Institutions, Management Practices and Challenges of Small-Scale Irrigation Systems in Ethiopia: A Case Study of Two Modern Smallholders Irrigation Systems in Western Oromia, Ethiopia

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Abstract

This paper examines the institutional arrangements that facilitate irrigation management and the present state of irrigation management and establishes where problems have occurred in the operation of Gibe-Lemu and Gambela-Terre Small-scale irrigation systems. The study employed the case study approach to tackle the research. Key informant and expert interview, desk review of different documents produced about the projects, group discussion, direct observation and structured interview schedule were used to collect data. The study proved the proposition that the government has uncritically supported the irrigation systems. Enabling legal system of land and water rights, strong woreda level state irrigation agency, support services (irrigation extension) and well-established water users associations through which purposes of irrigation are achieved were not adequately planned and put in place. These shortcomings undermined irrigation management, ultimately risked feasibility and sustainability of irrigated agriculture. Findings revealed poor record of accomplishment, in spite of the difference between the two systems, in managing water distribution in terms of the three most important performance indicators: adequacy, reliability and equity in water distribution. Water related conflicts are rampant but not settled yet. In addition, results indicated that irrigation had positively impacted irrigators' livelihoods in terms of diversification and intensification of crop production, household income, housing and employment generation and this social effect of irrigation was significantly different between irrigation systems (due to difference in the institutional and socioeconomic context of the two irrigation systems) and locations within irrigation systems. Nonetheless, many irrigators did not maintain these positive changes for long. The constraints were scarcity and unreliability of water and management and socioeconomic problems. These, in turn, were mediated by lack of: a) clearly defined and well enforced institutions of land and water rights; b) technical problems in design and construction; c) inadequate institutional capacity of the local state irrigation agency to coordinate and support decentralized management of irrigation; d) policy related problems; e) inadequate organization of users for self management; and f) problematic social relation of power among water users. Finally, the paper draws a number of conclusions, using the theoretical notions like context, social requirement for use, social effects and social construction, about policy options and requirements in the readjustment of the surveyed irrigation systems and in the design of irrigation projects of these types.

Key words: Institutions, irrigation, management practice and challenges

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Introduction

Gibe Lemu and Gambela Terre small-scale irrigation systems were constructed to promote household food security through effective and equitable use of the available land and water resources. However, these projects were poorly performing and the area under irrigation is below

expectation. Nevertheless, more grounded and detailed scheme-specific information on the reason why it is so is and which help guide future policy for smallholders irrigation promotion not available. It is increasingly being recognized that poor performance is not only a consequence of technical performance in design and construction, but institutional and management problems tended to be more common constraints to the success and exploitation of small-scale irrigation schemes in sub-Sahara Africa. In addition, in-depth understanding of technical and agronomic problems of irrigated agriculture is impossible without understanding the social organizations (institutions, the policy environment and social relations) in which it is embedded. The general objective of this study is, therefore, to examine and describe the reasons for the disappointing performance of the target irrigation systems with a focus on the institutional arrangements that facilitate irrigation management, the present state of irrigation management at the local and grassroots levels and establish where problems (gaps) have occurred.

Specific objectives:

- To analyze the institutional arrangements and relationships that affect management and 'performance' of the irrigation systems;
- To understand how users are organized for self management of irrigation;
- To understand how the irrigation systems are managed and;
- To identify and clarify the major challenges of the irrigation systems; and
- To suggest possible options/strategies for rehabilitation of the surveyed irrigation systems and in the design of similar irrigation projects

Methodology

The research work included both appraisals of theoretical assumptions on conditions of possibility for successful irrigation as well as the analysis of empirical data obtained during field research. The socio-technical approach to irrigation (the social shaping perspective of irrigation technologies) by Mollinga (2003) and elements of the social organization of innovation theory by Engel (1997) were used in developing the instruments for data collection; formulation of the hypothesis and in the interpretation and explanation of the data collected and the facts in the irrigation systems.

The study employed the case study approach to tackle the research. There are ample reasons for using the case study approach. The first reason is the nature and objective of the research itself; irrigation management practices and analysis of institutional contexts and causes of the problem are complex processes and therefore require detailed investigation and comprehensive understanding. Secondly, the conventional questionnaire survey (structured interview schedule) alone does not allow comprehensive understanding and adequate description of how the schemes are actually managed and what institutional and socio-economic variables and processes explain poor performance of the schemes.

Methods of Data Collection

Secondary Data Collection

Secondary data was collected through desk review of the regional and national irrigation policy statements, legal frameworks regarding irrigation land and water rights institutions, proclamations and regulations, project write-ups, project appraisal documents, different reports produced about the projects and past case study papers on irrigation.

Primary Data Collection

Relevant primary data were collected using various instruments such as

- Key informant interview; conducted to generate general understanding of the irrigation systems. In addition, the information obtained through this tool was also used for developing more focused questionnaire for the household interview
- Interview (semi-structured) with

executive committee of water users and officials and experts with relevant government agencies at regional, zone and wereda levels of accountability

- Group discussion: 60 purposively selected irrigators, divided into six groups (three in each irrigation system), and each with group size of 10 members were involved. Irrigators from the head-end to the tail-end areas were included in the groups so the data generated reflects the actual situations and facts at all water levels.
- Direct observation of events during many visits paid to the schemes
- Household interview using structured questionnaire

For the questionnaire survey, 65 sample households were selected using the following procedure:

a) First, the sample frame was obtained from the executive committee of WUAs;
b) Then, the beneficiary households were stratified into head-end, middle and tail-end irrigators based on their location in the farm layout of the irrigation systems and proportion was assigned to each group for inclusion in the sample; and
c) The households were stratified on the basis of their location with the basic assumption that there could be inequity in the distribution of irrigation water and the benefits derived from irrigation as a result of weakness in water control, technical problems and lack of management structures that suit layout of the irrigation infrastructures (see also Vermillion/IIMI, 1997:30-31);
d) 30 % (from each scheme) of the sample frame were selected using stratified random sampling technique and participated as respondents in the household interview.

2.2. Data Analysis

Both qualitative assessment and descriptive analysis techniques were used for data analysis. The data generated through household interview was analyzed by employing SPSS. The study employed descriptive statistical methods such as frequency, percentage, mean, and[23] standard deviation, X^2-statistic, T-test and ANOVA/F-test for analyzing the data generated through household interview.

Rsult and Dscussion

Description of the Irrigation Systems

Gibe Lemu Lemu and Gambella-Terre irrigation systems are found Gobu Seyo District, East Wellega Zone of Oromia Region. Gibe-Lemu is located at 80km towards Addis Ababa from Nekemte, capital of East Wellega zone and 3Kms from Bako town. Gambela –Terre SSIS is located at 12kms from Ano-town, the district capital and 30km from Bako, the biggest town providing access to markets for farmers. The rainfall in both irrigation systems is unimodal. The unimodal rainfall pattern dictates the single cropping season. However, in recent years, the pattern of the rainfall becomes uneven and unpredictable with negative implication on food production.

The total irrigable command area of the Gibe-Lemu irrigation scheme is 113 ha. A main canal having a length of 7kms conveys water into the command area. The method of distribution to the main, secondary canals and TUs is continuous, while it is rotational in the farm units as per the initial design of the project. However, currently, the method of supply to the TUs is rotational due to the decline in the volume of water conveyed into the diversion weir. The method of application to the farm units is rotational, while the method of application of water is furrow. Seven days are one irrigation interval for each farm unit at the time of design (Korea Design Team, 1990). However, there is severe water

scarcity in the scheme to day to supply water in accordance with this interval.

Gambella-Terre SSI project was initiated (during the Derg Regime) in line with the political interest of the Derg, i.e., to be used as instrument for promoting collectivism through cooperative farming. Initially, it was designed to develop an irrigable area of 80ha. In 1995, additional 34 turnouts, division box and other structures were constructed along the main conveyance canal to bring additional 70 ha of land, which was not considered in the initial design, under its command area so as to benefit up stream farmers whose land holdings fall on the left and right sides of the main conveyance canal. This increased the command area from 80ha to 150 ha. Nevertheless, there is a wide gap between the supply of water to day and during the time of designing the project (1988).

