Journal of Spatial Hydrology
Vol.8, No.1 Spring 2008

Technical and Institutional Evaluation of Geray Irrigation Scheme in West Gojjam Zone, Amhara Region, Ethiopia

Gashaye Checkol[2] and Tena Alamirew[1†]

Abstract: The technical and institutional performance evaluation of Geray Irrigation Scheme was made in order to identify management practices for implementation to improve the system operation and the performance of the irrigation system. The evaluation was made based on the selected performance indicators such as conveyance efficiency, application efficiency, water delivery performance, and maintenance indicators. The availability of institutional and support services were also investigated through a questionnaire administered to beneficiary farmers and other stakeholders. The results obtained showed that the main and tertiary canal conveyance efficiencies were 92 and 82 percents respectively. Many of the secondary and tertiary canals are poorly maintained and many of the structures are dysfunctional. Application efficiency monitored on three farmers' plot located at different ends of a given secondary canal ranges from 44 to 57 percent. Water delivery performance was only 71% showing a very substantial reduction from the design of the canal capacity. Maintenance indicator evaluated in terms of water level change (31.9%) and effectiveness of the infrastructures showed that the scheme management was in a very poor shape. Dependability of the scheme evaluated in terms of duration and irrigation interval showed that the scheme is performing below the intended level. The 47% of the land initially planned for development is currently under irrigation while there is no change in the water supply indicating that the sustainability of the scheme is in doubt. The cooperative support services that had been rendered to the beneficiaries in the past four years were found to be minimal. Moreover, there were few indicators that show the production was market oriented. The evaluation clearly revealed the fact that conflict resolution remains to be the duty of the local community authorities and Water User Associations (WUA) has no legal right to enforce its bylaws. In conclusion, the overall technical adequacy of the scheme is rated very poor requiring tremendous mobilization of the community to sustainably manage it. Proper institutional setup needs to be in place, and WUA needs to be more empowered in order to enforce its by-laws.

Keywords:- Irrigation performance, irrigation institutions, support services, Ethiopia

[†]corresponding author and Assistant Professor, Department of Agricultural Engineering, Haramaya University, P O. Box 138, Dire Dawa, talamirew@haramaya.edu.et

1. Introduction Ethiopia is known as the 'water tower of Africa'. Its geographical location and endowment with favorable climate provide a relatively higher amount of rainfall in the continent. Preliminary studies and professional estimates put the nation's annual surface runoff to 122 billion m^3, groundwater potential to 2.6 billion m^3 and the average rainfall of 1090 mm (Kassahun, 2007). However, the spatial and temporal distribution of the rainfall is extremely uneven, these average annual figures give the wrong impression that 'the country has adequate rainfall for crop production (Rahimato, 1999).

As the capacity of the country to store the excess water is very poor, most of the water flows out carried by transboundary rivers to neighboring countries. Consequently, the country suffers from water scarcity triggered hazards, such as more frequent crop failure, food insecurity, drought and famine (Teshome, 2003). About 52% of the population or 214 districts of the country are known to be food insecure. The population requiring food assistance is increasing in absolute terms. In 2006, for instance, about 15 million people were food insecure mainly because of rainfall variation (Kassahun, 2007).

Despite the endowment of Ethiopia with huge (3.5 million ha) irrigable land, the area under irrigation development is only five percent (195 thousand ha)(Leulseged, 2003). This shows that water resources have made little contribution towards the development of agricultural sector in particular and the community in general to date.

To address the challenges of food insecurity and associated poverty, improving agricultural productivity occupies a central place in the 'Agricultural Development Lead Industrialization (ADLI) strategy of the present Ethiopian government. Fighting poverty and reducing food deficiency are at the heart of ADLI. The government has committed itself to the reduction of poverty by half, through the endorsement of the Millennium Development Goals (MDG) (MOWR, 2001). Irrigation development is one of the pursued strategic interventions in this regard. The government now recognizes that it is implausible to expect any great degree of agricultural production intensification under rainfed dry land farming system. Hence, tremendous efforts are underway to promote large, medium and small scale irrigations through huge financial and labor investments.

