ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

INSTITUTIONAL ANALYSIS OF WATER MANAGEMENT ON COMMUNAL IRRIGATION SYSTEMS IN ETHIOPIA: THE CASE OF ATSBI WEMBERTA, TIGRAY REGION AND ADA'A WOREDA, OROMIYA REGION

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ECONOMICS (NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS)

JANUARY, 2008
ADDIS ABABA

ACKNOWLEDGEMENT

First and foremost, I would like to thank Lord God Almighty for giving me the strength and courage to go through all this work. God, I praise you forever.

I would like to express how grateful I am to Dr. Berhanu Gebremedhin, my research advisor for his remarkable role in giving constructive comments from the very inception of the work and guiding me throughout the study. His insightful comment for the betterment of the whole work was appreciable.

Much credit also goes to the International Livestock Research Institute (ILRI) for granting me the financial assistance needed to complete the study. My special thanks also go to Dr. Gebremedhin Woldewahid, Ato Dawit and Ato Amare Girmay of Atsbi Womberta ILRI-IPMS staffs for their remarkable help during my field work in Tigray.

I owe an even much debt to my beloved family: my father, mother, sister and brothers and to my favorite aunt /Etalem/, and to my dearest, Daniel. You all are the greatest blessing in my life. I don't know what I would do without you. I love you all and thank you very much.

Finally, all other people who helped me during the study are also acknowledged. I am especially thankful to the farmers who responded to my numerous questions with remarkable patience.

Dedicated

To My Beloved Parents,

for your devotion to the six of us…

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ACRONYMS

ADLI- Agricultural Development Led Industrialization

asl- above sea level

Co-SAERs- Regional Commissions for Sustainable Agriculture and Environmental Rehabilitation

Co-SAERT- Commission for Sustainable Agriculture and Environmental Rehabilitation for Tigray

EPRDF- Ethiopian Peoples' Revolutionary Democratic Front

FDRE- Federal Democratic Republic of Ethiopia

GRII- Gender Performance Indicator for Irrigation

IDD- Irrigation Development Department

IWMI- International Water Management Institute

IPMS- Improving Productivity and Market Success

MoA- Ministry of Agriculture

MoWR- Ministry of Water Resource

NGO- Non-Governmental Organization

OLS- Ordinary Least Square

PA- Peasant Association

TGE- Transitional Government of Ethiopia

VIF- Variance Inflation Factor

WUA- Water Users Association

WUC- Water Users Committee

ABSTRACT

This study analyses the institutional and organizational arrangements of irrigation water management and identifies the determinants of collective action and its effectiveness in managing communal irrigation schemes in the districts of Atsbi Wemberta (Tigray region) and Ada'a (Oromiya region), Ethiopia. Results are based on data collected from a survey of 169 groups (communities) and 22 scheme level focus group interviews. All tabias which have irrigation projects that operated, in year 2006/07 are included. Analysis of descriptive and econometric methods are used. Analysis of qualitative information supplemented the econometric results.

Our result reveals that in Atsbi, over 221.1 ha of land, there are 14 irrigation schemes which are used by 1855 beneficiary households. On the other hand, in Ada'a there are a total of 2059 irrigation water beneficiaries in 8 communal managed schemes, which irrigate 960.5 ha of land. Each irrigation scheme is a common property resource that is owned and managed by the community. In both study areas, each scheme has its own water users association which is administered by water users committee. The associations are local institutions which have a basic character of authority and by-laws. In addition, water users form groups at each outlet (block) level for administrative purposes, which are managed by group (block) leaders. They are 94 in Atsbi and 75 in Ada'a. In each irrigation schemes, rotational irrigation is practiced based on counting dates or complaints, but not based on the water need of plants.

The econometric results show that collective action is more effective in irrigation water users of Atsbi than Ada'a. We also found evidence for an inverted U-shaped relationship between number of household beneficiaries and collective action. The findings also imply that community irrigation water management can contribute to a more sustainable irrigation water use and as a result in increasing agricultural production and productivity. Collective action for irrigation water management may be more beneficial and more effective in areas with intermediate number of beneficiaries, in areas that are close to market access, in groups that have longer years of experience in irrigation water use, groups with larger family sizes, in communities with greater number of local organizations, and in schemes where there was participation of beneficiaries during construction of the scheme.

Though women are found to be significantly involved in irrigation agriculture in male headed households, the revenue generated from agriculture is controlled by men. On the other hand, we found that the participation of female headed households at forum and leadership is very low. However, the estimation result shows that less number of conflicts and violation of rules are associated with high proportion of female household heads. This suggests policy intervention is needed to encourage the participation of women in farm, forum and at leadership level in water users association and in conflict resolution committee. In addition, effort should be made to change the wrong perception of the society towards gender inequality.

Our evidence also shows that instead of higher level of education status, it is greater number of provision of training which favors collective action. Thus, expansion of training for beneficiary farmers by governmental and non-governmental organizations will have a positive and a significant impact on increasing efficiency water use collectively. In communities that are more remote from markets or have larger number of beneficiaries, private–oriented approaches to resource management may be more effective. Access to formal credit and extension programs have a positive significant impact on collective action. Therefore, emphasis should be given on availability of such institutional support services. The presence of external organizations reduce local efforts to enforce the restricted rules, suggesting that the roles of external organizations needs to be demand driven and complementary to local inputs .

Generally, collective action in managing irrigation water functions well in both study woredas. It is found that farm households have started to grow crops which were not previously grown in the areas. It was also found that it has a positive impact on their income as well as on the living standard of their families. In addition, through time beneficiary farm households depend more on the production from their irrigated fields, which enabled them to harvest more than once a year. Therefore, as beneficiary farmers shift to high value but perishable commodities, emphasis should be given to marketing extension, especially in facilitating markets and marker linkages to farmers. Furthermore, through time the demand for irrigation water increases among beneficiary farmers. Therefore, assigning of water rights and strengthening organization and operation of WUAs will be very essential for further efficient use of the common pool resource.

CHAPTER ONE
INTRODUCTION

1.1. Background of the Study

Ethiopia is the second most populous country in sub-Saharan Africa, with an estimated population of over 77 million. In order to meet the food needs of its rapidly growing population, the country needs to double the production of its cereal production by 2025 (IWMI, 2007). Agriculture is the largest sector of the economy contributing about 50 % of the country's GDP and employing over 85% of the population. Agriculture in Ethiopia is mostly based on rain-fed small holder system (IWMI 2005).

Although the Ethiopian agriculture is basically rainfall–based, the country is endowed with vast water resources including 12 major river basins and 22 natural and artificial lakes. Considering both the available on surface water resources and the annual run-off amount, it was estimated that there would be about 1707 m^3 water /person/year available (Ibid).

Rainfall in Ethiopia is characterized by high spatial and temporal variability. Moreover, land degradation, mostly soil erosion, deforestation and overgrazing is high and is one major cause of declining crop and livestock productivity in the country. The challenge the country is facing is how to meet the increasing food demand with the existing but dwindling natural resource base under worsening climatic conditions. It is important to apply the right agricultural practices and management systems in order to increase agricultural productivity and production. This will require improved economic incentives, conducive organization policy and institutional environment for the agriculture sector.

Irrigation is one means by which agricultural production can be increased to meet the growing food demands in Ethiopia. Irrigation can also stabilize agricultural production. Ethiopia indeed has significant irrigation potential. Realizing the potential irrigation development can contribute towards food security and improved welfare, the Government of the Federal Democratic Republic of Ethiopia (FDRE), has embarked on wide range of water development efforts throughout the country. A separate Ministry of Water Resource Development has been established.

Irrigation development in Ethiopia has been focused on the agronomic, engineering and technical aspects of water projects, with little consideration to issues of management, beneficiary participation and availability of institutional support services. Moreover, in many developing countries the success of irrigation systems is highly affected by policy, institutional and social factors much more than technical issues (Gebemedhin and Peden, 2002).

1.2. Statement of the Problem

In rural Ethiopia, communities depend significantly on common property resources[1] for irrigation water, fuel wood, grazing land and construction materials. However, most of these resources are exploited on a first come, first-served basis which results in the

[1] Common property resources are defined as those resources that are owned and managed by a given community. They are contrasted with open access resource, which have no defined owner (Gebremedhin et al, 2002)

inefficient utilization of the resources and inequalities in the distribution of benefits to users (Gebremedhin et al 2002).

The solution to this problem in most developing countries depends not only on appropriate technologies and efficient market prices, but also on local level institutions of resource management and organizations that enforce them. This implies that just establishing the institutional set-up for the resource management is not a sufficient condition for sustainable use of the resources. Effectiveness in internal governance is needed for the effective application of community rules. Therefore, the need to identify factors that facilitate or hinder the development and effectiveness of local formal and informal institutions and organizations becomes important (Ibid).

Because water is liquid, it is characterized as flowing, seeping, evaporating and transpiring. These attributes cause problems in identifying the source and measuring the resource and also result in interdependencies among water users. Moreover, water supplies are often uncertain and variable. As a result of these attributes, the exclusive property rights which are the basis for an efficient exchange economy are difficult to establish and enforce. Relatively complex legal and administrative systems are needed in water allocation (Young, Daubert, Morel-Seytoux, 1986).

In Ethiopia, with food production already lagging behind, population growth, inefficient allocation of water for agriculture may worsen the problem of current food insecurity despite the availability a large volume of water in the country.

Since 1991, the role of local communities in resource management has been increasing in Ethiopia. Locally there are different institutional arrangements for irrigation water management; examples include use of "water masters" and executives of water users' associations. These institutional arrangements and the monitoring and enforcement of the laws and regulations have two implications; production (efficiency)[2] and distributional (equity)[3] dimensions. Water distribution to farmers can be explained based on timeliness and volume. Water available at the wrong time during the production process may be of little value, while water available in time but in lesser volume than needed may not have the desired effect on productivity. Hence, the design of the appropriate water management institutions becomes critical.

However, little evidence exists regarding local level institutions and organizations for irrigated water management in Ethiopia. More generally, even if there is extensive literature on common property resource management (Ostrom, 1990; Bromley 1992), further empirical research is required to analyze institutional aspect of the common pool resource and to identify factors associated with collective action effectiveness and failure

[2] *Efficiency refers to application of irrigation water to plots based on the requirement of the crop which takes into consideration soil type, crop type and stage of growth.*
[3] *Equity refers to equal distribution of irrigation water to all beneficiary farmers. It should be based on the required timeliness and volume.*

in developing countries, since the effectiveness and failure of collective resource management strategies is likely to be context specific (Runge, 1992).

1.3. Objectives of the Study

The general objective of the study is to analyze the institutional and organizational aspects of irrigation water management in Ethiopia, and investigate the nature and determinants of collective action of irrigation management in Atsbi Wemberta and Ada'a Woredas in Ethiopia.

Specific objectives of the study are:

- To analyze the institutional and organizational arrangements of irrigation water management in the two woredas;
- To assess the types of water management distribution mechanisms being used among site users and between upstream and downstream users;
- To study the conflict resolution mechanisms used by irrigation water users;
- To investigate the participation of women at different levels of irrigation water management and use;
- To evaluate agricultural returns at each irrigation scheme;
- To investigate the nature, levels and determinants of collection action for provision and appropriation of irrigation water.

1.4. Significance of the Study

Ethiopia has developed a 15-year water development project for the period 2002-2016 in order to enhance the appropriate and comprehensive water use policies and related institutional arrangements. It ensures multiple uses of this vital resource among various users. Among the water sectors agricultural water use has got the most attention through the strategy called Agricultural Development Led Industrialization (ADLI). The intervention of the plan is to address most of the supply-demand gap within 15 years time through increasing the number of large, medium and small scale irrigation schemes. In addition, the Government of Ethiopia (GoE) recognizes, community managed small-scale irrigation water schemes as viable alternative to privatization and state ownership of the resource.

Establishing appropriate water management institutions and strengthening capacity of water management organizations could help for efficient and equitable distribution of irrigation water for beneficiaries, thus contributing to increased productivity. Water management institutions are also important to avoid and manage conflicts and ensure the participation of women and the poor. In this regard, the findings of this study will contribute to narrowing the information gaps regarding the organizational and institutional context, management practices and collective action regarding irrigation water, and the major problems of irrigation development at the grass-root level. It will also shed some light on the problems of management and sustainability of agricultural water use in both areas. Therefore, the outcome of this study may serve as a source of additional information for use by policy makers and planners during the design and implementation of irrigation development programs and prospects.

1.5. Scope and Limitation of the Study

This study is based on a cross-sectional data for the time period of 2006/07 aimed at analyzing institutions of irrigation water management in the two selected woredas, i.e., Atsbi Wemberta (one of the drought prone woredas in Tigray) and Ada'a (a relatively high agricultural potential area in the Oromiya region).

The major limitations of the study relates to the unavailability of secondary data needed to supplement the primary data. Secondary data on investment costs, yield of previous production seasons and others were needed. In response to this limitation, we used triangulation data collection method, while we were collecting the data. Due to resource and time limitations, the study had to focus on only a few most important questions.

1.6. Organization of the Report

The study comprises eight chapters. Chapter two deals with review of literature. Chapter three presents methodology of the study and research hypotheses. Chapter four presents analysis of institutional arrangements of irrigation water management in Atsbi and Ada'a woredas. Chapter five presents results of the profitability analysis of irrigation agriculture in the study areas. Analysis of the participation of women in the irrigation sites are discussed in chapter six. Chapter seven deals with results of econometric analysis of the level and effectiveness of collective action for irrigation water management. Chapter eight concludes the thesis and presents implications.

CHAPTER TWO
REVIEW OF LITERATURE

2.1. Nature and Roles of Institutions

Institutions are the rules of the game in society. Formally, they are the humanly devised constraints that shape human interaction. As a result, they structure incentives in human exchange, whether political, social, or economic. Institutional change shapes the way societies evolve through time and it is the key to understand historical changes (North, 1990).

From economics point of view, institutions define and limit the set of choices of individuals. They include any form of constraint that influences the action of individuals and shape human interaction. Institutions can be formal or informal: formal constraints are rules that human beings devise and informal constraints are conventions and codes of behavior. Institutional constraints include both what individuals are prohibited from doing and under what conditions some individuals are permitted to undertake certain activities. Therefore, they are the framework within which human interaction takes place. They are very similar to the rules of the game as in a competitive team sport. That is, they consist of formal written codes of conduct that underline and supplement informal rules. This means that if the formal rules or the informal codes are violated, punishment may be enforced (Ibid).

The major role of institutions in a society is to reduce uncertainty by establishing a stable (but not necessarily efficient) structure to human interaction (North, 1990). Institutions changes through time ranges from conventions, codes of conduct, and norms of behavior to state law, common law and contracts between individuals (Ostrom V., 1971).

2.1.1. Why do Institutions Exist?

If we combine a theory of human behavior and a theory of costs of transacting we can understand why institutions exist and what role they play in the functioning of societies. We can then analyze the role of institutions in the performance of economics. The costliness of information is the key to the costs of transacting, which consist of the costs of finding a transaction partner, measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements. These measurement and enforcement costs are the sources of social, political and economic institutions (Ostrom, 1990, North, 1992).

For two hundred years the gains from trade were made possible through increasing specialization and division of labor and have been the cornerstone of economic theory. This implication of the costliness of economic exchange realizes the transaction costs approach from the traditional theory economists have taken from Adam smith. It was assumed that specialization can be realized by increasing the market and division of labor and end up with better economic performance and more specification. However, an exchange process which involves transaction costs suggests significant modifications in economic theory and very different implications for economic performance (ibid).

According to Wallis and North (1986), transaction costs are growing overtime, since transaction increase as economy grow. The total costs of production consist of the resource inputs of land, labor and capital involved both in transforming the physical attributes of a good’s size, weight, chemical composition etc, and in transacting, defining, protecting, and enforcing the property rights to goods (the right to use, the right to derive income from the use of, the right to exclude, and the right to exchanges). In addition, commodities, services, and the performance of agents have numerous attributes. Their levels also vary from one agent to another. Knowing the measurement of these levels is too costly to be fully accurate.

Generally, institutions give the structure for exchange that (together with the technology employed) determines the cost of transacting and the cost of transformation. How well institutions solve the problems of coordination and production is determined by the motivation of the players (their utility function), the complexity of the environment, and the measurement and enforcement. Transaction cost of transfer constitute two parts: the market costs and the costs of time each party must devote to gather information. The greater the uncertainty of the buyer, the lower the value of the asset. The institutional structure also determines the risk to the seller that the contract would be violated. It is very important to note that the uncertainties with respect of security of rights are a critical distinction between the relatively efficient markets of high income countries today and economics in the past as well as those in the third world today (Ostrom,1986).

2.1.2. Institutions in Economic Theory and Economic Performance

We cannot see, feel, touch, or even measure institutions. They are constructs of the human mind but even the most convinced neoclassical economists admit their existence and typically make them parameters (implicitly or explicitly) in their models. Institutions are the underlying determinant of the long-run performance of economies. If we are interested to construct a dynamic theory of change, it must be built on a model of institutional change (Hoff, 2003).

Integrating institutional analysis into static neoclassical theory entails modifying the existing body of theory. But building a model of economic change needs the construction of an entire new theoretical framework, because no such model exists. Time path dependence is a key factor for a change in economic performance. Incorporating institutional factor into the economic model results in an approach that offers the promise of connecting micro level economic activity with the macro level incentives provided by the institutional framework (Williamson, 1986).

According to Williamson (1986), the consequences of institutions for contemporary economic analysis can be summarized as follows:-

- Economic and political models are specific to particular application of institutional constraints that differ radically both through time and cross sectionally in different economies. The models are very sensitive to institutions and end up with alternation of institutional constraints.

- The assumptions of rational choice and efficient market hypothesis have curtained the implication of incomplete information and the complexity of environments and human motivation. This enables us to understand not only why institutions exist but also how they influence outcomes.

- Institutions play a major role influencing how much ideas and ideologies matter. They in turn shape the subjective mental constructs that individuals use to interpret the world around them and make choices. By structuring the interaction of human beings in certain ways, formal institutions determine the prices individuals pay for their actions. Moreover, they provide the freedom to individuals to incorporate their ideas and ideologies into the choices they make.

- Political and economic decisions are interlinked in a way that they affect the performance of the economy. Therefore, a true political economy discipline must be developed. A set of institutional constraints define the exchange relationships between the two. A useful model of the macro and the micro aspects of an economy must build the institutional constraints into the model.

2.1.3. The Economics of Institutions and the Source of Growth

According to Matthews (1986), institutional changes have made a positive contribution to economics and growth. The idea of institutional change as a source of economic growth has taken two distinctly different forms: (1) institutions need continual adaptation in the face of a changing environment of technology and taste. Institutional change is a necessary part of economic change but not an independent source of it. (2) The movement towards Pareto-superior institutions cannot be achieved at once but as a very long run, possible permanent process. This process can come about by the continual emergence and diffusion of institutional innovation, comparable to technological innovations. In other words, it can come about in a manner of a repeated game; in which people gradually learn or are selected against if they do not. For the state, it is easer to alter institutions than the private parties do, which implies that the state involvement with institutions is inherent. This is because the state is ultimate guarantor of property rights. It has to decide what kinds of rights and obligations it is prepared to recognize and enforce.

2.2. Irrigation Water-A Common Pool Resource

Two characteristics distinguish public goods from private goods 1) excludability that refers to the ability of supplies of a good or service to exclude or limit potential beneficiaries from consuming and 2) rivalry that refers to whether or not one person's use or consumption of a good or services reduces its availability to another. As shown in the following table, private goods are characterized by both high excludability and high rivalry, while public goods are characterized by low excludability and low rivalry (http://www.econport.org)

Table 2. 1. Taxonomy of Goods

		Excludability	
		High	**Low**
Rivalry	**High**	Private Goods	Common-Pool Resources
	Low	Club Goods	Public Goods (Toll Goods)

Taxonomy of Goods

Source: adapted from Ostrom, (1990)

Water falls in the form of rain, and flows and evaporates with no regard to any boundary. Water is, however, subject to rivalry in consumption and, thus cannot be categorized as a public good. Instead, it is a common pool resource, meaning that there is a finite amount that must be shared in common over a variety of uses and over geographic areas (Dalhuisen, 2000).

Bromley (1992) has a slightly different view on that categorization. He stated that there is no such thing as a common property resource per se there are only resource controlled and managed as common property, state property, private property or resources over which no property rights have been recognized. For Bromley (1992) “Irrigation systems represent the essence of a common property regime. There is a well-defined group whose membership is restricted, there is an asset to be managed (the physical distribution system), there is an annual steam of benefits (the water which constitutes a valuable agricultural input), and there is a need for group management of both the capital stock and the annual flow (necessary maintenance of the system and process for allocating the water among members of the group of irrigators) to make sure that the system continues to yield benefits to the group.”

In her seminal book “Governing the Commons”, Ostrom (1990) too complains about the misleading understanding when definitions are not clearly made. Failure to distinguish between subtractability of the ‘resource units’ (water spread on one farmer’s field cannot be spread onto the field of someone else) and the jointness of the resource system (all appropriators benefits from maintenance of an irrigation canal) leads to confusion about the relationship of common pool resources to public resources (or collective resources). Typical for a common pool resource is the subtractability of the resource unit, which leads to the possibility of approaching the limits of the number of resources units produced (Osrtom, 1990).

The well-known common pool dilemma is often the consequence. The expression "tragedy of the commons" is used to symbolize the degradation of the environment to be expected whenever many individuals use commonly a scarce resource. In Hardin's famous article (1968), he explains the logic behind this model illustrating it by the well-known example of a pasture with open access to all. The essence is that each herder is motivated to add more and more animals and bears only a share of the costs resulting from overgrazing. Since users are likely to ignore the effects of their actions on the pool when pursuing their self-interest, it must be concluded that most of the resources bear the risk of a tragedy of the commons.

In more recent literature, many authors like, McCay (2000), Olson (1965), Ostrom (1990) and Wade (1994) criticize the approaches to solve this social dilemma as insufficient. It is neither sufficient to create a system of private property rights, nor is it the only solution that the central government keeps control over common resources. Especially, Ostrom contributes to an empirically valid theory of self organization and self governance with the view to the problem of common pool resource (Ostrom, 1990). The implication is that collective action can be a means by which societies can overcome common property resources and use the resources in a sustainable way. Collective action is action taken by a group, either directly or on its behalf through an organization, in pursuit of members perceived shared interest (Marshall, 1998).

Water Users Association and collective Action –

According to Von Benda -Beckmann and Von Bendci-Beckmam 2000 quoted in B. Van Koppen 2002 irrigation institutions are defined as the collective arrangements at scheme level for water control and use which include water distribution, construction of infrastructure, maintenance and rehabilitation. Water is derived from streams, dam, river diversion or groundwater, then allocated and distributed.

Identification of factors that facilitate the establishment and effectiveness of collective action for irrigation development would help identify where collective action can easily be established and be effective, and where concerted effort is needed for the establishment and effectiveness of collective action. Key research issues regarding collective action for irrigation management include how people organize themselves with respect to irrigation water, what consistent and detectable influences of policies and other instruments can be deployed to modify stakeholder behavior, and how experience in participatory research and extension and common property management be used to facilitate local organizations for water management. The best starting point perhaps is to learn from the success of traditional irrigation systems, especially from the institutional and legal aspect of water administration and management. Understanding the evolution, development and functioning of traditional water uses associations[4] should give important insights as to how to organize and develop modern irrigation associations (Gebremedhin and Peden, 2003).

[4] *Water User Association can be arranged in informal or formal institutional aspect that collective action of irrigation water use is applied (Gebremedhin et al.2002).*

International experience with farmer irrigation management suggests that, for a successful community management of irrigation schemes, the economic and financial costs of sustainable self –management must be a small proportion of improved income, the transaction cost of the organization must be low, and irrigation must be central to the improvement of livelihoods for a significant number of members. Developing local leadership skills for irrigation management also appears to be a key factor for successful collective irrigation management (ibid).

2.3. Review of Empirical Literature-Evidence from outside Ethiopia

The following empirical studies relate to this study either in the methodology applied or the issues discussed. The studies deal with on farmers' and other stakeholders participation on local commons in developing economies; the impact of irrigation on different socio-economic groups; comparison between the performance of different institutional arrangements; relation between agricultural productivity and irrigation and gender issues and women's participation in irrigated agriculture.

Vandersypen, et. al (2006), using descriptive and qualitative analysis, evaluated farmer organizations of water management at tertiary level[5]. The author focused on two principal activities of water management: water distribution and maintenance in Mali. For both activities, the rules in use and their ability to resolve possible collective action problem are assessed and the impact of the type of infrastructure on the rules was examined. The bulk of the data for this study was drawn from a questionnaire survey of 89 farmers on 59 tertiary canals from five villages in Mali from June to October 2003.

[5] *Tertiary level indicates sub-lateral canals.*

Results showed that rules are devised only on 30% and 24% of the canals for water distribution and maintenance, respectively. Moreover, there is often no consensus on rules among farmers. Besides, monitoring and sanctioning mechanisms were absent. These results arose from individualistic behavior which caused problems on water distribution and maintenance for respectively 20% and 43% of the interviewed farmers. The study indicates that with water supply being abundant and the infrastructure recently rehabilitated, organization of water management at community level is not always required to avoid problems.

Kurian and Dietz (2005) employed descriptive analysis to argue that participatory watershed management projects need not necessarily safeguard the interests of poorer rural households. The study was based on a survey and case study evidence from 28 watershed management groups in Harayana, India. They demonstrated that given a particular institutional contract, irrigation service provision by contractors proved to be more effective than provision by a community organization. It ensures that water allocation, collection of irrigation service fees and routine maintenance of irrigation infrastructure by contractors was more effective than the community. The analysis of benefit distribution reveals that wealthier landholding households benefited more from management of irrigation and forest resources as compared to relatively poorer households. With regard to the distribution of costs arising from watershed management, the researchers found that the workload for women was greater than that of men as a result of the doubling of agricultural yields under irrigation conditions.

Fujile, Hayami and Kikuchi (2005) examined factors affecting the success and failure of collective action for management of local commons in developing economies, using the case of irrigation in the Philippines. The study was based on cross-section survey of 46 irrigators' associations in 25 national irrigation systems under the command of the National Irrigation Administration over six provinces in the Philippines: Batangas, Cavity, Laguna, Occidental Mindoro, Oriental Mindoro and Quezon.

Results of Probit and OLS regressions were consistent with the hypothesis that collective action by water users for the operation and maintenance of irrigation system is difficult to organize (a) where the water shortage rarely occurs (b) where the difference in water supply is large between upstream and downstream farmers (c) where irrigator's association is large in terms of service area and the number of farmer beneficiaries within its territory, (d) where the local community is sparsely populated, involving low social interactions (e) where farm households have the option of ready exit from farm to non-farm economic activities and (f) where farmers had traditionally practiced rain-fed farming with no previous experience in managing communal irrigation systems.

Panjab et. al (2004) in Pakistan studied the causes of low productivity of land and water, using panel data from irrigated settings in Chaj sub-basin of the Indus basin. Lalian and Khadir are the two tributaries which were used in this study. The result show that there is a significant difference in wheat yields across head, middle and tail reaches, within and across water courses along the two tributaries. Farmers who had land in head-reaches had higher yield than in tail-reaches. However, yield differences among head, middle and tail-ends are found to be much higher than within water courses. The study also found that, in places where canal water was in extreme short supply there were no significant gains in aggregate yields and crop profitability.

Using purely qualitative data, Theesfeld (2001), analyzed constraints for collective action in Bulgaria's irrigation sector, in three different regions of Bulgaria's irrigation sector. (Veliko Tamowo, Pavel Banja, Haskowo regions). Two kinds of case studies were conducted, in the three months field study. First 17 village case studies were made which gave an overview about the irrigation situation in the villages. The second kind of case studies is in depth studies of four villages which gave much more specific and very detailed information.

The results showed that most of the people living in the selected areas were too old and were no more active in agricultural production. Most of them were subsistence producers having less than 20 decors[6]. Only a few young families wanted to live on agriculture and they had to rely on irrigation for their production. Therefore, only a small actor group was concerned when discussing changes in operational irrigation rules towards collective action. The attitude towards collective action was very pessimistic and there seems to be no trust among the villagers. Moreover, individualistic behavior prevailed. Especially the actor's characteristics and the information asymmetry pave the way for opportunistic behavior. The author attempted to show the effects of the following factors on collective action

[6] *1 decor =0.1 hectare*.

(1) resource system characteristics, (2) the resource characteristics, (3) the actor groups characteristics, (4) the evolving local rules in use, (5) the effective institutional settings and (6) the formal political settings.

The researcher used qualitative method of analysis but it could be more appropriate to use instead econometric analysis to investigate each effect on the collective action. In addition the author concentrated on three regions of Bulgaria, but tried to generalize the results to all parts of the country.

Makombe et.al (2001) compared and evaluated the performance of traditional irrigation system (*bani*) with governmental and community irrigation systems in Zimbabwe. They used a sample of 149 from government system, and 69 from community and 42 from *bani* (traditional) systems. In addition, plot level data were collected. They used frontier production function analysis in order to estimate technical inefficiency across farms.

The results showed that the formal systems require by far greater amounts of inputs like land, fertilizer, and irrigation to produce a fairly same level of output with the bani system. Marginal and average productivities of inputs except labour are higher for the bani system compared to the other, which imply that the bani (traditional system) has a potential to achieve the objectives of irrigation.

Meinzen-Dick et.al (2000) identified factors that affect organization of water users' associations and collective action by farmers in major canal irrigation system in India.

The study was based on qualitative and econometric analysis of a stratified sample of 48 irrigation outlets in four irrigation systems (two each in Rajasthan and Karnataka). The study first examined the conditions under which farmers are likely to form formal or informal associations at the outlet level (serving several watercourses and one or more villages). Results indicate that organizations are more likely to be formed in larger commands, closer to market towns and in sites with religious centers and potential leadership from college graduates and influential persons. Number of beneficiaries at head or tail-end location did not have a major effect. Lobbying activities are not more likely where there are organizations, but organizations do increase the likelihood of collective maintenance work.

Pender and Sherre (1999), investigated the determinants of local organizational density and the impact of local and external organizations on collective action and private natural resource management decisions using econometric analysis. The study was based on a survey of 48 villages in the central hillsides regions of Honduras.

With regard to the determinants of local organizational development in central Honduras, the main findings of the study were that population growth contributes to organizational development at low level of growth. However, it has a diminishing and possibly negative effect at high growth rate. Proximity to the urban center reduces local organizational presence. In addition, the presence of immigrants appears to favor local organizational development. Local organizational development related to natural resource management is positively associated with population density (land scarcity) and positively associated with education level and expansion of coffee production.

The result also indicates that local organizations contribute to collective investment in natural resource management and assist in regulating use of common property resources and dealing with externalities. Local organizations have mixed impact on farmers' private decisions to adopt resource conservation measures, such as no burn practices and plowing in crop residues. External governmental organizations seem to displace collective investment in natural resource management, though they promote other kinds of collective investment such as construction and maintenance of water systems and roads. External organizations have a stronger impact on promoting adoption of labor-intensive conservation measures (such as no-burn, plowing in crop residues and terracing) on private cropland.

Bastidas (1999), examines gender issues and women's participation in irrigated agriculture in Carchi, Ecuador. Data for this study were collected during two summer field visits (June-August 1996 and May-August 1997). A combination of qualitative and quantitative methods was used for analysis. The findings showed that women's participation in irrigated agriculture was higher in female-headed households (10% of the households in the study area). In young couples who have small children, women's participation was very limited by family obligations. In old couples lived by themselves, women were either too old or too sick to participate. In households where the couple had no small children, women preferred to engage in other activities where they could control their income. It was also found that women with a rural background are more likely to participate in irrigated agricultural activities than those with an urban background. Although women's participation in water user associations is low, and culture plays a strong role in terms of their decision-making power. In the contrary, women who had higher than average education occupied positions of leadership in the water user organizations. Also, women tried to solve their irrigation-related problems through informal ways where they had more decision making power.

Makombe and Sampath (1998) evaluated the performance of smallholder irrigation systems in Zimbabwe. They took three smallholder irrigation systems; two from government managed system and one from the community or farmer managed irrigation system. In order to evaluate the production efficiency, they use production function analysis. The Theil information theoretic measure is used to evaluate inequality in the distribution of benefits from irrigation and the Theil forecast error method is used to evaluate management performance. The results shows that the farmer managed irrigation system performed better consistently than the government managed irrigation system in production, distribution and management performance.

Zwarteveen (1997) explored the implications of individual allocation of irrigated plots in terms of intra-household labor allocation, agricultural productivity and intra-household gender relations in Burkina Faso. A detailed semi-structured individual and group interviews with male and female members of 20 households were conducted in the Dakiri irrigation system in Burkina Faso during the 1994 wet season. Each of these 10 households had a female and a male holder of an irrigated plot and the other 10 had only male plot-holders. The findings of the study show that the productivity of both irrigated land and labor is higher in households where both men and women have an irrigated plot each, in comparison with households in which only men have plots. Women are equally good as men or even better in irrigated farming. Their motivation to invest labor in irrigated production increase when they have their own irrigated plots. The proportion of labor contributed by women to men's plots is virtually the same. The increase in income obtained by having irrigated plots reduces women's economic dependence on men, and strengthens their bargaining position within the household.

2.4. Irrigation Development in Ethiopia

Traditional irrigation has a very old history in Ethiopia, especially in some parts of the country like Konso. The country's irrigation potential ranges from 1.0 to 3.5 million hectares of irrigable land, of which between 160 –190 thousand hectares (5-10%) is estimated to be currently irrigated (Gebemedhin and Peden, 2002). About 65,000 hectares of land is operated by 359,000 farmers under traditional small scale irrigation in Ethiopia (MoWR, 1997). Per capita irrigated area is also estimated at about 35 m^2, compared with the world average of 450 m^2. About 352 thousand hectares of land is said to be irrigable using small–scale irrigation schemes (Gebemedhin and Peden, 2002).

Although, traditional irrigation system had been practiced for centuries in highlands of the country, modern water development schemes are recent phenomenon in Ethiopia. The first initiative to develop irrigation was taken by the imperial government in 1950's. Most of the initiative concentrated in the Awash valley. At the beginning of 1970's, about 100 thousand hectares of land was estimated to be under modern irrigation. During the imperial regime, the main objective of irrigation was to provide industrial crops to the growing agro-industries in the country, many of which were controlled by foreign interests, and to increase export earnings (Gebemedhin and Pedon, 2002).