Table3.1 Average distance from the market

Round trip distance (minute):	Gibe Lemu Mean	N	St.De	Gambela Terre Mean	N	SD
From the main road:	55.20	25	40.56	116.75	40	64.22
From the market:	93.24	25	51.32	144	40	77.49

Source: - Field survey, *=household, **= Male headed households, ***=Female headed households

The average round trip distance from the main asphalt road and the market place is different between the two irrigation systems. Irrigators in Gambela Terre have to walk longer hours than Gibe Lemu to access the nearest local market to sale their agricultural produces (Tables 3.2). In addition, there is no all-weather road connecting the irrigation system to the main asphalt road despite the fact that it is one of the material contexts for successful irrigation (Engel, 1997; Mollinga, 2003; Dillon, 1992: FAO, 2003). Further, farmers in Gibe Lemu have long standing (more than half a century) tradition in practicing traditional irrigation while farmers in Gambella-Terre had no irrigation experience before arrival of the new irrigation project.

The Institutional Setting of Irrigation Management at Local and Grassroots Levels

3.2.1. Local Level Institutional Arrangements

Structure and Management Capacity of the District Irrigation Desk (DID)

Oromia Irrigation Authority was responsible for SSI development in Oromia between 1999 and 2004. Following the 2004 restructuring, the independent district irrigation extension office and the specialized development centers were merged with the District Agriculture and Rural Development Department (DARDD) with no clear line of communication with the Branch and

Regional Offices of the Irrigation Agency responsible for irrigation development in Oromia. The District Irrigation Desk (DID) has been created in the DARDD as a team in 2004 and the full time irrigation extension workers become multipurpose.

Now the Gobu Seyo District Irrigation Desk (GSDID) and the extension centers are accountable for supporting user-based/decentralized management of irrigation and coordination of efforts of partners in the administration of irrigation in the district. Nonetheless, it has inadequate capacity to shoulder these responsibilities in terms of human resource development, technical units, structure and logistics in spite of the government policy for capacity building and institutional development. The GSDID has been consisted of only one team leader who is in charge of the Desk. It operates only with 20% of the required technical staff (table 3.2). Regarding

transportation means, the Desk is equipped with only one motor bicycle, one room (office), one table and one chair which are exclusively used by the Team Leader by the survey date (March, 2005). In terms of structure, the GSDID lacks organizational unit (development centers) with DAs fully responsible for irrigation at the scheme levels. But, CTA (1999: 91-92) argue that a necessary condition for more efficient and lasting management of smallholders' irrigation is existence of management capabilities, which are built through organizational and institutional development at various levels; from the apex through the middle level to the grassroots levels.

Table3.2 Manpower status of GSDID; as of March 2005

Discipline (positions)	Required and Approved	Available	Gap
Team leader	1	1	-
Irrigation Engineer	1	-	1
Irrigation Agronomist	1	-	1
Community participation Expert	1	-	1
Water Harvesting Expert	1	-	1
Total	5	1 (20%)	4 (80%)

Institutional instability had adversely affected the human resource capacity and structure of the local irrigation agency. For example, the irrigation sector institution in Ethiopia experienced reorganization in 1983, 1994, 1995, 1999 and 2004. This in turn has challenged human resource development and affected structure and existing human resource capacity of the irrigation sector institution. It could not maintain its trained manpower at both district and grassroots levels. The number of trained professionals who were working on irrigation at the District Irrigation Office was reduced following the restructuring in 2004. This weakened irrigation expertise at the District level. Until the 2004 reorganization, there had been one trained DA (Diploma graduates, who received in-service training in irrigation) in each irrigation system. These trained DAs were taken to district to work in other offices. However, no full-time and trained DAs assigned after that. In addition, the newly assigned DAs have multiple mandates and over stretched with many activities. Therefore, they are unable to undertake strict follow up of user-management of irrigation and could not deliver adequate irrigation extension services to farmers.

Stakeholders and Partnership in Irrigation Management

The policy framework for small-scale irrigation development in Ethiopia states that management of SSIS is a joint responsibility. In view of this, the regional state irrigation agency identifies cooperative promotion and input supply desks, district and grassroots level administrative and legal entities and farmers and their organizations as main stakeholders in the administration of irrigation in the study area. In addition, in 2004, the regional government merged five concerned district level government agencies in one institution; Agriculture and Rural Development Department (ARDD), with the assumption that organizational proximity can provide a fertile ground for collaboration. Although merging is a good opportunity, the five institutions did not work together in irrigation management as expected; the achievement has mainly been physical proximity of the agencies although the social shaping perspective of irrigation technologies assumes that irrigation systems are socially constructed.

The responsibility for coordinating partners fell on the District Irrigation Desk (DID). Nevertheless, it could not manage to do it owing to lack of well-established institutional and

functional framework for cooperation and harnessing their efforts. Lack of adequate involvement of the partners in turn adversely affected irrigation management in many ways, including:

- Necessary inputs for irrigation could not be availed to farmers regularly; his responsibility fell on the input Supply Desk.

- Irrigation has no research input; adaptive crop varieties that work under the situation of irrigation and watering frequency (irrigation agronomy) recommended for irrigation are non-existent. Although there exists one big research center of the Oromia Agricultural Research Institute in the nearby area, it has not been supporting irrigation development through supplying relevant technologies. This is due to the fact that agricultural research policies and strategies are not adjusted to meet requirements of irrigation and none-existence of enabling institutional framework for harnessing efforts of the research system with irrigation;

- The district and village level administrative and legal entities do not play any meaningful role in water control and conflict resolution though the task has become more complex to be addressed by 'Kore Aba Laga' and the simple informal rules alone (bylaws); and

- Water users not organized into legally recognized entities in accordance with the principles of organization of cooperative societies. This responsibility rests with the cooperative promotion desk. Nevertheless, it did not discharge this responsibility.

Support Services

The support services, in Molliga's and Engel's words 'the material conditions of possibility' for successful irrigation include, among others, improved seeds that work under irrigation and strong extension services (Engel 1997:147, Mollinga 2003: 24 and Dillon, 1992: FAO 2003). However, survey results revealed only 48% and 35% of the sample households ever used seeds of improved vegetable and cereal crop varieties in Gibe Lemu and Gambela Terre respectively. Out of the sample households, 36% in Gibe Lemu and 27.5% in GTSSIS procured improved seeds of maize and potato from the extension service. Nonetheless, the maize and potato seeds they obtained from the extension service are not recommended specifically for irrigation. In addition, seeds of carrot, onion, tomato, chile and other vegetable crops that irrigators regarded as 'improved' seeds have mostly been procured from the market or shops; they are not specifically recommended for production under irrigation. Therefore, they did not suit the irrigation systems, for they are affected by disease.

Overall, irrigators have not regularly been supplied with these support services mainly because the government policy on agricultural input supply, agricultural research and rural extension, gives more priority to those farmers registered in package program for rain fed agriculture. It tended to favor, in terms of both supply and timing of supply, rain fed agriculture during the main rainy season.

Institutional and Organizational Conditions within the Irrigation Systems

Land Distribution and Its Problems

Gibe Lemu and Gambela Terre Small-scale irrigation schemes were constructed to resolve the problem of farmland shortage, increase production and productivity and to improve farmers' livelihoods through effective and equitable use of the developed land and water resources. In view of this, ORLUA Proclamation No. 56/2002) states a maximum of 0.5 ha is retained for each former landholder in the command area and each member is equally allocated 0.25 ha per household. Nonetheless, this has not been finished in practice in both irrigation systems. Results indicated the whole command area has been owned only by 22.4%

(in Gibe Lemu) and 57% (in Gambela Terre) of the intended beneficiary households. Former plot holders continued to control and manage land areas that fall in the range of 0.5ha to 12ha in Gibe Lemu and 2ha to 5ha in Gambela Terre irrespective of their resource capacity to fully use it for irrigation. This has been in spite of the fact that the rest farmers are landless; tenants and/or sharecroppers (specially in Gibe-Lemu SSIS).

The problem of landlessness and skewed distribution of irrigable land was more severe in Gibe Lemu. Out of the irrigators, 2o% did not possess own irrigable plots, while some rich farmers were managing 9-12ha of potentially irrigable land. T-test also showed there was significant difference among households in Gibe Lemu; which is significant at the 5% level. Landless farmers and those who own small plots access irrigation land mainly through sharecropping system, labor exchange and exchange of ox for land **(see appendix table**). Similar study by JICA and OIDA (2003: 3-6) in East Shoa and Woldeab (2003) in Tigray also documented that sharecropping system (leasing-in and leasing-out) is one of the common option available to land owners with low resource capacity and landless farmers and farmers with smallholding.

Fair distribution of irrigable land has not been achieved in both irrigation systems by the survey date. The government failed to achieve fair distribution of irrigable land because: a) land redistribution issue was not dealt with during design and construction, b) GTSSIS was initiated in line with the political interest (collectivism) of the Derg regime in which case land redistribution was not an issue and; c) lack of policy and enabling legal system for redistribution for a long period and a time lag between the issuing of the Oromia Rural Land Proclamation and operational regulation.