In the last few years, heavy investments have been made to harness the water resources of the country towards irrigation development. The ongoing Tendaho, Kessem, Fentale, Koga irrigation projects over and above huge work on rainwater harvesting pond construction that has been aggressively pursued all over the country are evidences for the communities' and government's commitment to irrigation development. However, given the dismal and undesirable experience on the performance of the irrigation schemes developed earlier, there is no guarantee that the new schemes will deliver the anticipated benefits.

Given the anticipated importance of irrigation in food security and poverty reduction and the huge investments committed on irrigation infrastructure, it is imperative that the irrigation sector is efficient and effective in yielding desired socioeconomic returns. However, the performances of many of the existing irrigation schemes have been far from satisfactory. Several of the previously constructed irrigation projects are totally or partially abandoned. Most have not reached their

planned levels of productivities and many are not financially or technically sustainable in their present forms.

For irrigation schemes to be sustainable, mutual supportiveness of irrigation hardware (irrigation infrastructure) and software (institutions) are vital. Mutual supportiveness is ensured when the hardware is cost and labor efficient, easy to operate, and yielding predictable results. The software is characterized by individual/collective interest and management skill embodied in a lean organization of water users besides adequate support services (Ostrom, 1992). Lack of appropriate skill and commitments to accomplish mutual responsibilities on the water user's side, and inadequate organizational and management setup of the local irrigation scheme managers is the biggest constraint.

The paradox of big expectation from irrigation development to alleviate food insecurity and rural poverty versus inability to sustainably utilize developed schemes calls for detail scrutiny of the relative contribution of prevailing technical and institutional problems of failed schemes (Teshome, 2003). One such failed scheme selected for this study is Geray Irrigation Scheme. This scheme, provided with excellent quality of irrigation water from a spring with virtually no silt problem, was expected to operate with minimum technical problem. However the scheme has not been able to live up to the expectations. Hence, this study was made to evaluate the contribution of the institution related problems for its technical underperformance.

2. Data and Methodology

2.1. Location of the Study Site

Geray irrigation scheme is located 10' 60'' latitude and 37' 26'' longitude in Arbaetuensisa Keble located 5 km from Finoteselam in West Gojam zone. Finoteselam is located 380 km from Addis Ababa on the main road to Bahir Dar. Construction of the solid masonry diversion started in 1971 and was completed in 1972. Construction of canals and other structures continued slowly and reports indicate that the scheme was commissioned in 1984 (Chekol, 2007).

2.2. Technical Performance Evaluation

Technical performance indicators monitored in this study included the measurement of conveyance efficiency of the main canal and tertiary canals, application efficiency and water delivery performance.

Conveyance efficiency – It was estimated by measuring inflowing and outflowing water along the selected canal lengths and applying equation 1 (Boss, 1997; Boss et al., 1993)

$$\text{Conveyance efficiency} = \frac{\text{water flowing in the canal}}{\text{water flowing out of the canal}} \quad (1)$$

Application efficiency - The ratio of the depth of water added to the root zone to the depth of water applied to the field was measured from three farmer fields that were growing potato. The criteria for selecting farms were their location associated with the reach of the canal, i.e. top, middle and lower end of the canal. The three plots of farms were chosen among those that served on the same secondary canal at the head, middle and tail reaches with the presumption that there will be differences in the availability of water among these category of irrigators. Application efficiency (E_a) was computed as follows (equation 2).

$$E_a = \frac{\text{Depth of water added to the root zone}}{\text{Depth of water applied to the field}} \quad (2)$$

The water delivery performance indicator:- It was calculated by measuring the actually delivered volume of water to the intended (design) volume water to be delivered (equation 3)

$$\text{Water Delivery Performance} = \frac{\text{Actually delivered volume of water}}{\text{Intended volume of water to be delivered}} \quad (3)$$