After the fall of the imperial regime, the all large–scale irrigation schemes were nationalized by the military government and handed over to the Ministry of State Farms. Most of the landlord based small scale irrigation schemes also fell into the hands of producer-cooperatives. The military government also gave much emphasis to large-scale irrigation system schemes which were used by the nationalized agro-industrial and agricultural enterprises. In all these times the importance of small-scale irrigation was marginalized. It was after the devastating famine of 1984/85 that the government showed some interest on small-scale irrigation system. In response to these catastrophic droughts Irrigation Development Department (IDD) was established in the Ministry of Agriculture (MOA). However, only 35 small-scale projects were constructed until 1991(ibid).

After 1991, when EPRDF took power, the focus on large-scale irrigation development and the neglect of small-scale schemes was reversed. The EPRDF government has given more attention to the development of small-scale irrigation schemes and improvement of farmer–managed traditional schemes at the forefront of its water development policy. The establishment of MoWR (Ministry of Water Resources) enables the unification of public agency for water resources development. Irrigation Development Department (IDD) was dissolved in 1994 and was replaced by Regional Commissions for Sustainable Agriculture and Environment Rehabilitation (Co-SAERS) in a number of regions. The primary mandate of the Co-SAERs also remained rather technical–oriented, with inadequate attention accorded to policy, socio-economic and institutional issues. However, there have been significant improvements in beneficiary participation compared with during the military regime.

2.5. Irrigation Management Experiences in Ethiopia

According MoWR (2002) as cited in IWMI (2005), irrigation schemes in Ethiopia are classified into three on the basis of size of land area irrigated.

1. *Large and medium scale irrigation* – Irrigation projects in Ethiopia are identified as large-scale irrigation if the command area is greater than 3,000 hectare, medium–scale if it falls in the range of 200 to 3,000 hectare. Even though these types of irrigation schemes are considered important; the number of such projects has remained stagnant in the last decade. They are associated with useful infrastructure development, create job opportunities, and contribute to agricultural growth and the macro economy. Parallel to the water sector development program, there are a remarkable effort to develop master plans for various river basins. Actually, comprehensive master plans for five basins have already been developed.

2. *Small scale irrigation schemes* - it includes traditional small–scale schemes up to 100 hectare and modern communal schemes up to 200 hectare. There might also be especial instances, such as the traditional spate irrigation in Tigray which would cover up

to 400 hectare. The construction of these kinds of schemes is initiated by farmers with limited assistance from the government. The farmers manage it through their own water users association or committees. The farm size varies from 0.25 hectare and 0.5 hectare. Water user associations have long existed to manage traditional schemes. They are well organized and operated effectively. There is strong social capital in such areas; therefore, there is not a problem of information asymmetry. Typically, members' number can be up to 200 users who share a main canal or a branch canal. They may be grouped into several teams of 20 to 30 farmers each. The associations handle construction, water allocation; operation and maintenance functions. Small-scale modern schemes can be also constructed by the Federal or Regional government in order to overcome the catastrophic climatic change and drought since 1973. Such schemes involved dams and the diversion of streams and rivers. After construction, usually they are handed over to Water Users Associations for management, operation and maintenance with the support of personnel from Regional Bureaus (IWMI, 2005).

Generally, small scale systems may have greater advantages than large scale systems. Small scale technology can be based on farmers' existing knowledge, local technical, managerial and entrepreneur skills. Migration and resettlement of the labor is not usually required, planning can be more flexible. In addition, social infrastructure requirements are lower. On the other hand, large projects can ensure the benefit of the surrounding population by providing employment opportunities. However, the successfulness of the irrigation system is not determined by its size but by its institutional, physical and technical factors (ibid).

3. Micro-irrigation – This system is not understood in the same way in the different places of the country. Sometimes the term is used for small-scale schemes of less than one hectare developed at household level, such as rainwater harvesting. Others consider micro irrigation in relation to the technology used. For example, drip irrigation needs treadle and small power pumps to lift water; and a variety of irrigation application technologies, such as small bucket and drip systems and small sprinkler systems. Micro-irrigation has the following advantages:- it can be used individually, low cost in terms of their capital and operating costs per farm. They are efficient in use of water with high productivity, with improving crop quality and reducing labor costs. Currently, the use of micro irrigation in Ethiopia is low with regard to area covered or volume of water used. Actually the use of micro irrigation by poor farmers has not properly begun in the country. Its introduction is a recent phenomenon and some attempts are done by the government, some NGOs and Universities (IWMI, 2005).

2.6. Empirical Review of Literature on Common Property Resource Management in Ethiopia

2.6.1 Irrigation Management

Salilih (2007) employed both qualitative and quantitative approach, to assess the contribution of irrigation on household food security and irrigation management and problems associated with it in the case of Zingni and Fetam small-scale irrigation schemes in blue Nile basin of Amahara national regional state. The findings of the study revealed that irrigation contribution on minimizing household's socio-economic poverty significantly vary from one irrigation scheme to another. Its contribution also vary across irrigation systems depending on the physical structures of the scheme, amount of irrigation water, plot size, availability of agricultural inputs, management qualities and educational status of individual farmers to accept new ideas. For instance, 83.3 % and 42% respondents in Wonjella (Fetam) and Deninatquashta Kebeles (Zingni) ,respectively confirmed that improved irrigation system benefited them to minimize households' socio-economic poverty. However, the degree of poverty is still high in Deninatquashta than in Wonejella Kebele and socio-economic and institutional problems are commonly much higher among female-headed households especially those households that have no close relatives and farmers who are disabled and aged. The two modern schemes are constrained by socio-cultural and technical problems. With the presence of these problems it is very different to generalize that irrigation system can reduce household socio-economic and institutional poverty.

Finally, the author forwarded conclusion and recommendation based on the findings, farmers participation from inception to completion of irrigation projects should be a prerequisite for the sustainability of irrigation schemes, equitability and security in access and right to resource such as land, water and credit. In addition, training on irrigation water management contribute to break rural households' socio-economic poverty and help mainstreaming of gender in each irrigation management activities.

Checkol and Alamirew (2007) conducted a study on technical and institutional evaluation of Geray irrigation scheme in west Gojjam zone, Amhara region, Ethiopia. The technical evaluation was made by looking into the selected performance indicators such as conveyance efficiency, application efficiency[7], water delivery performance[8] and maintenance indicators. The result of the study showed that the main and tertiary canals conveyance efficiencies were 92% and 82%, respectively. Many of the secondary[9] and tertiary canals are poorly maintained and many of the structures are disfunctional. Moreover, application efficiency monitored on three farmers' plot located at different ends of a given secondary canal ranged 44 % up to 57%. Water delivery performance was only 71% implying a very substantial reduction from design of the canal capacity. Besides, maintenance indicator evaluated in terms of water level charge[10] (31.9%) and effectiveness of infrastructures[11] (67%) shows that the scheme management was in a very poor shape.

The result also depicts that the 47% of the land initially planned is currently under irrigation while there was no change in the water supply indicating that the sustainability of the scheme is in doubt. The scheme has been managed by Water Users Association for four years, despite the fact that it was constructed 27 years ago. Moreover, the study shows that the overall performance of the Water Users Association in terms of managing the schemes was very poor. Furthermore, support services rendered to the beneficiaries were minimal. There were very few indicators that production was market oriented. Ironically, farmers didn't recognize market as their problem. Conflict resolution has been

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[7] *Application efficiency indicates watering crops using irrigation water without wastage but applying according to the crop requirement rate.*

[8] *Water delivery performance shows that whether beneficiary farmers get water at the appropriate time and volume*

[9] *Secondary and tertiary canals refer to lateral and sub-lateral canals*

[10] *Water level charge implies the amount of money farmers ought to pay for using irrigation water*

[11] *Effectiveness of infrastructure indicates how much the irrigation infrastructure functions*

the duty of the *Kebeles* Council and Water Users Association has no legal authority to enforce its by-laws.

A study by Shimelis (2006) evaluated the institutional and management practices of small scale irrigation systems in Ethiopia. He took the case of two small scale irrigation systems in eastern Oromiya: Gibe Lemu and Gambela Terra. A total of 65 sample households were selected from 216 households. Interview with key informants, Water Users Association committee members and different experts were made. Focus group discussion was also held.

The result shows that the irrigation systems were poorly managed in terms of water allocation and distribution, conflict management and system maintenance, because of lack of well-established organizational and institutional conditions. The water user associations are not well organized and found to be weak to run the irrigation systems. Users have problematic social relation. Clearly defined and well-enforced land and water rights are non-existent at the operational level. Regarding technical resources such as improved seed that is adaptive to the situation of irrigation, labor and knowledge of irrigated agriculture (extension service and capacity building for irrigators) have not been met in the two irrigation systems.

Zeleke (2006) employed qualitative approach, to examine water rights and the process of negotiations among irrigators along Indris modern scheme in Toke Kutaye district, West Shoa zone, Ethiopia. The findings of the research depicted that Indris scheme marked three different significant phases in its historical development. In these phases, exploration pertaining to water rights and processes of negotiations were found to be at their immature ground. Multiple water right rules emanating both from the customary and formal water acts have co-existed to direct the actions of users. In this regards, the theoretical orientations of pluralism in water right paradigms proved to coincide with the programmatic context of water users from the scheme. Furthermore, the main reasons for conflict occurrence in connection to irrigation water use and rights are decline in the volume of water resource, institutional failures to address the causes adequately, week observance on governing water right rules and increasing demands of users. As a result, negotiation process aiming to settle disputes was repeatedly initiated either by users, committee members (elder) or courts.

Gebremedhin and Pender (2002) analyzed the productivity of irrigation in the highlands of Tigray in 1998/99. The survey was based on 50 communities and 100 villages. The result showed that irrigation was found to increase the intensity of input use, especially labor, oxen, improved seeds and fertilizer. Controlling for other factors, use of manure or compost was about 50% more likely on irrigated plots than on rain-fed plots. By increasing such inputs, irrigation contributed to increase crop production. The predicted impact of irrigation was 18% increase in crop production relative to rain-fed field plots. On the contrary, the impact of irrigation on the productivity of land management practices was statistically insignificant.

In the same way, another survey was done in Amhara highlands of Ethiopia. Irrigation was associated with improved technologies such as fertilizer and manure, and other inputs like improved seeds and pesticides, labor and draft power. However, the impact of irrigation on the productivity of farming practices was insignificant (after controlling other factors) (Benin et al. 2002).

Gebremedhin and Pender (2002) recommended that in both the highlands of Amhara and Tigray, the reason for failure of irrigation to improve productivity of farming practices needs further careful research on the technical, institutional, governance and managerial aspects of irrigation. In addition, they also suggested that such an investigation can give important guidance for policy and institution intervention to increase the impact of irrigation on productivity and income.

2.6.2 Management of Other Common Pool Resources

Gebremedhin et.al (2002) using both descriptive and econometric analyses investigated the nature and determinants of collective action and its effectiveness in managing woodlots in Tigray, northern Ethiopia. The study was based on a survey of 50 *tabias*[12] in the highlands of Tigray, in 1998-99 cropping season. The empirical models adopted by the study were Tobit, Probit and OLS. Results of the study revealed that despite the community benefits were limited due to various restrictions on use of woodlots, collective action in managing woodlots generally functions well in Tigray, which supports the role of community resource management in redressing resource degradation.

[12] *Tabias- The smallest administrative unit in Tigray, comprising usually four or five villages*

Benefits were greater and reported problems of managing the woodlots were less on woodlots managed at the village level than on those managed at the higher *tabia* level.

The econometric analysis showed that the factors that significantly affect collective action include population density (higher collective labor input and lower planting density at intermediate than at low or high density), market access (less labor input, planting intensity and tree survival where market access is better) and presence of external organizations promoting the woodlot (reduces local effort to protect the woodlot and tree survival). The finding of an inverse U-shaped relationship between population density and collective labor input is consistent with induced innovation theory, with the increased labor/land ratio promoting collective effort to invest in resources as population density grows to a moderate level, while incentive problem may undermine collective action at high level of population density.

Gebremedhin and Pender (2002) examined the nature and determinants of collective action for grazing land management in the highlands of Tigray, northern Ethiopia. The results were based on data collected from a survey of 50 *tabias* which were selected using a stratified random sampling. Both descriptive and econometric analysis revealed that collective action for grazing land management is widespread in the highlands of Tigray and reportedly contribute to sustainable use of the resource. Most collective action is locally initiated and is organized at the village level. Communities which have smaller areas of restricted grazing land per household exhibited higher levels of various indicators of collective action (payment for the guard, establishment of penalty system and reported less violations). There is also an inverted U-shaped relationship between population level and collective action. Market access detracts from collective action as does wealth heterogeneity of community. Experience in organizing and running local organizations encourages collective actions for grazing land management.

Benin and Pender (2006), using data from 98 villages in the highlands of Amhara region, examined the determinants of collective action and its effectiveness in communal grazing lands management and the effect of restricting access and use in certain grazing areas on the condition of other communal grazing resources.

The results of descriptive analysis reveal that more than one-half of the communities had at least one such restricted grazing area, with the total area in each of those communities averaging twenty-two hectares. About 70 percent of the restricted grazing lands were managed at the village level, while the remaining was managed at a higher *Kebele* level.

Result of econometric analysis showed that collective action is more likely to be successful in communities that have large areas, are far from markets, and where wealth is more equally distributed. Where there is more alternative source of feed and in irrigated areas, collective action is not likely to succeed. In addition, increasing the proportion of restricted grazing land has a robust negative impact on the quality of other unrestricted grazing resources, although managing the restricted grazing land at the lower village level had a robust positive impact. Population growth has had negative effect on availability, quality and erosion level of grazing lands. Besides, severity of erosion of grazing lands was lower in areas with higher rainfall areas and better access to credit and extensions programs offered by NGO'S.

Thus, we can observe that from the aforementioned literature review the gap and linkage existed on the institutional and organizational context of communal managed resources in Ethiopia both from the objectives of the studies and the methodology used.

CHAPTER THREE

METHODOLOGY AND SOURCE OF DATA

3.1. Description of the Study Areas

The data for the analysis is obtained from a community-level survey in Atsbi Wemberta woreda in Tigray Region and Ada'a woreda in Oromiya Region.

3.1.1. Astbi Wemberta Woreda

Astbi Wemberta woreda is located about 860 km north of Addis Ababa; 65 km northeast of the capital of Tigray Regional State, Mekelle. About half of the distance from Mekelle to the capital of the woreda, Endasselassie, is off the main road from Mekele to Adigrat to the east departing at the town of Agula'e. This woreda is one of those woredas in Tigray that borders the Afar Regional State. The woreda is geographically located $13^0$37'N latitude and $39^0$30'E longitude. There are 16 peasant association (administrative localities, called *tabia*) and 2 town dwellers associations in the woreda. A combined total area of the woreda is estimated at 1223km^2. The areas of the 16 PAs ranges from 26.5 km^2 (Hadinet) to 209 km^2 (Kilesha Emene). According to the recent woreda population reports, the estimated total number household heads in the woreda was 21,398, with total population of 110,578 in 2003/04 (Atsbi Wemberta Woreda Pilot Learning Site Diagnosis, 2005).

Agro ecologically, the woreda is classified as *Dega*. Altitude in the area ranges from 918 to 3,069 m and 75% of the woreda is in upper highlands (2600masl or above) and only 25% is found in midlands (between 1500 and 2600m asl) and lowlands (below 1500m asl). Lithic Leptosols are the soil types covering nearly 100% in the woreda, except in some parts where Vertic Cambisols are also observed (Ibid).

Altitude and rainfall increases from south to north and east to west. Shortage of rainfall is a major constraint of agricultural production in the woreda. Rainfall is usually intense and short in duration. The average annual rainfall in (1995/96 to 2002/03) was 642 mm/yr. Under normal conditions, rain starts around the last days of June. As a result of all these, Atsbi Wemberta is one of the drought prone woredas in the Tigray region. The area receives bimodal rainfall: *Belg* (short rains) from Mach to April and *Meher* (long rainy season) from June to September. The short rainy season is not reliable enough for crop production except for growing grass for livestock. Nearly all the cereals and legumes are planted during the main rain (Ibid).

The woreda is classified into two farming systems– i) Pulse /Livestock system-Nine of the 16 PAs grow barley, wheat, pulses and small ruminants farming system and are found starting from the central southern parts of the woreda to the tip north. Barley is the dominant crop followed by wheat and pulses. The altitude of these PAs in this farming system is around 2600 m asl or higher and as a result, frost is one of the major crop production problems in the area.

ii) Apiculture/livestock farming system- Teff, wheat, barley, livestock and apiculture system is predominant in parts of the woreda where altitude is below 2600masl. This system is found starting from the middle of the woreda to the southern end. There are 7

PAs that belong to this farming system. A good part of the eastern escarpment is known for honey production.

Despite the large population of livestock, livestock productivity is low as in many other parts of Tigray. The population of livestock in Atsbi is 48,870; 72,471; 10,427 and 10,000 heads of cattle, sheep, goats and equines, respectively. The number of poultry is estimated at about 44,000. Out of the cattle population, there are an estimated 16,319 drought oxen. On the other hand, there are 6,729 beehives of which 2,000 are modern ones.

3.1.2. Ada'a Woreda

Ada'a woreda is one of the woredas in east Shoa Oromiya region which is located about 47 km southeast of the capital Addis Ababa. The woreda is geographically located $8^0$30' N latitude and $39^0$17' E longitude. The woreda covers an area of 92,751.33 ha stretching east of the Bole International Air Port to the Northwest of Koka dam. The population in Addis Ababa, Adama and Bishoftu create a large market for most agricultural commodities.

There are 27 peasant associations and 9 town dwellers associations with a total population of 138,147, of which, 18,450 and 1,912 are male and female headed households, respectively.

Agro-ecologically, the woreda is best suited for diverse agricultural production. There are a number of rivers and crator lakes that are being used for irrigated agriculture. There are two cropping seasons in the area. Belg (short rainy season) from March to April and Meher (main rainy season) from June to September. *Belg* rains are mainly used for initial breaking of the soil. *Meher* rain which accounts for about 74% of the annual precipitation is the most economically important rain for crop production. March, April and May are the hottest months and November and December are the coldest months. The long term (1953-2003) average rainfall recorded by ILRI Debre Zeit and EARO Debre Zeit research stations are found to be 839mm/yr. Mean minimum and maximum temperature recorded for 27 years ranged from 7.9^{0}c to 28^{0}c, respectively. Mean annual temperature for the same period was 18.5^{0}c (Ada'a Woreda Pilot Learning Site Diagnosis and Program Design, 2005).

Black clay (locally called Koticha) and red light soils are the dominant type. Lithosol (red light soils) in Ada'a is highly degraded infertile soils, while Vertsol is generally fertile with good moisture holding capacity. They are hard and crack during dry and sticky when it is wet (ibid).

Livestock production is an integral part of the production system. Production of cattle, sheep, goat and poultry is a common practice and there is an existing market–oriented production system (fattening and dairy production). The population of livestock in the woreda is 138,738; 19,305; 28,501; 1,094; 1,191; 34,900 and 922,002 heads of cattle,

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sheep, goats, mules, horses, donkeys and poultry, respectively. Moreover, honey production is another source of livelihood of farmers in specific sites of the woreda.

3.2. Data Source and Sampling

This study relies on primary cross-sectional data collected in 2006/07 cropping season that is obtained from five types of semi-structured community level questionnaires. All *tabias*[13] which have irrigation projects operated during the study period, 2006/07 cropping season were included in the study. In other words, during the study period, 14 and 8 irrigation projects were operating in Atsbi and Ada'a, respectively. All these irrigation schemes were included in the study. The questionnaires were administered at *tabia (kebele)*, scheme and group levels.

There are 94 and 75 groups of beneficiary farmers (*Gujele*(in Atsbi) and *Gere*(in Ada'a). *Gujele* and *Gere* refer to the smallest administrative unit of Water Users Association (irrigation scheme). The size of a group (the number of beneficiaries) differs from *tabia* to *tabia*. The size of the group is decided by the community and ranges from 4- 280 number of beneficiaries in Atsbi and 8 up to 297 beneficiary farmers in Ada'a.

[13] *Tabia, Peasant Association and Kebele have the same meaning. In this study, the three of them represent the lowest administrative units in Tigray and Oromiya regions, which comprise usually four to five villages.*

Table 3.1. Tabias and PAs included in the study

S. No.	Name of Tabias in Atsbi included in the study	No. of groups (Gojeles)	Name of PAs in Ada'a included in the study	No. of groups (Gere's)
1	Golgol Naele	37	Godino	**31**
2	Feleg Woini	6	Kataba	**17**
3	Ruba Feleg	4	Ganda Gorba	**3**
4	Zarema	2	Koftu	**9**
5	Adi Mesaenu	4	Hidi	**15**
6	Haressaw	25		
7	Hadnet	9		
8	Hayelom	7		
Total		*94*		*75*

One method for collecting valid and reliable case study data is triangulation. Triangulation means using multiple sources of evidence (Yin, 1994; Bitsch, 2001). This opportunity is the major strength and advantage of a case study strategy. Data triangulation was also ensured in this study by collecting data from different data sources. The first type of questionnaire was a community level questionnaire on 169 groups (94 *Gujeles* and 75 *Geres*). Each interview involved ten respondents chosen randomly to represent different age, gender, position in the irrigation scheme, level of education (literate and illiterate), income (low, middle and high). This questionnaire helped us to collect information on nature and determinants of collective action, its failure and effectiveness of the communal managed irrigation system in both woredas.

Effort was also exerted to conduct in depth focus group discussions with beneficiaries at each scheme level that ranged from 10 to15 beneficiary farmers within the same scheme. As Ostrom (1994) stated, theorists interested in institutional questions have to dig deeper to understand how rules combine with a physical and cultural world to generate particular types of situations. This data collection method was undertaken in all irrigation schemes of the two woredas. It gave much more specific and very detailed information about the institutional context of the communal managed irrigation schemes such as water distribution systems, conflict resolution mechanisms and legal framework. The number of female headed households in the schemes are very small (21.67% in Atsbi and 13.4% in Ada'a). As a result, there was under–representation of women. Therefore, in addition, discussion with female-headed irrigation water beneficiary households in eight *tabias* of Atsbi and five PAs of Ada'a was carried out, in order to enhance the availability and quality of information related to women farm decision makers in the irrigation sites. The participant ranged from 7-10 women household heads within the same irrigation scheme. Additional data were also gathered at each *tabia* level in order to capture the cost farmers incurred and benefits they accrued from using irrigation water in year 2006/07. It enabled us to measure the profitability of beneficiaries. Furthermore, interview with experts working on irrigation in different offices of governmental and non governmental organizations have been undertaken. As a result, substantial quantitative and qualitative information were gathered and analyzed.

3.3. The Field Procedure

The first step of the fieldwork was brief field visits for 5 consecutive days in Atsbi (6-10, November 2006) and 7 days in Ada'a (November 28-December 04, 2006). It enabled me to get an understanding of the situation in the woredas and identifies issues, which should be included in study in addition to the checklist already developed.

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The next stage was to prepare different types of questionnaire in order to gather substantial quantitative and qualitative information, followed by pre-testing the questionnaires in the study areas. Considering the changes made in the final questionnaire from the pre-test, all the final questionnaires were developed.

Before going to the final survey the group (‘*Gujele’* and ‘*Gere*’) interview questionnaire was translated into Tigrigna for Atsbi and Oromifa for Ada’a. Ten enumerators in Atsbi Wemberta and seven enumerators in Ada’a were involved. In addition, one supervisor in each area was employed based on their educational qualification and their previous work experience.

The questionnaires for in depth focus group discussions (at scheme level and with female headed households) were done by the researcher herself with the help of language translators in both areas. Moreover, the *tabia* level data (for measuring profitability) were collected from each *tabia* and the woredas office of agriculture.

A day and half long training were conducted for all enumerators and supervisors in both areas. The final fieldwork (survey) was implemented from February 19-March 15, 2007 in Atsbi and from April 01-May 02, 2007 in Ada’a. The field survey was successfully completed in both woredas.

3.4. Analysis Approach

Institutional analysis of communal managed irrigation systems is very complex. Usually these kinds of resources are frequently characterized by multiple users. In addition, there is a need for arrangement for negotiation and mechanisms for conflict resolution among different stakeholders. Rules for sharing the resources comprise property right, which are useful in resolving conflicts and creating incentives for investment for the development of the resource. At the same time, there is need to have institutions for collective action, either in the form of formal organizations or informal forms of cooperation, to abide by the property rights as well as act collectively for betterment of the community.

These characteristics of irrigation institutions become a bit difficult to be analyzed quantitatively as (Mattews, 1996) stated;

"Theory has made an indispensable contribution in recent times to advances of understanding in economics. But it seems to me that in the economics of institution theory is now outstripping empirical research to an excessive extent. No doubt the same could be said about other fields in economics, but there is a particular point about this one. Theoretical modeling may or may not be more difficult in this field than in others, but empirical work in it is confronted by a special difficulty. Because economic institutions are complex, they do not lend themselves easily to quantitative measurement. Even in the respects in which they do, the data very often are not routinely collected by national statistical offices. As a result, the statistical approach which has become the bread and butter of applied economics is not straightforwardly applicable."

However, qualitative approaches are increasingly used in conjunction with quantitative approaches and such combinations can enhance the validity and reliability of analysis and evaluation (Bamberger, 2000).

A mixture of both quantitative and qualitative approaches was appropriate in this case because it provides the quantifiable results of factors which determine collective action and its effectiveness in communal managed irrigation schemes, in addition to, the cost–

benefit analysis of beneficiary farmers in the sites. It also provides explanations on irrigation water distribution, conflict resolution mechanisms and gender related issues in irrigation.

3.4.1. Descriptive Analysis Approach

This part mainly focused on analyzing the descriptive statistics of the whole data. The data mainly contained information regarding nature of collective action. In addition, characteristics and actual uses of communal irrigation schemes were included. Besides, the socioeconomic characteristics of irrigation water beneficiaries including family size, education status, access to market, agricultural extension programme and formal credit, soil quality, years of experience, training provision and experience with external and local organizations were also observed.

Moreover, the data also contains beneficiary farmers' decision with regard to the use of inputs: modern fertilizer, manure/compost, seed and labor (man power and oxen). This data was collected using secondary data from *tabias* administration, in addition to focus group discussion with beneficiary farmers at scheme levels. After calculating the total value of yield harvested in year 2006/07 using irrigation water, analysis of the net revenue of input costs like labor, fertilizer, pesticides, herbicides, seed etc., at each *tabia* and crop type was made. Besides, based on the farming system crop pattern of farm household's has been assessed.

3.4.2. Qualitative Analysis Approach

This approach analyzed the whole picture of institutional and organizational arrangements in water distribution system and mechanisms used to distribute the irrigation water among site and between upstream and downstream users. Specifically, the data contained management system in communal irrigation schemes. This included the participation of different stakeholders in promotion, development of irrigation system and provision of technical support for beneficiary farmers. Besides issues like water distribution system, water rights and legal framework which constitutes the written by-laws, and conflict resolution mechanisms were part of the data. Women participation at farm, forum and leadership level in the irrigation sites was also assessed using qualitative data. The qualitative information was gathered using an open-ended question that was included in the questionnaire in order to augment the results of the econometrics analysis.

3.4.3. Econometric Approach

Following Gebremedhin et. al (2002) the econometric model used to investigate the determinants of indicators of collective action, its failure and effectiveness for both provision and appropriation of communal irrigation water management is stated below.

Let **M** represent collective management of irrigation water. We assume there is decreasing marginal benefit and increasing marginal cost of collective management which includes the cost of monitoring and enforcing collective action. The benefit **(B)** and cost**(C)** functions can thus be specified as:

$$B(M) = aM - bM^2$$
$$C(M) = cM + dM^2$$

Where ***a, b, c,*** and ***d*** are positive constants. Collective management is affected by a vector of exogenous factors **(X)** which includes; Group Characteristics **(X_G),** Farm Characteristics **(X_F),** Village Characteristics **(X_V)** and Scheme Characteristics **(X_S).** These exogenous factors are assumed to shift the marginal benefit and cost curves but do not affect the slope of the curves. Incorporating the effect of the exogenous factors into the cost and benefit functions, we have.

$$B(M,X) = (\alpha X + \xi_B)M - bM^2 \text{................}(1)$$
$$C(M,X) = (\beta X + \xi_C)M + dM^2 \text{..............}(2)$$

Where α and β are coefficients to be estimated, and ξ_B and ξ_C are stochastic disturbance terms. Using the definitions of the exogenous factors, equations (1) and (2) can be rewritten as.

$$B(M,X) = [\alpha_0 + \alpha_G X_G + \alpha_F X_F + \alpha_V X_V + \alpha_S X_S + \xi_B]M - bM^2 \text{....................}(3)$$
$$C(M,X) = [\beta_0 + \alpha_G X_G + \beta_F X_F + \beta_V X_V + \beta_S X_S + \xi_C]M + dM^2 \text{...................}(4)$$

3.4.3.1 Explanatory Variables

The explanatory variables are categorized into 4 vectors:-

Region **(X_R)-** whether the woreda is Atsbi or Ada'a

Group Characteristics (X_G) include:-

Total number of households in the group **(X_HN),** Total number of households in the group squared**(X_HN ^{2}),** Proportion of female households in the group **(X_HF),** Proportion of literate headed households in the group**(X_HL),** Average family size in the group **(X_HSIZE),** Proportion of households who used formal credit **(X_HC),** Proportion of households who have access to extension programme **(X_HE),** Proportion of households whom irrigated agriculture is the main source of income in the group **(X_HIN),** Total irrigated area in the group (**X_GAREA**), Total agricultural land in the group (rain-fed) (**X_GAGRI**), TLU of the group (**X_GTLU**), Proportion of beneficiaries at the tail-end**(X_GTAIL**), For how many years beneficiaries have used the irrigation water(**X_GYEARS)**, Numbers of times beneficiaries have received training on issues related to irrigation water use (**X_GTRAIN**).

Farm Characteristic **(X_F)** includes

Proportion of soil coverage of the farm considered good by the group **(X_FSOIL)**.

Village Characteristics (**X_v**) include

Whether rainfall adequacy in the village was considered good by the group **(X_vRAIN)**

Access to Market and services (in hrs.)

Walking time from that specific groups' irrigated land to the nearest-town market **(X_vTOWN),** village market **(X_GVILL),** the *tabia* development post **(X_vFTC).**

Scheme Characteristics **(X_S)** include

If the irrigation scheme was promoted by external organization (**X_SEXTER**), Number of external organization(s) which is (are) operating in that irrigation site now (**X_SNOW**), Number of local organization(s) which is (are) operating in that irrigation site currently (**X_SLOCA**), Whether there is farmers' participation during construction of the scheme **(X_SSTRUC**), type of irrigation system (micro-dam, river diversion, spring water, shallow well and communal pond. Communal pond is identified in the base category.

Thus, equation (1) and (2) can be rewritten as:-

$$B(M,X)=\begin{bmatrix} \alpha_0+\alpha_1 X_G N+\alpha_2 X_G N^2+\alpha_3 X_G F+\alpha_4 X_G L+\alpha_5 X_G SIZE+\alpha_6 X_G C \\ +\alpha_7 X_G E+\alpha_8 X_G IN+\alpha_9 X_G AREA+\alpha_{10} X_G AGRI+\alpha_{11} X_G TLU+ \\ \alpha_{12} X_G TAIL+\alpha_{13} X_G YEARS+\alpha_{14} X_G TRAIN+\alpha_{15} X_F SOIL+\alpha_{16} X_V RAIN+ \\ \alpha_{17} X_V TOWN+\alpha_{18} X_V VILL+\alpha_{19} X_V FTC+\alpha_{20} X_S EXTER+\alpha_{21} X_S NOW \\ +\alpha_{22} X_S LOCA+\alpha_{23} X_S STRUC+\alpha_{24} X_S MICRO+\alpha_{25} X_S RIVER+ \\ \alpha_{26} X_S SPRING+\alpha_{27} X_S SHALLOW+\xi_B \end{bmatrix} M-BM^2 \text{....(5)}$$

$$C(M,X)=\begin{bmatrix} \beta_0+\beta_1 X_H N+\beta_2 X_G N^2+\beta_3 X_G F+\beta_4 X_G L+\beta_5 X_G SIZE+\beta_6 X_G C \\ +\beta_7 X_G E+\beta_8 X_G IN+\beta_9 X_G AREA+\beta_{10} X_G AGRI+\beta_{11} X_G TLU+\beta_{12} X_G TAIL \\ +\beta_{13} X_G YEARS+\beta_{14} X_G TRAIN+\beta_{15} X_F SOIL+\beta_{16} X_V RAIN+ \\ \beta_{17} X_V TOWN+\beta_{18} X_V VILL+\beta_{19} X_V FTC+\beta_{20} X_S EXTER+\beta_{21} X_S NOW \\ +\beta_{22} X_S LOCA+\beta_{23} X_S STRUC+\beta_{24} X_S MICRO+\beta_{25} X_S RIVER+ \\ \beta_{26} X_S SPRING+\alpha_{27} X_S SHALLOW+\xi_C \end{bmatrix} M+dM^2 \text{...(6)}$$

We assume that $\alpha_1,\alpha_4,\alpha_5,\alpha_6,\alpha_{7,}\alpha_8,\alpha_9,\alpha_{10},\alpha_{11},\alpha_{13},\alpha_{14},\alpha_{15},\alpha_{16},\alpha_{17},\alpha_{18},\alpha_{19},\alpha_{22},\alpha_{23} > 0$;

and the sign of $\alpha_{2,}\alpha_3,\alpha_{12},\alpha_{20},\alpha_{21},\alpha_{24,}\alpha_{25},\alpha_{26},\alpha_{27}$ are indeterminate.

$\beta_2,\beta_{4,}\beta_9,\beta_{12},\beta_{15},\beta_{16},\beta_{17},\beta_{18} > 0$;

$\beta_1,\beta_{5,}\beta_6,\beta_7,\beta_8,\beta_{10},\beta_{13},\beta_{14},\beta_{19},\beta_{20},\beta_{21},\beta_{22},\beta_{23}, < 0$;'

and the sign of $\beta_3\beta_{24},\beta_{25},\beta_{26}$ and β_{27} are indeterminate.