1.

Inadequate land tenure in turn has created management difficulties in the schemes. Both 'Kore Aba Lega', DAs and the local state irrigation agency do not clearly know the actual size of irrigable plot managed by individual households. Hence, they could not adjust water allocation and resource mobilization to amount of water used and irrigable area controlled by individual households. Equal contributions are requested from all members who cultivated 0.5ha-12ha of irrigable plots. Ali Seid (2002), Lema (2004) and JICA and OIDA (2003) found similar problem in their study in North Wello and East Shoa zone respectively. In addition, some farmers are over supplied with water, while some others obtained water, which is far short to meet their needs due to the guesswork in water allocation. Over supply has led to misuse in the context of severe water scarcity.

2.

3.

Organization of Users for Self-Management of Irrigation

Organizational Set-up

In accordance with the federal and regional policy framework for small-scale irrigation development in Ethiopia, "Kore Aba Lagas" are in charge of water allocation, distribution, observing the water rights of members, conflict management and coordination of maintenance activities.

Although there are many deficiencies in their organization, the water users in both irrigation systems have created their own management structures and crafted internal bylaws as one of the social requirements for better management. Executive committees, sub-committees and water user teams (WUTs) were formed at irrigation system and distribution levels [territory units (TUs)] to facilitate water control and coordination of maintenance activities

All water users are organized into 6 WUTs (Water users teams) in Gibe-Lemu (group size ranging 10-20 members and in Gambela Terre into four WUTs "goxi" with the number of members per WUT ranging from 17 to 44. Nonetheless, the group size of two WUTs in Gambela Terre is above the optimum range (20-30) for good management (See Woulter, 2002: Blank, 2002). In these WUTs it has been observed, because of large group size, greater socioeconomic differentiation and lack of mutual understanding among users, which led to severe problem of water distribution and conflict over water. Similar study in Kenya showed that, the whole schemes or part of it was not operational, in all schemes consisting of groups of over 30

members (Woulter, 2002). With a membership below 30, he observed no water distribution problem in Kenya. To the contrary, the situation in Gibe Lemu contradicts with Woulter's findings. The number of members of WUTs is 10-20, which is below 30 but still there is water distribution problem and users could not settle water dispute themselves. This shows group size is not the only factor for social cohesion and effective group performance in water distribution.

Viability of the Water Committees for Self-Management of Irrigation

The responsibility for running management of the irrigation systems was delegated to "Kore Aba Laga" in the hope of enhancing effectiveness, equity and responsiveness in irrigation management and to ensure sustainability. Nonetheless, they were not organized in such a way they can ensure these objectives of decentralized management, although good organization is one of the social requirements for good irrigation governance. They have deficiencies in their management structures. They have no recognized legal power and the roles, responsibilities and authorities of the different positions along the management structure are not clearly defined and even it is totally missing from the by-laws of the 'Kore Aba Lagaa' in Gambela Terre.

The committee lacks transparent accountability to users although it is one of the essential factors for good irrigation governance. Constituencies (water users) accuse committee members for power abuse, selfishness, lack of commitment, and for not observing the internal bylaws. Nevertheless, informants reported that they were not held accountable through legal processes. One informant in Gibe Lemu, Name-Mohammad Shumiye, expressed the intensity of the accountability problem using the following proverb:

"Y**egebere balesiltan yasyilign gebeya new'**, meaning, the committee members abuse the power and authority we vested on them and prioritize their interest and irrigation fields in water allocation and distribution"

Irrigation Management Practices within the Irrigation Systems

Water Management

Water Allocation

Water committees are in charge of water allocation with little support from irrigation agronomists and development agents. They allocate water and prepare rotational schedules every year in September. However, water users expressed that Water allocation made by the 'Kore Aba Lagas has limitations in terms of both design and implementation. In terms of design, it does not clearly define water rights of individual farmers and TUs due to the guess work in water allocation. Equal water supply period per turn is allocated for all TUs and individual water users in spite of the variation in water requirements of the different crops grown, area of irrigable plots managed by individual irrigators and water demands in different TUs. The major impediments for proper allocation and scheduling of water distribution (as reported by committee members), include:

- Guess work in water allocation; the water committee undertakes water allocation and defines water rights of members not based on study on water requirements of different crops, irrigable plot area possessed by individual irrigators and measurement of the yearly water supply due to capacity problem. This is because the local state irrigation agency failed to provide satisfactory technical assistance in undertaking these water management tasks and in building their capacity; and.

- Water users are not willing to register types of crops they grow (vegetables or perennials) and area of their irrigable plots with the committee for clear definition of water rights in spite of the law (bylaws).

Water Distribution

The most important performance indicators in the distribution of irrigation water include adequacy, timeliness and equity in the supply of water (World Bank, 2000). Table 3.3 shows users' evaluation of performance of "Kore Aba Legas" in water distribution. The water committees in both irrigation systems were found to be in efficient in managing water distribution in terms of the three indicators. In Gibe Lemu and Gambela Terre, 80% and 90% of the sample households witnessed that they could not obtain the quantity of water that can support irrigation over the plot area they manage. The vast majority, 76% (in Gibe-Lemu) and 80% (in Gambela Terre) of irrigators were not able to obtain water in a reliable manner. Further, results of chi-square analysis indicated

Table 3.4.Water users' opinion about water distribution in Gibe Lemu and Gambela Terre irrigation systems

Item	Opinion by irrigation system and location			
	Gibe Lemu (N=25)		Gambela Terre (N=40)	
	Count	%	Count	%
Enough water is not obtained	20	80	36	90
Water is not reliable	19	76	32	80
Water distribution is unfair	21	84	33	82.5

Source: Field Survey

Access to adequate irrigation water and the problem of unreliability of water has strong association with location of farmers' irrigable plots relative to the headwork. The difference between locations was highly significant in Gambela Terre (X2=10.6, X2-Prob. =0.005 (for adequacy) and P<0.005 for reliability). This implies there is a greater probability that access to adequate and reliable supply of water is highly unlikely if the farmer's irrigable plot is in the tail-end area in Gambela Terre (appendix Table1). Water is scarce and the problem of unreliability is more severe in tail end areas in both irrigation systems.

Table3.4 Order of reasons why farmers do not obtain adequate water for irrigation, Gibe-Lemu and Gambela Terre SSIS

Irrigation system	Statistics	Water scarcity	Seepage loss	Poor water control	Turn abuses
Gibe Lemu	N	6	3	5	9
	% Of farmers	24	12	20	36
	Rank	2nd	4th	3rd	1st
Gambela Terre	N	20	2	8	9
	% of farmers	50	5	20	22.5
	Rank	1st	4th	3rd	2nd

Source: Field survey, March 2005

Tables3.4 shows farmers ranking of problems that constrained the supply of adequate water in a timely fashion. Water scarcity due to decline in the quantity of water conveyed into the scheme and uncontrolled distribution were the prime factors responsible for scarcity and unreliability of water. In Gibe_lemu, hydraulic and technical problems (water scarcity and seepage water loss) tended to be the least important constraints for not meeting water needs in the scheme, indicating institutional and management

Problems are more relevant. Water users in Gibe Lemu believe that the current volume of water

conveyed into the scheme can meet water requirement in the command area with some adjustment and adaptation of water allocation to the change in water supply and if there had been strong system management. Water scarcity is the most important reason for not obtaining the needed amount of water for irrigated agriculture in command areas of Gambella Terre SSIS

Table 3.5 Social groups that get more water by illegal means

Groups	*Percentage of farmers giving the response*			
	All HHs (N=65)	Gibe (N=25)	Lemu	Gambela Terre (N=40)
			4.	
Farmers with large family size	89.5	60		42.5
Head-end farmers	89.5	76		82.5
Rich farmers who irrigate perennials	39.7	36		35

Source: Field survey

Alongside the above, results revealed that Water Committees were not able to ensure equity in water distribution (Table3.5). Informants reported that powerful and rich socioeconomic groups, in their words, 'gulbetegnas'/'bully farmers' have been benefited more. Head-end farmers had better access to irrigation water owing to their proximity to the headwork (location advantage). They release water for the down stream farmers once their fields saturated with water. Households with large family size are more powerful (because of size) and often, they exercise power to obtain water by illegal means. They also take advantage of the relatively large family size and/or labor in defending their water rights. Rich farmers in the middle areas, especially in Gambela Terre, irrigate large areas of tree crops which are not in the priority list and do not releases water for the tail-end farmers. Nonetheless, the WUA committee could not regulate this distribution inequity owing among others to resistance by the powerful groups.