2.3. Maintenance Indicators

Proper maintenance enables the keeping of water control infrastructure in good working condition so that the design water level is maintained. The head loss across structures (water level difference between upstream and downstream of structure) in irrigation canals is the single most important factor disrupting the intended delivery of irrigation water. The maintenance indicators were evaluated by the following hydraulic performance indicators (Boss, 1997; Kloezen and Garces-Restrepo, 1998.).

a. **The relative change of water level (RCWL)** - It was computed by taking the actual water depth from the canal bottom and comparing it with the design water depth at the same position in the main canal, i.e. change of water depth from the intended level (equation 4).

$$RCWL = \frac{Change\ of\ Depth}{Intended\ Depth} \quad (4)$$

b. **Effectiveness of infrastructure** – It measures the ratio of the number of functioning structures to the total number of structures initially installed (equation 5).

$$Effectivity\ of\ Infrastructure = \frac{Number\ of\ functioning\ structures}{Total\ number\ of\ structures} \quad (5)$$

c. **Dependability of duration** – It is estimated as the ratio of the actual duration of water delivery compared to the plan as computed by equation 6.

$$Dependability\ of\ duration = \frac{Actual\ duration\ of\ water\ delivery}{Intended\ duration\ of\ water\ delivery} \quad (6)$$

d. **Sustainability** – is measured as the ratio of current area under irrigation to the initial total irrigable area (equation 7).

$$Sustainability\ of\ Irrigable\ Area = \frac{Current\ irrigable\ area}{Initial\ total\ irrigable\ Area} \quad (7)$$

2.4. The Irrigation Institution Performance Assessment

Institution refers to social arrangements that shape and regulate human behavior and have some degree of permanency and transcending individual human lives and intentions. In this survey, the status of irrigation institution and availability of support services were assessed through questionnaires administered to the different stakeholders of the scheme. Focus group discussions were made with beneficiary farmers, elders, water user cooperative (WUC) management, the Kebele Council, and Cooperative Promotion Staff of Agriculture and Rural Development Office. Samples chosen include 13 WUC members, seven WUC executives, five Kebele Council representatives, 10 irrigable land owners who are not members of the WUC, three farmers owning irrigable land but not rainfed, three farmers that don't possess but are renting irrigable land and four elderly farmers who participated during the weir construction.

3. Major Findings and Discussion

3.1 Characterization of the scheme

Reports indicate that Geray Irrigation scheme was officially commissioned in 1984 upon finalizing the construction of tertiary canals for the four of the seven secondary canals by the then Irrigation Development Department, while the head work was finished in 1974 by the Ministry of Agriculture. The project was government initiated in an effort to build the capacity of the then Arbaetuenissia Producers Cooperative.

The net irrigable area of the scheme was 618 ha. However, the actual area developed for irrigation was 454 ha. The main canal was 9.8 km long. The number of secondary canals was nine with a total length of 12.5 km while that of the tertiary canals was over 52 km long in total. The weir had 105 m crest length and 4 m height.

The numbers of beneficiary households that own irrigable land were 790 out of which 400 were members of the WUA and the remaining 390 were non-members. However, during the study period (2006), the area under irrigation was 215 ha only. The number of potential beneficiaries of the scheme is estimated to be 3950 people. The lowest average driest month of Geray River discharge from which water was diverted to the main canal was reported to be 1.9 m^3/s. The main canal design discharge with the gate fully opened was 1.54 m^3/s. The lowest environmental flow was set to be 0.36 m^3/s. During this study, the actual flow measured in the main canal when the gate was fully opened was 1.1 m^3/s.

During this survey, the majority of the drop and other structures were dysfunctional. There are a number of illegal water abstraction and canal breaching. Majority of installed tertiary canals were not operational.

Farmers practice furrow irrigation. The furrow lengths range from as long as 54 m to as short as 8 m. There is no restriction for the type of crop one grows, but 75% of the farmers grow potato.

3.2 Technical Efficiencies

Conveyance and application efficiencies

The average main and tertiary canal conveyance efficiencies were measured as 92 and 81%, respectively. It was observed during the field work that water was leaking on places where the canal was breached, flow in canal network was not uniform, canals were heavily vegetated, and water overtops the canal banks.