Higher total number of households in the group leads to greater scarcity of the resource, hence greater marginal benefit of collective management (**α_1**>0).The effect of proportion of female headed households on collective action is unknown because it is highly influenced by the socio-cultural background of the community. Higher family size in the group increases marginal benefit of collective management, since irrigated agriculture needs higher labor force individually as well as collectively, (**α_5**>0). Higher literacy rate, higher experience in irrigation water use(in number of years), provision of training may increase collective benefit in such a way that beneficiaries will have better understanding and awareness about the management of the resource more efficiently,($\boldsymbol{\alpha_4}$, $\boldsymbol{\alpha_{13}}$, $\boldsymbol{\alpha_{14}}$> 0). Higher proportion of households whom agriculture is the main source of livelihood may appreciate collective action which leads to increment of benefits, since all beneficiaries have the same interest ($\boldsymbol{\alpha_8}$>0). Greater size of area of irrigated land increases the benefit of collective action ($\boldsymbol{\alpha_9}$>0). Higher level of physical wealth (agricultural land and TLU) indicates the capacity of higher cost coverage for operation and maintenance of the irrigation scheme, ($\boldsymbol{\alpha_{10}}$>0). High proportion of beneficiaries at the tail-end lead to greater scarcity of the resource for irrigation purposes, as a result there may be higher marginal benefit ($\boldsymbol{\alpha_{12}}$> 0). However, on the other hand, if it becomes very scarce, competition may be so high and decrease the benefit ($\boldsymbol{\alpha_{12}}$<0). Higher agricultural potential (soil and rainfall) and access to market and services(town market, village market, and development post, formal credit and access to extension programme) increase benefit to manage the limited resource ($\boldsymbol{\alpha_6}$, $\boldsymbol{\alpha_7}$, $\boldsymbol{\alpha_{15}}$, $\boldsymbol{\alpha_{16}}$, $\boldsymbol{\alpha_{17}}$, $\boldsymbol{\alpha_{18}}$, $\boldsymbol{\alpha_{19}}$>0). External programmes may increase the benefit of collective management by increasing awareness of profitable opportunities or of new technologies ($\boldsymbol{\alpha_{19}}$, $\boldsymbol{\alpha_{20}}$>0), but they may undermine benefits if the programmes prevent communities from full participation ($\boldsymbol{\alpha_{20}}$, $\boldsymbol{\alpha_{21}}$<0). The involvement of local organization may increase benefits ($\boldsymbol{\alpha_{22}}$>0), since local decision makers are likely to be more aware of local conditions affecting benefits. Farmers participation during the construction of the infrastructure (irrigation scheme) enhances sense of ownership among beneficiaries. Hence, it increases the benefit of collective action ($\boldsymbol{\alpha_{23}}$>0).

Economies of scale are assumed to reduce costs of monitoring and enforcing collective action as the number of total households increases from a low level (**β_1**<0), but at high number of households, diseconomies of organizing and enforcing agreements are assumed to dominate (**β_2**>0). Formal credit enables farmers to use complementary inputs such as fertilizer, pesticides, herbicides and varieties of seeds that needs high amount of water, as a result transaction cost to enforce rules and regulations may decline(**β_6**<0). Higher proportion of beneficiaries at tail-end leads to more scarcity of irrigation water at the tail. As a result, frequent conflict and violation of restricted rules will occur. It leads to higher costs for monitoring (**β_{12}**>0). Higher proportion of households whom agriculture is the main source of income, larger rain-fed land size and TLU may decrease the cost of collective action. (**β_8, β_{10}, β_{11}**<0). Costs of managing a resource are likely to increase with the size of the resource (**β_9**>0). Greater literacy rate, higher agricultural potential (soil and rainfall) or better access to market and services (town market and village market) may lead to higher labor opportunities and wages, hence higher costs of collective action (**β_4, β_{15}, β_{16}, β_{17}, β_{18}**>0), unless labor markets are so well integrated that local wages are not affected by local opportunities (**β_{15}, β_{16}, β_{17}, β_{18}** =0). On the other hand, access to extension programme and development post may decrease the cost of collective action (**β_7, β_{19}<0**). Involvement of external programmes, long time experience in using irrigation water, provision of training are likely to help reduce the cost of organizing and enforcing collective action because of better understanding of the concepts of rules and regulations (**β_{20}, β_{21}, β_4, β_{13}, β_{14}** <0). Collective management organized at a more local level is likely to be easier (less costly) to enforce (**β_{22}**<0).

Higher participation of farmers during construction also decreases the cost of collective action (**β_{23}**<0).

Then, using equation **(1) and (2),** the necessary conditions for maximization are

$$\frac{\partial B}{\partial M} = 0 = \alpha X - 2bM ....(7)$$

$$\frac{\partial C}{\partial M} = 0 = \beta X + 2dM ....(8)$$

Combining equations **(7) and (8)** and rearranging terms we have:

$$M^* = \frac{\alpha X - \beta X}{2(b+d)} ....(9)$$

And

$$\frac{\partial M^*}{\partial X_i} = \frac{\alpha_i - \beta_i}{2(b+d)} ....(10)$$

Hence, we have the following comparative static results:

$$\frac{\partial M^*}{\partial X_G N} = \frac{\alpha_1 - \beta_1 + 2(\alpha_2 - \beta_2)\chi_G N}{2(b+d)} > 0$$ at low **N,** since $\alpha_1 - \beta_1 > 0$ and will be larger than $2(\alpha_2 - \beta_2)N$ for low enough N;

<0 at high **N** if $\alpha_2 - \beta_2 < 0$ (example, if $\alpha_2 \le 0$); and

>0 at all **N** if $\alpha_2 - \beta_2 > 0$.

$$\frac{\partial M^*}{\partial X_G F} = \frac{\alpha_3 - \beta_3}{2(b+d)}$$ **-** indeterminate; $$\frac{\partial M^*}{\partial X_H L} = \frac{\alpha_4 - \beta_4}{2(b+d)} > 0$$ **,** if there is no divergence of interest.

$$\frac{\partial M^*}{\partial X_G SIZE} = \frac{\alpha_5 - \beta_5}{2(b+d)} > 0$$ **,if** family members participate in the irrigation agriculture, if not $\alpha_5 = 0$

$$\frac{\partial M^*}{\partial X_G C} = \frac{\alpha_6 - \beta_6}{2(b+d)} > 0;\qquad \frac{\partial M^*}{\partial X_G E} = \frac{\alpha_7 - \beta_7}{2(b+d)} > 0;\qquad \frac{\partial M^*}{\partial X_G IN} = \frac{\alpha_8 - \beta_8}{2(b+d)} > 0$$

$$\frac{\partial M^*}{\partial X_G AREA} = \frac{\alpha_9 - \beta_9}{2(b+d)} > 0$$ **,** if economies of scale reduce cost of management relative of benefits ($\alpha_9 > \beta_9$)

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$$\frac{\partial M^*}{\partial X_G WEALTH} = \frac{\alpha_{10} - \beta_{10}}{2(b+d)} > 0 \textbf{;} \qquad \frac{\partial M^*}{\partial X_G TAIL} = \frac{\alpha_{11} - \beta_{11}}{2(b+d)} < 0 \textbf{, if } (\beta_{11} > \alpha_{11})$$

$$\frac{\partial M^*}{\partial X_G YEARS} = \frac{\alpha_{12} - \beta_{12}}{2(b+d)} > 0 \textbf{;} \qquad \frac{\partial M^*}{\partial X_G TRAIN} = \frac{\alpha_{13} - \beta_{13}}{2(b+d)} > 0$$

$$\frac{\partial M^*}{\partial X_F SOIL} = \frac{\alpha_{14} - \beta_{14}}{2(b+d)} > 0 \textbf{;} \quad \frac{\partial M^*}{\partial X_V RAIN} = \frac{\alpha_{15} - \beta_{15}}{2(b+d)} > 0$$

In both cases, if agricultural potential (soil quality and rainfall) does not increase the opportunity cost of labor or provide more ‘exit’ options, thus increasing the cost of enforcing collection action (i.e., $\beta_{14}\beta_{15} = 0$).

$$\frac{\partial M^*}{\partial X_V TOWN} = \frac{\alpha_{16} - \beta_{16}}{2(b+d)} > 0 \textbf{;} \qquad \frac{\partial M^*}{\partial X_V VILL} = \frac{\alpha_{17} - \beta_{17}}{2(b+d)} > 0$$

If town and village market access does not raise opportunity cost of labor or provide more ‘exit’ options $(\beta_{16} = \beta_{17} = 0)$.

$$\frac{\partial M^*}{\partial X_V FTC} = \frac{\alpha_{18} - \beta_{18}}{2(b+d)} > 0$$

$\frac{\partial M^*}{\partial X_S EXTER} = \frac{\alpha_{19} - \beta_{19}}{2(b+d)} > 0$; if external organization(s) do not displace the local organization(s).

$\frac{\partial M^*}{\partial X_S NOW} = \frac{\alpha_{20} - \beta_{20}}{2(b+d)} > 0$**,** if the community doesn’t entirely depend on the organization

$$\frac{\partial M^*}{\partial X_S LOCA} = \frac{\alpha_{21} - \beta_{21}}{2(b+d)} > 0 \textbf{;} \qquad \frac{\partial M^*}{\partial X_S SRTU} = \frac{\alpha_{22} - \beta_{22}}{2(b+d)} > 0$$

3.4.3.2. Dependent Variables

The dependent variables are divided in to three categories.

i) Indicators of presence of collective action (see Table 3.2).

- ✓ Average value of a household contribution for the resource management per year[14] ,
- ✓ Whether there is (are) guard(s) for protection of the irrigation site (1; 2),
- ✓ Whether group members contribute for the guard's payment (1; 2),
- ✓ If there is (a) person(s) in charge of equitable water distribution and appropriate usage of irrigation water (1; 2),
- ✓ If group members contribute for the water distributor payment (1; 2).

ii) Indicators of failure of collective action are

- ✓ Number of times violation of restricted rules occurred by beneficiaries per group in 2006/07;
- ✓ Number of times conflict occurred due to irrigation water distribution related issues in 2006/07

iii) And indicator of collective action effectiveness/enforcement includes

- ✓ Number of times the penalty system applied per group in 2006/07;

Therefore, the econometric models for indicators of collective action, its failure and effectiveness can be written as follows:

$$ACONT = f(X_R, X_G, X_F, X_V, X_S)$$
$$DGUAR = f(X_R, X_G, X_F, X_V, X_S)$$
$$CGUAR = f(X_R, X_G, X_F, X_V, X_S)$$
$$DWATD = f(X_R, X_G, X_F, X_V, X_S)$$
$$CWATD = f(X_R, X_G, X_F, X_V, X_S)$$
$$NVIOL = f(X_R, X_G, X_F, X_V, X_S)$$
$$NCONF = f(X_R, X_G, X_F, X_V, X_S)$$
$$NPENA = f(X_R, X_G, X_F, X_V, X_S) \ldots\ldots\ldots\ldots\ldots\ldots(12)$$

[14] *All the data was collected for the year 2006/07*

3.2.Description and Measurement of Indicators of Collective Action its Failure and Effectiveness-Dependent Variables included in the Model

Variable Name	Definition and Measurement	No. of Observation	Frequency (%age)	Mean (Standard Deviation)	Minimum	Maximum	Type of regression model used
I) INDICATORS OF COLLECTIVE ACTION							
Value of a group member contribution for irrigation water management **(ACONT)**	Average annual value of a household contribution. in cash + kind + labor in the group (all converted to in Birr value)	169		200.17 (152.4683)	0	312	**OLS**
If there is (are) guard(s) for protection of the irrigation site**(DGUAR)**	Dummy variable for 1=yes 2= no	 169 169	 103(61) 66(39)				**Probit-Selection model**
Whether group members contribute for the guard(s) in year 2006/07**(CGUARD).**	Dummy variable for 1=yes 2= no	 103 103	 60(58) 43(42)				**Probit-Selection model**
If there is (are) person(s) in charge on equitable water distribution and appropriate usage of irrigation water in the irrigation site**(DWATD)**	Dummy variable for 1=yes 2= no	 169 169	 109(65) 60(45)				**Probit-Selection model**
Whether group members contribute for the person(s) in charge on equitable water distribution and appropriate usage of irrigation water in the irrigation site in year 2006/07**(CWATD**).	Dummy variable for 1=yes 2= no	 109 109	 65(60) 44(40)				**Probit-Selection model**
II) INDICATOR OF COLLECTIVE ACTION FAILURE							
Number of times violation of restricted rules occurred**(NVIOL)**	Total number of times violation of rules and regulations occurred in year 2006/07 in a group**.**	169		20.33846 (17.63036)	2	72	**OLS**
Number of times conflict occurred**(NCONF)**	Total number of times conflict occurred among irrigation users in year 2006/07 in a group	169		15.33846 (16.25963)	0	71	**Tobit /Tobit Decomposition**
III) INDICATOR OF COLLECTIVE ACTION ENFORCEMENT/EFFEVTIVENESSS							
Number of times the penalty system had been applied**(NPENA)**	Total number of times the penalty system had been applied in year 2006/07 in a group	169		4.684615 (4.457921)	0	28	**Tobit /Tobit Decomposition**

Table 3.3.Description and Measurement of Explanatory Variables included in the Model

Variable Name	Definition and Measurement	No of observation	Frequency (%age)	Mean (Standard Deviation)	Minimum	Maximum	Atsbi	Ada'a
Region(X_R)								
Woreda	Dummy variable for the woreda 1= Atsbi 0= Ada'a	 169 169	 94(55) 65(44)					
Group Characteristics(X_G)								
	Total number of households in a group in 2006/07., no	169		25.50888 (44.39167)	4	297	20.531*$_1$ (3.379684)*$_2$	31.74667*$_1$ (6.380773) *$_2$
	Proportion of female households in a group in 2006/07	169		.2059 (.1537399)	0	.67	0.2374362 (0.0162794)	0.1663747 (0.0161268)
	Proportion of literate headed households in a group in 2006/07	169		.3964337 (.252199)	0	1	0.3066809 (0.0186778)	0.508924 (0.0326861)
	Average family size in a group, no	169		5.83432 (1.280255)	3	9	5.478723 (0.1216909)	6.28 (0.1465028)
	Proportion of households who use formal credit in a group in 2006/07	169		.3395976 (.4124674)	0	1	0.1524468 (0.332288)	0.57416 (0.0455406)
	Proportion of households who have access to extension programme in a group in 2006/07	169		.9636095 (.0385834)	.87	1	0.963617 (0.0039756)	0.9636 (0.0044908)
	Proportion of households for whom the primary source of livelihood is irrigate agriculture in a group in 2006/07	169		.2610122 (.3439764)	10	1	0.1494794 (0.0296739)	0.4008 (.041471)
	Total irrigated area in the group(ha)	169		7.192759 (15.48685)	.56	192	2.713577 (0.3938537)	12.80667 (2.500013)
	Total agricultural land in the group(rain-fed)(ha)	169		12.86287 (20.34169)	.25	230	4.385645 (0.6471031)	23.48767 (3.020455)
	Tropical Livestock Unit for the group	169		85.65166 (70.90984)	9.18	39.346	48.63854 (6.16249)	132.0414 (6.332693)
	Proportion of beneficiaries at the tail-end in a group in 2006/07	169		.2964142 (.1157906)	0	.6	0.3129468 (0.0092286)	0.2756933 (0.0161637)
	Years of experience of irrigation water use in a group, no	169		11.71598 (10.78534)	1	100	10.04255 (0.7250644)	13.81333 (1.608165)
	Number of training provision to farmers on issues related to irrigation water use	169		1.349112 (1.673324)	0	10	1.138298 (0.1576256)	1.613333 (0.2095842)
Farm Characteristics(X_F)								
	Proportion of soil coverage considered good by the group	169		.6019231 .2902698	.015	1	.5100532 (0.0319113)	0.7170667 (0.024987)

Table 3.3. continued

Variable Name	Definition and Measurement	No of observation	Frequency (%age)	Mean (Standard Deviation)	Minimum	Maximum	Atsbi	Ada'a
Village Characteristics(X_V)								
	Dummy variable for whether rainfall adequacy in the village considered good by the group							
	1=good	169	78 (46.15)				4(4.26)	74(98.67)
	2=not good	169	91 (53.85)				90(95.74)	1(1.33)
Access to market	Walking time from that specific group's to the nearest,(in minutes)							
	-town market	169		251.7515 (125.5681)	40	485	200.3617*[1] (14.22391) *[2]	316.16*[1] (7.603438) *[2]
	-village market	169		39.50888 (17.75331)	10	90	62.59574 (1.429285)	80.2 (6.180032)
	-development post	169		40.68639 (20.46198)	10	100	34.71277 (2.079776)	48.17333 (2.121055)
Scheme Level Characteristics								
	Dummy variable for if the irrigation scheme was promoted by external organization							
	1=yes	169	69(40.83)				42(44.68))*[3]	27(36) *[3]
	2=no	169	100(59.17)				52(55.32) *[4]	48(64))*[3]
	Number of external organization(s) which (is) are operating currently in the irrigation site	169		1.95858 (1.381661)	0	4	2.957447 (0.106862)	2.96 (0.19949)
	Number of local organization(s) which (is) are operating currently in the irrigation site	169		2.698225 (1.47924)	1	5	1.034043 (0.093455)	1.053333 (0.228976)
	Dummy variable for whether there was farmers' participation during construction of the whole structure							
	1=yes	169	126(74.56)				94(100)	32(42.67)
	2=no	169	43(25.44)				0(0)	43(57.33)
	Dummy variable for whether the irrigation system is							
	1=micro-dam	169	122(72.19)				62(65.96)	60(80)
	2=river diversion	169	39(23.08)				24(25.53)	10(13.33)
	3=spring water use	169	5(2.96)				5(5.32)	0(0)
	4=shallow well	169	1(0.59)				1(1.06)	0(0)
	5=communal lake (identified as the base)	169 `	2(1.18)				2(2.15)	5(6.67)

*[1]- In variables with continuous data the values represent the mean of the observation of the variable under consideration

*[2]- In variables with continuous data the values in brackets represent the standard error of the mean

*[3]- The numbers out of the bracket shows number of observations in each category for discrete data

*[4]- In variables with discrete data the values in the bracket represent the percentage distribution of the variable from the total observation.

3.4.3.3. Model Specification and Estimation

The type of regression model to use depends on the nature of the dependent variable:-

Least squares regression was used for annual average value of household contribution for the resource management and number of violation restricted rules occurred in 2006/07, since these variables are continuous.

Selection models (Probit) are used to examine the determinants of; whether there is(are) guard(s) for protection, whether group members contribute for the payment of the guard, whether there is(are) person(s) in charge of equitable water distribution and appropriate usage of irrigation water in the site, whether group members contribute for the payment of the water distributor. Dependent variables - whether group members contribute for payment of guard is conditional on having guard. This implies that members contribute if only if in cases where there is guard (which only in 103 number of observations in our case). Similarly, whether group members contribute for payment of water distributor is conditional on presence of water distributor. This shows that members contribute if only if there is water distributor (which only in 109 number of observations in this study). As a result we use Selection model in order to test and control sample selection bias, which is created by selecting only cases that have guard/water distributor.

We used two–step estimating procedure-

In the first step the model - absence /presence of guard/ water distributor, attempts to capture the factors governing the probability of having guard/ water distributor. This equation is used to construct a selectivity term known as the 'Mills ratio' which is added to the second stage 'outcome' equation. If the coefficient of selectivity term is significant then the hypothesis that the first equation is governed by an observed selection process is confirmed. Moreover, with the inclusion of extra term, the coefficient in the second stage 'selectivity corrected' equation is unbiased (Zaman, 2001). We select the explanatory variable - proportion of beneficiary households who had access and used formal credit as the offset variable, because it is one of the most statistically significant variable for both the dependent variables (whether there is (are) guard (s) for protection of the site and whether there is (are) person (s) in charge of equitable water distribution and appropriate usage of irrigation water in the site, but it has less effect on whether to contribute or not.

Decomposing Tobit Coefficients- Tobit analysis was developed for analyzing censored dependent variable, variables whose actual values are not observed for a large proportion of cases (Tobin, 1958). It is also appropriate for analyzing dependent variables that cannot take below and above a particular limit. In this study, we also used Tobit model for analyzing determinants of frequent occurrence of conflicts and application of penalty system in communal managed irrigation schemes for the year 2006/07, since the dependent variables for which a large proportion of cases have zero as the lowest possible value. Among 169 number of observation, 25 number of them had zero value of conflict occurrence, similarly 35 of 169 number of observations had zero as the lowest value of member penalty system exercised. Unfortunately, clear procedures for interpreting of Tobit coefficients are not available. Therefore, it is important to decompose the Tobit coefficients, which reveal important additional findings that could not be discerned from the ordinary Tobit coefficients (Roncek, 1992).

Among groups with no conflicts and no penalty system exercised, varying values of the independent variables imply different probabilities of occurrence of conflicts and experiencing penalty system application. For groups experiencing at least one conflict and application of penalty system, varying values on the independent variables imply variation in the conflict occurrence and penalty system exercised. Thus two types of effects should be discussed for each independent variable in many Tobit models: (1) the effect on the values of the dependent variable for cases with a non-limit (non-zero in our cases) values on the dependent variable, and (2) the effect on the limit value (zero in our case) of the dependent variable. These two effects parallel the structure of the Tobit model, which has two formulas for predicting values of the dependent variable-one for cases at the limit values and another for cases above the limit used in this study.

Diagnostic Tests - We run 8 different models (2 OLS, (4) Sample selection- Probit and 2 Tobit and decomposing its coefficients) using STATA 0.9. For each of the models we applied different diagnostics, as notes by Darnell and Evans (1990), before proceeding to test a hypothesis, one should apply several diagnostic tests to make sure that the chosen model is reasonably robust. The first one is to find whether there is potentially[15] a problem of multicollinearity, but found potential problems only between total number of households in the group and total households in the group squared; total area irrigated land in the group and total number of households in the group; the regional dummies and rainfall. The correlation between these variables was leading to high variance inflation factors (34.1- 57.9 VIF) (Gujarati, 1995 and Chatterjee and Price, 1991). However, we

[15] As notes by Gujarati (1995), if the pair –wise or zero-order correlation coefficient between two regressors is high, say, in excess of 0.8, then multicollinearity is a serious problem.

included all the variables in the models since they are statistically significant coefficients. Moreover, omitting one of the variables would result in omitted variables bias. The other variables had a variance inflation factor less than 7.10, indicating that multicollinearity was not a major concern for these variables [16](Gujarati, 1995 and Chatterjee and Price, 1991). Robust regression is undertaken to avoid the hetroskedasticity problem. We also tested if there is a problem of incorrect functional form. The result indicated that there was no evidence of functional form misspecification. We also tested normality and singled out the outliers.

3.4.3.4. Why Did We Use Community Level Survey for Econometric Analysis in this Study?

Analysis of common property resource management can be done at any one of several levels, including those of individual farm household and community level. In this survey the data which is used in econometric analysis was administered at community (*Gujele* and *Gere* level). There are at least two reasons why a community (group) level survey is appropriate, as compared with household level. The first reason is *Gujele* and *Gere*[17] is the smallest social unit that has the capacity to govern the administration and utilization of the common pool resource- irrigation water. Programmes will need to be managed by a larger collection of individuals. The second reason is since communal managed irrigation water has the attribute of a common pool resource in that the exclusion of farmers within the command area is difficult, but if use exceeds supply capacity it will

[16] *As a rule of thumb , if the VIF of a variable exceeds 10 (this will happen if R_j^2 exceeds 0.90), that variable is said to be highly collinear, Gujarati (1995) Chatterjee and Price(1991)*

[17] *Gujeles and Geres are the smallest administrative units in a scheme(WUA)*

become exhausted. Thus, in arranging collective action, it faces two types of common pool resource management problems: provision and appropriation problems (Ostrom, 1994). The problem of provision arises in arranging the construction and maintenance of canals and appropriation problem arises in water distribution arrangement. As a result, the whole structure of institutional water management may most closely reflect the combined practices of farmers in the group rather than that of any single household irrigated farm.

3.4.3.5. Research Hypothesis

The vectors used to explain variations in indicators of collective action, its failure and effectiveness include: Region **(X_R),** Group Characteristics **(X_G),** Farm Characteristics **(X_F)**, Village Characteristics **(X_V)** and Scheme Characteristics **(X_S).** The hypothesis about how these factors may influence collective action draw from the literature on collective action (North, 1990; Baland and Platteau, 1996; Pender and Scherr, 1999; Gebremedhin, Pender and Tsefaye, 2002)

Group Characteristics **(X_G)**

When the total number of households in the irrigated area is small, collective action may be low due to high fixed cost. While when the number of households is very high, collective action may also be low due to increasing variable transaction costs of attaining and enforcing collective action or higher competition for the resource. (Pender and Scherr 1999; Gebremedhin et al, 2002). Hence, we hypothesize an inverted U-shaped relationship between number of households in a group and collective action for communal irrigation water management. Intermediate number of beneficiary farmers favors collective action, while low and very high household number hinders collective action.

The effect of proportion of female headed households on collective action is unknown because it is highly influenced by the socio-cultural background of the community. Higher family size in the group expected to increase the benefit of collective management, since irrigated agriculture demands higher labor use individually as well as collectively. Higher literacy rate have two possible excepted effects; the first one is, it may increase collective action since that beneficiaries may have better understanding and awareness about the management of the resource. The other effect, it may undermine collective action, since it allows high 'exit' options.

Higher proportion of households who use formal credit favor collective action, since most of the time farmers get credit to buy inputs such as fertilizer, improved seed, pesticides, herbicides etc., which are complementary inputs with irrigation water use. However, we should note the difference in obtaining, need and access to credit since those who need and have access to credit may not obtain credit. Those who need may not have access and from those who have access some may not be interested to obtain credit due to different reasons. Similarly, access to extension programme appreciates collective action as does higher proportion of households whom agriculture is the main source of income. Community physical capital endowment; groups that have better physical assets (higher TLU and larger size of rain-fed agriculture plots) are the ones who are more likely to cover operation and maintenance costs and have better irrigation structure than groups that have few physical assets. Hence, physical capital is expected to have positive relationship with collective action. Economies of scale are important in favoring collective action. We expect that collective action should be greater and more effective in groups which have larger irrigated lands.

Higher proportion of beneficiaries at the tail-end lead to greater scarcity of the resource for irrigation purposes, as a result collective action may increase. However, at high levels of scarcity and ecological stress institutional arrangements often break down as people scramble for survival and discount rates increase, which leads to lower collective action. Longer years of experience of irrigation water use and provision of training may increase awareness towards how to use the water efficiently and how to co-ordinate themselves, hence, leads to more collective action.

Farm Characteristics **(X_F)**

The effect of soil quality on collective action may have two different effects. While better soil quality may increase the value of the return from managing the irrigated water effectively, thus favoring collective action. The other one is soil quality may also decrease the incentive of members to abide by the rules, increasing the opportunity cost of labour or by providing more ‘exit options’, making enforcement of rules more difficult.

Village Characteristics (X_V)

The effect of group members' access to markets on collective action is mixed. Better access to markets may increase the value of the return from managing the irrigated water effectively, thus increase collective action. Better markets may also undermine individual's incentives to co-operate by increasing the opportunity cost of labour or by providing more 'exit options', making it more difficult to punish those who fail to co-operate. Rainfall adequacy in the village may also have mixed impacts on collection action for similar reasons. Access to development post appreciates collective action, since farmers will have close contact with DAs and experts.

Scheme Level Characteristics (X_S)

External organizations can have two different effects. On the one hand, they can favour collective action by providing interventions that are complementary to local collective action and if they are demand-driven. On the other hand, external organizations may retard collective action if their role substitutes local collective action such as by replacing local effect or dictating management decisions or otherwise undermining collective action (such as by increasing 'exit options' of local community members).

It is expected that the effect of experience with local organizations on collective action will have a positive relationship due to possible learning effects and the effect of social capital on the costs or ability to enforce collection action. Farmers' participation during construction increases collective action, since it increases the sense of ownership and belongingness.

CHAPTER FOUR
INSTITUTIONAL ARRANGEMENT OF IRRIGATION WATER MANAGEMENT

This chapter focuses on the big picture of institutional and organizational arrangement of water distribution mechanisms in the two study woredas. It also discusses about the characteristics of beneficiary farmers, the existing legal framework, conflict resolution mechanisms and nature of collective action in the communal irrigation schemes.

Soon after the failure of the military socialist government, both the Transitional Government of Ethiopia (TGE), formed in 1991 and the Federal Democratic Republic of Ethiopia (FDRE), established in 1995 took a decision to construct new irrigation scheme. This also involved the clean up and rehabilitation of the old canal system in Atsbi and Ada'a woredas, in both modern and traditional irrigation sites. A massive effort was exerted in constructing dams, diversions, shallow wells and ponds. In all these activities, the community was actively involved both in labor and kind contribution. The irrigation schemes are aimed at improving productivity, achieving food self sufficiency and sustainable development based on a strategy called Agricultural Development–Led Industrialization (ADLI).

4.1. Potential and Actual Uses of Irrigation Water

4.1.1. Atsbi Wemberta

Currently, in the woreda, there are 5 micro-dams- Teghane, Haresssaw, Kelish Emni , Ruba Felg, Era; 6 modern river diversions - Endaminu, Barka Adi Sebha, Hadnet, Habes, Adi Mesaenu, Kuret; 5 traditional river diversions- Gera Rebue, Afenjow, Kimber, Mebrahtom, Era Erere; 3 spring water use sites- Tsquaf, Samera, Tsigaba; 1 communal shallow well and 2 communal ponds in Adi Mesaenu. The overall potential of irrigable land of the woreda is unknown. However, according to the woreda agricultural office the potential for some of the irrigation sites is stated in Table 4.1 and Table 4.2.

In Atsbi woreda, all the above irrigation schemes cover over 221.1 ha of land. In this command area 1855 beneficiary farmers were involved, of which 402 (21.67%) are female-headed households and 1453(78.3%) are male–headed households. According to the woreda office of agriculture, the potential irrigable land using micro-dams is over 155.5ha (excluding Era micro-dam) serving 1,184 beneficiary farmers. But actually the size of land under irrigation is only 71% of the potential estimated, indicating under–utilization of the resource.

From the total number of irrigation water users in the woreda, nearly, 38% of beneficiary farmers use micro-dams as a source of irrigation water, of which 27% of them are female headed households and 73% are male headed households. Of the above 5 micro dams only Tegahane (at Golgol Naele) and Haressaw micro-dam are operational currently (see

Table 4.1). Debre Selam, located in Ruba Felig *tabia*, is the largest micro-dam in the woreda where conflict has occurred repeatedly since 1997[18].

All of the modern schemes have been established since the fall of the former *Derg* government in 1991. The establishment of these schemes have been promoted by external organizations. For instance, Golgol Naele micro-dam was constructed by Co-SAERT (Commission for Sustainable Agricultural and Environmental Rehabilitation for Tigray) in 1997. Similarly, Haressaw and Ruba- Felg were constructed by World Vision (NGO) in 1992. Because of severe shortage of water in the area, farmers around Kelisha Emni and Era micro-dams prefer to use the water for drinking purpose for their livestock.

Like the micro dams, the woreda office of agriculture estimated potential of 85 ha of irrigable land for the river diversions, with 1,012 beneficiaries. However, about 104.3ha of land is actually irrigated. This indicates that unlike the micro-dams, over-utilization of the resource is observed. All of the modern diversions were promoted by Tigray Regional Water Resource Bureau. The largest diversion in the woreda is Endaminu which is found in Hayelom *tabia*. It irrigates 64.4ha of land, which constitutes 61.7% of the total land irrigated using modern river diversions in the woreda. Fourty years ago farmers around the river Chuhet had begun to use the diversion traditionally but later on in 2003 with the fund support of IFAD, Tigray Regional Water Resource Bureau constructed the main modern diversion called Hayelom. Following this, beneficiary farmers formed union of cooperatives in 2005, which helps them to access more easily inputs like fertilizer,

[18] *The whole conflict issue will be discussed in detail at the end of this chapter.*

improved seeds etc. It also creates market linkages to their produced crops using irrigation water.

Since the construction of the modern diversion, Gera Rebue traditional river diversion operates partially because of the decline in the volume of water from the source (since both the traditional and modern schemes have the same source). Under the modern diversion, there are a total of 507 beneficiaries, of which 19% are female headed households. Farmers at this irrigation site have on average 28 years of experience in irrigation water use. There are a total of 7 *Gugles* in Hayelom river diversion which range from 33 to 280 beneficiary farmers in a group.

Following Endaminu, Hadnet river diversion is the second largest diversion in the woreda. It irrigates 25.14 ha of land with a total of 68 beneficiaries, of which 8.8% of them are female headed households (see Table 4.1). Kuret and Adi Mesaenu also cover a command area of 8.535 ha and 6.25ha of land, respectively. In Adi Mesanu, all the beneficiaries are male household heads, while in Kuret 18.2% are female household heads. According to the woreda irrigation expert, Habes and Barka Adi Sebha cut-off drain river diversions are mainly used for restricted grazing land management (see Table 4.2).

Table 4.3 shows the characteristics of the traditional river diversions. Like the micro-dam, the traditional river diversion at Era was unfunctional in 2006/2007. Gera Rebue river diversion in Haylom *tabia* covers the widest command area compared to other traditional river diversions in the woreda, i.e., 9.875 ha of land. In its command area, 62 beneficiaries are included with 19.4% of female farm decision makers. As mentioned before, the total command area covered has decreased after the construction of the new main diversion. A total 6.5 ha of irrigated land is utilized under Tsquaf and Samera irrigation sites which are found in Ruba Felg *tabia*. It embraces 13 women and 65 male headed households. Mebrahtom and Kimber are recently developed traditional river diversions with a total area of 2.4782 ha and 1.25 ha of land and 32 and 13 beneficiaries, respectively.

According to discussion with key informants, there were many spring water sources in the woreda. However, eventually most of them had become drier and finally disappeared at all. In the woreda, there are 2 spring irrigation water use sites 1 in Ruba Felg and 1 in Zarema. Under these spring sites 7.5 ha of land was cultivated for 66 household heads of which 4.5% are female.

In additional to all these, farmers at Adi Meseanu made an effort to use two communal ponds and one communal shallow well for irrigation. They took a collective credit in 2005 from World Vision for buying motor pumps. Twenty five beneficiaries were included in this package, of which only one of them is woman farm decision maker.