Water Scarcity: Causes and Coping Measures

Causes of Water Scarcity

Water is scarce in the irrigation systems; especially in Gambella Terre. Table3.6 shows perceptions of irrigators about causes of water scarcity. Gibe and Dokonu rivers, which are water sources for Gibe Lemu and Gambela Terre, were diverted at 2 and12 locations respectively. This decreased the quantity of water conveyed into the schemes. Nevertheless, the problem has not been addressed due mainly to first, there was no enabling legal system, which clearly defines the water rights of the upstream traditional irrigators and irrigators in the new irrigation projects. In spite of the general constitutional rule, there are no formal operational rules and regulations for managing the relation between the upstream and downstream irrigators in sharing the water from the same river. In the second place, the responsibility for addressing such problem (the role who should do what) of the different stakeholders has not been defined by the survey date.

TABLE3.6 Perceptions of irrigators about causes of water scarcity by irrigation system

Causes of water scarcity	% of farmers giving the opinion		
	All HHs (N=65)	Gibe Lemu (N=25)	Gambela Terre (N=40)
Diversion of water by traditional irrigators	89.32	88	97.5

Seepage loss	47.74	52	52.5
Increasing number of users	63.14	80	62.5
Lack of strict water control	70.84	80	80

Source: Field Survey, March2005

Alongside water diversion by traditional irrigators, the problem of water scarcity has been mediated by abuses (uncontrolled distribution), social incompatibility (in Gambela Terre) and increase in the number of water users in Gibe Lemu, against the declining quantity of water conveyed into the scheme(table3.6). Farmers in the middle areas, especially in Gambela Terre, irrigate large areas of perennial tree crops, which are not in the priority list of crops to be grown; leading to scarcity the in tail end area. Further, the designed irrigation season for the scheme (Gambella Terre) is October to March every year. However, the indigenous growing season for rain fed agriculture in the area is May to December. Farmers start irrigated agriculture by the end of December. Nevertheless, by this time, the volume of water flowing to the diversion weir has declined substantially to the extent that it cannot support irrigation over the command area of the scheme or dries totally (problem of social incompatibility). Similar studies have also documented that increasing number of users on the limited irrigation water has led to scarcity, and even limiting the types of crops grown by farmers (Alula, 2001 and Freeman and S.Silim, 2002).

Coping Measures

The following coping measures were taken to over come water scarcity

- Changing the duration of water delivery for TUs in response to the change in quantity of water conveyed into the scheme;
- Prioritizing crops to be grown; vegetable crops, which require frequent watering, were given priority. Nonetheless, irrigators did not observe this cropping pattern for not strictly implemented to supply water in a reliable manner to grow vegetables. Hence, irrigators shifted from vegetables to perennial tree crops as an adaptive measure to the problem of unreliability of water;
- Night storage was constructed (in Gambela Terre SSIS) to over come water scarcity through rotational distribution day and night. Still the volume of water flow is far short of water needs in the scheme; and
- Water users in Gambela Terre employed a paid guard; to control water distribution and to address the coordination problems of 'Kore Aba Laga' . However, the guard could not adequately manage the distribution because of the size of the irrigation system that needs control, which is beyond the capacity of one person to control.

Overall, the problem has not been fully addressed by all these means due to in built defects in the design and implementation of the adaptive measures.

Conflict Management

Water disputes persistently occur between irrigators in the new schemes and upstream traditional irrigators and among irrigators within the irrigation systems. Further, results of household interview that the majority (56% in Gibe Lemu and 57.5% in Gambela Terre) of the sample households have faced conflicts arising from water allocation and distribution (table3.8). Informants reported increasing number of water users in Gibe-Lemu (against the declinigng quantity of water conveyed), water scarcity (from the source) and poor water control as major causes.

The number of claimants of irrigation has increased over time, without being accompanied by institutional adaptation, led to competition and conflict over water. Similar findings are

demonstrated in studies conducted by Freeman and S.Silim (2002) and Alula (2001). With increasing number of users, conflicts arising from water allocation became more common; water management became more problematic and the interval between watering of plots increased almost to "breaking point" (Alula, 2001).

Powerful households and rich farmers who grow crops which are not in the priority list, such as coffee, chat, and sugarcane, in the middle areas capture more water by illegal means (more serious problem in Gambela Terre); leading to scarcity in the tail-end area and tough conflict between the two groups. Nevertheless, it was beyond the capacity of 'Kore Aba Laga' to be contained. Diversion of the Source Rivers by traditional irrigators had also gave rise to external water disputes. The local irrigation agency mentioned lack of legal frameworks as the main reason for not addressing the problems.

In summary, 'Kore Aba Lagas' are ineffective, reluctant and less committed in taking care of the water rights of members and in resolving conflicts. Table4.8 shows farmers' ranking of problems that discouraged commitment of the water committees. The prominent gaps include:

1. Lack of satisfactory support from the local administrative and legal entities and the multipurpose DAs. The committees transfer cases of irrigators who were found guilty of illegal water abstraction to these entities. But they do not give satisfactory response though the task of conflict management has been beyond the legal power and capacity of 'Kore Aba Lagas' the WUA committees;
2. Lack of incentive for the managing entities; i. e.; board members of the WUA have no incentive for the time they spent in irrigation management. Coupled with resistance it frustrated and discouraged their commitment to undertake strict control of water distribution..
3. Problematic social relation of power among water users. Some members, especially the powerful households do not observe the group-based rules and do not usually give consent to be governed by the WUA committee members. Mollinga (2003) has also proved in his study in India that socioeconomic differentiation (social inconsistency) among water users had impeded emergence of viable water users organizations who can undertake effective water control.

Table3.7 Farmers' ranking of causes of poor water control and poor conflict management by water committees by irrigation system

Reasons	% of farmers and rank					
	Gibe Lemu			Gambela Terre		
	N	%	Rank	N	%	Rank
WUA-committees are reluctant	7	28	3rd	12	30	3rd
Resistance by water users	8	32	2nd	15	37.5	1st
Lack of adequate external support**	10	40	1st	13	32.5	2nd

Source: Field survey, March 2005

Maintenance of the Irrigation Systems

Farmers undertake canal cleaning and system maintenance activities under the leadership of the water committee with the assistance of

multipurpose DAs. Most of the time members contribute labor for maintenance. Maintenance is carried out twice a year and very irregularly in Gambella Terre albeit the O and M manual prepared for the schemes recommends that it should be undertaken thrice a year.

In Gibe Lemu the majority (56%) of the interviewees stated that maintenance of the structures was very good; 36 percent said it was good and only 4 percent said very poor (table4.9). Evidences obtained from the DA office and the GSDID also showed that more than 75 percent of the water distribution canals were functional by the survey date although there was no clear evidence whether it had been functioning fully or partially. This is because irrigators in Gibe Lemu are more committed to maintain and sustain the irrigation system in spite of the severe coordination problem. The most important reason they suggested for farmer commitment was the role of irrigation in the life of farmers in the area and the high market value of horticultural crops produced using irrigation due to accessibility to the good commercial opportunity in Bako Town. A review of impacts of irrigation management transfer by Vermillion (1997:19) came up with similar results.

Table 3.8. Users' opinion about maintenance of the schemes

Description	Number and percent of irrigators					
	All HHS		GIBE-LEMU		Gambela Terre	
	Count	%		5.	Count	%
Very good	16	24.6	14	56	2	5
Good	22	33.8	9	36	13	32.5
Acceptable	4	6.2	1	4	3	8
Poor	12	18.5	-	-	12	30
Very poor	11	16.9	1	4	10	25
Total	65	100	25	100	40	100

Source: Field Survey, March 2005

In Gambela Terre, conveyance and distribution canal networks deteriorated due to a number of reasons. The distribution and conveyance canals became flat in many areas and pockets of water ponds created at many points along the conveyance and distribution canals (see the photo below). Results of survey on farmers' opinions indicated poor coordination of maintenance (92%), breaching of canals (87.2%) to extract water by illegal means and damage from animals (98.5%) as the major causes of damage and threats to safety of the irrigation system. Culturally, livestock freely graze over the command area for not all farmers

cultivate their irrigable plots uniformly. In addition, turnouts are far a part and not evenly distributed in some areas. Hence, irrigators break canals and extract water where there is no turnout; implying technical problems in design and construction have contributed to the deterioration of the scheme, in addition to the institutional and management weaknesses.