The application efficiencies measured on the three farms selected for this study is presented in Table 1. The values obtained were close to each other and low, but not very far from what is expected in surface irrigation system.

Table 1. Application Efficiency

Farm	Applied Depth (mm)	Stored Depth (mm)	Application Efficiency (Ea %)
Head end of the canal	215.5	123.7	57.39
Middle of the canal	188.4	83.7	44.41
Lower end of canal	123.5	60.9	49.33

Water Delivery Performance

The water delivery performance calculated as the ratio of actual delivery (1.1 m^3/s) water to the intended volume of water (1.54 m^3/s) of water to be delivered was 71%. A 29% reduction in the capacity of the system was large. The effect of this reduction in the carrying capacity of the main canal was reflected in reduced irrigated area.

The Relative Change of Water Level

As per the design document, the main canal carries 1.54 m^3/s discharge when the depth of water from bottom of canal is 0.47 m; whereas the depth of water measured was 0.32 m with measured discharge of 1.1 m^3/s, resulting in a 32% water level change. This showed that the intended water level in the main canal was achieved; consequently, less discharge was delivered to the farms forcing farmers either to increase the irrigation time or decrease the irrigated area.

Effectiveness of Infrastructure

As per the design document, the total number of different structures constructed was 111, but only 74 of them were functional. As a result, the value of effectiveness of infrastructure was

calculated to be 67%. Nearly one-third of the structures had been destroyed. Severe mutilation of water control structures for their iron bars reported.

Dependability of Duration

The intended duration of water delivery as per the design document was 10 hours irrigation time per day. However, farmers were irrigating up to 18 hours a day. The calculated dependability duration was 180%, showing that it requires more time than anticipated to irrigate the fields.

From all the indicators monitored in this survey, the scheme's technical performance was sub-optimal in all standards, and requires urgent maintenance.

3.3. Institutional and Support Services

3.3.1 Scheme Management

The scheme management, since it was commissioned 27 years ago, has been changed over and over. Earlier in the previous government, it was managed by producer cooperatives. But when the cooperatives disbanded, the local government through the Agriculture and Rural Development Office with all its inefficiencies tried to manage the scheme. Later on, however, knowing that it can no longer effectively manage it, it crafted farmers' cooperative and passed the management without proper consultation with all stakeholders.

For the past four years, Geray Irrigation Scheme has been administered by this water user cooperatives (WUC) registered under Amhara Regional Cooperatives Promotion Agency. The cooperative adopted a generic bylaw drafted by the Agency. The bylaw indicated that the association is responsible for water distribution, system maintenance, collection of water fees, soliciting for input supplies, credit facilitation, planning and monitoring, etc. But none of these responsibilities have been executed as desired.

3.3.2. Performance of the Water User Cooperative

Institutional arrangement on irrigation is required to overcome problems related to irrigation water as a common property resource, to provide incentive to members, disincentive for free riding and shirking. As mentioned earlier, the WUC was provided with a generic bylaws binding on all cooperative members. The first challenge in the functioning of the cooperative was the principle clash in which cooperatives were organized – i.e., membership ought to be fully on voluntary basis. When farmers share the same irrigation water resource, organizing some of them under the cooperative umbrella while leaving others as non-members seriously challenge to the effectiveness of the cooperative in water management. This is against one of the principles of enduring self governing institutions (Ostrom, 1992; Sarker and Itoh, 2001). Moreover, the cooperative manual lacks detailed operational rules (such as entry, allocation, penalty, input rules) and organizational structure specific to the irrigation scheme.

3.3.3. Operation and Maintenance Problems

As per the response of the farmers interviewed in the study area, some of the major problems that the farmers face include weir and canal leakage, and siltation of canals. These were also in clear evidence during the survey. Although the maintenance of leaking weir may be beyond the capacity of framers in which case they may solicit the support of the local government, the canal maintenance should be the duty of the cooperative. However, the status of the secondary canals and their water control structures showed that no proper maintenance has been carried out for a long time and the cooperative was not effectively shouldering the scheme management. The beneficiary farmers also acknowledged that the scheme was poorly maintained, and they attributed the problem to lack of fund for maintenance. It was, however, noted that farmers are neither contributing money for operation and maintenance nor do they pay for the irrigation water they use.