Communal Irrigation Schemes in Atsbi Wemberta Woreda

Table 4.1- Micro- Dams

S.No	Tabia	Kushet	Year of construction	No. of *Gugles*	Actual years of experience of using the irrigation (Mean)	Potential		Actual				Distance from the woreda town(Enda Selassie) in Km.
						Total irrigable land (ha)	Total no. of Beneficiaries	Total land irrigated (ha)	No. of beneficiaries			
									Total	Female	Male	
1	Golgol Naele	Tegahane	1997	37	8.36	41.50	457	41.6728	542	138[1] (25.5%)[2]	404 (74.5)	2
2	Harressaw	Feliga	1994	25	12	39	271	42.3008	305	96 (31.5%)	209 (68.5%)	20
3	Kelisha Emni	Adi Shehu	1997	0	0	54	284	0	0	0	0	44
4	Ruba Felig	Debre Selam	1993	0	2.5	21	172	0	0	0	0	11.5
5	Era	Era	1996	0	0	NI	NI	0	0	0	0	28
Total				***62***				***83.9736 ((38%))[3]***	***847 ((45.7%))[3]***	***234 (27.6%) ((58.2%))***	***613 (72.4%) ((42.2%))***	

Source-Own survey and computation except figures used in potential irrigable land and potential total no. of beneficiaries. (applicable for all tables and figures)

[1] Numbers out of the bracket shows number of observation in that category,
-actual years of experience of using the irrigation (mean),
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme

[3] Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda

Table 4.2. Modern River Diversions

S.No	Name of river diversion	Type of Technology	Year of construction	No. of *Gugeles*	Actual years of experience of using irrigation water (Mean)	Potential		Actual				Distance from the woreda town(Enda Selassie) in Km.
						Total land irrigable in ha	Total no. of Beneficiaries	Total land irrigated (ha)	No. of Beneficiaries			
									Total	Female	Male	
1	Enda minu (in Haylom Tabia)	Main-diversion	1996	6	28.28571	48	490	64.375	507	97[1] (19.1%)[2]	410 (80.9%)	26.5
2	Barka Adi Sebha	Cut-off drain	1996	0	0	7	112	0	0	0	0	7
3	Hadnet	Cut-off drain	1997	9	5.4	10	175	25.14	68	6 (8.8%)	62 (91.2%)	36
4	Habes	Cut-off drain	1997	0	0	7	95	0	0	0	0	12
5	Adi Mesanu	Cut-off drain	1996	1	1	6	20	6.25	9	0	9 (100%)	6.5
6	Kuret	Cut- off drain	1997	3	8	7	120	8.535	159	29 (18.2%)	130 (81.8%)	5
Total				***19***		***85***	***1,012***	***104.3 ((47.2%))[3]***	***743 ((40%))[3]***	***132 (17.8%) ((32.8%))***	***611 (82.2%) ((42%))***	

[1] Numbers out of the bracket shows number of observation in that category,
-actual years of experience of using the irrigation (mean),
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme.

[3]Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda.

Table 4. 3. Traditional River Diversions

S. No.	Name of the river diversion	Tabia	No. of *Gugeles*	Actual years of irrigation wate use(Mean)	Actual				Distance from the woreda town(Enda Selassie) in Km.
					Total land irrigated(ha)	Total no. of beneficiaries	Female	Male	
1	Gera Rebue	Hayelom	1	40	9.875	62	12[1](19.4%)[2]	50 (80.6%)	25
2	Tsiquaf	Ruba Felg	1	24	1.5	20	5(25%)	15(75%)	10
3	Samera	Ruba Felg	2	25	5	58	8(13.8%)	50(86.6%)	10
4	Kimber(Tsigaba)	Zarema	1	3	1.25	13	0	13 (100%)	16
5	Mebrahtom	Felg Woini	3	2	2.4782	32	7 (21.9%)	25 (78.1%)	4.5
6	Era Erere	Era	0	0	0	0	0	0	28
Total					***20.1032*** ***((9 %))***	***185*** ***((9.97%))[3]***	***32 (17.3%)*** ***((7.96%))***	***153 (82.7%)*** ***((10.5%))***	

[1] Numbers out of the bracket shows number of observation in that category,
- actual years of experience of using the irrigation (mean),
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme.

[3]Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda.

Table 4.4.Spring water use

S. No.	Name of the river diversion	Tabia	No. of *Gugeles*	Actual years of irrigation water use	Actual				Distance from the woreda town(Enda Selassie) in Km.
					Total land irrigated(ha)	Total no. of beneficiaries	Female	Male	
1	Afenjow	Ruba Felg	2	23	4.5	42	2[1] (4%)[2]	40(96%)	11
2	Tsigaba	Zarema	1	6	3	24	1 (4.2%)	23 (95.8%)	17
Total					***7.5*** ***((3.39%))[3]***	***66*** ***((3.56%))[3]***	***3 (4.5%)*** ***((.7%))***	***63 (95.5%)*** ***((4.3%))***	

Table 4.5. Shallow Wells and Artificial Lakes

S. No.	Name of the river diversion	Tabia	Type of Irrigation Water	No. of *Gugeles*	Actual years of irrigation wate use	Actual				Distance from the woreda town(Enda Selassie) in Km.
						Total land irrigated(ha)	Total no. of beneficiaries	Female	Male	
1	Gereb Gesa	Adi Mesanu	Shallow wells	1	2	2	5[1] (100%)	0	5	7
2	Gereb Gesa	Adi Mesanu	Communal pond	2	2	3.25	8(89.9%)	1(11.1%)[2]	9	7
Total						***5.25*** ***((2.37%))***	***13*** ***((.75%))[3]***	***1 (7.1%)*** ***((.2%))***	***14 (92.9%)*** ***((.89%))***	

[1] Numbers out of the bracket shows number of observation in that category,
- actual years of experience of using the irrigation (mean)
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme.

[3]Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda.

4.1.2. Ada'a Woreda

Currently, in the woreda there are 4 modern and 2 traditional irrigation schemes from Wedecha-Belbela dam (see Figure 4.6). There are also one river diversion under operation from Mojo river and one natural lake, named Hora Kilole (see Table 4.7). The overall potential of the woreda is unknown especially after the separation from Liben. The woreda irrigation office has in its record a land area of 2,017 ha under irrigated land, with 5,043 total beneficiary households. It also shows that an average land holding size of about 0.5 ha irrigated area per household.

The Wedecha- Belbela Dam Storages System

The Wedecha dam was first constructed for state farm purpose in 1978 by the former socialist government of Ethiopia in collaboration with the Cuban government. Currently the dam supplies Keteba Gimbi, Gohaworko, Godino and Harawa irrigation schemes in the woreda. The dam itself is located in the border of Sendafa and Gimbichu woredas. The farmers in these woredas have not been beneficiaries of the irrigation water except for some emerging interest to irrigate some of their land. Because of this reason, farmers who live around the dam complain and conflict arises frequently (farmers in Sandfa and Gimbichu tried to destroy the main regulator for a number of times). Later on the new canals were constructed by Oromiya Rehabilitation fund which lead to Keteba Gimbi and Harawa schemes.

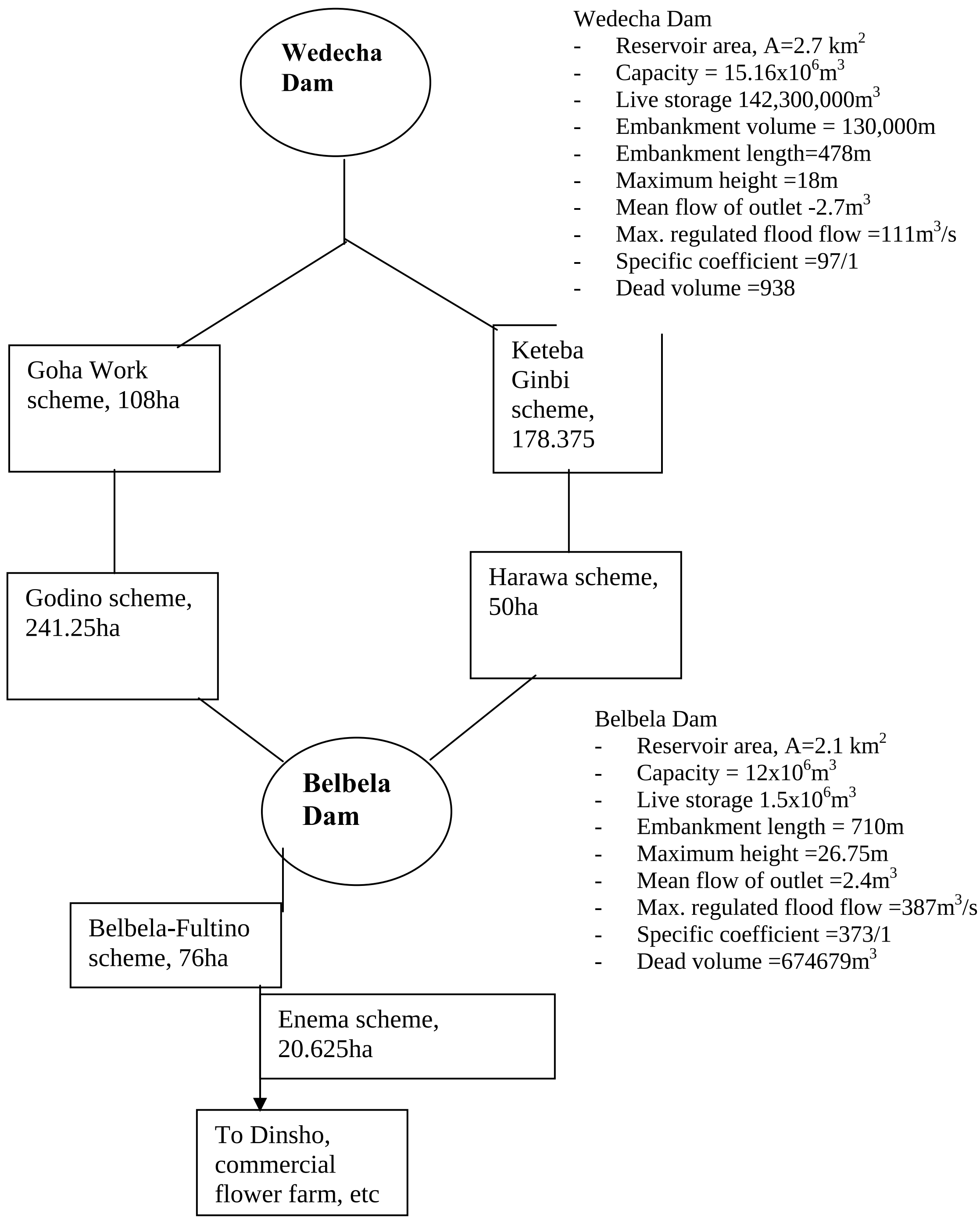
The Wedecha dam stores a water volume of 15.160 X 106 m^3 mainly from flood water. This stored water is utilized in the right and left channels and feeding the various schemes along its way until it ends up in Belbela dam. The current usage of water for irrigation before the entry to Belbela dam is 577.625 ha and a new expansion with a size of additional 120 ha is underway upstream of the Keteba Gimbi scheme.

The Belbela Dam has a capacity of 12 X 10^6 m^3. Similar to Wedecha dam it is a flood harvesting dam. After the Wedecha water flows via Keteba Gimbi and Harawa, the water stores in Belbela Dam, it supplies water to Belebela and Fultino schemes.

Dinsho owned large irrigable land which is not currently under use. However, the new expansion of commercial flower farming is expanding to the command area of the Belbela dam, and they use the water from the dam for irrigation at this stage. The overall combined use of Belbela Dam is less than 100 ha with a potential to expand by 100 ha.

The irrigation water at Wedecah –Belbela dam has unfunctional main and lateral gates; therefore, there is an overnight storage provision. The aim is to reduce the misused amount of water during night time when farmers don’t use the irrigation water, in stead it flows to this overnight storage called Seroba.

Figure 4.1. Wedecha and Belbela Dam Schematic Representation and the Associated Irrigation Schemes



4.6. Functional Irrigation Schemes from Wedecha-Belbela Dam, River Diversion and Natural Lake Use

Functional Small Scale Irrigation Schemes from Wedecha-Belbela Dam								
S. No.	Name of the irrigation scheme	PA	Actual years of irrigation water use	Actual				Distance from the woreda town (Debre Zeit)
				Total irrigated land	No. of beneficiaries			
					Total	Female	Male	
1	Godino	Godino	13.95	241.25	495[1]	90 (18.2%)[2]	405(81.8%)	12
2	Gohaworko	Godino	39.625	108	267	65 (24.3%)	202(75.7%)	13
3	Harawa	Godino	19.6667	50	68	24(35.3%)	44 (64.7%)	18
4	Belbela-Fultino	Koftu	10	76	247	28 (11.3%)	219(88.7%)	7.5
5	Dhanama	Ganda Gorba	7	20.625	54	8 (14.8%)	46 (85.2%)	10
6	Kataba-Gimbi	Kataba	9.058824	178.375	427	71 (16.6%)	356(83.4%)	21.75
				674.25 ((70.2%))[3]	***1558 ((65.4%))***	***286(18.2%) ((90%))***	***1272(81.6%) ((61.8%))***	

[1] Numbers out of the bracket shows number of observation in that category,
- actual years of experience of using the irrigation (mean)
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme.

[3] Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda.

Table 4.7. River Diversion and Lake Irrigation Use in Ada'a

S. No.	Name of the irrigation scheme	Type of irrigation system	Name of PA	Actual years of irrigation water use	Actual				Distance from the woreda town (Debre Zeit)
					Total irrigated land	No. of beneficiaries			
						Total	Female	Male	
1	Mojo river	River diversion	Hidi	10.11	263.5 [1]	698	25 (3.6%)	673 (96.4%)	13
2	Hora Kilole lake	Lake use	Hidi	3	22.75	125	7 (5.6%)[2]	118 (94.4%)	14.5
					286.25 ((29.8%)) [3]	***823 ((34.6%))***	***32 (3.8%) ((10.1%))***	***791 (96.1%) ((38.4%))***	

[1] Numbers out of the bracket shows number of observation in that category,
- actual years of experience of using the irrigation (mean)
- irrigated land size

[2] Numbers within the bracket shows percentage distribution of the variable from the total number of beneficiaries in that specific scheme.

[3] Numbers within the double bracket shows percentage distribution of the variable from the total number of beneficiaries in whole existing schemes in the woreda.

The above two tables show that in Ada'a woreda, there are a total of 2,059 irrigation water beneficiaries on 960.5 ha of land. Among the irrigation sites, Godino irrigation scheme is the largest in both size of command area and number of beneficiaries. It has the command area of 241.2 ha of land that is 35.8% of the whole Wedecha–Belbela dam command area. A total of 495 household beneficiaries are served, of which 81.8% are male headed households. Kataba-Gimbi traditional irrigation scheme is the second vast command area in the woreda. In this scheme 178.375 ha of land is irrigated by 427 household heads, out of which 16.6% of them are female. The other two irrigation sites that are found in Godino PA are Gohaworko and Harawa. Those schemes have a long history of using Wedecha and Belbela spring water for irrigation purposes. The Wedecha–Belbela dam was named after these old aged spring water sites- Wedecha and Belbela. The two schemes (Gohaworko and Harawa) cover a total of 108 ha and 50 ha of land with total beneficiaries of 267 and 68, of which 24.3% and 35.3% are female headed households, respectively.

Belbela dam is the source of two schemes namely Fultino (found in Koftu PA) and Dhanama (located Ganda Gorba PA). The command area under these two schemes has 76ha and 20.625ha of land with 247 and 54 beneficiary farmers, out of which 88.7% and 85.2% are male household heads.

Regarding river diversion, there is only one river which crosses the woreda through Hidi PA. There are 698 farmers who use the irrigation water on 263.5ha of land. Hora Kilole natural lake is another source of irrigation water for farmers living around Hidi PA. It covers 22.75 ha of land with 125 household beneficiaries, out of which 5.6% are female and 94.4% are male beneficiary farmers. Similar to farmers at Adi Mesanu in Atsbi, farmers who live around this natural lake took credit collectively from Ratson (NGO) for buying motor pumps for irrigation purpose.

4. 2. Management Systems in Communal Irrigation Schemes

Irrigation Water Administration

Irrigation water administration covers the organizational, managerial and institutional structures including the regulatory apparatus and conflict resolution mechanisms, which are directly connected to the water sector.

Organizational Framework

The general organizational framework of irrigation water sector in Ethiopia can be briefly described by highlighting the key actors playing different roles at the centre, in the regions and at grassroot level.

Regional Water Resource Bureaux (Tigray for Atsbi and Oromiya for Ada'a) provide oversights of the irrigation sites. As discussed previously almost all the diversions in Atsbi were constructed by the Tigray regional water resource bureau. It also gives financial support for maintenance at the outlet and system level, with the assistance of the community and other stakeholders. Similarly, the woreda agricultural office and the woreda water resource office have a larger role in the provision of technical assistance for beneficiary farmers. In both study areas, under the woreda agriculture office, the irrigation team sub-division provides trainings and irrigation use awareness programs. The sub-division has coordinated training progrmmes a number of times in collaboration with NGOs and external organizations such as World Vision, IPMS-ILRI and Genesis. It creates a bridge between beneficiary farmers and other stakeholder.

Moreover, there are a number of governmental and non-governmental organizations which play a huge role in enhancing the productivity of farmers in the schemes. World Vision, Irish AID, REST, Safty Net, World Bank and BoARD in Atsbi, and Ratson, Kale Hiwot, Voca and Genesis in Ada'a; IPMS-ILRI in both study woredas are the major external and non governmental organizations, which give technical support for beneficiary farmers. There are also local organizations which attempt to assist the farmers through provision of input such as Hayelom and Alph Goha Co-operatives in Atsbi and Ada'a, respectively. Furthermore, research organizations like Debre Zeit and Melkhasa Agricultural Research Institute in Ada'a are also participating actively in introducing new technologies to beneficiary farmers.

Each irrigation scheme is a common property resource that is owned and managed by the community. Each site has formed Water Users Association (WUA) which is administered by Water Users Committee (WUC). Under normal circumstances, everybody who is the beneficiary of irrigation water is a member of WUA in a particular scheme. WUA is a local institution and has a basic character of authority and by-laws. It has rules, methods and sanctions for selecting executive committee, raising finances, setting disputes among irrigation water beneficiaries and supervising provision of the irrigation water service.

Each irrigation site has an elected committee with 3-7 members and a chair, which varies from scheme to scheme; with one-chair person, one-vice chairperson, one secretary, one-treasurer (cashier), controller (s) and other members. It also embraces a water distributor, (in Atsbi locally called *Abo-Mai*[19]*)*, who is responsible for everyday operation of the scheme. Under these water users associations and the executive committee, the new structure was created by water users with water course representatives at the outlet (block or group[20]) level (*Gujele* and *Gere* level).There are 94 *Gujele* and 75 *Gere leaders* in Atsbi and Ada'a, respectively. In this study *Gujele* and *Gere* leaders means group (block) leaders. These leaders are in charge of any issue concerned with monitoring and controlling of water distribution in their group. The water distributor controls these block (group) leaders at the scheme level. Usually, the water distributor is one person per scheme.

The executive committee is an official link between irrigation water users and the government officials in *tabias* and woredas. They represent irrigation landowners and not the government. While they are appointed by the water users, they don't have any formal office, payment or compensation for their services. Ownership of land within the same catchment's area, active participation within the community, age and good family background are important considerations for appointment as a committee.

[19] *Abo Mai means water distributor at scheme level in Tigrigna (Atsbi).*

[20] In this study Gujele, Gere, group and block are refer to the same meaning

According to discussions with water user farmers, the principal duties of the executive committees and water distributor include:-

(1) enforcing the rules and regulations of the association;

(2) collecting of annual cash contribution from each water user farmer;

(3) mobilizing the resources for operation and maintenance of the scheme;

(4) assisting all offices of the government in executive of their public duties and supply the required information and generally act for and on behalf of the landowners and lease-in farmers in the catchment area;

(5) resolving any conflict that relates to water distribution;

(6) monitoring and controlling the water volume from the main regulator, lateral and sub-lateral;

(7) planning, organizing and enforcing clearance and maintenance of the main canal, laterals and sub-lateral canals;

(8) After negotiation with all water users, they decide the water schedule (when each group and user get the water) and the mechanism how to distribute it and

(9) listening any complaints and give resolutions.

In both places, local associations are influential and powerful to the local communities. Most people feel a stronger sense of identity and belongingness than in the formal set-ups.

4.3. Characteristics of Community Managed Irrigation Schemes

The descriptive statistics for characteristics of communal managed irrigation schemes in the two woredas is indicated in Table 3.3. There are a total of 94 *Gujeles* and 75 *Geres* in

Atsbi and Ada'a woredas, respectively. Besides, the average number of beneficiaries in a group is 20.5 in Atsbi, with the minimum number 4 in Adi Mesanu communal pond irrigation use and a maximum of 280 irrigation water users in one of Endaminu's modern river diversion groups. Similarly, in Ada'a the average number of beneficiaries in a group is 32. The largest *Gere* embraces 297 beneficiaries in a group and the smallest group includes 8 farmers.

With regard to group characteristics, average family size for a combined irrigation schemes (Atsbi and Ada'a) is nearly 6, with slight variation among groups in the two woredas. In terms of education wise distribution, a large percentage of the household heads in the groups are illiterate. In both cases, only 30% and 50% are literate beneficiaries in Atsbi and Ada'a, respectively.

As Table 3.3 shows, large proportion of households in the group have access to agricultural extension programme. In both cases, 96% of households have access to extension programme, indicating a possible positive association between access to extension and irrigation water use. Regarding financial capital endowment of irrigation water users in a group in cropping season of 2006/07, only 33% of beneficiaries obtained credit from formal organizations for the combined population. The mean variation in this respect is very large, 15% in Atsbi and 57% in Ada'a. The major reasons for lower mean percentage of beneficiaries that obtained credit are due to the inability to repay back the previous credit, insufficient supply of credit, credit aversion, shortage of prepayment cash and different other reasons.

The population density in irrigated areas of Atsbi is very high. The average number of beneficiaries per hectare is 8 in Atsbi and 3 in Ada'a. With respect to soil fertility, the beneficiaries were asked what percentage of their groups' irrigated farm land soil coverage is considered 'good', based on their perception. Only 51% and 72% of the soil of irrigated land is classified as 'good' in Atsbi and Ada'a, respectively. The mean proportion of beneficiaries at the tail-end is comparable among irrigation beneficiaries in Atsbi and Ada'a at 0.31 and 0.27, respectively.

Furthermore, average years of irrigation water use experience shows that most of the schemes were constructed or began to operate after the fall of the military government. It has been on average 10 years, since the irrigation schemes started to operate in Atsbi, while it has been 13 years in Ada'a. The average number of times training was given in 2006/07 cropping season for beneficiaries is higher at Ada'a than in Atsbi, i.e., twice in Ada'a and once in Atsbi. This shows that less involvement of stakeholders in training provision in both woredas. There is much variation in total ownership of agricultural land (non-irrigated land) and TLU across irrigation water beneficiary communities in the two woredas.

The combined mean for walking time to the town market for a round trip takes 251.75 minutes (4:20 hrs). The mean walking time to Enda Selassie (the woreda town of Atsbi) takes 200.36 minutes (3:33hrs) with the maximum of 455 minutes(7.58hrs) from Hadnet to Enda Selassie and the minimum of 60 minutes (1hr) from Tegahne (Golgol Naele *tabia*) to Enda Selassie. On the other hand, the average walking time to Debre Zeit (the woreda town of Ada'a) takes 316 minutes (5.26 hrs), with the minimum of 180 min(3hrs) from Koftu PA (Belbela-Fultino scheme) to Debre Zeit and the maximum of 415 min.(6:59 hrs) from Kataba PA to Debre Zeit. However, village markets are nearer to irrigated villages of the woredas as compared with the town markets. The combined mean for walking time to the nearest village market for a round trip is 70 minutes (1:10hrs), with some variation between the two woredas (20 min.). In both cases, the town markets are very remote from the irrigated *tabias* which might reduce incentive to sell the product in town market that the beneficiary farmers start to produce using irrigation water.

The result shows that, 82% of the current irrigation sites in Atsbi were promoted by external organizations like Co-SAERT, Tigray Regional Office of Water Resource and World Vision, with the full participation of the community in food-for-work programme. However, Wedecha- Belbela dam was constructed by the then socialist government in collaboration with Cuban government. The results of focus group discussion reveals that during the construction of Wedecha- Belbela dam, only some farmers participated as a daily laborer. While the diversion from Mojo river and Hora Kilole lake was initiated and promoted by farmers around the water source. The average number of external and local organizations which operate currently is comparable among irrigation water beneficiary groups in both woredas (3 external organizations and 1 local organization per scheme in both woredas). Moreover, in both woredas, micro-dam is the main source of irrigation water, 65% in Atsbi and 80% in Ada'a.

4.4. Nature of Collective Action in the Irrigation Sites- as a common pool resource

4.4.1. Participation of Members in WUA

Like in any other common pool resource, collective action arrangement in irrigation water use faces two types of resource management problems: provision and appropriation. The problem of provision arises in arranging the construction and maintenance of canals, while appropriation arises in water distribution arrangement. To overcome these problems, as we discussed previously, irrigation beneficiaries has formed WUA and WUC at each scheme, and block (*Gujele* and *Gere*) leaders at each outlet level.

Before the start of the irrigation season, water users in general assemble to negotiate when to clean the canals (the main canal, lateral and sub-lateral canals) and then decide the water distribution programme, i.e., where to start (upstream or downstream), rotational irrigation intervals, for how much time to irrigate per person etc. Especially, water distributors have a big role in organizing the water distribution programme and the mechanism to achieve the goals.

The irrigation group leaders are in charge of control at turnout gates of lateral and sub-laterals. They also inspect at farm–level water distributions that are to be carried out by each block.

Participation of Members in Meetings- Many of the problems related to irrigation are solved directly by farmers themselves. According to the current status of the rule and the regulations of the WUA in both woredas, members should meet once a month and WUC once at fortnight to discuss problems, make decisions and once a year to elect new executive committee and water distributor. However, in practice, it is hardly the case. It seems that the only occasion that brings farmers and WUC to meetings is when they negotiate on the issues like when to clean the canals, when the irrigation system ceases to function or when an urgent action is needed.

All farmers are allowed to participate equally in all meetings, which are led by WUC. Representation by other family members is quite common. Double representation is considered (by men and women) inefficient and unnecessary. In addition, all members of WUA (women and men) have equal right to vote and to be elected to serve as an executive committee, water distributor or block leader.

4.4.2. Water Distribution System

In both selected areas, rotational irrigation is practiced. Rotational irrigation is the application of irrigation water in a given amount at the given time and in proper order, so that all farmers may get enough water to irrigate their fields. The irrigation distribution is designed according to the existing system layout and actual topographic conditions, so that irrigation water can be simultaneously delivered into each rotation block or group. This is why each irrigation site is divided into different *Gugeles and Geres* (blocks). Actually, water distribution shifts are established based on counting dates or complaints, instead of water needs by plants.

Under normal circumstances, a group gets water for a day whereby the interval differs from season to season, which depends on the amount of water stored in the reservoir. In both woredas, efficient and effective use of rainfall is an important source of irrigation water. Presently, all the existing micro-dams conserve rainfall as the irrigation water. Raising the fields to capture more rain water is the method used. Other sources of irrigation water are also directly related to the amount of rain-fall during wet season.

Farmers also claim to follow crop-water requirement rates in irrigating their plots. However the application is without consideration of the soil type, crop type and stage of growth. According to focus group discussions with beneficiary farmers, they know and use crop–water requirement rates. Nevertheless, interview with the woreda and *tabia* irrigation experts revealed that beneficiary farmers always try to over-irrigate their fields thinking that more water results more yields.

4.5. Indicators of collective Action to Manage the Irrigation Schemes

Table 4.9 depicts indicators of collective action in communal irrigation schemes in the two woredas. The combined average area of irrigated land per households is 0.31 ha/household, with high variation among the two woredas, which is 0.15 ha/household in Atsbi and 0.43 ha/household in Ada'a. This may be due to the presence of high population density in the highlands of Ethiopia, especially in such places where there is high potential of agriculture.

There are three kinds of contributions among irrigation water beneficiaries: in cash, kind and in labor form. Farmers in the two woredas have comparable annual total average value of contribution per household for the resource management that is nearly 190 *Birr* in Atsbi and 206 *Birr* in Ada'a. The most common members' contribution is in form of labor, that members clean and maintain canals collectively in a number of times in a year. This form of contribution accounts for 95% in Atsbi and 86% in Ada'a as compared with the total amount of contribution.

All of the beneficiaries of the irrigation water have an obligation to participate in cleaning, maintenance and minor construction of canals, water gates and spill ways. Months like September and February are the most favorable times to clean the canals. The farmers form a group and a team leader and agreed on how much meter of canal to clean. If a group can't finish in the agreed time, it will be punished by a cash fine set by the WUA.

In Ethiopia and in many other developing countries around the world, the ability of government to ensure irrigation cost recovery is the most important problem. In these two woredas, the canal water charge is zero. They have only collected money to cover some operation and maintenance costs and payment for guards and water distributor. In Atsbi, the mean annual cash contribution is 2.81 *Birr* per household. Whereas, in Ada'a average annual household cash contribution is 19.82 *Birr* for the resource management.

Table 4.8–Indicators of Collective Action to Manage the Irrigation Schemes in the Woredas

Indicators	Atsbi	Ada'a	All irrigation schemes
Area of irrigated land per household (ha)	.1534593$*_1$ (.0190819)$*_2$	.4256 (.0222955)	.3104635 (.0192127)
If there is formal written rules (Yes, No)	150(89)	163$*_3$(97)$*_4$	159(94)
Average value of a group member contribution for the resource management(in cash+kind+labor)	189.9 (10.03769)	206.2511 (18.63855)	200.17 (11.55121)
Value contribution in cash form (in *Birr*)	2.81 (1.50)	19.82 (2.789)	12.6 (1.876063)
Value contribution in kind form (converted to in *Birr*)	5.6 (2.448)	10.1(2.662)	8.2 (1.855946)
Value contribution in labor form (converted to in *Birr*)	181.5 (11.37)	177.8 (16.98)	179.3 (10.88)
Number of times violation of rules and regulations occurred in 2006/07 (no.)	12.72727 (1.510782)	25.92 (1.748)	20.33846 (1.320701)
Number of conflicts occurred related to irrigation water use in 2006/07 (no.)	9.927273 (1.48774)	19.30667 (1.630)	15.33846 (1.199113)
Number of penalty exercised in 2006//07(no.)	3.109091 (.4017409)	5.84 (.615)	4.684615 (.4096386)
If there is(are) guard(s) for protection of the irrigation site(Yes, No)	32 (19)	162 (96)	105(62)
Number of guards in the irrigation site (no.)	.3090909 (.141832)	2.506667 (.0917759)	1.576923 (.1244501)
Number of months guards protect the irrigation site (no.)	9.818182 (.433831)	8.36 (.4570331)	9.238462 (.4532798)
Whether group members contribute for the guard(s) (Yes, No)	28.73(17)	145(86)	98(58)
Value of contribution per guard per month *(in Birr*)	52.36364 25.44415	206.7387 (11.55267)	141.4262 (14.280)
If there is water distributor in the irrigation scheme (Yes, No.)	94 (100)	69(41)	110(66)
Number of water distributor in the irrigation site (no.)	1 (.)	.6666667 (.0547997)	.8076923 (.0346998)
Number of months the water distributor operates in a	8	5.373333	6.484615

year time in the irrigation site (no)	(.2201928)	(.5229071)	(.3348626)
Whether group members contribute for water distributor(Yes, No)	63 (37)	144(85)	101(61)
Value of contribution per water distributor per month (in Birr)	52.36364 (25.44415)	108.6267 (12.38735)	84.82308 (13.09309)

$*_1$- In variables with continuous data the values represent the mean of the observation of the variable under consideration
$*_2$- In variables with continuous data the values in brackets represent the standard error of the mean
$*_3$- The numbers out of the bracket shows number of observations in each category for discrete data
$*_4$- In variables with discrete data the values in the bracket represent the percentage distribution of the variable from the total observation.

The third type of contribution is in kind. In some cases of irrigation schemes of Atsbi, guards who protect the irrigation farm and the infrastructure are paid in kind (cereals like wheat and sorghum). During minor construction, beneficiaries also contribute in kind, for instance raw materials such as stone and soil. The average annual contribution in kind is 5.6 *Birr* per household and 10.1 *Birr* per household in Atsbi and in Ada'a, respectively.

Minor construction and maintenance that needs community level participation is organized by the water committee. Water committee mobilizes resources and fixes time of maintenance. Resources for these kinds of maintenance are from three sources: income from punishment, community labor, community contribution in cash form (additional to the one annually paid) and contribution in kind.

In both areas, interview with the woreda expert reveals that there is no problem with labor contribution and mobilization for maintenance and clearance of canals. Every water user is equally committed to the purpose. However, informal discussion with beneficiary farmers shows that tail-enders[21] usually have to contribute more labor than the head-enders.

Farmers clean the canals two-four times a year in order to prepare the structure for irrigation during the dry season. The agreement is that beginning from the uppermost part of the scheme, every user has to contribute labor until the lower–most canal that serves for a common use. Therefore, beneficiaries in every group should come out and clean up the canal. But when we come to the actual case, the head–enders usually flee maintenance work once the head- end part has been done. The rest of the work is up to the tail-enders.

4.6. Water Rights

The issue of water rights and water quotas as a mechanism for allocation and accountability assume the importance of decreasing scarcity and conflict among communities and individual users. Unfortunately, Ethiopia does not have any explicit legal framework for irrigation use water rights. Individual rights to irrigation water is recognized only indirectly through land rights. Hence, a farmer who has land near the irrigation water can have a right to use the irrigation water.

4.7. Legal Framework

Formal and informal institutions are closely linked and greatly depend on each other. In both study areas, for many years, there have been a variety of locally managed water related institutions in traditional river diversions and spring water use. These institutions

[21] *The tail and head-enders are identified by beneficiary farmers.*

are in the form of informal customs and conventions for water sharing as well as community–based organizations for water management. These institutions had remained largely independent of formal water institutions and had operated only at the periphery of the formal water sector. However, the present government of Ethiopia gives special attention and makes an effort to create a link between the informal and formal institution arrangements, with the understanding that informal customs and conventions can still provide very valuable insights for designing institutional mechanisms that are needed for filling the organizational vacuum existing at grassroot level of water management.