Photo: Water pond created on the main water conveyance canal due to damage by livestock and lack of maintenance, Gambela Terre SSIS

Irrigated Agriculture: Livelihood Impacts and Threats to Feasibility and Sustainability

Impact on Farmers' Livelihoods

Irrigation had contributed towards improvement of irrigators' livelihoods through its effect on

crop production. Irrigation brought about change in cropping pattern and increased production and farm income, improved housing and wage labor employment.

One method to show the social effect of the intervention on diversification is through comparison of types of crops cultivated by farmers before and after irrigation. The types of crops and the number of farmers who grew a wide range of horticultural crops has substantially increased after irrigation (table3.8). Chi-square analysis also revealed that the production of potato ($P<0.05$), onion ($P<0.05$) and tomato ($P<0.05$) was significantly different before and after the introduction of irrigation in Gambela Terre area (table 3.8)

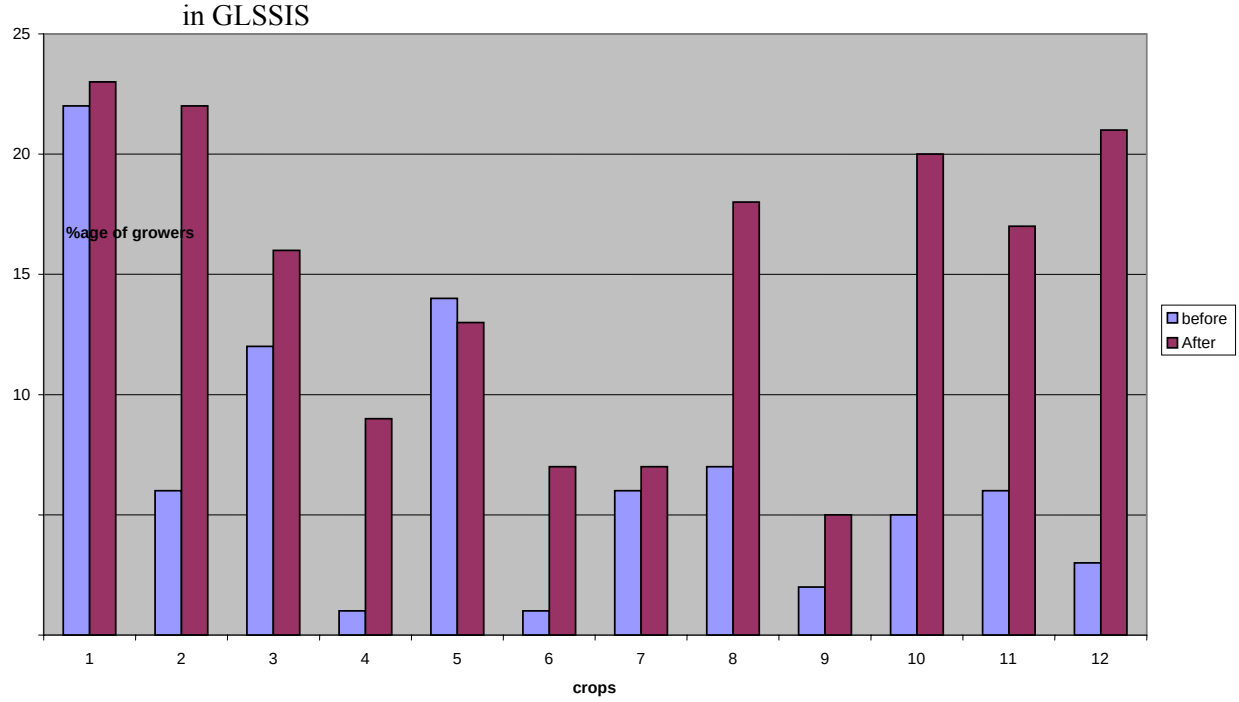
Table3.9 Comparison of agricultural diversification before and after

Crops grown	Gibe Lemu (N=25)				Gambela Terre (N=40)				
	HHs growing the crop				HHs growing the crop				
	Before		After		Before		After		X^2-tatist.
	N	%	N	%	N	%	N	%	
Maize	22	88	23	92%	15	50	23	23.59	0.835NS
Potato	6	12.5	22	875	9	29.0	29	93.5	5.226**
Onion	12	36	16	64	6	19.4	25	80.6	4.476**
Cabbage	1	-	9	37.5	7	23.3	17	56.7	0.709 NS
Pepper	14	58.3	13	54.2	11	36.7	19	63.3	0.660 NS
Carrot	1	4.3	7	30.4	2	6.9	14	48.3	2.005 NS
Chat	6	26.1	7	30.4	1	3.4	14	48.3	.967 NS
Coffee	7	28.0	18	72	5	17.2	23	79.3	1.616 NS
Sugarcane	5	20	20	80	1	3.4	10	34.5	.545 NS
Mango	6	24	17	68	8	26.7	24	80	.384NS
Tomato	3	12	21	84	6	20	21	70	4.802 *

Source: Field survey, NS=Non-significant, **=Significant at $P<0.05$

The second most visible impact of irrigation was temporal diversification of production. In Gibe Lemu, the number of households who used to grow twice increased from 8% before irrigation to 88% after irrigation and in Gambela Terre, from 2.5% before to 70% after irrigation. Results also revealed that it is significantly different between locations in Gambela Terre (X2-Prob. = 0.000) and farmers in the tail-end area benefited least. This is owing to inequity in the spatial and temporal distribution of irrigation water in the tail-end area. Furthermore, the proportion of irrigators who grow twice a year was higher in Gibe Lemu (88%) compared to Gambela Terre (70%). The difference is attributed to more severe problem of scarcity and unreliability of water and farmers biased ness towards rain-fed agriculture in Gambela Terre (see also fig3.3).

Figure3.1 Comparison of agricultural diversification before and after irrigation in GLSSIS

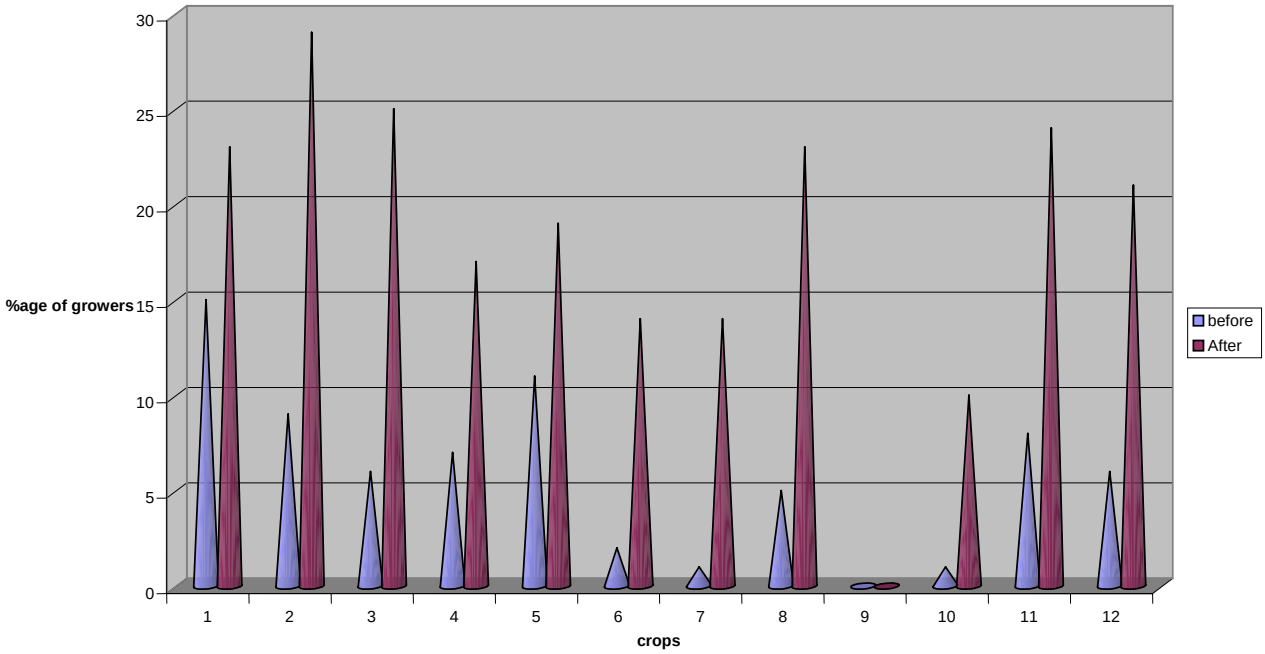


N.B:1=maize,2-potato,
3=onion,4=cabbage,5pepper,6carrot,7=chat,8=coffee,forage,10=sugacane,11=mango and 12-mango

Alongside diversification and intensification of crop production, SSI had a positive impact on the income of farm households in 2004/05. However, ANOVA showed that there was a significant difference ($F=13.47$, $P<0.0001$) in the net income of households between irrigation system and between locations. The average household net income from all sources in 2004/05 was relatively higher in Gibe Lemu (Table3.8). This could possibly be due to the relatively better supply of water, better water management and more commitment of farmers to irrigated agriculture in Gibe Lemu.