3.3.4. Conflict and Conflict Resolution Mechanisms

Conflict between and among the beneficiaries and the downstream farmers who are not served by the canal water was said to be rampant. Among the 45 interviewed beneficiary farmers, 44 acknowledged the presence of conflict. They attributed water shortage to be often times the cause of conflict. The survey also showed that there was no water sharing agreement between upstream and downstream users, and there was no equity in water distribution (Table 2)

The survey also showed that the majority of the interviewed farmers (73%) had no confidence in the capacity of WUC management to resolve conflicts. In fact, it was learned that the major actor in conflict resolution was the Kebele Council and social courts. The problem with Kebele leadership and social courts in handling disputes was that the majority of them were not among irrigation beneficiaries. Hence, when WUC lodge complaints to the social courts, verdicts took a long time and the penalty was never proportionate to the offence.

In conclusion, the WUC is not empowered to take punitive action and enforce its by-laws. The majority of the water management problems revolve around the inability of the association to sanction offenders. The tortuous legal processes in the judicial system and the lack of recognition of the cooperatives by-laws were the most serious challenges that the cooperatives were facing currently.

Table 2. Beneficiary farmers' responses to conflict related questions

	Frequency	Percent
1. Have you ever come across a conflict between those living around the canal tertiary units and the downstream users?		
i. Yes	44	97.8
ii. No	1	2.2
2. What are the probable causes of the conflict?		
i. Unequal water distribution	4	8.9
ii. Irrigation schedule disturbed	25	55.6
iii. Scarcity of water	11	24.4
iv. Both i and ii	5	11.1
3. Is there a water sharing agreement among each of the branches?		
i. Yes	3	6.7
ii. No	38	84.4
iii. Have no information	4	8.9
4. Is water equally available to all users in the scheme?		
i. Yes	2	4.4
ii. No	42	93.3
iii. No response	1	2.2
5. Who are the actors in conflict resolution?		
i. WUA	4	8.9
ii. Kebele council/social courts	11	24.4
iii. Both i and ii	30	66.7

3.4. Support Service

3.3.1. Extension and Training

Given the potential benefit that the scheme could provide to the beneficiary farmers and the local community, a qualified extension agent would have been imperative. It was, however, learned that farmers were not getting advice from an irrigation agronomist or from a qualified development agent. There were no organizations committed towards providing farmers with the needful training and extension services.

Table 3. Response of farmers to the kind of support they get from the government

What kind of support the scheme gets from the government now?		**Frequency**	**Percent**
i	Input supply	3	6.7
ii	Advice	13	28.9
iii	i to ii	6	13.3
iv	No support	10	22.2
v	Have no information	12	26.7
	Total	45	

3.4.2. Access to Market and Input Supplies

The Addis Ababa – Bahir Dar highway is only some 5 km from the scheme. The status of dry weather road to the farms during the study period was fair. The zonal town, Finoteselam, is only some 7 km from the scheme. Market factor does not play a role in what and when to produce. When farmers were asked whether they have problem to sell their produce, their responses were that they don't have market problem. However, when farmers were asked to explain why many beneficiary farmers grow only potatoes, the response they gave was:

> *'We grow potatoes because if we can't sell them in Finoteselam market, we can dry them, store and use them for home consumption'.*

Drying potato to extend its shelf life was a useful technology farmers practice to keep produce when it is in excess. Therefore, it is evident that farmers are not producing for a serious market. No effort of farmers was observed in the study area to take advantage of soaring demand for vegetables either in nearby Bahir Dar nor Addis Ababa markets. The problem was identified to be the fact that a truck is required to transport to the markets at Bahir Dar and Addis Ababa. However, such facility is not available to the farmers. Trucks do not come to collect one farmers pick as it would be too small to fill a truck. In principle, the solution for this problem would be to organize farmers to jointly plan and produce for the market on a pre-negotiated price. If this happens, the produce would be large enough to hire a truck, and transport the produce where market is available.