Before the construction of modern schemes in both woredas, the community has long experience of using rivers and spring water for irrigation purposes. For example in Atsbi river Chuhet (in Hayleom *tabia*), Kimber spring water (in Zarema *tabia*) and Samera river (in Ruba Felg) are some of rives and spring water uses which have been there for many years. In Ada'a also Hidi river, Wedecha and Belebla spring water have been used for long without much knowledge of how to use the water effectively and how much benefit they would accrue using irrigation water. It is a recent phenomenon that farmers in both woredas have begun to cultivate cash crops such as onion, cabbage and tomato.

For irrigation water management the beneficiaries collectively prepare and agree on a set of rules of restricted access to water and make arrangements of water for their plots. It is the executive committee, water distributor and group leaders who are in charge of enforcing the use of restricted rules and regulations.

Concerning the existence of formal written rules, 89% of *Gujeles* in Atsbi have formal written rules. The figure is even higher in Ada'a, i.e., 97% of *Geres* have written rules. These rules and regulations for operation and water management were formulated by the irrigation water beneficiaries in collaboration with the woreda agricultural offices. These arrangements were written, but documented only at the woreda agricultural offices. Neither water users nor WUC have the written document of the rules. They run the operation simply as a commonly understood convention and recall punishment rates as they want.

4.7.1.The Written By-Laws in Atsbi

In Atsbi, in all the irrigation schemes the components of the by-laws are the same, except the penalty system part. It varies scheme to scheme, depending on discussions in the general assembly of beneficiary farmers at the beginning of each year.

The formulated written by-law constitutes three parts.

(i) *Rules and Regulations*- in this section the whole obligations of beneficiary farmers are stated (see annex 1).

(ii) The second section explains the rights beneficiary farmers have as a member of WUA and;

(iii) The third part and the more detailed section is the penalty system for not abiding by the rules and regulations (see annex 1).

A very interesting observation in Atsbi is that the rules and regulations have been revised many times, since the beginning of the establishment of the association. This has implication on management and utilization of the resource

4.7.2. The Written By-Laws in Ada'a

In Ada'a the presentation of the written rules and regulations is a bit different from Atsbi. It was also observed that in all schemes the by-laws are the same. The by-laws are divided into seven articles:-

Article 1- states the name of the Water Users Association (WUA),

Article 2- identifies the address of the association,

Article 3–states when it was established and the aims, objectives and vision of the association,

Article 4- duties, responsibilities and obligations of member beneficiaries

Article 5 &6- explains about the rights and obligations members have as a beneficiary of irrigation water user. It also includes duties and responsibilities of the executive committee. Finally, article 7 states how often members and WUC should meet.

However, the realty is far from this, according to discussions with the executive committee in Ada'a, attendance to the WUA meetings is far less than expected. In addition, the level of obedience to the WUAs by-laws is low. It was noticed that in Ada'a the WUA was established in each scheme in 2000. Since then, the document is put in the agriculture office of the woreda and there was not even a single revised article of regulation. In addition, less observance of laws and regulation was noticed among irrigation water users.

The most frequent violation of use restrictions of irrigation water is stealing of water (using water without turn), inappropriate usage of water (over irrigating own plot and the nearby irrigated fields), infrastructure damage caused by livestock, not attending and being late in meetings. The mean variation in number of times for violation of rules and regulations among beneficiaries in these two woredas is very high. It occurred nearly an average of 13 number of times per group in Atsbi and 26 number of times per group in Ada'a in year 2006/07. Similarly, the mean number of times conflict occurred in 2006/07 cropping season due to irrigation water related issues was 19 times in Ada'a per group and 10 times per group in Atsbi.

Irrigation schemes in Ada'a are protected in almost all cases by an average of 3 guards, 96% of which are paid their salary in cash. The WUC collect money annually and pay an average of 207 *Birr* for a guard per month. These guards in average give services for 8 months. However, guards at Wedecha and Belebla dam protect the dams all year round. Fourty one percent of the schemes in Ada'a have water distributor in which only 5 months[22] of a year he monitors the water distribution system in a scheme.

However, in Atsbi, there is guard to protect the scheme in only 19% of the cases. It is the beneficiaries themselves who protect the irrigation sites turn by turn. In cases where

[22] *The water distributor monitors the water distribution during the irrigation scheme is under operation (only 5 months a year).*

guards are in charge of protecting schemes, average monthly payment is 52 *Birr* per guard. On the contrary, in all the cases, there are *Abo Mais* in Atsbi with a mean of 416 *Birr* payment from the beneficiaries for giving 8 months of service in a year.

4.8. Conflict Resolution Mechanisms

Formal and informal institutions interact appreciably in conflict resolution at the local level in both study areas. Most disputes on the water use are resolved informally at the lower levels before they erupt into serious conflicts. There are 4 identified ways of considering both informal–formal conflict resolution mechanisms as mentioned below:

- One to one level between the victims: both parties speak out and agree on resolving the conflict;
- At block or group level: this is a semi-formal, since block or group leaders are elected among water users. Normally the group leader is well respected person for both parties and can give more trustful and appreciable judgment;
- Scheme level : water distributor and the executive committee will involve in the conflict resolution mechanism when the above solutions have failed and;
- *Tabia* administration and the community court: the water users committee refers conflict management cases beyond its capacity to the *tabia* administration and the community court. The community court which is responsible for managing almost every type of conflict in the community is said to be supporting the water committee with resolution of high level conflicts over water use. However, according to scheme level focus group discussion results, irrigation water

beneficiaries and the executive committee complain that the community court is so busy and slow in deliberating and delivering solutions immediately.

Generally, water users prefer informal routes over formal ones (*tabia* level court system). This is because of the existence of a greater sense of identity and hope for justice than they would experience in the courts of formal law where decisions are based on ‘I loose-you-win’ or ‘I win-you-loose’ principles. Such parallel forums provide an effective conflict resolution institution for managing water conflicts at a lesser cost.

Due to scarcity of water and other relevant reasons, conflict may arise among irrigation water users which may be the cause of sever injury. According to results from focus group discussions, in these two woredas the number of conflict occurrence increases from year to year because of two possible reasons. The first one is eventually, the volume of irrigation water decreases due to decreasing trend of rainfall in the areas. The second one is, through time farmers have begun to realize the benefits of using irrigation water. Therefore, every year the command area becomes wider.

4.9. Unresolved Conflicts

Pre-feasibility and feasibility study is needed when investment is made on a long-term common property resource. Otherwise, the results will be disappointing, which leads to frequent occurrence of conflicts among different interest groups. Debre Selam micro-dam which is located in Ruba Felg *tabia* and Wedecha- dam which is found at the boarder of Sendafa and Gimbichu woredas, are the two best examples, which causes the displacement of many households to other places and end up with frequent conflict occurrences.

4.9.1 The Land of Controversies -Ruba Felg

Ruba Felg means the land of rivers and spring water in the local language Tigrigna. It was World Vision which took the lead to construct the dam in Debre Selam in 1993-94. The goal was to reduce poverty through increasing the production and productivity of farmers through irrigation water use. The farmers express their appreciation through participating in labor during the construction of the dam. As one of the farmers explained, "We were all happy. Even other farmers who lived in other *tabias* also came to participate during the construction. We hoped the better for tomorrow but the result is very disappointing as you can see it, for a number of years the dam has been unfunctional, we cannot use the water. Every time we try to use it, conflict arises. We loss a big benefit every year." It is right. It has been nine years since farmers have not used the irrigation water in Debre Selam.

After the construction of the dam had been finished, World Vision handed the micro-dam to the community. After using it for only two years the canals began to crack and there was high amount of seepage. Therefore, Co-SAERT (Commission for Sustainable Agriculture and Environmental Rehabilitation for Tigray) came to maintain the canals in 1997. After 1998, conflict has occurred between displaced grazing land owners and the current irrigation water users.

Here is the whole story of the conflict. Totally, there are four *Kushets*[23] in Ruba-Felg *tabia*, namely Hineto, Afenjow, Agew and Debre Selam. The dam is found in Hineto *Kushet* on 3ha of land but the beneficiaries are from Agew and Debre- Selam *Kushet*s. On the 3ha of land, there were people who used to have resident houses (10 in number), plots of land and grazing lands (37 in number). People who had resident houses and plot of land got compensation for their losses. However, individuals who had grazing land were left with nothing. It is this problem which caused almost a decade of conflict.

The dam has an irrigation potential of 70ha of land in the two *Kushets*; namely Agew (consists of 138 households) and Debre-Selam (116 households). The rationale solution for this problem is, as the benefit goes to these two *Kushets*, the cost also should go to both of them. Unfortunately, people who live in Agew (in Samera *Goth*[24]) already gave their land for construction of health and development post. Thus, they do not volunteer to give additional piece of land for another public purpose, since the development and health post give services for the whole dwellers of that *tabia*. However, the farmers at Debere Selam are very willing to give up some piece of land to those former grazing land owners, but the land is not fertile for grazing purposes.

There is also additional situation which aggravates the problem. The present *Kushets* in Ruba Felg *tabia* were previously part of two different *tabias*, namely Agewo and Debre Selam. Agewo consisted of three *Kushets*: Samera, Agewo and Aserti. On the other hand, Debre Selam included: Hineto, Debre Selam, Afenjow and Tsquaf *Kushets*. But, now

[23] *Kushets means villages in the local language of Tigrigna*
[24] *Goth is a sub-division of village*

Ruba Felg constitutes some *Kushets* from Agewo and some *Kushets* from Debre Selam. However, during the construction period the agreement was the compensation would be on the lands of Debre Selam *tabia*. But just after the construction of the dam, the *tabias* were restructured. The basic question was raised, ‘who will bear all the costs?’

Conflict Resolution Mechanism:- As many parts of Ethiopia, for centuries as the mechanism for resolving conflicts at the micro–level, there are traditional and informal village level institutions in Atsbi .

From both *Kushets,* the people elected 3 elders from Debre Selam and 3 from Agewo (Samera *Goth*). These elders are influential, widely respected and are expected to serve the community genuinely and are opinion leaders. It is expected that these respected elders will come up with optimal solution for all the concerned parties.

However, for the time being, there are four guards who protect the dam and its whole structure from any external attack. These guards are paid 90 quintals of wheat from food-for-work programme. The former grazing land owners attempted to break the main regulator and spill way three times. It was World Vision which covered the maintenance expenses with 22,000 *Birr* each time.

4.9.2. The case in Ada’a - There is also similar case in Ada’a. The place where the Wedecha dam was constructed is between the woredas of Sendafa and Gembichu. However, the beneficiaries are farmers from Ada’a woreda. Farmers who live in these woredas had asked to use the water for irrigation many times, but they didn't receive any answer from a concerned authority. Just like the case in Ruba Felg, people from those woredas attempted to break the main regulator and the spill way for a number of times. This is the reason why there are three guards who protect the micro-dam in every season of the year, 24 hours a day without exceptions. Two of the guards are from Gimbichu woreda and one of them is from Sendafa. The farmers around the dam are allowed to water their cattle from the dam.

4.10. KEY FINDINGS AND IMPLICATIONS

In Atsbi, under 221.1 ha of land, there are 14 irrigation schemes used by 1855 beneficiary households, of which 402 (21.67%) are female and 1453 (78.3%) are male headed households. Currently, there are 5 micro-dams, 6 river diversions, 5 traditional river diversions, 3 spring water use, 1 communal shallow well and 2 communal ponds. On the other hand, in Ada'a, there are 4 modern and 2 traditional irrigation schemes from Wedecha- Belbela dam, with addition of one river diversion (Mojo river) and one natural lake use (Hora Kilole). The irrigation system has 960.6ha of land in its command area Out of 2,381 beneficiary farmers, 318 (13.4%) are female and 2059 (86.6%) are male-headed households.

The afore-mentioned irrigation schemes are common property resources with their own water users associations and water users committee (appointed by water users). Every beneficiary of irrigation water is a member of WUA in a particular scheme. WUA is local institution and has a basic character of authority and by-laws. In addition, there are a water distributor in each scheme and block leaders (*Gujele* and *Gere* leaders), which are 94 in Atsbi and 75 in Ada'a. Regional Water Resource Bureaux (Tigray for Atsbi and Oromiya for Ada'a) and the woreda agricultural office and the woreda water resource office have immense role in provision of technical support for beneficiary farmers. Other stakeholders like: World Vision, IPMS-ILRI, REST, Irish AID and World Bank in Atsbi; Ratson, IPMS-ILRI, Oromiya Rehabilitation Fund and Debre Zeit Agricultural Research Institute in Ada'a are the major non-governmental and governmental organizations which participate actively in introducing new technologies and in training provision of beneficiary farmers.

With regard to characteristics of community managed schemes, within 94 *gujeles* which are found in Atsbi, the smallest group has 4 household beneficiaries and the largest 280, with average number of households of 20.5. On the other hand, in Ada'a the maximum number of beneficiaries in a group is 297 and minimum 8. The average family size in the irrigation is nearly 6, with slightest variation among the woredas. About 30% and 50% of beneficiary farmers are literate in the irrigation sites of Atsbi and Ada'a, respectively. Besides, large proportion of households in the group have access to agriculture extension program in both study areas. Moreover, nearly 15% farm decision makers in Atsbi and 57% in Ada'a obtained credit from formal organization. The mean area irrigated land in a group is 2.71ha in Atsbi and 12.8 ha in Ada'a. The mean proportion of beneficiaries at the tail–end in a group is comparable among Atsbi and Ada'a, 0.31 and 0.27, respectively. When we look at the average years of experience of irrigation water use, it is 10 years for Atsbi and 13 years in Ada'a. In addition, the average number of times for provision of trainings in 2006/07 is twice in Ada'a and once in Atsbi.

Before the start of the irrigation season (dry season), water users in general assemble and negotiate on: when to clean the canals and decide the schedule of water distribution; in order to overcome provision and appropriation resource management problems. Water distributor is a person in charge of organizing the operation and distribution of irrigation water. Group leaders also control the irrigation water at turnout gates of lateral and sub-lateral canals. In both selected areas, rotational irrigation system is practiced. Farmers also claim to use crop-water requirement rates in plot level, even if the application is without consideration of soil type, crop type and stage of growth.

The other interesting information we found is, irrigated land in Atsbi is more densely populated than in Ada'a, which is 0.15 ha/household and 0.43ha /household, respectively. Moreover, there are three kinds of contributions for the resource management, that are in cash, kind and in labor form. The average value of contribution per household is comparable in both woredas, nearly 190 Birr in Atsbi and 206 Birr in Ada'a per year. Labor constitutes the dominant share, for maintaining and clearance of canals and minor construction.

In addition to this, beneficiaries collectively prepare and agree on a set of use rules for the irrigation water management, in their respective WUA, in order to have access to water and make arrangements of water for their plots. It is the executive committee, water distributor and the group leaders who are in charge of enforcement of these rules and regulations. Eighty nine percent of *Gujeles* in Atsbi have formal written rule. This figure is even higher in Ada'a, i.e., 97% of the *Geres* have their own written rules and regulations. Furthermore, violation of restricted rules and conflict among beneficiary farmers on water distribution issues are common phenomenon in the irrigation sites. The mean violation occurrence per group in 2006/07 is 13 and 26 number of times in Atsbi and Ada'a, respectively. Similarly, the average number of times conflict occurred in 2006/07 is 19 numbers of times per group in Ada'a and 10 times per group in Atsbi. Generally, as can be observed, even if there are water users associations and executive committees who are responsible for the restricted rules enforcement, there is a wide gap between the by-laws stated on papers and the actual realty of actions of beneficiaries. Thus, awareness raising programmes on the concepts of restricted rules and regulations and the importance of imposing and enforcing them should be provided extensively for further sustainable use of the resource. Besides, governmental intervention is needed to strengthen the water users associations in a number of dimensions.

In Ada'a the schemes are protected by guards in about 96% of the times. The payment is fully covered by beneficiary farmers' contribution for an average of 8 months of a year. However, in Atsbi, in 81% of the cases, the irrigation sites are protected by the community turn by turn. This suggests that the effect of social capital to manage the communal managed resources at less cost. In addition, all the schemes have water distributor (*Abo Mai*) in Atsbi who are paid a mean average monthly salary of 52 *Birr*.

The focus group discussion with beneficiary farmers showed that through time the frequency of conflict occurrence increases in the irrigation sites. There are two main reasons; the first one is over time the volume of the irrigation water decreases due to erratic nature of rainfall in the woredas. The second one is farmers have began to realize the benefit accrued from irrigation water use, therefore, every year the command area becomes wider. Thus, in the face of growing demands of irrigation water with declining water resource, relevant institutions need to exert further endeavor on the formulation of water policies that clearly stipulate specific water entitlements to irrigation water users.

Even if there are two kinds of conflict resolution mechanisms in both woredas (formal and informal systems), water users prefer the informal one. This is because of the existence of a greater sense of identity and hope for justices. Such parallel forms of conflict resolution methods provide effective conflict resolution institutions for managing water conflict at a lesser cost. Therefore, intervention should be made to strengthen the capacity of the informal system.

CHAPTER FIVE
PERFORMANCE EVALUATION OF IRRIGATION AGRICULTURE IN ATSBI AND ADA'A WOREDAS

5.1. Irrigated Agriculture

The introduction of irrigation has offered households the possibility of increasing the annual agricultural output. However, it has not replaced traditional rain-fed agriculture; rather, farm households use the irrigated production to supplement the rain-fed production. Having access to irrigated plots helps households to meet families' consumption requirements. The average plot sizes of irrigated fields (0.15ha/household in Atsbi and 0.45ha /household in Ada'a) are relatively small compared to rain-fed holdings, which are 0.5 ha/household and 1.75ha/household in size in Atsbi and in Ada'a, respectively.

The produce from the rain-fed are used mainly to meet the household's cereal needs. Most holders of irrigated plots use their income from the sale of high–value crops such as onion, tomatoes, potato, to purchase their other household requirements.

According to the result of focus group discussion with irrigation water beneficiary farmers, over the last years, productivity of rain-fed agriculture has considerably decreased due to sever soil degradation. As a result, the production of the rain-fed fields is seldom sufficient for meeting family consumption needs. Through time households depend more on the production from their irrigated fields, which enabled them to harvest twice in a year.

5.2. Cropping Pattern

As part of the institutional analysis of irrigation water management the study has employed a descriptive analysis to compare costs farmers incurred and benefits they accrued in communal managed irrigation schemes in year 2006/07. In order to increase the reliability of the data, all *tabias* with irrigation projects were included. Here, the crop types are classified into five categories; vegetables, fruits, pulses, spices and cereals.

Table 5.1 and Table 5.2 present the descriptive statistics for the size of land coverage of each crop in each *tabia* of the two woredas. In Atsbi a total of 220.675 ha of land was covered with different crops using irrigation water. The major types of crops were vegetables which covered 104.122 ha of land and accounted for 47%; pulses with 80.45 ha of land (36.46%). From vegetable crops category that had larger share were tomato, onion (cross-bred), cabbage, potato and swiss chard, accounting for 23.75ha (10.8%), 23.257ha (10.5%), 16.1ha (7.3%), 13.43ha (6.1%) and 9.45ha (4.3%), respectively. With respect to pulses, peas and faba beans covered the largest area of land, 41.9ha (19%) and 27.3ha (12.4%) of land, respectively. Moreover, almost 25ha (11%) of the irrigated land was covered with spices where fenugreek, green pepper, lin seed, *'azmud'* and *'camoon'* represented 17.3ha (7.8%), 4.8ha(2.2%), 3ha(1.36%), 0.125 ha (0.057%) and 0.05ha (0.02%) of land, respectively. Cereals took the smallest area as compared to other categories in the irrigated land of Atsbi which covered 10.25ha and accounted for 4.64%. This crop category type was only grown in Ruba Felg, Adi Mesanu, Hayelom and Hadnet *tabias*. Maize covered the widest cereal area which was 5.75ha of land (2.6%). Apple and banana were also grown using irrigation water although they covered a small piece of land only in Zarema *tabia*, on about 0.56ha (0.25%). Surprisingly, even though Endaminu irrigation scheme covered the largest area, 74.37ha, the most diversified[25] crop types were observed in Hadnet scheme on a total of 43.25ha of irrigated land.

On the other hand, in Ada'a woreda, the irrigation system had over 961.87ha of land. Vegetables, pulses, spices and others represented 629.55ha (65.45%), 299.27ha (31.1%), 28.55ha (2.968%) and 4.5ha (0.468%), respectively. Besides, in the vegetables category the two types of onion (cross-bred and local) had the lion share which took 193.15ha (20%) and 130.7ha (13.6%), followed by, tomato 75.75ha (7.9%), spinach 62.45ha (6.49%) and potato 60.15ha (6.25%). The second major crop category is pulse, in which chick pea, lentil and *'guaya'* took 171.22ha (17.8%), 102.55ha (10.7%) and 14.75ha (1.53%), respectively. Spices also covered 28.55ha of the irrigated land in the woreda, the main type being fenugreek 13.75ha (1.43%), green pepper 11ha (1.14%) and *'beso bela'* 3.8ha (0.395%) of land. Whereas, '*gesho*' accounted for 0.46% (4.5 ha) of the irrigated land.

Unexpectedly, fruits were not observed in the irrigation sites of Ada'a at all. Although, Godino PA had the widest irrigation scheme in the woreda, it was Hidi PA that has diversified crop types.

[25] *Crop diversification was measured in the number of types of crops grown using irrigation water in that specific tabia during the study period.*

5.1. Area Coverage of Each Type of Crop in hectare– Atsbi

Crop type	Golgol Nael	Felg Woini	Ruba Felg	Adi Mesanu	Zarema	Haylom	Haressaw	Hadnet	Total
Onion (cross-bred)	0.5*1(1.9%)*2	1.3(12.1%)	0.625(5.8%)	0.32(2.8%)	0.25(5.88%)	17.25(23%)	2.75(6.4%)	0.262(1%)	23.257((10.5%))*3
Onion (local)	0	1.06(9.8%)	0	0.5(4.4%)	0	0	1.2(2.8%)	0.225(.9%)	2.985((35%)
Garlic	0.25(.6%)	0.4(4%)	0	0.5(4.4%)	0	1.03(1.4%)	0.55(1.3%)	0.1625(.68%)	2.8925((1.3%))
Tomato	0.25(.6%)	0.3(2.89%	0.5(4.65%)	2.25(19.6%)	0.25(5.88%)	19.45(26.2%)	0	0.75(3.1%)	23.75(10.8%))
Potato	0.5(1.22%)	0.9(8.67%)	0.5(6.65%)	1.5(13%)	1(23.5%)	8.85(11.9%)	0	0.1625(.68%)	13.43((6.1%))
Carrot	0.5(1.236%)	0	0.625(5.8%)	0.05(.4%)	0.0625(1.5%)	1.1625(1.6%)	0.25(.58%)	0.75(3.1%)	3.3998 ((1.5%))
Beet root	0	0	0	0.125(1.1%)	0	1.03(1.4%)	0	1(4.2%)	2.155((.98%))
Cabbage	3(7.15%)	0.2(2.02%)	0.5(4.65%)	1.75(15.3%)	0.5(11.8%)	5.15(6.9%)	4(9.2%)	1(4.2%)	16.1((7.3%))
Swiss chard	0	0.2(2.02%)	0	0.25(2.2%)	0	6.5(8.7%)	0.75(1.7%)	1.75(7.3%)	9.45((4.3%))
Lettuce	0.25(.6%)	0.25(2.3%)	0	0.05(.4%)	0.125(2.9%)	1.025(1.4%)	5(11.56%)	0	6.7((3%))
									104.122(47%)
Apple	0	0	0	0	0.28(6.6%)	0	0	0	0.28((.13%))
Banana	0	0	0	0	0.28(6.6%)	0	0	0	0.28((.13%))
									.56(.25%)
Field peas	10.25(24.4%)	2.9(27.2%)	3.5(32.6%)	0.25(2.2%)	0	0	18(41.6%)	7(29.2%)	41.9((19%))
Faba beans	8(19.07%)	2.8(26%)	2.5(23.3%	1.25(10.9%)	1.25(29.4%)	0	8.75(20.2%)	2.75(11.5%)	27.3((12.4%))
Lentil	6(14.3%)	0	0	0.75(6.5%)	0	0	1.25(2.9%)	1.625(6.8%)	9.625((4.4%))
Chick pea	0	0	0	0	0	0	0	1.625(6.8%)	1.625((.74%))
									80.45(36.46%)
Green pepper	0	0	0	0	0	4.8(6.5%)	0	0	4.8((2.2%))
Fengreek	10.45(24.9%)	0.3(2.89%)	0.75(7%)	1.5(13.1%)	0.125(3%)	2.5(3.36%)	0.75(1.7%)	0.925(3.9%)	17.3((7.8%))
Lin seed	2(4.77%)	0	0.25(2.3%)	0	0	0	0	0.75(3.1%)	3((1.36%))
'Camoon'	0	0	0	0.05(.4%)	0	0	0	0	0.05((.02%))
'Azmud'	0	0	0	0	0.125(3%)	0	0	0	0.125((.057%))
									25.275(11.45%)
Barley	0	0	0.5(4.65%)	0	0	0	0	1.25(5.2%)	1.75((.79%))
Wheat	0	0	0.5(4.65%)	0.125(1.1%)	0	0.125(.17%)	0	1(4.2%)	1.75((.79%))
Maize	0	0	0	0.25(2.2%)	0	5.5(7.4%)	0	0	5.75((2.6%))
Millet	0	0	0	0		0	0	1(4.2%)	1((.453%))
									10.25(4,64%)
Total	**41.95(100%)**	**10.812(100%)**	**10.75(100%)**	**11.47 (100%)**	**4.24(100%)**	**74.37(100%)**	**43.25 (100%)**	**43.25(100%)**	**220.657(100%)**

*1- The numbers out of the bracket show total land covered by that specific crop type (in ha) of crop.

(.)*2- The percentage land size coverage of the crop as compared to other crops coverage which were grown using irrigation water in that specific *tabia.,*

((.))*3- The percentage land size coverage of the crop as compared to the total crop coverage irrigated land.

Table 5.2. Area Coverage of Each Type of Crop in hectare– Ada'a

Crop type	Hidi	Ganda Gorba	Fultinao	Godino	Kataba	Total
Onion (cross-bred)	45*1(15.7%)*2	1.25(6.33%)	4.5(5.8%)	100.15(25.07%)	42.25(23.6%)	193.15 ((20%))*3
Onion (local)	29.25(1.2%)	1.5(7.59%)	0.75(.968%)	84.2(21.08%)	15 (8.38%)	130.7 ((13.6%))
Onion(Barro)	5.75(2%)	0	1.5(1.935%)	7(1.75%)	0	14.25 ((1.48%))
Garlic	15.75(5.5%)	0	0.75(.968%)	2(.5%)	9.5(5.3%)	28((2.9%))
Tomato	44.75(15.6%)	2.5(12.66%)	22(28.39%)	4(1%)	2.5(1.397%)	75.7 ((7.875%))
Potato	10(3.49%)	0	1.25(1.61%)	43.4(10.86%)	5.5(3.07%)	60.15((6.25%))
Carrot	1.75(.611%)	1.625(8.2%)	0	1.5(.376%)	4.5(2.515%)	9.375((0.97%))
Beet root	4.75(1.66%)	1.625(8.2%)	0	3.2(.8%)	3.5(1.956%)	13.075((1.36%))
Sweet potato	0	0	3(3.87%)	3(.75%)	0	6((0.624%))
Cabbage	2(.699%)	0	4.5(5.8%)	4.8(1.2%)	3.5(1.956%)	14.8((1.54%))
Spinach	18.5(6.46%)	0	0.75(.968%)	43.2(10.8%)	0	62.45((6.49%))
Swiss chard	3.25(1.1%)	0	2(2.58%)	4(1%)	2(1.118%)	11.25((1.17%))
Lettuce	4.25(1.48%)	0	1.5(1.9%)	2.6(.65%)	1.25(.699%)	9.6(0(.998%))
Kiyar'	0	0	1(1.29%)	0	0	1((0.10%))
						629.55(65.45%)
Lentil	27.75(9.7%)	1.5(7.59%)	5.5(7.097%)	33.8(8.46%)	34(19%)	102.55((10.7%))
Chick pea	50(17.47%)	4(20.25%)	24(30.97%)	61.6(15.42%)	31.62(17.7%)	171.22((17.8%))
Sunflower	0	0	0	0	7.5(4.19%)	7.5((0.78%))
Guaya'	5.25(1.8%)	2.5(12.658%)	2.75(3.55%)	0	4.25(2.375%)	14.75((1.53%))
Haricot beans	0	0	0	0	3.25(1.82%)	3.25((0.34%))
						299.27(31.1%)
Green pepper	7(2.4%)	1.25(6.3%)	0.5(.645%)	0	2.25(1.26%)	11((1.14%))
Fengreek	6.25(2.18%)	1.25(6.3%)	0	0	6.25(3.493%)	13.75((1.43%))
'Beso bela'	1(.349%)	0.25(1.266%)	1.25(1.61%)	1(.25%)	0.3(.168%)	3.8((.395%))
						28.55(2.968%)
Gesho'	4(1.4%)	0.5(2.53%)	0	0	0	**4.5((.468%))**
Total	**286.25(100%)**	**19.75(100%)**	**77.5(100%)**	**399.45(100%)**	**178.92(100%)**	**961.87(100%)**

*1- The numbers out of the bracket show total land covered by that specific crop type (in ha) of crop

(.)*2- The percentage land size coverage of the crop as compared to other crops coverage which were grown using irrigation water in that specific *Kebele*

((.))*3- The percentage land size coverage of the crop as compared to the total crop coverage irrigated land.

An interesting result that was obtained from focus group discussions with beneficiary farmers in the two study areas is that farmers have started to grow crops which were not previously grown in the areas. Besides, the result of discussions indicated initially, most farm households had concentrated on specific crops; however, eventually the types of crops also have increased in number and in the area coverage.

5.3. Input Use Decision of Beneficiary Farmers for Each Crop Type

Table 5.3 and Table 5.4 present the descriptive statistics of beneficiary farmers input use decision for each crop type, i.e., fertilizer, compost/manure, herbicides, pesticides and seeds use, labor (man power) and oxen power usage in each *tabia*. In both study woredas, for all kinds of crops grown, fertilizers were used in all irrigation schemes except for '*guaya*' and chick pea (in Ada'a). However, fertilizer was used more evenly in Ada'a than Atsbi. In Ada'a the mean amount of fertilizer use (kg/ha) was equal in almost all cases of crop types. Hence, in Atsbi, in some *tabias* farmers did not use fertilizer at all.

In relation to the use of commercial fertilizer, over a total cost of 167,431 *Birr* and 527,549 *Birr* was paid out for UREA and DAP in Atsbi and Ada'a, respectively. The average amount of fertilizer use per hectare was 217.18kg/ha in Atsbi and 242.9kg/ha Ada'a, but differed according to the types of crops grown. The highest amount was for tomato, 400kg/ha in both woredas.

Another important information that can be depicted from Table 5.3 and Table 5.4 is beneficiaries in Atsbi used higher amount of compost/manure indicating effort farmers made to supplement the modern fertilizer to manure/ compost. Furthermore, we find that, there was no usage of herbicides and pesticides at all in the irrigation sites of Atsbi during 2006/07 cropping season. However, in Ada'a, especially for onion (cross-bred), onion (local), carrot, beet root and lentil, herbicide was applied. Moreover, pesticides like Ridomingold, Karate, Selekrom and Tighnks were used. The highest amount of pesticides was used for lentil, 8 liters/ha of Tighnks and Karate, followed by chick pea (6 liter/ha), swiss chard and lettuce (4 liter/ha) and cabbage (3 liter/ha). In terms of the value of herbicides and pesticides, the total estimated cost was around 165,414 *Birr* and 485,622 *Birr*, respectively.

The other most important input was seed. Average amount of seed used per hectare varied by crop type grown. There was variation among the two study areas as well. For instance, the mean amount of seed used per hectare for onion (local) is 2600kg/ ha in Ada'a, however, it was 1200kg/ha in Atsbi. Besides, for lentil, it was 211.2kg/ha in Ada'a but 327.5 kg/ha in Atsbi. The same was true for green pepper, the average amount of seed used per hectare was 0.5kg/ha in Ada'a, in the contrary, in Atsbi, it was 3.5 kg/ha. In addition, the approximated value of seed used in the irrigation schemes in Atsbi and Ada'a was 222,351 *Birr* and 1,758,957 *Birr*, respectively.

Table 5.3.Use of fertilizer, compost/manure, herbicides, pesticides and seeds in Atsbi Wemberta woreda in year 2006/07

	Fertilizer use			Compost use			Herbicide use			Pesticide use			Seed			
Crop type	Mean amount (kg/ha)	Value Birr/kg	**Total value used@**	Mean amount (kg/ha)	Value Birr/kg	**Total value used@**	Mean amount (liter/ha)	Value Birr/lit	**Total value used@**	Mean amount (liter/ha)	Value Birr/lit	**Total value used@**	Mean amount (kg/ha)	Value Birr/kg	**Total value used@**	**Total cost[2]**
Onion (cross-bred)	391	3.5	**31,389**	229	0.4	**2130**	0	0	**0**	0	0	**0**	3.1	254.4	**18110**	**51,629**
Onion (local)	380	3.5	**3305**	180	0.4	**215**	0	0	**0**	0		**0**	1200	3.2	**12128**	**15,648**
Garlic	350	3.5	**2934**	293	0.4	**161.98**	0	0	**0**	0	0	**0**	400	7	**8204**	**11300**
Tomato	400	3.5	**30,100**	110	0.4	**1045**	0	0	**0**	0	0	**0**	0.51	484	**3060**	**35,155**
Potato	210	3.5	**8769**	179	0.4	**590**	0	0	**0**	0	0	**0**	1500	4	**62543**	**74,422**
Carrot	150	3.5	**1754**	200	0.4	**320**	0	0	**0**	0	0	**0**	4	160.9	**2216.2**	**4,290**
Beet root	250	3.5	**1776**	333	0.4	**287**	0	0	**0**	0	0	**0**	2.67	160	**875**	**2938**
Cabbage	218.57	3.5	**10,978**	302	0.4	**1944**	0	0	**0**	0	0	**0**	0.4	200	**1280**	**14,202**
Swiss chard	133.3	3.5	**4292**	172	0.4	**650**	0	0	**0**	0	0	**0**	8	399	**21010**	**25,952**
Lettuce	150	3.5	**3491**	200	0.4	**536**	0	0	**0**	0	0	**0**	1.44	230	**2759.7**	**6,789**
Field peas	255	3.5	**36,593**	110	0.4	**1843**	0	0	**0**	0	0	**0**	185	4	**33230**	**71,667**
Faba Beans	160	3.5	**14,560**	102.5	0.4	**1119**	0	0	**0**	0	0	**0**	198.3	3.83	**20256**	**35,935**
Lentil	175	3.5	**5512**	250	0.4	**962**	0	0	**0**	0	0	**0**	327.5	10.75	**31406**	**37,880**
Chick pea	200	3.5	**1137**	200	0.4	**130**	0	0	**0**	0	0	**0**	100	3.2	**528**	**1,795**
Green pepper	150	3.5	**2520**	400	0.4	**768**	0	0	**0**	0	0	**0**	3.5	2.1	**33**	**3321**
Fenugreek	43	3.5	**4515**	393	0.4	**2768**	0	0	**0**	0	0	**0**	0.5	10	**87**	**7370**
Lin seed	300	3.5	**131.25**	0	0	**0**	0	0	**0**	0	0	**0**	1.67	16	**62**	**193**
Barley	200	3.5	**1225**	110	0.4	**77**	0	0	**0**	0	0	**0**	50.5	18.9	**1339.6**	**2642**
Wheat	175	3.5	**918.75**	100	0.4	**70**	0	0	**0**	0	0	**0**	150	8.25	**959**	**1948**
Maize	225	3.5	**1181.2**	132.5	0.4	**304**	0	0	**0**	0	0	**0**	150	2	**2025**	**3510**
Millet	100	3.5	**350**	50	0.4	**20**	0	0	**0**	0	0	**0**	120	2	**240**	**610**
Total			**167,431**			**20,340**			**0**			**0**			**222351**	**410,123**

@ - Total value used is equal to mean amount (kg/ha) used * value (Birr/kg)* total area covered by that specific crop type (ha) in year 2006/07.

