation handled?
8. Do you have rule and regulations that that are applied by all members?
9. Are there special considerations for crop-type and stage of growth during water allocation? In what way?
10. If your answer to Q.10 is no what happens when somebody is convincingly in higher need of water for his/her field?
11. What are the sources of conflict in relation to irrigation in the area?
12. 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?
13. What is your ability and practicability to pay O and M fee, water fee, service fee, and the need for massive effort both to construct new facility and to improve the existing irrigation facility?
14. How is input and output marketing managed?
15. What is the source for drinking water, livestock drinking, washing clothes, bathing and is there conflict with multiple use of irrigation?
16. What is the most important productivity constraint and intensification constraints?
17. Does the irrigation scheme create special benefit to women? What are the benefit?
18. To what extent are women participating in the decision-making process within the WUA?
19. What is your general opinion on the contribution of irrigation to household food security/
20. What is your experience on the continuity and availability of irrigation water and irrigated agricultural soil fertility?
21. According to your opinion what is the negative and positive socio-economic and environment impact of irrigation?
22. What do you suggest for the improvement of your irrigation scheme performance in the future?_____

III. Questionnaires for Key Informant

Key informant interview for Deder District Water office, Agricultural and Rural Development office, Cooperative offices.

1.

1.1. Organization_____
1.2. Name_____
1.3. Educational status_____
1.4. How long have you worked at this post_____
1.5. How do you know about
- The extent of land degradations in this woreda?

_____

1.6. Major forms of land degradations in the woreda?

_____

1.7. Major problems of forest resources? And its factors?

_____

1.8. Major problems of water resources? And its factors?

_____

1.9. Major problems of land resources and its factor?

_____

1.10. What is/are the critical environmental concerns (issues, resources etc) that may pose conflict in the future?

_____

1.11. What are the major efforts being done by your office to conserve soil, water and forest resources? In this woreda?

_____

1.12. How do you see the land/soil, water and forest conservation package as a leader?

_____

1.13. What is /are the major strength and weakness of this package?

_____

1.14. Which one of the soil/land, water and forest conservation technology do you think is more/most acceptable and adopted by farmers? And why?

_____

1.15. What is your suggestion with related to sustainable management of natural resource/policy options?

1.15.1. For land management(grazing and cultivation)

_____

1.15.2. For water resource management

_____

1.15.3.For forest resource management

_____

IV. INTERVIEW QUESTIONNIES TO DEVELOPMENT AGENTS

Date_____

Woreda_____

Name of the irrigation scheme_____

Name of Interviewee_____Sex_____

1. What is the agro-climatic condition of the study area?
2. Was there food insecurity problem in the area for the last ten years in the area and if it is yes how much it is serious?
3. What was the trend of food security in the past three years?
4. How is the condition of the following issues in this area; access to basic school facility, health facility, drinking water for human and animal, irrigation services, road infrastructure, credit facilities, access to grazing land, access to modern farm inputs(fertilizer, improved seeds, pesticides, veterinary drugs) and natural resource management practices in the area?
5. What are the major social organizations in the area and what are their roles?
6. What are the major environmental problem in the area?
7. What are of-farm activities available in the area?
8. What are the major threat that could bring down the sustainability of Nedhi Gelan Sedi SSI?

V. CHECK LEAST FOR KEY INFORMANT

(ZONAL WATER RESOURCE OFFICE, AGRICULTURAL AND RURAK DEVELOPMENT OFFICE)

Date of the interview_____

Name of the interview_____

Position of the interview_____

1. How supportive or restrictive is the policy environment for farmer managed irrigatation like Nedhi Gelan Sedi SSI?
2. Did the government agency adequately prepare the community involvement to manage and sustain their irrigation schemes? (Yes/No), if "NO" what is the reasons?
3. How do you see the coordination of your organization/office with the lower governments and other stakeholders to give post-construction support?
4. Do you carry out monitoring and evaluation of already constructed project and what is your performance indicators, threat indicators and system resialence to this threat, with specific to Nedhi Gelan Seadi?
5. What request are maily reported to your office from the lower government offices/community in relation to irrigation schemes(if available about Nedhi Gelan Sedi)?
6. What problem are faced by your organization/offices to support the irrigation scheme survice functionality for long period of time(sustainability)?

THANK YOU VERY MUCH

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

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By

Elias Abdi

DEVELOPMENT STUDIES

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