From the survey results (Table 4) shortage and/or unavailability of seeds was also cited as another problem for diversification of crops under irrigation. This again showed that the cooperative was not discharging the fundamental cause for its formation, that is providing inputs and facilitating markets.

Table 4. Causes for inability to diversify crop production

What are the problems relating to diversifying irrigated Agriculture?	Frequency	Percent
i. Scarcity of seeds	37	82.2
ii. Plant diseases	0	0
iii. Market availability	0	0
iv. Lack of sufficient irrigable land	0	0
v. Low market price for output	1	2.2
vi. Items i, ii and iii above	2	4.4
vii. Items i and ii above	2	4.4
viii. No response	3	6.7
Total	45	

3.5. Other Key Findings of the Survey

From the focus group discussion held with beneficiary farmers and the community, the following important issues were captured:

a. The WUC was not empowered to take administrative actions and enforce its by-laws. The social courts do not use the cooperative by-laws as valid instrument to sanction penalties. Farmers use local adage saying that the WUC management is a 'Lion without teeth'.

b. The penalties that the offenders pay fail to be commensurate with the infraction to deter him or her from committing similar offence in the future. Moreover, the penalties that the offenders pay were deposited into Kebele's account. Therefore, the WUC would not benefit by taking an offender into a lengthy legal battle.

c. At the time of this survey, there had been no Development Agent (DA) assigned to the scheme. Farmers reported that there had been a DA with natural resource management background but he stayed only for less than one season. Hence, all the indications were that farmers were not benefiting from any technical backstopping.

d. The scheme had been under management of the government authorities until some four years ago. Hence farmers did not feel that they own the water and the irrigation infrastructure. Farmers were uncertain of the land tenure arrangements. They reflected that the land they own today may be taken away by the government at any time for lease to investors. They tried to justify this worry by citing the 20 ha land leased to an investor in the middle of the scheme.

e. There was no mutual understanding to forge equitable distribution of irrigation water among all beneficiaries. Those located in the upstream end of the secondary canal could take as much water as they wish; consequently, not enough water reaches the downstream users. Hence, to avoid crop failure due to water supply interruption at critical growth stages, the farmers located in lower end of secondary canal prefer to rely on rainfed farming.

f. Most tertiary and field canals constructed as raised canals have become dysfunctional to convey water as intended in the design. As per the design document, siphon was to be used to divert water from the canals to the furrows. But none of the irrigators was practicing the same. Farmers were creating their own conveyance system bypassing developed canal and water control structures. Consequently, there was tremendous water loss when water was made to flow on temporary conveyance system.

g. The responses to the question of 'who owns the scheme?' – the government or the community – were illusive and it was difficult to obtain a mutually agreed response. Although farmers felt that the head work, primary and secondary canals were the responsibilities of government, they could not pin point any one of them. From the local governments end, those implicated in one way or the other are the Agriculture and Rural Development Office, Cooperatives Promotion Agency and Water Resource Office.

h. There was no enough consultation with all the stakeholders before transferring the scheme management to the farmers. Hence farmers were uncertain of the government's motive.

3.6. Key Reflections Captured during the Discussions with the Staff Members of Woreda Agriculture and Rural Development Division.

a. The absence of specific roles that the offices of agriculture, water, cooperative promotion agency should play has made none of them accountable for the poor performance of the scheme.
b. Many beneficiary farmers own excess irrigable land than they can manage. Some farmers have even rainfed land outside the command area. Consequently, they do not have the capacity and the commitment to manage both irrigated and rainfed farms. Simultaneously, one alternative idea suggested on to solve this problem was to limit maximum irrigable land holding of a family. Thus providing access to as many farmers as possible.
c. Level of awareness of farmers towards marketable and high value crop production was low. Farmers tend to be complacent with what they have and produce. They do not seem to be motivated towards market oriented production.
d. The irrigation skill of farmers was below satisfactory. Farmers do not appreciate, protect and attempt to use water conveyance and control structures established during the irrigation development.
e. Farmers were not paying for the provision of irrigation water. Moreover, no cost recovery attempt has been initiated.