- **Total cost[2] refers to total cost used to Fertilizer+ Compost+ Herbicide+ Pesticide+ Seed in year 2006/07**

Table 5.4.Use of fertilizer, compost/manure, herbicides, pesticides and seeds in Ada'a woreda during 2006 cropping season

Crop type	Fertilizer use			Compost use			Herbicide use			Pesticide use			Seed			Total cost [2]
	Mean amount (kg/ha)	Value Birr/kg	Total value used@	Mean amount (kg/ha)	Value Birr/ha	Total value used@	Mean amount (kg/ha)	Value Birr/ha	Total value used@	Mean amount (kg/ha)	Value Birr/ha	Total value used@	Mean amount (kg/ha)	Value Birr/ha	Total value used@	
Onion (cross-bred)	390	3.51	**18001**	0	0	**0**	4	80	**4208**	1.5	130	**2564**	3.8	253.6	**42250**	**67023**
Onion (local)	380	3.51	**174321**	0	0	**0**	4	80	**41824**	1.25	115	**18788**	2600	1.55	**121681.2**	**356614**
Onion(Barro)	367	3.51	**18356**	0	0	**0**	4	80	**4560**	0.5	156	**1112**	2	160	**4480**	**28508**
Garlic	200	3.51	**19656**	0	0	**0**	0	0	**0**	1.5	130	**5460**	400	10	**1120000**	**1145116**
Tomato	400	3.51	**106353**	0	0	**0**	4	80	**24240**	1.4	76	**8060**	5	80	**7497.5**	**146150**
Potato	250	3.51	**52781**	0	0	**0**	4	44	**10586**	2	52	**6256**	1500	3.75	**237900**	**307523**
Carrot	200	3.51	**6581**	0	0	**0**	5	80	**3750**	0.5	70	**328**	4	160	**6440**	**17099**
Beet root	200	3.51	**9178**	0	0	**0**	5	80	**5230**	1.5	130	**2550**	3.75	160	**7608**	**24566**
Sweet potato	350	3.51	**7371**	0	0	**0**	4	80	**1920**	2	70	**840**	1500	4	**36000**	**46131**
Cabbage	200	3.51	**10389**	0	0	**0**	0	0	**0**	3	70	**3108**	0.4	180	**2781**	**16278**
Spinach	200	3.51	**43840**	0	0	**0**	0	0	**0**	3	70	**13114**	1.67	15	**688**	**57642**
Swiss chard	200	3.51	**7897**	0	0	**0**	0	0	**0**	4	70	**3150**	9	399	**40399**	**51446**
Lettuce	200	3.51	**6739**	0	0	**0**	0	0	**0**	4	70	**2688**	0.28	230	**618**	**10046**
Lentil	100	3.51	**35995**	0	0	**0**	4	60	**28004**	6	120	**311448**	211.2	4.4	**60722**	**436169**
Chick pea	0	0	**0**	0	0	**0**	4	60	**41092**	8	77.5	**106156**	105.6	4.24	**68130**	**215378**
Guaya'	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	20	3	**1425**	**1425**
Green pepper	200	3.51	**7722**	0	0	**0**	0	0	**0**	0	0	**0**	0.8	12	**132**	**7854**
Fenugreek	50	3.51	**2369**	0	0	**0**	0	0	**0**	0	0	**0**	0.5	10	**63**	**2432**
Total			**527,549**			**0**			**165,414**			**485,622**			**1,758,814**	**2,937,400**

@ - **Total value used is equal to mean amount (kg/ha) used * value (Birr/kg)* total area covered by that specific crop type (ha) in year 2006/07.**

- **Total cost [2] refers to total cost used to Fertilizer+ Compost+ Herbicide+ Pesticide+ Seed in year 2006/07**

5.4. Labor Use in the Irrigation Sites

The total labor usage for the two study woredas is shown in Table 5.5 and Table 5.6. In this case, family, hired, sharecropping and exchange with relatives and neighbors were included in the labor usage in irrigation schemes. Labor was used for in five different activities: land preparation and planting, weeding and cultivation, watering, harvesting and threshing. In year 2006/07, the average labor person-days used by the households in the irrigation sites in Atsbi was around 98 person-days/ha and around 86 person-days/ha in Ada'a. This figure is much higher than the case of rain-fed agriculture with average 55 person-days/ha and 53 person-days/ha, in Atsbi and Ada'a, respectively. This result is consistent with the argument that irrigation agriculture demands higher labor, implying higher cost of production for the beneficiary farmers.

The highest labor person-day was needed for vegetable crop category in both woredas. In Atsbi, the highest of all was for tomato which needed around 136 labor person-days/ha, followed by onion (cross-bred and local) and carrot-around (120 person-days/ha), swiss chard and lettuce- (around 118 person-days/ha) and faba beans- (around 108 person-days/ha). Similarly, in Ada'a tomato was the major crop which demanded the highest labor person-days, (around 124 persons-days/ha), followed by onion (cross-bred and local), onion (*barro)* and garlic – (around 118 person-days/ ha).

Furthermore, the average labor person-days for land preparation and planting of crops was estimated 20 labor person-days/ha in Ada'a, whereas, in Atsbi, it was lower, around 18 person-days/ha. On the contrary, the mean manpower input for weeding and cultivation was lower in Ada'a (32 person-days/ha) compared to Atsbi which was 36 person-days/ha. Perhaps, this is due to complete absence of herbicides usage in the irrigation *tabias* of Atsbi in year 2006/07.

Another important result that can be observed from Table 5.5 and Table 5.6 is the labor usage for watering of crops. There is higher variation of person-days/ha for watering among irrigation water beneficiary farmers among the two woredas, 28 person-days/ha in Ada'a, whereas, it was 35 person-days/ha in Atsbi. Similarly, farmers in Atsbi had slightly higher labor usage in harvesting which was 7.3 person-days/ha as compared to 6.7 person-days/ha in Ada'a.

Most of the crops which are grown using irrigation water do not involve threshing. However, pulses and cereals such as field peas, faba beans, lentil, fenugreek, lin seed, maize and wheat demand man power as an input for threshing. The average labor person-day for threshing in both the woredas was 4 person-days/ha.

Table 5.5.Labor inputs used in the production-Atsbi Wemberta

ATSBI	Type of labor power used in farming using irrigation water																				
	Labor (family+hired+share cropping+exchange)															Animal power					
	Land preparation and planting			Weeding and cultivation			Watering			Harvesting			Threshing			Oxen power used			Mean person-days/ha	Total person-days/ha	Total value(Man power) [4]
Crop type	No. [1]	Value [2]	Total [3]	No.	Value	Total	No.	Value	Total	No.	Value	Total	No.	Value	Total	No.	Value	Total			
Onion (cross-bred)	24	14	**7812.3**	48	14	**15625**	44	14	**14326**	2	18	**837.04**	0	0	**0**	16	120	**44653**	**33.6667**	**118**	38600.34
Onion (local)	24	14	**1003**	48	16	**2292.5**	44	14	**1838.8**	2	15.1	**90.296**	0	0	**0**	16	120	**5731**	**33.6667**	**118**	5224.596
Garlic	24	14.8	**1029.5**	36	14.2	**1475.5**	48	14	**1943**	2	16.5	**95.453**	0	0	**0**	16	120	**5553**	**24.6667**	**110**	4543.453
Tomato	22	15.5	**8098.8**	50	15.3	**18169**	52	14	**17290**	12	16.7	**4759.5**	0	0	**0**	16	120	**45600**	**43.1667**	**136**	48317.3
Potato	22	14.1	**4177.8**	42	15.3	**8624.5**	24	14	**4512**	8	16.7	**1794.2**	0	0	**0**	16	120	**25785**	**33.8333**	**96**	19108.5
Carrot	24	14	**1142.3**	40	15	**2039.9**	50	14	**2798**	8	16	**435.17**	0	0	**0**	16	120	**7676**	**33.3333**	**122**	6415.37
Beet root	24	12.3	**636.16**	30	14	**905.1**	27	14	**814.59**	8	14	**241.36**	0	0	**0**	16	120	**4137**	**23.3333**	**89**	2597.21
Cabbage	24	14	**5409.6**	35	14	**7889**	30	14	**6762**	4	17	**1094.8**	0	0	**0**	16	120	**30912**	**29.6667**	**93**	21155.4
Swiss chard	24	13.2	**2993.8**	42	14	**5556.6**	40	14	**5292**	12	15.2	**1723.7**	0	0	**0**	16	120	**18144**	**27.6667**	**118**	15566.1
Lettuce	24	15.3	**2460.2**	42	23	**6472.2**	40	14	**3752**	12	21.4	**1720.6**	0	0	**0**	16	120	**12864**	**28.6667**	**118**	14405
Field peas	12	14	**7039.2**	32	14	**18771**	12	14	**7039**	8	15.7	**5252.6**	8	15.7	**5252.6**	24	120	**120672**	**20.6667**	**84**	43354.4
Faba Beans	12	13.5	**4422.6**	32	14.3	**12492**	12	14	**5241**	8	16	**3494.4**	8	16	**3494.4**	24	120	**78624**	**25.3333**	**108**	29144.4
Lentil	12	13.5	**1559.3**	32	15.7	**4826.4**	16	14	**2156**	8	15.5	**1193.5**	8	14	**1078**	24	120	**27720**	**28**	**96**	10813.2
Chick pea	12	15	**292.5**	32	15	**780**	24	14	**546**	8	11	**143**	8	11	**143**	24	120	**4680**	**27.3333**	**84**	1904.5
Green pepper	12	15	**864**	32	15	**2304**	32	14	**2150**	4	15	**288**	0	15	**0**	12	120	**6912**	**24**	**80**	5606
Fenugreek	12	13	**2698.8**	28	14	**6781.6**	16	14	**3875**	8	17	**2352.8**	4	17	**1176.4**	16	120	**33216**	**24.1667**	**68**	16884.6
Lin seed	12	14	**504**	32	14	**1344**	12	14	**504**	8	15.7	**376.08**	4	15.7	**188.04**	2	120	**720**	**33**	**88**	2916.12
Barley	12	10	**210**	30	12.5	**656.25**	12	14	**294**	8	12.5	**175**	4	11	**77**	24	120	**5040**	**31.5**	**86**	1412.25
Wheat	12	12.3	**258.93**	28	12.3	**604.17**	12	14	**294**	8	12.3	**172.62**	4	12.3	**86.1**	24	120	**5040**	**34.5**	**84**	1415.82
Maize	12	13	**897**	32	14	**2576**	12	14	**966**	8	14	**644**	4	14	**322**	24	120	**16560**	**37**	**88**	5405
Millet	12	12	**144**	28	15	**420**	12	14	**168**	8	15	**120**	4	15	**60**	24	120	**2880**	**31.3333**	**80**	912
Total			**53654**			**120605**			**82561**			**27004**			**11878**			**503,119**			**295,702**
Mean	**18**	**13.6**		**36**	**14.8**		**35**	**14.4**		**7.3**	**15.5**		**4**	**14.2**		**18**	**213**		**28.5682**	**98.286**	
Percent			**16.32%**			**36.68%**			**35.18%**			**8.21%**			**3.61%**						**100%**

[1] **No. stands for number of labor person-days per hectare,** [2] **Value refers to the value of one labor-person per day in *Birr***

[3] **Total is equal to number of labor person-days* the value of one labor-person per day* total area covered by that specific crop type**

[4] **Total value of man power refers to value of man power for land preparation and planning + weeding +watering + harvesting +threshing**

Table 5.6 .Labor inputs used in the production-Ada'a

ADA'A	Type of labor power used in farming using irrigation water																				
	Labor (family+hired+share cropping+exchange)															Animal power					
Crop type	Land preparation and planting			Weeding and cultivation			Watering			Harvesting			Threshing			Oxen power used			Mean person-days/ha	Total person-days/ha	[4] Total value(man power
	No.[1]	Value[2]	Total[3]	No.	Value	Total	No.	Value	Total	No.	Value	Total	No.	Value	Total	No.	Value	Total			
Onion (cross-bred)	28	18	**97348**	40	18	**139068**	48	17	**157610**	2	18	**6953.4**	0	0	**0**	16	60	**185424**	**39.333**	**118**	**400,979.4**
Onion (local)	28	18	**65873**	40	17	**88876**	48	16	**100378**	2	18.75	**4901.3**	0	0	**0**	16	60	**125472**	**39.333**	**118**	**260,027.7**
Onion(Barro)	28	20	**7980**	40	20	**11400**	48	18.3	**12517**	2	20	**570**	0	0	**0**	16	60	**13680**	**38**	**118**	**32,467.2**
Garlic	28	20	**15680**	40	20	**22400**	48	17.5	**23520**	2	20	**1120**	0	0	**0**	16	60	**26880**	**38**	**118**	**62,720**
Tomato	24	20	**36360**	40	19	**57570**	48	19	**69084**	12	15	**13635**	0	0	**0**	16	60	**72720**	**38.667**	**124**	**176,649**
Potato	20	20	**24060**	36	20	**43308**	20	20	**24060**	8	15	**7218**	0	0	**0**	16	60	**57744**	**24.667**	**84**	**98,646**
Carrot	20	19	**3562.5**	36	18.6	**6277.5**	24	19	**4275**	8	15	**1125**	0	0	**0**	16	60	**9000**	**22**	**88**	**15,240**
Beet root	16	18.75	**3922.5**	36	18.75	**8825.6**	20	19	**4968.5**	8	18.75	**1961.3**	0	0		16	60	**12552**	**21.333**	**80**	**19,677.88**
Sweet potato	20	20	**2400**	36	20	**4320**	24	20	**2880**	8	15	**720**	0	0	**0**		60	**0**	**25.333**	**88**	**10,320**
Cabbage	20	20	**5920**	20	20	**5920**	28	20	**8288**	4	15	**888**	0	0	**0**	16	60	**14208**	**19.333**	**72**	**21,016**
Spinach	12	18.75	**14051**	16	20	**19984**	28	20	**34972**	12	15	**11241**	0	0	**0**	16	60	**59952**	**21.333**	**68**	**80,248.25**
Swiss chard	20	20	**4500**	16	20	**3600**	28	20	**6300**	12	15	**2025**	0	0	**0**	16	60	**10800**	**22.667**	**76**	**16,425**
Lettuce	20	20	**3840**	16	20	**3072**	28	20	**5376**	12	15	**1728**	0	0	**0**	16	60	**9216**	**22.667**	**76**	**14,016**
Lentil	12	17	**20920**	32	17	**55787**	12	17	**20920**	8	17	**34867**	4	17	**12859**	32	60	**246120**	**20.667**	**68**	**145,353.4**
Chick pea	8	17	**23286**	48	17	**139716**	12	17	**34929**	8	17	**116430**	4	17	**30804**	32	60	**410928**	**26.667**	**80**	**345,163.9**
Guaya'	4	17	**1003**		0	**0**	8	17	**2006**	4	17	**4012**	4	17	**1615**	16	60	**14160**	**8**	**20**	**8,636**
Green pepper	24	20	**5280**	28	20	**6160**	24	17.5	**4620**	4	20	**3520**			**0**	24	60	**26400**	**22**	**80**	**19,580**
Fenugreek	20	15	**4125**	28	15	**5775**	15	15	**3093.8**	4	15	**3300**	4	17	**1870**	24	60	**33000**	**21.167**	**71**	**18,163.75**
Total			**340,111**			**622,059**			**519,798**			**216,215**			**47148**			**1,328,256**	**471.17**		
Mean	**20**	**16.93**		**32**	**16.02**		**28**	**16.47**		**6.7**	**15.08**		**4**	**17**		**19**	**60**			**85.944**	**1,745,329**
Percent			**19.49%**			**35.64%**			**29.78%**			**12.39%**			**2.70%**						

[1] No. stands for number of labor person-days per hectare, [2] Value refers to the value of one labor-person per day in Birr

[3] Total is equal to number of labor person-days* the value of one labor-person per day* total area covered by that specific crop type

[4] Total value of man power refers to value of man power for land preparation and planning + weeding +watering + harvesting +threshing

Moreover, in terms of value of labor, total value of labor person-days for the total households in the irrigation sites in Atsbi and Ada'a was 295,702 *Birr* and 1,745,329 *Birr*, respectively. Hence, of the total value of labor-days about 295,702 *Birr* in Atsbi, constituted labor usage for land preparation and planting, weeding and cultivation, watering, harvesting and threshing, accounted for 16.2% (53,654 *Birr*), 36.5% (120,605 *Birr*), 35% (82,561 *Birr*), 8.2% (27,004 *Birr*) and 4.2% (11877.5 *Birr*), respectively. The total value of labor person-days in irrigation agriculture in Ada'a, was used for 340,111 *Birr* (19.5%), 622,059 *Birr* (35.6%), 519,798 *Birr* (29.8%), 216,215 *Birr* (12.4%) and 47,147.8 *Birr* (2.7%) for land preparation and planting, weeding and cultivating, watering, harvesting and threshing, respectively. As expected, the largest components are costs for watering and weeding in both areas. This suggests that more effort is needed in the provision of herbicides. Moreover, research and development interventions need to take account of the labor and cost demand of the irrigation technology.

5.5. The Demand for Oxen Power for Irrigation Agriculture

In relation to animal power used, the mean oxen power-days used per hectare in the two woredas was comparable, which was around 18 oxen-days/ha and 19 oxen-days/ha in Atsbi Wembreta and Ada'a, respectively. Furthermore, value of oxen-days for the total households in the irrigation schemes in Atbi and Ada'a was 503,119 *Birr* and 1,328,256 *Birr*, respectively. The highest average oxen-days/ha was recorded for lentil and chick pea at 32 oxen-days/ha and field peas, faba beans, lentils, chick pea, wheat, maize and millet at 24 oxen-days/ha in Ada'a and Atsbi, respectively.

5.6. Value of Yield Harvested in Atsbi and Ada'a

After discussing all the costs incurred by beneficiary farmers in both study woredas, the next section will be analyzing the revenue they accrued by using irrigation water. Table 5.7 presents the mean yield harvested (kg/ha)-productivity of irrigated land, average price of each crop (birr/kg), the total value of each crop harvested per hectare and the total revenue. The average estimated value of crop yield in Atsbi was 4,413,538 *Birr* and 13,469,056 *Birr* for Ada'a. High variation among mean yield harvested per hectare (productivity irrigated land) was observed among crops grown in the woredas, which ranged up to 3,732 kg/ha of irrigate land. For instance, in the case of onion (cross-bred), the mean yield harvested per hectare was 3467.5 kg/ha in Atsbi, whereas, 7200 kg/ha in Ada'a. Perhaps, it is due to less input use such as fertilizer, pesticides and herbicides in Atsbi. There was also higher variation in the average price of crops per kg among the two woredas, that ranged up to 7.94 *Birr*. For example, in the case of green pepper, the average price per kg was 10 Birr in Atsbi but 2.06 Birr in Ada'a. Even though field peas covered the largest area in the irrigation schemes of Atsbi, faba beans took the highest productivity per hectare i.e., 14,350kg/ha. Although, onion (cross-bred) took a leading position area coverage in Ada'a, it is onion (local) which had the highest yield, which was 7775 kg/ha.

Table 5.7.Mean yield harvested (kg/ha), average price, productivity rate, total revenue of irrigation water beneficiary farmers in Atsbi and Ada'a

Crop type	Atsbi Wemberta					Ada'a				
	Area irrigated(ha)	Mean yield harvested (kg/ha)	Average price in *Birr*(kg)	Total value of crop yield harvested per hectare (in *Birr*)*1	Total value of yield harvested (Total revenue) in *Birr*	Area irrigated(ha)	Mean yield harvested (kg/ha)	Average price in *Birr*(kg)	Total value of crop yield harvested per hectare (in *Birr*)*1	Total value of yield harvested (Total revenue) in *Birr*
Onion (cross-bred)	23.257	3467.5	3.59	12448.325	**289,511 *2 (6.6%) *3**	193.15	7200	2.18	15696	**3,031,682 *2 (22.5%) *3**
Onion (local)	2.985	6425	2.625	16865.625	**50,344 (1.1%)**	130.7	7775	4.2	32655	**4,268,008 (31.7%)**
Onion(Barro)	0	0	0	0	**0**	14.25	4800	2	9600	**136,800 (1%)**
Garlic	2.8925	6425	8	51400	**148,675 (3.4%)**	28	4500	4.3	19350	**541,800 (4%)**
Tomato	23.75	4600	2.79	12834	**30,480 (6.9%)**	75.75	4950	2.49	12325.5	**933,656 (7%)**
Potato	13.4325	4500	2.21	9945	**133,586 (3%)**	60.15	3750	2	7500	**451,125 (3.3%)**
Carrot	3.4	2338	2.225	5202.05	**17,686 (0.4%)**	9.375	1775	1.5	2662.5	**24,960 (0.19%)**
Beet root	2.155	2026.67	2.3	4661.341	**10,045(0.2%)**	13.075	1900	2.25	4275	**55,895 (0.4%)**
Sweet potato	0	0	0	0	**0**	6	4000	1.2	4800	**28,800 (0.2%)**
Cabbage	16.1	3126	1.7875	5587.725	**89,962 (2%)**	14.8	4020	3.2	12864	**190,387 (1.4%)**
Spinach	0	0	0	0	**0**	62.45	22667.67	0.33	7480.3311	**467,146 (3.47%)**
Switchard	9.45	3280	2.4	7872	**74,390 (1.7%)**	11.25	1675	2	3350	**37,687 (0.3%)**
Lettuce	6.7	2466.67	2.3	5673.341	**38,011 (0.86%)**	9.6	1750	2.5	4375	**42,000 (0.3%)**
Field peas	41.9	7812.5	3.65	28515.625	**1,194,804 (27%)**	0	0	0	0	**0**
Faba Beans	27.3	14350	3.33	47785.5	**1,304,544 (29.6%)**	0	0	0	0	**0**
Lentil	9.625	1093.75	4	4375	**42,109 (0.95%)**	102.55	1820	4.75	8645	**886,544 (6.58%)**
Chick pea	1.625	2600	2.85	7410	**1,204 (0.27)**	171.22	4560	2.76	12585.6	**2,154,906 (16%)**
Guaya'	0	0	0	0	**0**	14.75	2400	1.6	3840	**56,640 (0.4%)**
Green pepper	4.8	3500	10	35000	**168,000 (3.8%)**	11	4375	2.06	9012.5	**99,137.5 (0.7%)**
Fengreek	17.3	2970	9.25	27472.5	**475,274 (10.8%)**	13.75	450	10	4500	**61,875 (0.46%)**
Lin seed	3	466.67	2.67	1246.0089	**3,738 (0.08%)**	0	0	0	0	**0**
Barley	1.75	1600	2	3200	**5,600 (0.1%)**	0	0	0	0	**0**
Wheat	1.75	2333	2.73	6369.09	**11,146 (0.25%)**	0	0	0	0	**0**
Maize	5.75	2566.67	2.27	5826.3409	**33,501 (0.759%)**	0	0	0	0	**0**
Millet	1	3200	1.8	5760	**5,760 (0.13%)**	0	0	0	0	**0**
Total	219.922				4,413,538.222 **(100%)**	941.82				13,469,056 **(100%)**

***1- Total value of crop yield harvested per hectare is equal to mean yield harvested (kg/ha)*average price (kg)**

***2 - Total value of yield harvested (Total revenue) is equal to area irrigated (ha) of that specific crop* mean yield harvested (kg/ha) of that specific crop *average price (kg) of that specific crop, (.%), *3The percentage distribution of the total value of that specific crop from the total value of yield harvested.**
Note that all values are given in Birr value.

In relation to total revenue obtained, in Atsbi, faba beans constituted the lion share of the total revenue, which took1, 1,304,544 *Birr* (29.6%), followed by field peas which accounted for 1,194,804 *Birr* (27%) and fenugreek 475,274 *Birr* (10.8%) On the other hand, in Ada'a, the main component of the total revenue generated was from onion (local), which represented 4,268,008 *Birr* (31.7%), followed by onion (cross-bred) and chick pea, which contributed 3,031,682 *Birr* (22.5%) and 2,154,906 *Birr* (16%), respectively.

5.7. Net-Revenue Gained in the Irrigation Sites of Atsbi and Ada'a

Table 5.8 indicates the net revenue of each crop produced using irrigation water in year 2006/07. As can be seen from the table below, producing crops using irrigation water generally functions well in both woredas, when we see in aggregate level. The total net revenue was estimated as 3,274,889 *Birr* for Atsbi, with total revenue of around 4,413,540 *Birr* and the total cost[26] of around 1,138,651 *Birr*. When we disaggregated it, faba beans, field peas and fenugreek were the major source of net revenue, which accounted for 1,160,841 *Birr* (35.4%), 959,113 *Birr* (29.3%) and 417,435 *Birr* (12.7%), respectively.

Furthermore, the net revenue was 7,458,069 *Birr* for Ada'a, with the total cost of around 6,010,985 *Birr* and total revenue of around 13,469,056 *Birr*. Onion (local and cross-bred), chick pea and tomato took the leading position in the composition of the net total

[26] *Total cost = value of (modern fertilizer use + manure/compost + herbicides + pesticides + seeds +labor (man power)+ oxen power)*

revenue which represented 3,525,895 *Birr* (47.2%), 2,378,256 *Birr* (31.8%),1,183,437 *Birr* (15.86%) and 538,138 *Birr* (7.21%), respectively.

In the irrigation sites, it was not only net-revenue observed, but also net-loss was recorded. In Atsbi, carrot (695 *Birr*), lin seed (91 *Birr*) and barley (3494 *Birr*) were the major crops which demanded higher value of cost of inputs compared to the total revenue in year 2006/07. Likewise, loss of (692,916 *Birr*) for garlic, (12,788 *Birr*) for potato, (16,378 *Birr*) for carrot and (900 *Birr*) for beet root were incurred in the irrigation schemes of Ada'a.

According to the result of focus group discussion with beneficiary farmers through time there is a shift in farm households' crop choice decision towards highly priced and marketable agricultural products. The farmers themselves witnessed, it has a positive impact on their income as well as on the living standard of their families. However, one thing to note in this case is, the level of magnitude of benefit accrued to the beneficiary farmers significantly depends on market and infrastructure accessibility, since most of the crops grown in the irrigation sites of the two woredas are perishable (see Table 5.1 and Table 5.2). Hence, unless these products are able to reach to consumers immediately after harvested, either their market value will decrease with time or it might be a complete loss to the farmers.

Table 5.8. Net revenue gained in the irrigation sites of Atsbi and Ada'a in 2006 cropping season

Atsbi					Ada'a			
Crop Type	Total Revenue (in *Birr*)	Total Cost (in *Birr*)	Net Revenue (in *Birr*)	Net Revenue in percent	Total Revenue(in *Birr*)	Total Cost (in *Birr*)	Net Revenue (in *Birr*)	Net Revenue in percent
Onion (cross-bred)	289510.6945	134,882	154,629	4.72%	3031682.4	653,426	2,378,256	31.8%
Onion (local)	50343.89063	26604	23,740	0.72%	4268008.5	742,114	3,525,895	47.2%
Onion(Barro)	0	0	0	0	136800	74,655	62,145	0.83%
Garlic	148674.5	2136	146,539	4.47%	541800	1,234,716	-692,916	-9.29%
Tomato	304807.5	128122	176,686	5.4%	933656.625	395,519	538,138	7.21%
Potato	133586.2125	116796	16,790	0.51%	451125	463,913	-12,788	-0.17%
Carrot	17686.97	18382	-695	-0.021%	24960.9375	41,339	-16,378	-0.21%
Beet root	10045.18986	5672	4,373	0.13%	55895.625	56,796	-900	-0.01%
Sweet potato	0	0	0	0	56,451	28800	27,651	0.37%
Cabbage	89962.3725	66269	23,693	0.72%	190387.2	51,502	138,885	1.862%
Spinach	0	0	0	0	467146.6772	197,842	269,304	3.610%
Swiss chard	74390.4	59662	14,728	0.4%	78,671	37687.5	40,984	0.54%
Lettuce	38011.3847	34056	3,955	0.12%	42000	33,278	8,722	0.116%
Field peas	1194804.688	235,692	959,113	29.3%	0	0		0
Faba beans	1304544.15	143703	1,160,841	35.4%	0	0		0
Lentil	42109.375	36413	5,696	0.17%	886544.75	827,642	58,902	0.78%
Chick pea	12041.25	5380	6,661	0.2%	2154906.432	971,470	1,183,437	15.86%
Guaya'	0	0	0	0	56640	24,221	32,419	0.43%
Green pepper	168000	15839	152,161	4.6%	99137.5	53,834	45,304	0.60%
Fenugreek	475274.25	57839	417,435	12.7%	61875	53,596	8,279	0.11%
Lin seed	3738.0267	3829	-91	-0.003%	0	0	0	0
Barley	5600	9094	-3,494	-0.1%	0	0	0	0
Wheat	11145.9075	8404	2,742	0.08%	0	0	0	0
Maize	33501.46018	25475	8,026	0.2%	0	0	0	0
Millet	5760	4402	1,358	0.04%	0	0	0	0
Total	4,413,540	1,138,651	**3,274,889**	**100%**	13,469,056	6,010,985	**7,458,069**	**100%**

Total revenue is equal to area irrigated (ha)* mean yield harvested (kg/ha)*average price(kg)
Total cost = value of (modern fertilizer use + manure/compost + herbicides + pesticides + seeds +labor (man power)+ oxen power)
Net revenue refers to Total revenue minus Total cost
Net revenue in percent is the percentage distribution of the net revenue of that specific crop from the total net revenue accrued
Note that all values are given in Birr .

Means of Transport for the Commodities Farmers Produced in Atsbi and Ada'a:-

The common means of transportation for commodities farmers produced in Atsbi is donkey. Beneficiaries at Hayelom *tabia* also use motor trucks to transport tomato and onion to the nearby town called Hayek Meshal and the woreda town market-Enda Selassie. The value is 15 Birr/quintal. Donkeys also have different values in different *tabias* (see Table 5.9 below) which depends on the distance they transport the product, whether it was to village market or town market.

Moreover, farmers in Ada'a also used donkeys and lorries as a main means of transport for their products. Mean value of transport using a donkey per day was 6.5 Birr/quintal and for lorries, it was 14.4/2 quintals Birr per one way trip. In addition, they also used motor trucks to transport their products such as onion, tomato, potato and sweet potato to the woreda town-Deber Zeit, the average value was 5.8 Birr/quintal.

Table 5.9. Means of transportation for commodities in Atsbi and Ada'a

	Tabia name	Mean value of donkey rent per day(*Birr*) to the village market	Mean value of donkey rent per day(*Birr*) to the woreda market	Value of lorry for one way trip (*Birr*)	Modern transport (*Birr*/quintal)
Atsbi Wemberta					
	Golgol Nael	-	5		-
	Felg Woini	4	5		-
	Ruba Felg	7	7		-
	Adi Mesanu	5	7		-
	Zarema	7	8		-
	Hayelom	5	10		15
	Harresaw	5	33		-
	Hadnet	6	-		-
		5.571429	10.71429		15
Ada'a					
	Hidi	7		14	6
	Ganda Gorba	7		14	6
	Fultina	6		16	6
	Godino	6		14	5
	Kataba	7		14	6
		6.6		14.4	5.8

5.8. KEY FINDINGS AND IMPLICATIONS

In Atsbi, out of 220.67 ha of land, 104.22 ha of land (47%) was covered by vegetables. Tomato, onion (cross-bred), cabbage, potato and swiss chard took the leading position in area coverage from vegetable category. The second largest share in land coverage were pulses, which accounted for 80.45ha of land (36.46%), with the majority of field peas and faba beans. Likewise, in Ada'a vegetables covered the largest irrigated area in the woreda, that was 629.55ha of land (65.45%), followed by pulses 299.27 ha (31.1%). Experience of growing fruits in both woredas was limited, especially in Ada'a where fruits were not observed at all in all of the PAs of the study areas.

Over a total cost of 167,431 *Birr* and 527,549 *Birr* was paid out on modern fertilizer mainly such as for UREA and DAP in Atsbi and Ada'a, respectively. The average amount of fertilizer use per hectare was 217.18kg/ha and 242.9kg/ha in Atsbi and Ada'a, respectively, but varied according to the types of crops grown. The highest amount was for tomato, 400kg/ha in both woredas. On the other hand, beneficiaries in Atsbi used manure /compost in year 2006/07 to supplement the modern fertilizer use. There had been no application of herbicide and pesticide in Atsbi. However, in Ada'a from 4 liter/ha up to 5liter/ha of herbicide was applied. Average amount of seed used was differed according to the crop type they selected. In general, the estimated value of seed used was 222, 351 *Birr* and 1,758,957 *Birr* in Atsbi and Ada'a, respectively.