Findings of the study also revealed that the increased income from the sale of crops produced using irrigation has enabled irrigators to invest in household assets. Table3.11 shows that 17 corrugated iron roofed and 9 grass roofed houses were built through income from irrigation. The number of corrugated iron roofed dwellings built in Gibe-Lemu is 3 times as large as Gambella-Terre. In addition, the number of dwellings built by irrigators in the tail-end areas of both irrigation systems was low as compared to the other two water levels.

Figure3.2 comparison of production diversification before and after irrigation in GTSSIS



NB:1=maize,2-potato,
3=onion,4=cabbage,5pepper,6carrot,7=chat,8=coffee,forage,10=sugacane,11=mango and 12-mango

Figure3.3 Comparison of cropping intensity before and after irrigation in Gibe Lemu and Gambella-Terre

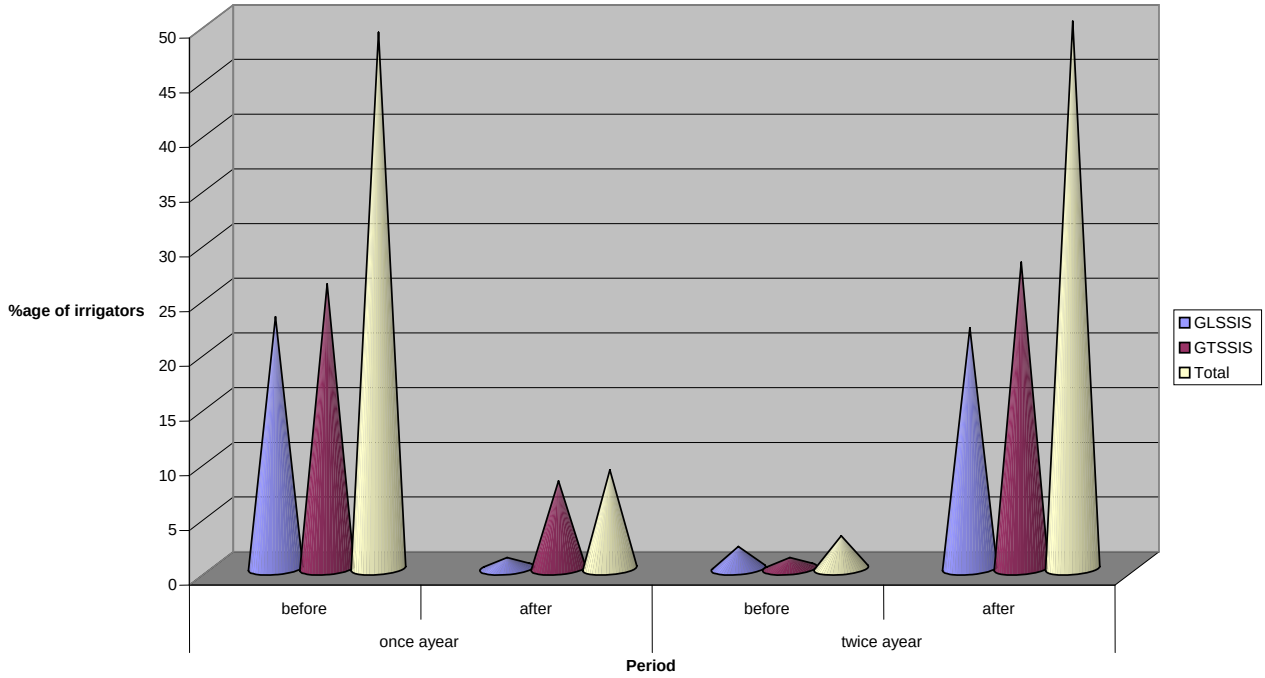


Table3.10 Household net income (Birr) from irrigated agriculture in 2004/05 by irrigation system, location and sex

Name of the irrigation system	Statistic	Location of farm plots				Sex of HHH	
		Head-end	Middle	Tail	Total	Male	Female
Gibe Lemu	Mean	946.23	797	1180	949.1	1011	534
	N	8	9	8	25	22	3
	St. Dev.	1145.9	1141	1727	1327	1396	586.02
Gambela Terre	Mean	394.61	624	276	351	372.16	177.5
	N	13	13	14	40	33	6
	St. Dev.	579.3	509.6	370	484.3	504.62	199.2

F=13.47, P<0.000

Source: Field Survey, Gibe Lemu and Gambela Terre, March-April, 2005

The use of hired causal (seasonal) and permanent labor was low in both irrigation systems as labor is not a major constraint. Irrigation created a limited number, 7 and 218, of employment opportunities (in 2004/05) for causal and permanent laborers respectively (Table3.14). A sum of birr 6705 was paid for seasonal and permanent hired labor (in 2004/05).

Table3.11 Roof materials of dwellings built through income from irrigation

Irrigation system	Roof materials of respondents house	Number and value of houses built			
		Number built (performance)	Value of the houses built		
			Mean	N	SD
Gibe Lemu	Corrugated iron	13	3801	10	2534.512
	Grass roof house	4	346.25	4	57.63
	Total	17	3704.57	14	3462.31
Gambella-Terre	Corrugated iron	4	4975.4	4	3386.62
	Grass roof house	5	380	5	164.32
	Total	9	2422.22	9	3190.52

Source:

Table 3.14 Employment impact of irrigation and cash paid for laborers in 2004/05

Description	Statistic	**Over all**		**GLSSIS**		**GTSSIS**	
		N	Cash paid (average)	No of laborers	Total cash paid	No of laborers	Total cash paid
Permanent labor	Sum	7	2805	3	1205	4	1600
	Mean	1	467.5	1	401	1	533.33
	N	7	6	3	3	4	3
	SD	-	382	0.00	288.67	0.00	166.04
Causal labor	Sum	218	3900	38	3330	180	570
	Mean	19.8	433.33	6.33	832.5	36	114
	N	11	9	6	4	5	5
	SD	38.2	970	11.62	1445.5	53.55	166.34

Risks to Feasibility and Sustainability of Irrigated Agriculture

The average plot size farmers allocated for irrigation occupies only a small portion while the land allocated for rain-fed agriculture represents the lion's share in Gambela Terre (appendix table4); implying farmers in Gambela Terre are committed less to irrigated agriculture. In addition, the actual irrigated area was small compared to the potential (150ha) and it has continuously been declining during 2001-2004/2005 (table3.15). Irrigation has totally collapsed in tail-end area that constitutes more than 53% of the total command area.

Table3.15 Estimates of actual irrigated area (ha) and its trend, 2001-2004/05)

Irrigation system	Irrigable land (ha)	Irrigated area (ha)							
		(1994) 2001/02		(1995) 2002/03		(1996) 2003/04		2004/05	
		Area (ha)	% of total	Irrigated area	% of total	Irrigated area	% of total	Irrigated area	% of total
Gibe Lemu	113	76.05	67.30	80	70.80	78	60.02	80.0	70.80
Gambela Terre	150	58.5	39	56.75	37.83	69.5	52.4	48.27	32.18
Total	263	134.55	51.16	136.75	52	130.4	49.58	1324	48.77

Source: Gobu Seyo District Irrigation Desk (GSDID)

The impact of irrigation projects on diversified and intensive irrigated horticulture and increased production not maintained for long for investment in these crops has become a risky business due to frequent crop failures. In Gibe Lemu and Gambela Terre, 92% and 84% of the sample households have faced crop failure. Hence, the majority of irrigators do not plant their irrigable plots to these fast growing vegetable crops regularly. They shifted to perennial tree crops such as: a) Sugarcane, chat, coffee and banana, in Gibe Lemu, b) Coffee, chat, 'Gesho', mango in Gambela Terre and to cereal production (mono-cropping) under rain-fed. Results of trend estimate revealed the actual irrigated area of the major vegetable crops (potato, tomato and chile) and maize has increasingly become shrunk during 2001/02-2004/05, while the area planted to perennial crops such as sugarcane and coffee had been increasing in Gibe Lemu (Figure3.4). In Gambela Terre, irrigated area of maize and chile had been declining; while irrigated area of sugarcane and coffee was increasing during 2001/02-2004/05 (figure3.5).