4. Conclusion

The irrigation potential for Geray irrigation scheme to change the life of the community is tremendous. It is endowed with excellent quality and quantity of irrigation water. The soil is highly suitable for irrigated agriculture. However, all the technical performance indicators showed that the scheme's performance was far from satisfactory. Many of the water control structures have become dysfunctional. The underperformance of the scheme was attributed to extreme neglect and lack of supervision by the local authorities. These it is concluded that the overall performance of the scheme was unsatisfactory.

The neglect was mainly attributed to lack of ownership. Further, many years of inefficient state management in the absence of committed development agent took the major blame for the infrastructure damage. Moreover, the recent transfer of management to service cooperatives did not confirm to the principle of long-enduring irrigation institutions. The fact that not all irrigation beneficiary farmers are members of the cooperative which again shows that the institute does not have clearly defined boundary condition which is one of the requirements for good irrigation institution.

Successful traditional schemes not very far from Geray Irrigation Scheme have been perfectly functioning over 70 years using rudimentary irrigation structures and extensive annual maintenance requirements. Hence, there should not be any reason why this scheme should not have been successful provided that proper institution had been crafted right from the very beginning. The major problem identified during this study was the absence of functional institution to properly manage the scheme. The cooperatives association recently crafted has no power either to sanction penalties or enforce them. Under this scenario, efforts made by the government to rehabilitate the structure may not bring the desired changes in the life of the beneficiaries. Rather, the WUC needs to be reorganized and made effective. Uncertainties relating to land

tenure need to be addressed at the earliest. Most importantly qualified development agent with irrigation agronomy background should be assigned to the scheme. Moreover, the DA should be given the responsibility to mobilize the community, following the major network rehabilitation skills and should be made accountable for the overall performance.

Acknowledgements

The authors thank International Water Management Institute (IWMI) East Africa Office at Addis Ababa and Austrian Government for their financial support to undertake this study.

References

Bos M. G. 1997. Performance indicators for irrigation and drainage. Irrigation and Drainage Systems, 11:119-137.

Bos, M. G., Murray-Rust, D. H., Merrey, D .J., Johnson, H. G. and Snellen, W. B., 1993. Methodologies for assessing performance of irrigation and drainage management. Irrigation and drainage systems. Vol. 7 No.4.

Chekol, G., 2007. Technical and Institutional Evaluation of Geray Irrigation Scheme, West Gojam, Amhara Region. MSc Thesis, School of Graduate Studies, Haramaya University, Ethiopia

Kassahun, D., 2007. Rainwater Harvesting in Ethiopia: Capturing the Realities Exploring Opportunities. FSS Research Report No. 1. Forum for Social Studies, Addis Ababa, Ethiopia

Kloezen W. H. and Garces-Restrepo C., 1998. Assessing Irrigation Performance with Comparative Indicators: The Case of the Alto Rio Lerma Irrigation District, Mexico. Research Report 22. International Water Management Institute. Colombo, Sri Lanka.

Leulseged, M., 2003. Irrigation Sub-sector situation analysis. Ministry of Water Resources, Addis Ababa (unpublished)

MoWR (Ministry of Water Resources). 2001. Irrigation Development Strategy. Ministry of Water Resources, Addis Ababa.

Ostom, E. 1992. Crafting Institutions for Self Governing Irrigation Systems. ICS Press, San Francisco, CA, USA

Rahmato, D., 1999. Water Resources Development in Ethiopia: Issue of Sustainability and Participation. FSS Discussion Paper. Irrigation Practices, State Intervention and Farmers' Life-Worlds in Drought-Prone, Tigray, Ethiopia.

Sarker, A and Itoh, T., 2001. Design principles in long-enduring institutions of Japanese irrigation common pool resources. Agricultural Water Management. 48(2001) 89-102.

Teshome, W., 2003. Irrigation Practices, State Intervention and Farmers Life-Worlds in Drought–Prone Tigray. PhD Dissertation, Wageningen, the Netherlands.