Our evidence is consistent with the argument that irrigation agriculture demands higher person days/ha (labor force). For instance, in year 2006/07, the average labor person-days used in the irrigation sites of Ada'a was around 86 person-days/ha, and around 98 person-days/ha in Atsbi. This figure is well above, as compared to the average 55 person-days/ha and 53 person-days/ha, labor needed for rain-fed agriculture in Atsbi and in Ada'a, respectively. With regard to oxen power used, even if the mean oxen power days/ha used in the two woredas was comparable, there was higher variation among the value of oxen /day/ha, which was 60 *Birr* in Ada'a and 120 *Birr* in Atsbi. This suggests that how huge role oxen play in agricultural sector of the country.

The average estimated value of crops yield (total yield) in Atsbi was 4,413,538 *Birr* and 13,469,056 *Birr* in Ada'a. In addition, there was high variation in productivity of irrigated land among the two study area, possibly due to magnitude difference in inputs use.

The findings imply that, producing crops using irrigation water generally functions well in both woredas. The total net revenue from using irrigation water was estimated as 3,274,889 *Birr* in Atsbi, with total revenue of around 4,413,540 *Birr* and total cost of around 1,138,051 *Birr*. Likewise, in Ada'a, being the total cost of around 6,010,985 *Birr* and total revenue of around 13,469,056 *Birr*, the total net revenue was 7,458,069 *Birr*.

The result of impact of using irrigation water in different *tabias* of the two woredas indicated that farmers have started to grow crops which were not previously grown in the areas. The farmers themselves witnessed that it has a positive impact on their income as well as on the living standard of their families. Effort still should be made on provision of technical assistance to farmers in supplying variety of seeds, herbicides, pesticides and training provision. The other point to be noted is the level of magnitude of beneficiaries mainly depends on market and infrastructure accessibility, since most of the crops grown in these areas are perishable. In addition, our findings also revealed that the productivity of irrigated land is highly affected by input used. Therefore, intervention is needed on the availability of institutional support services such as input supply and credit extension.

CHAPTER SIX
WOMEN PARTICIPATION IN IRRIGATION SITES

6.1. Gender and Irrigation

Evidence shows that the meaningful involvement of women in water resources development and management can help make projects more sustainable. It also ensures that infrastructure development yields the maximum social and economic returns and advance progress on the Millennium Development Goals. That is why during the past four decades critical case studies and successful innovations led to a growing consensus among many irrigation policy makers, interventionists, local irrigation leaders, and researchers world wide that gender[27] is an important variable in irrigation (van Koppen, 2002).

Women play crucial role in many water and food related issues; however, they still tend to be underrepresented in decision–making process. In this chapter, we try to see the participation of women at three different levels: farm (field) level, association (forum) level and leadership level in WUAs.

- Equal farm level access to water, which encompasses both water rights, irrigated land and associated obligations (van Kopper, 2002).
- Water users associations are the informal or formal networks to which, in principle, all farmers in the command area belong and in which rules for rights to water and land and related obligations are set and reinforced from the lowest to the highest tiers. Equal participation in forums or networks for collective water

[27] Gender refers to the socially constructed rather then biologically determined roles of men and women as well as the relationships between them in given society at specific time and place. These roles and relationships are not fixed, but can and do change. They are usually unequal in terms of power, freedom, agency and status as well as access to and control over entitlements, resource and assets.

management arrangements –generally required for strengthening access to water at farm level (ibid).

- Equality at leadership-level in the sense that the gender composition of leaders should reflect the gender composition of the farmers in the scheme. Women leaders should also be able to function as well as men (ibid).

The above generic analytical tool is called The Gender Performance Indicator for Irrigation (GPII), which helps to diagnose, indicate and analyze gender issues and performance in those collectively managed irrigation schemes.

6.2. Women Participation at Farm Level

Most households in the study woredas consist of one adult man, one adult woman and a number of children. The adult man is considered the head of the household, which implies that he is responsible for managing all labor and other means of production, with the objective of feeding all household members year-round. Most important input in terms of food security for the household is the so-called rain-fed collective or family field. All household members have the obligation to work on the rain-fed collective field on which cereals and legumes are grown.

Like other parts of the country, in both woredas, land allocation policies in command areas of old or/and new irrigation systems, plots are normally given to a households as a unit which is represented by men (husbands). According to experts at the woredas' office of agriculture, to allocate men as household representative stems from a number of implicit and explicit assumptions. The assumptions are related to the intra-household organization of agricultural production and the roles of women in this organizational set-up in particular. Since it is assumed that women (wives) will benefit from the plots, the need for allocating plots to women at the same time will cause inequitable land distribution. Moreover, unless plot sizes are varied, allocating more than one plot to a single household will lead to a situation where fewer households will have access to irrigation water.

Farm level women participation can be looked at in two different ways. The first one is access to water –to women farm decision makers (female households heads) and to households which women are under their male kin (most of the time their husbands). In the study areas, women farm decision makers are those female headed households which are single, widowed or divorced.

All women who have access to irrigation water are beneficiaries of irrigation water. As can be seen in Table 5.1 below, out of 1855 beneficiary farmers in Atsbi Wemberta, 402 (21.67%) of them were female headed households, who were either single, divorced or widowed at the study period.

Table 6.1.Proportion of female headed beneficiary households in Atsbi –Micro Dam and Modern River Diversion Users

Micro-Dams				Modern River Diversions			
Name of the Micro-Dam	No. of Beneficiaries			Name of the river diversion	No. of Beneficiaries		
	Total	Female	Male		Total	Female	Male
Golgol Nael	542	138[1] (25.5%)[2]	404(74.5%)	Endaminu	507	97[1] (19.1%)[2]	410(80.9%
Harresaw	305	96(31.5%)	209(68.5%)	Barka Adi Sebha	0	0	0
Kelisha Emni	0	0	0	Hadnet	68	6(8.8%)	62(91.2%)
				Habes	0	0	0
Ruba Felg	0	0	0	Adi Mesanu	9	0	9(100%
Era	0	0	0	Kuret	159	29(18.2%)	130(81.8%)
Sub-total	**847 [1] (((45.7%)))[4]**	**234[1] (27.6%)[2] ((58.2%))[3] (((12.6%)))[4]**	**613 (72.4%) ((42.2%)) (((33%)))**		**743 (((40%)))**	**132[1] (17.8%)[2] ((32.8%))[3] (((32.9%)))[4]**	**611 (82.2%) ((42%)) (((52.87%)))**

[1]The numbers out of the bracket shows number of observations in each category for discrete data.
(.)[2] -The percentage distribution of the variable from the total number of beneficiaries in that specific irrigation schemes.
((.)) [3] -The percentage distribution of the variable from the total number of female /male beneficiaries' categories.
(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda.

Table 6.2.Proportion of female headed beneficiary households in Atsbi –Shallow Wells and Large Communal Ponds

Shallow Well				Large Communal Ponds			
Name of the shallow well	No. of Beneficiaries			Name of the pond	No of beneficiaries		
	Total	Female	Male		Total	Female	Male
Gereb Gesa	5	0	5(92.9%)	Gereb Gesa	9	1[1] (11.1%)[2]	8(89.9%)
Sub-total	**5 [1] (((.27%)))[4]**	**0**	**5[1] (92.9%)[2] ((.34%))[3] (((.27%)))[4]**		**9[1] (((0.48%)))[4]**	**1[1] (11.1%)[2] ((0.2%))[3] (((0.05%)))[4]**	**8 (89.9%) ((0.5%)) (((0.43%)))**

[1]The numbers out of the bracket shows number of observations in each category for discrete data.
(.)**[2]** -The percentage distribution of the variable from the total number of beneficiaries in that specific irrigation scheme.
((.)) **[3]** -The percentage distribution of the variable from the total number of female /male beneficiaries' categories.
(((.)))**[4]** -The percentage distribution of the variable from the total number of beneficiaries in the woreda.

Table 6.3. Proportion of female headed beneficiary households in Atsbi –Traditional River Diversion and Spring Water Users

Traditional River Diversion				Spring Water Use			
Name of the diversion	No. of Beneficiaries			Name of the the spring water	No. of Beneficiaries		
	Total	Female	Male		Total	Female	Male
Gera Rebue	62	12[1] (19.4%)[2]	50(80.6%)	Afenjow	42	2[1] (4%)[2]	40(96%)
Tsiquaf	20	5(25%)	15(75%)	Tsigaba	24	1(4.2%)	23(95.8%)
Samera	58	8(13.8%)	50(86.6%)				
Kimber (Tsgaba)	13	0	13(100%)				
Mebrahetom	32	7(21.9%)	25(78.1%)				
Era Erere	0	0	0				
Sub-total	**185[1] (((9.97%)))[4]**	**32[1] (17.3%)[2] ((7.96%))[3] (((1.7%)))[4]**	**153 (82.7%) ((10.5%)) (((8.2%)))**		**66[1] (((3.56%)))[4]**	**3[1] (4.5%)[2] ((.7))[3] (((.16%)))[4]**	**63 (95.5%) ((4.3%)) (((3.4%)))**

[1]The numbers out of the bracket shows number of observations in each category for discrete data

(.)[2] -The percentage distribution of the variable from the total number of beneficiaries in that specific irrigation schemes

((.)) [3] -The percentage distribution of the variable from the total number of female /male beneficiaries categories

(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda

Table 6.4. Total female headed beneficiary households in Atsbi

Irrigation Beneficiary Female Headed Households in Atsbi		
Total	**Female**	**Male**
1855	402[1](((21.67%)))[4]	1453(((78.3%)))

[1]The numbers out of the bracket shows number of observations in each category for discrete data

(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda

In terms of micro-dams beneficiary farmers, out of a total of 847 beneficiary farmers, 234 were female who had access to irrigation water that accounted for 27.6% as compared to their male counterparts. Besides, among irrigation beneficiary female household heads 58.2% of them used micro-dams as a source. Furthermore, there were about 743 irrigation water users in the modern river diversions in Atsbi that represented 132 (17.8%) female headed households. Female beneficiaries who had access to modern river diversions constituted 32.8% and 32.9% as compared with other female irrigation water beneficiaries and the total irrigation water beneficiary farmers in Atsbi, respectively.

With regard to traditional river diversion, 32 female headed households participated in the irrigation use that accounted for 1.7% of the total irrigation water beneficiary farmers. Besides, there were only 3 women farm decision makers in spring water use, 2 of them were from Afenjow (Ruba Felg). Furthermore, in Gereb Gesa (Adi Mesanu) shallow well and communal ponds irrigation use, merely there was one female headed household who had access to irrigation water.

As indicated in Table 5.2 above, in year 2006/07, there were a total of around 2,381 farmers who had irrigation water access in Ada'a. Of which 318 (13.4%) them were female headed households. Even though it was Mojo river diversion which was accessed by many beneficiary farmers, the highest number of women farm decision maker beneficiaries were found in Godino scheme (18.2%), followed by Goha Worko scheme which had 65 women farm decision farmers, who represented 24.3%.

In addition, the majority of female headed households (90%) who had water right used irrigation water from Wedecha-Belbela dam. Moreover, in Mojo diversion and Hora Kilole lake, the number of women farm–decision makers is 25 and 7, respectively.

Table 6.5.Proportion of female headed beneficiary households in Ada'a from Wedecha-Belbela Micro-Dam

Name of the irrigation scheme	Wedecha-Belbela Micro-Dam No. of Beneficiaries		
	Total	**Female**	**Male**
Godino	495[1] (31.6%)[2]	90(18.2%)	405(81.8%)
Gohaworko	267(17%)	65(24.3%)	202(75.7%)
Harawa	68(4.3%)	24(35.3%)	44(64.7%)
Belbela-Fultinao	247(15.8%)	28(111.3%)	219(88.7%)
Dhanama	54(3.4%)	8(14.8%)	46(85.2%)
Kataba-Gimbi	427(27.2%)	71(16.6%)	356(83.4%)
Sub-total	**1558[1] (((75.7)))[4]**	**286[1] (18.2%)[2] ((90%))[3] (((13.8)))[4]**	**1272 (81.6%) ((61.8%)) (((61.78)))**

[1]The numbers out of the bracket shows number of observations in each category for discrete data
(.)[2] -The percentage distribution of the variable from the total number of beneficiaries in that specific irrigation schemes
((.)) [3] -The percentage distribution of the variable from the total number of female /male beneficiaries categories
(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda

Table 6.6. Proportion of female headed beneficiary households in Ada'a from Mojo River and Hora Kilole Lake

iver Diversion				**Lake Use**			
Name of the River Diversion	**No. of beneficiaries**			**Name of the lake**	**No. of Beneficiaries**		
	Total	**Female**	**Male**		**Total**	**Female**	**Male**
Mojo River	698	25[1] (3.6%)[2]	673 (96.4%)	**Hora Kilole**	125	7(5.6%)	118(94.4)
Sub-total	698[1] (((33.9%)))[4]	25[1] (3.6%)[2] ((7.9%))[3] (((1.2%)))[4]	673 (96.4%) ((32.7%)) (((28.3%)))	**Sub-total**	125[1] (((5.2%)))[4]	7[1] (5.6%)[2] ((2.2%))[3] (((0.29%)))[4]	118 (94.4%) ((5.7%)) (((4.96%)))

[1]The numbers out of the bracket shows number of observations in each category for discrete data
(.)[2] -The percentage distribution of the variable from the total number of beneficiaries in that specific irrigation schemes
((.)) [3] -The percentage distribution of the variable from the total number of female /male beneficiaries categories
(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda

Table 6.7. Total female headed beneficiary households in Ada'a

Irrigation Beneficiary Female Headed Households in Ada'a		
Total	**Female**	**Male**
2381	318[1](((13.4%)))[4]	2059(((86.6%)))

[1]The numbers out of the bracket shows number of observations in each category for discrete data
(((.)))[4] -The percentage distribution of the variable from the total number of beneficiaries in the woreda

Generally, 100% of female household heads in the irrigation sites of the two areas who have irrigation water access (who are in the command areas) have the right to use the irrigation water in their respective schemes. On the other hand, as can be seen in the tables above (Table 6.1 and 6.7), the majority of beneficiaries in the irrigation schemes of the two woredas were male headed households in year 2006/07, that accounted for 86.6% (2058) and 78.3% (1453) in Ada'a and Atsbi, respectively.

6.2.1. Labor Requirement for Irrigation in Male Headed Households

The introduction of irrigation to different parts of Ethiopia holds the promise of increase food security as well as marketable surpluses by enabling farm households to cultivate two or more rounds of crops per year. However, realizing the income and subsistence potential of irrigation depends crucially on the availability of family labor for year–round agricultural production. As many parts of the country, as much as land; labor is the most critical production input in agriculture. Hence, the main concern of many farm households is to maximize the return to labor. Arrangements for access to and control over labor and the products of labor (agricultural products) are crucial structuring principles in the intra-household organization of agricultural production. This is why household labor availability is not a simple function of the absolute number of adult household members; instead it is closely related to the intra-household division of rights and responsibilities. Gender is one of the main axes around which this division occurs.

The result of focus group discussion with beneficiary farmers at scheme level depicted that women in Atsbi and Ada'a have always done and still do, independent work in addition to working for on the family irrigated land (male-controlled irrigated plots). This labor contribution in the household is seen as the fulfillment of a woman's duty as a wife, in return for which she enjoys the general welfare and security of the household. Women were found significantly involve in each activity of irrigated agriculture, in planting, weeding, cultivation, sowing, watering, applying fertilizer, harvesting and marketing. The only irrigation activities they have not participated are plowing and threshing. However, the revenue generated from agriculture is controlled by men.

When asked about labor supply decision on family irrigation plot (male-controlled field), all women (wives) replied that they continue to provide the same amount of labor to the male-controlled fields. One woman explained: "We help each other in the rain-fed field and in the irrigated plot. If you would not have been here to interview me, I would have been working in the irrigated plot".

6.2.2. Labor Requirement for Irrigation Agriculture in Female Headed households

In both study areas, women have equal opportunity to use water as any other water user, provided that they are heading a family. Labor as a factor affecting users practice of irrigation is mostly related to gender with respect to household heads. Most of the time female headed households lack male labor, which is culturally decisive for practicing irrigation known for its high labor demand. Due to gender-typing of tasks in irrigation agriculture in societies, labor bottlenecks cannot be overcome by substituting one for the other.[28] As female beneficiary farmers explained "lack of male labor renders women household heads (those that are divorced or widowed) face a triple burden along side, care of children, other household duties, their responsibility as household heads placing income generation as additional burden on them."

Another problem which is faced in day-to-day activities of female headed households is, during irrigation water shortage seasons, farmers are allowed to use the irrigation water only at evening and night time. But, on the other hand, it is not safe for women to work in dark. In such situations, if they have a capacity to do, they prefer to hire daily laborer for their irrigation farm activities, 15-16 Birr/day with addition of free lunch and 'tela'(which is a local drink).

In addition, other inputs such as fertilizer, herbicides, pesticides and preparation of manure/ compost/ are required in the irrigation agriculture. But, according to discussions with key informants in the two woredas, in Atsbi 80%-90% and in Ada'a 70%-75 % female household heads are found in lower socio-economic condition in those communities, except when ranked with each other. Thus, the crucial problem in this case is not only labor shortage but also financial problems.

[28] *Irrigation labor requirement is discussed in detail in chapter 5.*

As a result, many women farm decision makers lacking man labor usually were forced to quit irrigation practices, and lease-out their plots in a form of contract payment or sharecropping. Hence, they were forced to give up some part of benefit from irrigation. Table 6.8 also shows that in year 2006/07, 32.2% (128) of female headed households leased-out the irrigated land in Atsbi. On the other hand, in Ada'a the figure was even higher, 64% of women farm decision makers were forced to lease-out irrigation land. Discussion with female headed households in Atsbi indicated that the situation was better than earlier. As explained by one of the women beneficiary farmer "For many years, I had leased-out the irrigated plot. But now the situation is different, I know how much benefit I can get from irrigation. Even if I have labor shortage problem, I beg for labor assistance from relatives."

Table 6.3. Choices made by female household heads

Choices made by female household heads	Atsbi - freq(%)	Ada'a- freq(%)
Lease-out	128(31.8%)	203(64%)
Practice irrigation	232 (57.8%)	115(36%)

6.3. Women Participation in the Water Users Association

As we described earlier in this paper, all farmers who have irrigation water access are members of their respective water users association, it is not different for women farm decision makers either. In Atsbi, all the 402 female farm decision makers were members of WUA, (91 (5.84%) were single, 167(10.7%) divorced and 144(9.2%) were widowed during 2006/07). The large percentage of women were married (they were part of male headed households), who represented 74.18% (1155 in number). Similarly in Ada'a, there were 1678 women under male headed households. While, the number of single female who used irrigation water were 54 (2.76%), the rest were those of divorced and widowed, who accounted for 176(9%) and 88(4.5%), respectively.

6.4. Female irrigation water users in Atsbi and Ada'a

Name of the woreda	Single	Married(are part of male headed households)	Divorced	Widowed	Total
Atsbi	91(5.84%)	1155(74.18%)	167(10.7%)	144(9.2%)	1557(100%)
Ada'a	54(2.76%)	1638(83.74%)	176(9%)	88(4.5%)	1956(100%)

One type of contribution expected of beneficiary farmers is labor. All members of WUA should participate in the maintenance, clearance and minor construction of the communal managed irrigation schemes. Besides, the financial problem women face, labor shortage is another constraint in female farm decision makers to practice irrigation in both farm and forum level activities.

At least two times a year .i.e., in the months of September and February, farmers clean the canals. 'Free riding' is not allowed with regard to cleaning and maintaining their parts of the irrigation canal. Women farm decision makers also have an obligation to participate; either themselves, their son(s) (relative) or they can hire a daily laborer. However, if their economic status and family labor constraint is realized by other members of the association, they are excused for not participating in provision activities of the irrigation system in the study areas.

Annual average value of farmers' contribution in WUA also constitutes contribution in cash form. The result of discussion with water users committee in many of the irrigation schemes showed that female farm decision makers pay their contribution for the committee as much as possible on time as compared to other members of the association.

With the exception of female headed households, men, more than women, control the resources, expenditure and income generation within the family. Men's dominant role in economic transactions, representation and legal matters and their contribution to family income is extended to the responsibility to participate in decision making bodies, such as WUAs and their meetings. As one of the executive committee from Godino PA in Ada'a explained, "Even if meetings are a very rare phenomenon in our association, a majority of members, especially women (those who are married as well as heads of the households) have considered the responsibility of attending meetings as an obligation rather than an opportunity, therefore, most of the time the majority of them are absent".

According to interviews with the executive committee, the overall participation of male and female members is low in the association meetings. When the meetings are crucial and it is imperative that a household member attend the meetings, it is usually a male member who attends (from male headed households). There is no rule that prevents women from attending and participating in the association meetings in the study areas. Either the husband or the wife or both are able to attend and represent their interests at the meetings. However, attending meetings and discussing matters are thought of as male activities.

Discussion with the woreda experts in both areas revealed the common reasons for the low participation of women in association meetings. Some of the major reasons include:- women do not have the time as mostly they are engaged in domestic activities; husbands do not prefer their wives going out to attend meetings; women lack experiences (for example in managing meetings, talking in front of people) and the wrong perception that there is no need for both husband and wife to attend meetings.

Generally, the rationale for female farmers, who attend the meetings but not participating actively in the discussions, can be found further in the prevailing gender ideology among the population in the case study areas. As articulated frequently by male and female respondents, women are considered to be less capable in their understanding of how the WUA functions. Thus, the main reason for women not participating in associations is lack of awareness towards gender equality that exists among both men and women.

6.4. Women Participation at the Leadership Level

The assumption that participation will be always in the interest of women and subsequently that women will always be eager to become members of WUC, to attend and participate actively in the discussion of meetings,…is not confirmed by this study. According to the woreda irrigation expert in Ada'a, most women those who can rely on their husbands or male relatives for representation of the household are not eager to take over the responsibilities, which they perceive to be the responsibility of men within and outside the household.

All women female household heads have equal chance of being elected as WUC. However, participation of women at leadership level is very low. There are a total of 14 and 8 water users associations in Atsbi and Ada'a, respectively. On average one WUA constitutes 5-7 executive committee. The WUC includes chair person, vice chair person, a secretary, a cashier, a controller and 1-3 members. Except in Kimber irrigation scheme (Zarema *tabia*), where there are only three elder men who serve as WUC. Surprisingly, there were only a total of three women in WUC in Adi Mesanu, Haressaw and Hadnet (in Atsbi) in year 2006/07. One of them is cashier (in Adi Mesanu) and the rest are secretaries in there respective WUA (Haressaw and Hadnet). The situation becomes worse when we come to Ada'a. During 2006/07, the only female who involved in WUC was found in Goha Worko. In addition, there was no female water distributor[29] at all in both study areas. Regarding the block leaders[30], there are 94 and 75 block leaders who are in charge of controlling the water distribution system at *Gujeles* and *Geres* level, however, none of them are female.

As we saw earlier in chapter four, there are two kinds of conflict resolution mechanisms in the irrigation sites of the two woredas; the formal –*tabia* level court system and elected elders at each scheme level. In both of the cases, there is no participation of women at all. The main reasons for absence of women participation in WUC are:-

- Unable to work at night;
- A lot of domestic work at home;

[29] Water distributor is a person in charge of irrigation water distribution at scheme level. He also controls the performance of block leaders (who are operating in his respective irrigation scheme).
[30] Block leaders are group leaders who are in charge of irrigation water distribution at outlet (block) level.

- Other perceptions; such as men know more how and what to say in meetings and in public gatherings and males also have more ability to convince others in conflict resolution cases.

Discussion with beneficiary farmers revealed that even though the participation of women in the WUCs is very low, all four of women members of the WUC were doing very well in both woredas.

The group discussions with female headed households in Ada'a irrigation schemes indicate that there is a combination of factors that prevents women from active participation in water user associations. Some of these factors are the prevailing norms of modesty and appropriate behavior for women; direct or indirect discouragement by other participants or the feeling that it is not their duty to contribute actively. Those women, who choose to participate actively, run the risk of being accused of inappropriate behavior.

6.5. KEY FINDINGS AND IMPLICATIONS

The purpose of this chapter was to assess the participation of women at farm, forum and leadership level in the two communal managed irrigation schemes.

In the two case study areas, plot allocation policies are based on the assumption that men are the main farmers, decision makers and providers. Plots are allocated to a household as a unit, with men (husbands) being the representative of the household, with the assumption that women would benefit through their husbands. The underlying estimates of labor availability are determined based on the belief that women would be willing and available to provide labor for family plots. In addition, discussions with female headed households indicate that even though women are found to be significantly involved in irrigated agriculture in male headed households, the revenue generated from agriculture is controlled by men.

When we consider women as household heads, 100% of female headed households who have irrigation water access have the right to use the resource in both case study woredas. On the other hand, large proportion of female headed households in the study areas quit to practice irrigation due to 3 major reasons. The first one is women farm decision makers face a triple burden along side; care of children, other domestic duties and responsibilities as household heads. The second is financial problem – most of them are categorized in low-income level group of the society, as a result, they cannot use complementary inputs like fertilizer, variety of seed etc. The third is during water shortage season, they are allowed to use the irrigation water only at night which involves security threats /concerns.

All farm decision markers in a WUA have an obligation to participate at association level. However, if the economic status and family labor constraint of female headed households is realized by other members of WUA, they will be excused for not participating in maintenance and clearance of canals.

There are a number of reasons which are mentioned by men as well as women farm decision makers for lower participation of women at farm, association and leadership level. Some of them are unable to work at night, a lot of work at home, husbands do no prefer their wives going out attending different economic and social activities (mentioned frequently in focus groups discussions with irrigation beneficiaries in Ada'a), women lack of experience (for managing meetings, talking in front of people).

However, the real rationale for lower participation of women is that the society they are living in, does not give men and women equal opportunities to become independent farm decision makers with access to land, skills, inputs, capital and markets. Women are not perceived as productive and main contributor as male. They are also considered to be less capable to understand how the WUA functions. Direct and indirect discouragement of women by other participants or the feeling that it is not their duty to contribute actively is the common phenomenon in the societies of the study areas.

Generally, when talking about gender inequality it is important to realize that it might be more important to focus on the most disadvantaged group of farmers, i.e., female headed households. Women farm decision makers are found in lower economic status of the community and have a problem of family labor constraint. Therefore, policy intervention is needed to improve the position of women (the most disadvantaged parts of the community) at farm, forum and leadership level and effort should be made to change the wrong perception of the society towards women (considering them as they are less capable of participating in economic activities).

CHAPTER SEVEN
DETRMINANTS OF COLLECTIVE ACTION AND ITS EFECTIVENESS FOR IRRIGATION WATER MANAGEMENT

7.1. Analysis of the Determinants of Collective Action in Communal Irrigation Schemes

The estimation results of determinants of collective action for indicators- average value of a household contribution for the resource management per year, whether there is (are) guard(s) for protection of the irrigation site, whether group members contribute for the guard's payment, if there is (a) person(s) in charge of equitable water distribution and appropriate usage of the irrigation water, whether group members contribute for the water distributor, is presented in Table 7.1.

7.1.1 Annual Average Value of Contribution per Household

We found that average value of household contribution for the resource management is negatively associated with number of households in the group. But it is positively associated with total number of households squared. This is because of economies of scale and a U-shaped relationship between annual average value of household contribution for the resource management and number of households in the group. Groups which have smaller number of beneficiaries should contribute more in order to cover the operation and maintenance cost of the resource management. But as the number of beneficiaries increases the average contribution per household decreases. However, after some point (as the number of households increases more), management costs increase rapidly, requiring higher per household contribution. The turning point in this relationship (where minimum expected number of beneficiaries occurs) was at 154 households/group, within the range of household number in the group in the two study woredas (from 4 to 297 households/ group)[31]. The magnitude of the impact of number of households is moderate. Average value of contribution per household also negatively correlates with proportion of female headed households in the group. It suggests that both financial and labor[32] constraint appear to be a greater concern for female headed households.

With respect to education status, groups which have higher proportion of literate household have negative association with average household contribution for the resource management. The result is both statistically (significant at 5% level) and qualitatively significant. Perhaps household heads with some level of education have better access to engage in non-farm activities, which offers higher income, hence undermines collective action.

Moreover, average family size is positively correlated with average value of household contribution for the resource management at 1% level of significance. This means groups with large average family size make higher contribution per household. This is due to great availability of family labor to participate in collective action of irrigation water use, since labor contribution constitutes 89.5% of the total contribution (cash+ kind+ labor) of members of the WUAs (see Table 4.9).

Not surprisingly, having access and using of formal sector credit is positively and strongly associated with average value of a group member contribution for the resource

[31] *For more information refer Table 3.3*
[32] *Total annual household contribution is in the form of labor, cash and kind*

management, indicator of more collective action (at 1% level of significance). This is possibly because of credit is used primary to purchase crop inputs such as fertilizer and improved seeds, which are complementary inputs to irrigation water use. Surprisingly, contact with the extension programme is not strongly (significantly) associated with average value of a group member contribution for the resource management.

Unexpectedly, higher proportion of households whom the primary source of livelihood is irrigated agriculture has no effect on average value of household contribution. It appears that it is not the livelihood strategy (being irrigated agriculture) of beneficiaries per se that is leading to higher amount of contribution in these woredas but rather other factors such as family size in a group and access of formal credit.

Wealth measurement indicators are also important determinants of collective action. Size of agricultural land in a group (non-irrigated land) and total group's TLU have mixed effect on average household contribution per year; negative with total agricultural land in the group and positive with TLU. The possible reason can be groups which have larger size of agricultural land may give more attention for their rain-fed agriculture, and higher TLU as a measure of wealth is an indication of ability to make contribution.

Table 7.1. Determinants of indicators of collective action in Atsbi and Ada'a, 2006/07 ***Coefficient (standard errors in parenthesis)***

Explanatory variables	Average value of a group member contribution for the resource management	If there is (are)guard(s) for protection of the irrigation site (dF/dx)‡	Whether group members contribute for the guard(s) (dF/dx)‡	If there is a water distributor in the irrigation scheme (dF/dx)‡	Whether group members contribute for the water distributor (dF/dx)‡
Regional Characteristics					
Woreda, cf.,Ada'a	-97.50147 (91.39847)	-.1004423 (.144125)	.0251459 (.0515297)	.8205165*** (.2488298)	-.7869334*** (.1790068)
Group Characteristics					
Total number of households in the group	-2.44839*** (.9388741)	.0125639*** (.0145803)	.0034242*** (.0017931)	.0011754*** (.0017479)	-2.19e-17*** (4.63e-16)
Total number of households in the group squared	.0079435** (.0032323)	-.0000372*** (.0000452)	-.0000915*** (.0000525)	-7.17e-06 (6.43e-06)	
Proportion of female headed households in the group	-54.14266 (52.90396)	.1279945** (.1843523)	.2524605*** (.1916403)	.1827336 (.1663727)	-3.81e-16 (8.12e-15)
Proportion of literate headed households in the group	-191.6583** (74.02852)	-.0273196 (.0643707)	-.1053229 (.1032882)	-.1377547 (.1023142)	8.78e-17 (1.81e-15)
Average family size in the group	24.3402*** (7.832015)	.0048154 (.0093878)	-.0008083 (.008546)	.0109844 (.0168198)	1.02e-16 (2.16e-15)
Proportion of households who have used formal credit in the group	1.095235*** (.2177543)	.0623452*** (.0947366)		.2919586*** (.1416184)	
Proportion of households who have included in the agricultural extension programme	221.1597 (210.5841)	-.0355268 (.2431854)	.5541125 (.3821659)	-.509087 (.5904329)	-5.14e-16 (1.09e-14)
Proportion of households whom the primary source of livelihood is irrigated agriculture	2.963661 (52.05627)	.0072542 (.0230683)	.0792391* (.0825772)	.1676395*** (.0837026)	3.63e-16** (7.69e-15)
Total irrigated area in the group	-1.260037 (2.395867)	.0095655** (.0134072)	.0029209 ** (.0037978)	.0030024 (.0043583)	2.15e-16 (4.53e-15)
Total agricultural land in the group(non-irrigated land)	-2.853806* (1.465202)	.0071554 *** (.009483)	.0030176 * (.0023954)	-.0016165 (.0028884)	-1.91e-17 (4.05e-16)
Tropical livestock unit for the group	.4433728* (.2589661)	.0003973* (.0005813)	.0002909 * (.0004376)	-.0007405 (.0004243)	3.68e-18** (7.78e-17)
Proportion of beneficiaries at the tail-end	26.69484 (75.93723)	-.0744927 (.1113372)	.1123086 (.1185141)	-.4724717 (.2524078)	8.61e-16 (1.81e-14)
Year of experience of irrigation water use, no.	-1.329808 (1.338798)	.0008542 (.0046769)	.0012329 (.0013417)	.0108338** (.004208)	3.36e-17 (7.14e-16)
Provision of training, no.	-.180455 (5.302972)	.0172791*** (.0242046)	-.015713 ** (.0164089)	.0234287** (.0160673)	-6.35e-17 (1.33e-15)
Farm Characteristics					
Proportion of soil coverage considered good by the group in the catchment area	-18.93334 (14.81855)	.012894 (.0400998)	.1925832 (.1339614)	.2886481*** (.0844612)	9.23e-18*** (1.90e-16)
Village Characteristics					
Whether rainfall adequacy in the village is considered good by the group	109.7401 (79.33109)	.0190732 (.0925456)	-.1510933* (.1498897)	.4405119** (.2471971)	-.9999088 (.000575)

Walking time from that group’s specific irrigated land to(in hours)					
Town market	-.1544492	-.0004761**	.0000305	-.0005327*	-3.07e-20
	(.1448537)	(.0006672)	(.00014)	(.0003076)	(6.38e-19)
Village market	.235727	-.0004279	-.0032064***	.0010231	-1.02e-18***
	(.6915918)	(.0014563)	(.0023282)	(.0015798)	(2.10e-17)
Development post	.5151172	-.000692	-.0035514***	-.0027727	-3.93e-19***
	(.6777663)	(.0019121)	(.0024127)	(.0018438)	(8.07e-18)
Scheme Characteristics					
Whether the irrigation scheme was promoted by the external organization	10.09033	.0425002	-.0045196	-.0808885	-8.18e-12
	(27.50153)	(.0740186)	(.0325335)	(.0614335)	(9.69e-11)
Number of external organization(s) which is (are)operating currently in that specific irrigation site	25.0423**	-.0207725	.0007954	.099223***	-2.07e-17
	(11.38271)	(.0300775)	(.0190842)	(.0327524)	(4.28e-16)
Number of local organization(s) which is (are) operating currently in that specific irrigation site	18.9421	.0736847***	-.0190024	.14125038**	1.26e-17
	(13.59268)	(.0919245)	(.0249432)	(.0535214)	(2.61e-16)
Whether there was farmers’ participation during construction of the whole structure	-40.34981	.9049967 **	.0000461**	-.1288109	.0000594
	(52.6411)	(.2456271)	(-.0317386)	(.1035174)	(.0003212)
Type of irrigation system dummy, cf., communal ponds					
Micro-dams	-78.77681	.0249966**	.0493252	-.0839703**	.1838809
	(92.72828)	(.0964438)	(-.022026)	(.0470526)	(.3470024)
River diversion	165.3306**				
	(82.8344)				
Spring water use	-14.36502				
	(89.38776)				
Shallow well	-181.9143*				
	(95.21018)				
_Cons	-112.0618				
	(318.0857)				
mills			**-.1931062****		**4.44e-17****
			(.1783197)		**(9.18e-16)**
Type of regression	**OLS**	**Selection Model-Probit**	**Selection Model-Probit**	**Selection Model-Probit**	**Selection Model-Probit**
Number of observation	169	169	103	169	109
F(28, 140)	29.77	212.65	123.67	100.77	179.47
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.6036	0.8650	0.6668	0.6169	0.7583

***statistical significant at 1%; ** statistical significant at 5%; * statistical significant at 10%

‡Reported coefficients represent effect of a unit change in explanatory variable on probability of the respective dependent variable.