Farmers' perception and ranking of cause shows that water shortage, unreliable access to water and prevalence of vegetable diseases (Due to lack of adaptive seeds of crop varieties and knowledge of irrigation agronomy) were the prime constraints that threatened irrigated agriculture and dictated the change in cropping pattern (Tables3.16). Water is unpredictable and scarce due to

Figure3.4 Estimates of the trend in irrigated area of major crops in GIBE LEMU, 2001/02-2004/05

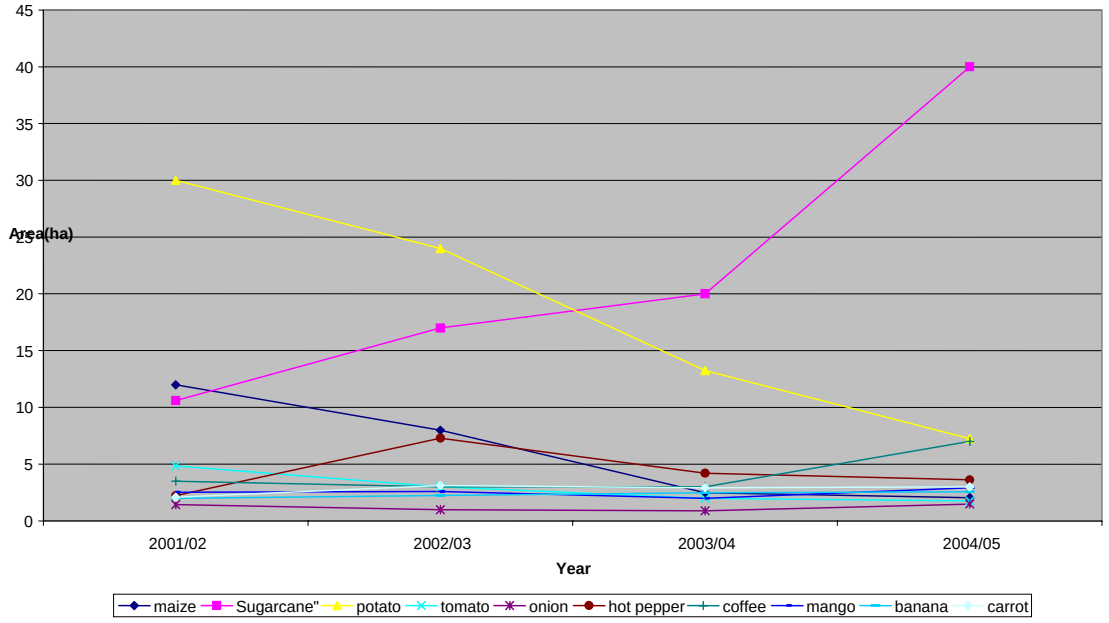
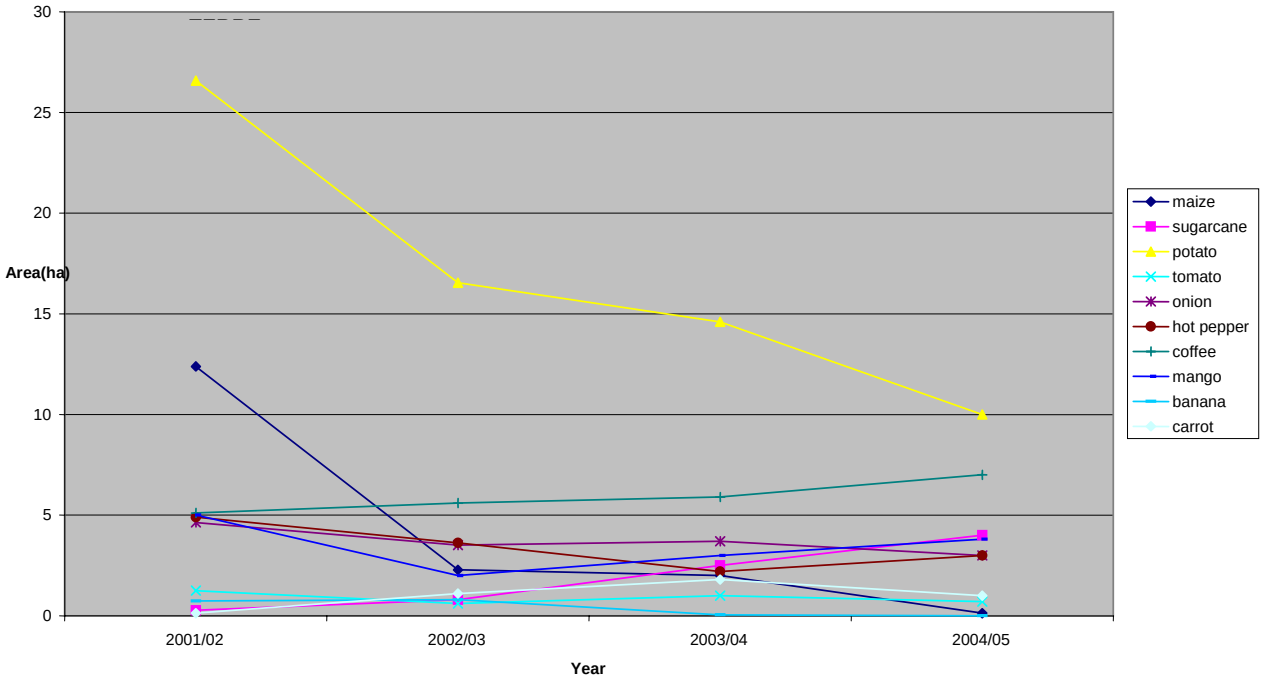


Figure3.5 Estimates the trend in irrigated area of major crops in GAMBELA



due to problems embedded in water management, definition of water rights, enforcing group-based rules and social relations among water users and decline in the amount of water from the source (hydraulic problem). Results of similar work by Alula (2001) also showed that unreliability of water supply and increased interval between watering of plots due

to scarcity and poor ware management, affected the type of crop that could be grown, even apparently limiting the practice of vegetable production.

Table3.16 Farmers' ranking of the reasons for under use of their irrigable land

Statistics	Water scarcity	Unreliable access to water	Shortage of labor	Vegetable diseases
GLSSIS N	7	9	4	6
% of farmers	28	36	12	
Rank	2nd	1st	4th	3rd
GTSSIS N	18	12	5	10
% of farmers	45	30	12.5	
Rank	1st	2nd	4th	3rd

Source: Field survey

Double cropping has been less feasible and unsustainable more in Gambela Terre. In addition to the gap in institutional development and support system and management and water scarcity problems, the various groups of informants reported that double cropping is less feasible owing to the following socio-cultural problems in the area:

- Farmers have limited or no experience in irrigation before arrival of the new project. Almost all (97.5%) of them own large area of rain-fed land as an option. It was initiated primarily to promote the collectivist interest of the Derg;
- The second problem was incompatibility between the new cropping pattern and the indigenous cropping pattern and the projects growing season and farmers' growing season despite the fact that compatibility is one of the social requirements for successful irrigation. Maize planted shortly after harvesting vegetable crops is affected by disease owing to the short time frame between harvesting of vegetable crops and planting maize, and lack of cropping sequence studied and specifically recommended for the irrigation system. Horst (1998: Woldeab, 2003) and FAO (1986) also write, 'incompatibility between the project cropping pattern and farmers' cropping pattern could lead to underutilization of irrigation water'
    - A culture of open grazing during the dry season in Gambela Terre; Crop damage from livestock discouraged interested farmers to engage them selves in irrigated farming.

Conclusion and Suggested Policy Options

The study used the socio-technical approach to irrigation technologies as conceptual frame in examining institutions, management practices and challenges. The following conclusions are drown from findings of the study using the theoretical notions like context, social requirement for use and social effects:

4.1. Although it is relatively better in Gibe Lemu, there was poor record of accomplishments in water management in terms of adequacy, timeliness and equity in the supply of water, conflict management and system maintenance. Access to adequate and reliable irrigation water is more unlikely if the farmer's irrigable plot is in the tail-end area (more serious problem in Gambela Terre). It was mainly because of the lack of the social conditions (Social requirements) of possibility for successful irrigation. The main irrigation agency has weak management capacity to support WUA management of irrigation although it is a necessary condition for efficient and lasting irrigation management. The WUAs are not properly organized to run irrigation management. Users have problematic social relation. Enabling legal systems of land water rights institutions are non-existent at the operational level. Efforts of

stakeholders were not harnessed in irrigation administration. These problems in turn have drastically affected management and utilization of the developed resources. Therefore, policies for future investment in smallholder irrigation development and for rehabilitation of the irrigation systems considered by this study should give due consideration to averting these problems.

4.2 Sustainable water rights of users not ensured in the irrigation systems. Water dispute (internal and external) is a major and undressed problem in both irrigation systems. It could no be addressed only through the general constitutional choice rule and the informal bylaws of water users. The problem is found to be very complex and beyond the capacity of users' organizations and local and village level administrative and legal entities. The major constraints are 1) there has been no enabling legal system (operational regulations) both at District and grassroots levels which clearly define the water rights of downstream and upstream users and rules which govern construction of new diversions; and 2) lack of clear definition of responsibilities (who should do what) for dealing with the problem. To ensure sustainable water rights of irrigators, facilitate shared use of water by downstream and upstream users and improve water management there is an urgent need for creating formal operational regulation.

4.3. Such technical resources as improved seed (technology) that is adaptive to the situation of irrigation and knowledge of irrigation (extension service and capacity building for irrigators) have not been met. This problem has been a major impediment to feasibility of irrigation. Therefore, policies for input supply, technology development (agricultural research) and rural extension have to be adjusted to meet these requirements of irrigated agriculture in the irrigation systems.

4.4. In spite of the lack of strong system management, water scarcity and unreliability and organizational and institutional problems, acceptable commitment of farmers was observed and the impact of the implemented SSI on farmers' livelihood was also relatively higher in Gibe Lemu. This could possibly be due to market stimulus (access and the good commercial opportunity at Bako Town), shortage of adequate rain-fed land and the problem of landlessness, experience and interest of farmers in irrigation and the role of irrigation in the life of farmers. This shows that irrigation should find its appropriate socioeconomic and institutional location to work effectively. The policy implication is that:

- Small-scale irrigation should be promoted where it is most demanded; and;
- Farmers' priorities and interest, compatibility of irrigation to the socio-cultural environment and farming system of the area and the opportunities (cultural, institutional, economic) for irrigation should be understood before intervention.

4.5. Irrigation has been a success in the first few years of project implementation. It has positively contributed towards increased diversification and intensification of production and livelihood improvement. Nonetheless, many farmers, what Engel (1997) and Mollinga (2003) call `the human agents` did not maintain these practices for long. They, do not practice irrigated vegetable production regularly, discontinued it, shifted to perennial tree crops or returned to the former cereal/mono-crop production under-rain-fed. The constraints that discouraged farmers participation were among others institutional and organizational weaknesses that led to poor irrigation management or the lack of what Engel (997) calls `the social organization` to coordinate and manage the irrigation systems. Therefore, adequate institutional and organizational development is crucial to enhance effectiveness of irrigation promotion and to ensure sustainability of the benefits of irrigation and the irrigation systems.

4.6. Expansion of traditional irrigation in the upstream areas of the rivers that are water sources for the schemes is a major threat to sustainability of the irrigation systems. There has been continuous decline in the quantity of water conveyed into the schemes. This led to progressive degeneration and collapse of irrigation in the tail-end area of Gambela Terre, covering more than 53% of the command area. Therefore, there is an urgent need for addressing

the problem through establishing and enforcing the necessary institutional/legal framework.

4.7. One of the major factors for underperformance of the Gambela Terre SSIS is water scarcity. Therefore, future fate (sustainability) of the scheme should be determined through detailed hydrological study on the water source before embarking upon any investment aiming at rehabilitation of the irrigation system.

4.8. In nut shell, change to sustainable diversified irrigated agriculture and to double cropping not met in both irrigation systems. The challenges and sustainability constraints that need urgent intervention through developing and enforcing appropriate institutional support systems at all level, from the apex and grassroots levels, include:

1. Institutional and management limitations that led to scarcity and unreliability of water
2. Prevalence of vegetable diseases because farmers have not regularly been supplied with improved and adaptive seeds of vegetable crops that work under irrigation; because extension service and in put supply policy is biased both in terms of supply and timing of supply to rain-fed agriculture. It is not adjusted to meet the requirements of SSI at the grassroots level (the role of policy)
3. Expansion of traditional irrigation in the upstream areas of the rivers that are water sources for the schemes leading to water scarcity in the schemes. Nevertheless, there has been no enabling legal framework that facilitate the shared use of water by the two groups
4. Weak institutional capacity of the local state irrigation agency to support decentralized management of SSI
5. Weak linkage among stakeholders of SSI management both at the District and scheme levels;
6. Problem of social incompatibility between the new cropping pattern and the indigenous cropping pattern and between the projects growing season and the indigenous growing season (in Gambella Terre)
7. A culture of open grazing during the dry season in Gambela Terre

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APPENDIX

Tables

Appendix table1 Water users' opinion about water distribution by irrigation system and location of farm plots

Item	Response (yes/No)	%age of water users giving the opinion by irrigation system and location							
		Gibe Lemu (N=25)				Gambela Terre (N=40)			
		Head	Middle	Tail	X2-Stati.	Head	Middle	Tail	X2-Stat.
Enough water is obtained	Yes	12	8	-	1.32NS	7.5	2.5	-	10.6**
	No	20	28	32		25	30	35	
Water is received when needed	Yes	16	8	-	4.5NS	15	5	-	9.8**
	No	16	28	32		17.5	27.5	35	
Water distribution is equitable	Yes	16	-	-	5.5*	12.5	5	-	9.6**
	No	16	36	32		20	27.5	35	

Source: Field Survey, NS= Non-significant, *= significant at P<0.1, **=Significant at p<0.005

Appendix table2 Major crops cultivated, estimates of irrigated area and trends (2001/02-2004/05), Gibe Lemu and Gambela Terre SSIS

DESCRIPTION OF CROPS GROWN	Irrigated area in ha (2001/02-2004/05)							
	GLSSIS				GTSSIS			
	2001.02 (1994)	2002/03 (1995)	2003/04 (1990)	2004/05 (1997)	2001/02 (1994)	2002/03 (1995)	2003/04 (1996)	2004/05 (1997)
MAIZE	12	8	2.5	2.06	12.38	2.28	2	0.125
SUGARC	10.60	17	20	40	0.27	0.8	2.25	4
POTATO	30.00	24	13.25	7.24	26.58	16.55	14.60	10
TOMATO	4.85	3.5	2	1.76	1.25	0.61	1.00	0.7
ONION	1.44	1	0.90	1.50	4.64	3.51	2.00	3.00
PEPPER	2.22	7.3	4.21	2.05	7.33	3.63	4.21	1
COFFEE	3.50	3.00	3	7.01	5.11	5.60	5.92	7.00
PAWPA	4.00	-	0.5	0.12	0.08	0.05	0.03	-
MANGO	2.52	2.6	2.92	2.92	5.00	2.00	3.3	6.50
BANANA	4.00	3.12	2.93	3	0.74	1.8	1.20	1

Source: Gobu Seyo Wereda Irrigation Desk

Appendix Table3 ANOVA of household net income from irrigation in 204/05

		Sum of squares	df	Mean square	F	Sig.
Amount (Br.)*irrigation sys*location	Between groups (combined)	13570199	1	13570198.64	13.47	0.000
	Within groups	1.51E+08	150	1007749.71		
	Total	1.65E+08	151			
Amount (Br.)*irrigation sys*Sex	Between groups (combined)	13570199	1	13570198.64	13.47	0.000
	Within groups	1.51E+08	150	1007749.71		
	Total	1.65E+08	151			

Appendix table 4 Average land holding by type of use

Type of use	Average plot size per household					
	Gibe Lemu			Gambela Terre		
	Mean	N	SD	Mean	N	SD
Total land size (ha)	2.54	25	3.05	3.16	40	1.77
Irrigable area	1.08	20**	0.72	0.72	39**	0.99
Area under rain-fed	1.57	25	1.73	2.5	40	1.27

Source: Field survey, the sign `**` implies the rest sample irrigators (five in Gibe Lemu and one in Gambela Terre) do not have own irrigable land

Appendix Table5 Vegetable growers who faced crop failure, by irrigation system and location of plots

Irrigation system	Do you grow vegetables every year using irrigation? (%)		Ever faced problem of crop failure (Yes/No)			
			All HHs	By location of farm plots (%)		
				Head-end	Middle	Tail-end
Gibe Lemu (N=25)	Yes	8	92	24	36	32
	No	92	8	-	4	4
Gambela Terre(N=40)	Yes	77.5	84.2	26.3	26.3	31.6
	No	20	15.6	10.5	5.3	-

Source: Field survey