From scheme level characteristics, communities with greater presence of external organizations make higher contribution per household for the resource management. This result is statistically and qualitatively significant. A unit increase in the presence of external organization which operates currently in that specific irrigation site, increases average value of annual contribution per household by 25 *Birr*. Perhaps the current external organizations in these irrigation schemes may be engaged in provision of complementary inputs to local collective action rather than displacing it.

The result of the regression analysis also depicts that in terms of types of irrigation system dummies, river diversion is found to be positively and statistically significant associated with average value of household contribution (at 5% significance level). That is groups that are located in river diversions contribute more per household than groups that are found in communal lakes. Perhaps structures of river diversions demand high contribution of labor during clearance and maintenance than communal lakes do. Shallow well irrigation type dummy is also negatively associated with average household contribution, since most of the times farmers who use shallow wells don't have canals, their labor contribution is less as compared with communal lake users.

7.1.2. Presence of and paying for guards in the communal managed irrigation sites, 2006/07

Table 7.1 also presents the estimated Probit-selection model results of indicators of the determinants of having guard and paying for guard for irrigation water management during 2006/07. It was found that an inverted U-shaped relationship between number of households and employing guard. Irrigation water beneficiary farmers are more likely to have and pay for guard at intermediate number of households in a group than at low or very high total number of households per group. Possibly due to higher fixed costs at lower number of households and higher variable costs at larger number of households for having and hiring guard. The turning point in these relationships is 169 and 160 households per group respectively (where maximum probability of communities for having and contributing for guards). Higher proportion of female headed households in the group increases the likelihood of having and contributing for the guard, perhaps due to an attempt` to compensate for labor constraints for protecting the irrigated farm land.

Furthermore, the greater the proportions of households who have used formal credit in the group, the higher the probability to have and pay for guard. The statistical significance and positive direction of the effect of proportion of households whom the primary source of livelihood is irrigated agriculture on contribution of guard is consistent with the hypothesis we stated. It gives evidence that obtaining higher benefits from irrigation water use encourages beneficiaries to more collective action. Moreover, total irrigated area in the group has strong statistical association with the presence of and paying for guards. It indicates that as the irrigated land size increases, the importance of employing guard becomes very crucial to protect the whole structure of irrigation sites with addition to the irrigated farm land.

We also find that groups which have larger size of land for agriculture and with higher TLU have positive association with having and contributing for guard. It suggests that contributing for guard relates to affordability issue. Thus, groups with a better physical resource are more likely to employ guard than those with few physical resources. Groups with more frequent provision of trainings are significantly and more likely to employ guard. The expectation is that they can understand the benefit more easily and are more open to access of information than groups with less frequent of provision of trainings. Thus, more frequent provision of trainings for beneficiaries will have a remarkable impact on benefiting from irrigation water use, which in turn leads to more collective action.

With regard to village level factors, rainfall adequacy also has negative effect on paying for guard, implying that groups with adequate amount of rainfall are also less likely to contribute for guard. It suggests that having better agricultural potential may tend to undermine individuals' incentives to cooperate by offering more "exit" options, giving more attention for rain-fed agriculture. Expectedly, groups which are closer to the town market are more likely to have guard. In addition, being closer to village market and *tabia* development post have positive correlation with contributing for payment of guard. This finding is consistent with the hypothesis that having better access to markets increases the value of resources and thus the value of managing resources well, which may favor collective action. In addition, beneficiary farmers which are closer to *tabia* development post are more open to access of information than irrigation users which are very far away from development post.

From scheme level factors, communities with greater presence of local organizations have higher probability of having for guard. This finding is consistent with the argument of experience with local organizations may favor collective action due to possible learning effects of how to enhance the ability to enforce collective action. Increasing the number of local organizations by one unit increases having guard by 7.4%.

Community participation during construction of the irrigation scheme increases the likelihood of having guard than communities who did not participate in any form. This implies that beneficiaries who contributed for the construction of the scheme give more emphasis for the protection of the scheme. It indicates presence of stronger sense of belongingness and ownership towards the irrigation site. Statistically significant and positive correlation is depicted between groups which use micro-dam irrigation water and having guard. The expectation is that, the structure of modern micro-dams has reservoirs, spill way, different outlets, canals (main, lateral and sub-laterals) which needs higher protection from external as well as internal damage caused by individuals and cattle.

As we can see from the above table the inverse Mills ratio is statistically significant at 5% level. This indicates that there is a sample selection bias. Since we use sample selection model, it was tested and controlled.

7.1.3. Presence of and paying for water distributors in the communal managed irrigation sites, 2006/07

As can be shown from Table 7.1., groups which are found in Atsbi are strongly and positively associated with having water distributor in the irrigation scheme, but negatively correlated with contributing for the service he gives (1% statistical significance for both) than groups which are found in Ada'a. It suggests that the presence of *Abo-Mai* is a common phenomenon in schemes that are found in Atsbi. It also indicates that how immense role he plays in the irrigation water distribution system in Atsbi. Moreover, it also implies that how social capital helps to reduce the cost of attaining and enforcing collective action in the communal irrigation sites of Atsbi.

We also found that irrigation water beneficiaries are more likely to have water distributor at intermediate number of households. Perhaps the reason might be at low number of households, the cost of having water distributor is large. Therefore the probability of having water distributor becomes low. Similarly, at high number of households the probability of having water distributor becomes low, because for one person it becomes very difficult to monitor very large number of population. Instead it might be wiser (effective) to put group leaders in charge for monitoring and controlling irrigation water distribution in every block. Besides, as the number of households increases, it is less likely to contribute for the water distributor.

The result also shows that the greater the proportions of households who have used formal credit in the group, the higher the probability to have and pay for water distributor. Higher proportion of households whom the primary source of livelihood is irrigated agriculture is positively associated with presence of water distributor and on their payment (statistically significant at 1% and 5%, respectively). It implies that obtaining higher benefits from irrigation water use appreciates collective action. Groups with larger TLU (wealth measurement indicator) have positive association with contributing for water distributor.

Years of experience of irrigation water use is positively correlated with having water distributor in the scheme. It witnesses that through time beneficiaries have understood the benefit of having a person who is in charge of the whole water distribution system by simply selecting individuals who are influential local leaders who give services. It also shows that the importance and viability of social capital in community managed resources. Groups with more frequent provision of trainings are significantly and more likely to have water distributor. The reason is that they can understand the benefit more easily and are more open to access of information than groups with less frequent of provision of trainings.

Group members were also asked to categorize, what percentage of the soil coverage was considered good by them in their groups' farm land. Soil type which has the capacity of absorbing medium amount of water was considered 'good' by beneficiary farmers. Higher proportion of land in good soil has positive and statistically significant association with employing for water distributor (at 1% statistical significance level). These findings are consistent with the argument that having better agricultural potential increases the benefit of using irrigation water and thus the value of managing the resource well, which appreciates collective action. Similarly, communities with good adequacy amount of rainfall are significantly and more likely to have a person in charge of water distribution.

With regard to access to market and *tabia* development post, groups which are closer to town market are more likely to have water distributor. In addition, being closer to village market and *tabia* development post have positive correlation with contributing for the payment of the water distributor.

From scheme level factors, communities with greater presence of local organizations have higher probability of having water distributor. Besides, presence of external organizations in the community managed irrigation schemes increase the likelihood of having water distributor. It indicates that external organizations may increase the benefit of collective action management by introducing profitable opportunities and new technologies to beneficiary farmers. Statistically significant and negative correlation is depicted between groups which use micro-dam irrigation water and having water distributor. The expectation is that because of the presence of modern structure that can be easily handled by group leaders, the water distribution-related problem is less in micro-dams as compared with other types of irrigation schemes. Therefore, the importance of having water distributor becomes less.

As expected, the inverse Mills ratio revealed that there is correlation between the two error terms (for the dependent variables- whether there is water distributor in the scheme and whether members contribute for the water distributor), but it is taken care of by the coefficient in the second stage –'the selectivity term'.

7.2. Analysis of the Determinants of Failure of Collective Action

7.2.1. Determinants of Violation Occurrence of Restricted Rules and Regulations

The estimated regression results of the determinants for frequent violation occurrence of rules and regulations is presented in Table 7.2. There is no statistically significant association between regional dummies and number of violation occurrence. Unexpectedly, occurrence of violation of use rules and regulations is positively associated with total number of beneficiaries in a group but negatively associated with total number of beneficiaries squared. This implies that an inverted U- shaped relationship between number of households in a group and collective action. This finding indicates that larger number of beneficiary farmers in a group leads to greater scarcity which increases number of violation occurrence. At higher scarcity and ecological stress institutional arrangements often breakdown as people scramble for survival and discount rates which leads to increasing 'exit options' of irrigation users. They keep only the membership title in WUA but unable to use the resource due to high number of households (since they are unable to use the water, they can't violate the rules). As a result, number of violation occurrence start to decline. The turning point where maximum expected number of farmers is almost 225 households /group. It is within the range of total number of beneficiaries in a group which ranged from 4 to 280 households in Atsbi and 8 to 297 beneficiaries /group in Ada'a[33]. However, this is only an *ex-post* hypothesis to explain a result that we did not expect[34], and further research would be needed to confirm or reject the hypothesis.

Higher proportion of female headed households per group has negative association with number of violation occurrence. It confirms the explanation farmers and the executive committee gave us during focus group discussion about women's performance in the irrigated agriculture. Women understand the rules and regulations just as equal as male irrigation water users and keep it as more than their male counter parts, implying its remarkable importance to make policy implication.

One of the most convincing reasons for higher number of violation of rules and regulations is larger proportion of beneficiaries at the tail-end (at 1% significant level), which causes for irrigation water scarcity (least secure water supplies) and longer hours of cleaning of canals.

[33] *Summary statistics of variables used in the regression is presents in Table 3.3.*
[34] *We expected that as the number of beneficiary household increases number of violation of rules and regulations will be high.*

Table7.2.1.Determinants of frequent violation occurrence in community managed schemes, 2006/07

Explanatory Variable	Coefficient	t	p>/t/
Regional Characteristics			
Woreda, cf.,Ada'a	-7.287844	-1.20	0.233
Group Characteristics			
Total number of households in the group	0.6140693***	6.22	0.000
Total number of households in the group squared	-0.0013674***	-4.94	0.000
Proportion of female headed households in the group	-11.54029*	-1.70	0.091
Proportion of literate headed households in the group	-3.296027	-0.58	0.563
Average family size in the group	0.0023655	0.00	0.998
Proportion of households who have used formal credit in the group	-0.035994	-1.17	0.245
Proportion of households who have included in the agricultural extension programme	-20.53341	-0.78	0.439
Proportion of households whom the primary source of livelihood is irrigated agriculture	0.7578805	0.15	0.879
Total irrigated area in the group	0.2715149	0.9	0.368
Total agricultural land in the group (non-irrigated land)	0.2185159	-1.88	0.159
Tropical livestock unit for the group	0.0048166	1.42	0.822
Proportion of beneficiaries at the tail-end	35.70082***	3.9	0.000
Year of experience of irrigation water use, no.	0.0941158	1.01	0.315
Provision of training, no.	-2.064542**	-2.48	0.014
Farm Characteristics			
Proportion of soil coverage considered good by the group in the catchment area	-4.436368*	-1.88	0.063
Village Characteristics			
Whether rainfall adequacy in the village is considered good by the group	-8.307804	-1.45	0.148
Walking time from that group's specific irrigated land to(in hours)			
Town market	0.0212133*	1.94	0.054
Village market	-0.1590093*	-1.92	0.057
Development post	0.0928955	0.99	0.325
Scheme Characteristics			
Whether the irrigation scheme was promoted by the external organization	3.679401	1.58	0.116
Number of external organization(s) which are(is) operating currently in that specific irrigation site	0.0934963	0.06	0.949
Number of local organization(s) which are(is) operating currently in that specific irrigation site	1.265134	0.87	0.386
Whether there was farmers' participation during construction of the whole structure	6.163928	1.26	0.209
Type of irrigation system dummy, cf., communal ponds			
Micro-dams	-7.707983	-0.87	0.384
River diversion	-11.74274	-1.44	0.152
Spring water use	-6.625995	-0.64	0.524
Shallow well	-16.53446	-1.33	0.185
_Cons	26.78845	0.82	0.414
Type of regression	OLS		
Number of observation	169		
F(28, 140)	29.69		
Prob > F	0.000		
R-squared	0.6271		

***statistical significant at 1%; ** statistical significant at 5%; * statistical significant at 10%

The result of regression analysis also shows that groups with more frequent provision of training experienced lower number of violation occurrence at 5% level of significance. It suggests that human capital and access to information favor for collective action. One more provision of training for beneficiary farmers, decreases number of violation occurrence by 9% per group. Thus, provision of training expansion by both governmental and non-governmental organizations will have a remarkable impact on enforcing of use rules of collective action in both study woredas.

Expectedly, farm characteristics are also important determinants for the frequent occurrence of violation of by-laws. Higher proportion of land in good soil is associated with lower number of violation occurrence in year 2006/07. A unit increase in proportion of soil coverage considered ‘good’ by the group in the catchment’s area decreases the number of violation of restrictions occurrence by 4 number of times per group.

Access to markets has a mixed effect. There is more frequent violation occurrence in groups closer to village market. Being further by an hour (walking time) from the village market implies 15% less violation occurrence. The possible reason might be groups closer to village markets most likely scramble for maximizing their benefit from irrigation water use without considering the rules. As a result, there might occur higher number of violation of rules. Groups closer to the woreda town market also experienced less frequent violation of rules and regulations. Being closer to the woreda town market by an hour (walking time) implies 2.1% less occurrence of violation.

Table 7.2.2.Tobit /Tobit Decomposition Results – Determinants of the Failure of Collective Action in Community Irrigation Water Management, 2006/07
Number of conflict occurred in 2006/07

	Marginal Effects		
Explanatory Variables	1 Latent Variables	3 Conditional on being Uncensored	4 Probability Uncensored
Regional Characteristics			
Woreda, cf.,Ada'a	-5.035339 (8.409348)	-3.666065 (6.17193)	-.0672957 (.11023)
Group Characteristics			
Total number of households in the group	.4870427*** (.1090967)	.3513605*** (.07973)	.0066967*** (.00172)
Total number of households in the group squared	-.0013044*** (.0003321)	-.000941*** (.00024)	-.0000179*** (.00001)
Proportion of female headed households in the group	-18.72516** (7.842905)	-13.50863** (5.696920	-.2574672** (.11172)
Proportion of literate headed households in the group	9.39432 (6.189696)	6.777215 (4.46446)	.12917 (.08701)
Average family size in the group	-1.77056* (.9559716)	-1.27731* (.68953)	-.0243448* (.01357)
Proportion of households who have used formal credit in the group	.1657701 (3.866335)	.1195892 (2.78918)	.0022793 (.05316)
Proportion of households who have included in the agricultural extension programme	10.97963 (28.80865)	7.92088 (20.782)	.1509677 (.39667)
Proportion of households whom the primary source of livelihood is irrigated agriculture	1.305513 (3.728566)	.9418182 (2.68928)	.0179505 (.05135)
Total irrigated area in the group	.505004* (.2982261)	.3643181* (.21557)	.0069437* (.00419)
Total agricultural land in the group(non-irrigated land)	.2330373 (.1652178)	.1681169 (.11927)	.0032042 (.00231)
Tropical livestock unit for the group	0055565 (.0243579)	.0040085 (.01758)	.0000764 (.00033)

Table 7.2.2. continued

Marginal Effects

	Marginal Effects		
Explanatory Variables	1 Latent Variables	3 Conditional on being Uncensored	4 Probability Uncensored
Proportion of beneficiaries at the tail-end	31.66201***	22.84148***	.4353463***
	(9.451805)	(6.85976)	(.1413)
Years of experience of irrigation water use, no.	.1082202	.0780718	.001488
	(.1317924)	(.09509)	(.00182)
Provision of training, no.	-2.822012***	-2.035845***	-.0388021***
	(.7500963)	(.54685)	(.01136)
Farm Characteristics			
Proportion of soil coverage considered good by the group in the catchment area	-3.81969	-2.755586	-.05252
	(4.405514)	(3.18131)	(.06084)
Village Characteristics			
Whether rainfall adequacy in the village is considered good by the group	-5.561101	-3.980742	-.0786816
	(8.30507)	(5.89241)	(.12191)
Walking time from that group's specific irrigated land to(in minutes)			
Town market	.0124345	.0089704	.000171
	(.0131478)	(.00949)	(.00018)
Village market	-.2379589***	-.1716674***	-.0032719***
	(.0912393)	(.06613)	(.00132)
Development post	.1992439**	.1437377**	.0027396**
	(.097155)	(.0703)	(.00138)
Scheme Characteristics			
Whether the irrigation scheme was promoted by the external organization	.28171	.2033986	.0038628
	(2.835483)	(2.04927)	(.03876)
Number of external organization(s) which are(is) operating currently in that specific irrigation site	2.597125*	1.873608*	.03571*
	(1.427277)	(1.02923)	(.02023)
Number of local organization(s) which are(is) operating currently in that specific irrigation site	.9038073	.6520212	.0124272
	(1.71336)	(1.2363)	(.02361)
Whether there was farmers' participation during construction of the whole structure	-17.29776***	-10.72948***	-.3503727**
	(5.847238	(3.07866)	(.15195)

Table 7.2.2. continued

Explanatory Variables	[1]Latent Variables	[3]Conditional on being Uncensored	[4]Probability Uncensored
Type of irrigation system dummy, cf., communal ponds			
Micro-dams	4.387408	3.063705	.0669518
	(12.85366)	(8.67663)	(.21636)
River diversion	1.585662	1.159462	.0208243
	(12.64176)	(9.36703)	(.15841)
Spring water use	2.254329	1.680774	.0275922
	(14.65023)	(11.271)	(.15809)
Shallow well	-20.37767	-10.10033**	-.5389041
	(13.44198)	(4.088060	(.41277)
_Cons	-25.44499		
	(37.22276)		
/sigma	12.23234		
	(.7399531)		
Type of regression	**Tobit**		
left-censored observations at nconf<=0	25		
uncensored observations	144		
right-censored observations	0		
Number of observation	169		
LR chi2(28)	127.78		
Prob > chi2	0.0000		
Pseudo R2	0.0984		
Fraction of sample above the limit and adjustment factor for unconditional expected value: **$(\Phi(z))$**	.852		
Fraction of mean total response above limit and adjustment factor for cases above limit: **$(1-z\varphi(z)/\ \Phi(z)-\varphi2(z)/\ \Phi2(z)$**	.63152		
Adjustment factor for cases at the limit **$(\varphi(z)/\sigma)$**	.0192928		

***statistical significant at 1%; ** statistical significant at 5%; * statistical significant at 10%

[1]Latent variables give ordinary Tobit results, [3]Conditional on being uncensored value shows the effect of the independent variable for cases with a non-limit values on the dependent variable and [4]Probability on uncensored indicates the effect on the probability of having a non-limit value for cases with the limit value of the dependent variable.

7.2.2. Determinants for Conflict Occurrence in Community Managed Irrigation Schemes, 2006/07

The estimated result of the Tobit model and the decomposed Tobit coefficients of the determinants for conflict occurrence are presented in Table 7.2.2. From the total of 169 observations, only 144 groups had experienced conflict related to water distribution issues in 2006/07, so the proportion of cases above the limit (i.e., zero in our case) **($\Phi(z)$)** is 0.85.

As shown in the table, there is no strong correlation between the regional dummies and number of conflict occurrence in 2006/07. Related to household factors, we found that conflict occurrence is positively associated with total number of households per group, but negatively associated with total number of households squared. This finding suggests an inverted U-shaped relationship between total number of households in a group and number of conflict occurrence. The turning point in this relationship is nearly 196 households per group; within the range of number of households observed (the range in our case is from 4 to 297 households per group). Possibly it indicates that, as the number of households increases, the resource becomes scarcer and unable to be shared as the members want. As a result number of conflicts increases but after some point it begins to go down. This witnesses that as number of households grows to very high levels, the gains from collective action may be outweighed by the incentive problems associated with it. As rising scarcity increases, the benefit from attempting to 'free-ride' on the efforts of others also increases. Consequently, 'exit options' increases, users start to frustrate and leave to co-operate but keep only the membership title which has a negative impact on number of conflict occurrence. Similar to the previous section (determinants of number of violation occurrence), we did not expect this relation[35]. Further research is needed to accept or reject the *ex-post* hypothesis.

With regard to, proportion of female headed households, we found that groups which have larger proportion of female headed households experienced less number of conflicts. This witnesses in stead of arising conflicts frequently, women contribute to solve their irrigation-related problems through informal discussions. This result is both statistically and qualitatively significant. This suggests that policy intervention is needed to encourage women's participation in farm, forum and leadership level (in both WUC and conflict resolution committee) in all irrigation schemes.

Average family size in a group is also negatively correlated with conflict occurrence at 10% level of statistical significant. This means that groups which have larger average family size have experienced less number of conflicts in water distribution use. Perhaps, it is because of great availability of family labor to contribute as much as collective action demands which decreases the probability of conflict occurrence and 'free-riding' problem in the irrigation sites. Increase in average family size of a group by a unit, results in an expected decrease of 1.2 units of conflict in groups that have already experienced a conflict and also 2.4 % lower probability of experiencing a conflict in groups with no conflicts.

[35] *Our hypothesis was as the number of beneficiaries in a group increases number of conflicts also increases.*

Furthermore, another group characteristic which has statistically significant association with conflict occurrence is total irrigated area in a group. That is larger area of irrigated land in a group is more likely to have higher number of conflicts, since it becomes more difficult to monitor the water distribution sequence for group leaders. Therefore, beneficiaries begin to shirk or collude against the use rules which leads to more conflict occurrence. However, it should be noted that even if it is significant statistically the variable has insignificant effect in magnitude implying its less importance to make policy implication.

One of the most important group level factors which the result is both statistically and quantitatively significant is the proportion of beneficiaries at the tail-end in a group. A unit increase in the proportion of beneficiaries at the tail leads to an expected increase of number of conflicts by nearly 23 units in groups that have experienced a conflict. It also increases the probability of experiencing a conflict by 43.5% in groups with no conflict experience. The possible reasons could be the resource becomes scarcer at the tail; as a result beneficiaries scramble to get a share which leads to conflict occurrence. There is also a great of possibility for intervening by other farmers as the water flows from head-end to tail-end fields. The greater cumulative effect of seepage and evaporation losses in delivery canals as fields are more distant from the water source is also another reason for the scarcity of irrigation water at the tail. It also suggests that intervention is needed in those irrigation schemes that have higher proportion of beneficiaries at the tail-end.

With regard to provision of training, there is a negative association with number of conflict occurrence. One more time of training provision by beneficiaries in a group implies an expected decrease change of conflict experience by 2 units and decreases the probability of experiencing a conflict by 3.9% in groups with no conflict occurrence. This might be because of the training helps them to use the water efficiently in wet as well as in dry seasons. The training also enables them to respond more easily for the problem they face through informal ways.

Access to markets also affects the number of conflict occurrence, though the effects are mixed. Groups closer to the village market have experienced higher number of conflicts. Possibly it is because of high demand of irrigation water. Being 1 hour further from the village market implies an expected decrease in the conflict occurrence by 0.17 unit in groups that have experienced a conflict and also 0.33% decline in the probability of experiencing a conflict in groups with no conflict experience. On the other hand, conflict has been occurred less frequently in groups closer to *tabia* development post.

Concerning scheme level characteristics, groups with greater number of external organizations are positively and statistically significant associated with higher number of conflict (10% significant level). This evidence supports the hypothesis that the presence of external organizations may undermine collective action if they are providing substitutes for collective action. We also found that as the number of external organizations increases by one unit, increased expected conflict occurrence by almost 2 units in groups that have experienced a conflict and increase in the probability of experiencing conflict by 3.6% in groups with no conflict experience.

As expected, farmers' participation during construction of the whole structure of the irrigation scheme and number of conflict experienced in 2006/07 have negative correlation. It is statistically (at 1% significant level) as well as quantitatively significant. Each additional unit participation of farmers implies 10.7 units expected decline of number of conflict occurrence in groups that have already experienced a conflict. 35% less probability of experiencing a conflict occurs per farmers participation, in groups with no conflict experience. The most interesting implication of this result is that, it may serve as one type of policy instrument to increase effectiveness of collective (community) managed natural resource. In terms of irrigation system type shallow well dummy found to be negatively associated with frequent number of conflict occurrence as compared with beneficiaries who use communal lake water for irrigation purpose.

Note that the expression in Table 7.3 **(1-zφ(z)/ Φ(z)- φ2(z)/ Φ2(z)** a numerical value of less than 1.00, i.e., 0 .63152 is the fraction of the total effect of an independent variable that is attributable to the effect of being above the limit(McDonald and Moffit 1980). Put simply, in our case, only about 63% of the total change in number of conflict occurrence, resulting from a change in the independent variables, in groups that had conflict. Whereas, about 37% of the total effect of the independent variables is generated by changes in the probability of experiencing a conflict in groups with no conflicts.

7.3. Analysis of the Determinants of Enforcement of Penalty System

Following all these results, one thing we should consider is devolving rights to local communities to manage resources, i.e., establish use rules and regulations is only a necessary condition for successful community resource management. Sustainable resource management also requires that the community rules are enforced.

As shown in Table 3.2, almost 95% of the groups in the study area have their own formal written restricted rules. It includes the penalty system (punishment if some one from the WUA is found out not to abide by the rules). In addition, on average nearly 23 number of times per group in year 2006/07 violation of rules and regulation had occurred (with 2 a minimum value and 72 a maximum value). However, the number of times the penalty system applied has a mean value of 4 times per group (with 0 as a minimum and 28 as maximum value). This leads to the question of what are the determinant factors of enforcement of penalty system. We will discuss it in the following section.

Table 7.3.Tobit/Tobit Decomposition Results – Determinants of Effectiveness of Collective Action on Community Irrigation Water Management, 2006/07.
Number of Penalty exercised in 2006/07 cropping season

	Marginal Effects		
Explanatory Variables	1 Latent Variables	3 Conditional on being Uncensored	4 Probability Uncensored
Regional Characteristics			
Woreda, cf.,Ada'a	11.89077*** (3.129638)	6.556517*** (1.65821)	.7737188*** (.14347)
Group Characteristics			
Total number of households in the group	.0105169 (.0214443)	.0062018 (.01266)	.0007203 (.00147)
Proportion of female headed households in the group	.9746128 (2.724429)	.5747295 (1.60746)	.0667499 (.18661)
Proportion of literate headed households in the group	.1497064 (1.950338)	.0882819 (1.15007)	.0102532 (.13358)
Average family size in the group	.0264495 (.3127141)	.0155973 (.18441)	.0018115 (.02142)
Proportion of households who have used formal credit in the group	.0402548 (.0338929)	.0237383 (.02001)	.002757 (.00233)
Proportion of households who have included in the agricultural extension programme	4.595077 (9.652505)	2.709719 (5.68971)	.3147108 (.66205)
Proportion of households whom the primary source of livelihood is irrigated agriculture	.9326368 (1.222324)	.5499762 (.72051)	.0638751 (.08394)
Total irrigated area in the group	.0586374 (.0780284)	.0345785 (.04603)	.004016 (.00535)
Total agricultural land in the group(non-irrigated land)	-.0625308 (.0529208)	-.0368744 (.03129)	-.0042827 (.00364)
Tropical livestock unit for the group	.0051532 (.0081646)	.0030389 (.00482)	.0003529 (.00056)

Table 7.3.continued

	Marginal Effects		
Explanatory Variables	[1] Latent Variables	[3] Conditional on being Uncensored	[4] Probability Uncensored
Proportion of beneficiaries at the tail-end	5.009939 (3.058099)	2.954363 (1.80447)	.3431241 (.21126)
Year of experience of irrigation water use, no.	-.0006786 (.0420731)	-.0004002 (.02481)	-.0000465 (.00288)
Provision of training, no.	.5419897** (.2430756)	.3196115** (.14359)	.0371202** (.01694)
Farm Characteristics			
Proportion of soil coverage considered good by the group in the catchment area	.0474522 (.9905721)	.0279826 (.58415)	.0032499 (.06784)
Village Characteristics			
Whether rainfall adequacy in the village is considered good by the group	16.9014*** (3.268852)	10.53624*** (2.03316)	.8593785*** (.08878)
Walking time from that group's specific irrigated land to(in hours)			
Town market	-.0079778* (.004421)	-.0047045* (.0026)	-.0005464* (.00031)
Village market	-.0549612* (.0290206)	-.03241078* (.01707)	-.0037642* (.00202)
Development post	-.1059926*** (.0320375)	-.0625039*** (.01885)	-.0072593*** (.00229)
Scheme Characteristics			
Whether the irrigation scheme was promoted by the external organization	-1.512739* (.8855637)	-.8770504* (.50704)	-.1064902* (.06417)
Number of external organization(s) which are(is) operating currently in that specific irrigation site	1.657044*** (.4960262)	.9771596*** (.29505)	.1134888*** (.03513)
Number of local organization(s) which are(is) operating currently in that specific irrigation site	-.4523449 .5786978	-.266748 (.34164)	-.0309805 (.03972)
Whether there was farmers' participation during construction of the whole structure	1.690883 (1.773824)	.9466532 (.94064)	.1255824 (.14151)

Table 7.3.

continued

	Marginal Effects		
Explanatory Variables	[1]Latent Variables	[3]Conditional on being Uncensored	[4]Probability Uncensored
Type of irrigation system dummy, cf., communal ponds			
Micro-dams	8.376642* (4.383649)	3.981087** (1.70444)	.6660501** (.30028)
River diversion	11.78554*** (4.297464)	9.058153** (3.67628)	.4253279** (.10626)
Spring water use	3.141721 (5.30952)	2.188808 (4.24391)	.1480139 (.14802)
Shallow well	-8.654913 (4.444963)	-2.984805 (.79237)	-.7110354 (.20176)
_Cons	-28.80875** (13.09756)		
/sigma	4.008876 (.25278)		
Type of regression	Tobit		
left-censored observations at nconf<=0	35		
uncensored observations	134		
right-censored observations	0		
Number of observation	169		
LR chi2(28)	89.23		
Prob > chi2	0.0000		
Pseudo R2	0.0996		
Fraction of sample above the limit and adjustment factor for unconditional expected value: **(Φ(z))**	.792899		
Fraction of mean total response above limit and adjustment factor for cases above limit: **(1-zφ(z)/ Φ(z)- φ2(z)/ Φ2(z)**	.5731		
Adjustment factor for cases at the limit**(φ(z)/σ)**	.07696299		

***statistical significant at 1%; ** statistical significant at 5%; * statistical significant at 10%

[1]Latent variables give ordinary Tobit results, [3]Conditional on being uncensored value shows the effect of the independent variable for cases with a non-limit values on the dependent variable and [4]Probability on uncensored indicates the effect on the probability of having a non-limit value for cases with the limit value of the dependent variable.

The estimated results of the Tobit model and the decomposed Tobit coefficients for determinants of effectiveness of penalty system in community managed irrigation schemes, 2006/07 is presented in Table 7.4. Among the total of 169 observations, only 134 groups had exercised penalty for the violation of rules and regulations occurred during 2006/07, so the proportion of cases above the limit(that is, zero in our case)**($\Phi(z)$)** is 0.79.

We found that there is a positive and very significant association between regional dummies and number of penalty applied (at 1% statistical significant level). That is groups which are located in Atsbi had applied the penalty system more often than groups which are found in Ada'a. Perhaps, there has been strong informal code of conduct for long period of time in Atsbi. Groups which are found in Ada'a have 77.8% lower probability of applying penalty system.

Not surprisingly, provision of trainings and enforcement of penalty system in year 2006/07 are highly and positively correlated (at 5% level of significant). This result is consistent with the previous findings in this study, provision of training on collective action. One more time provision of training implies 3.7% higher probability of exercising a penalty system, in groups with no penalty had exercised. This indicates that groups which have received more frequent training better understand the whole purpose of imposing and enforcing use rules and regulations. They may be more aware of the benefits of applying penalty system on effective utilization and sustainable use of the resource. This gives support for recommendation that more frequent provision of trainings to beneficiary farmers will have a remarkable and positive impact on increasing the benefit of collective action.

In areas where there is adequate amount of rainfall, less use of the penalty system is observed. This finding is consistent with the argument that higher agricultural potential may lead to higher labor opportunities and wages, hence higher costs of collective action. Access to market also affects the number of penalty system enforced. Groups closer to town market, village market and *tabia* development post had exercised more penalty system. Probably, beneficiaries have more access to information and also understand the benefit of imposing rules and regulations on irrigation water use to produce more market oriented crops, which they can sell it in those markets.

In relation to scheme characteristics, the study shows that the initial involvement of external organization (whether the scheme was promoted by external organization or not) has negative association with penalty enforcement. Perhaps, it is due to the fact that external organizations might displace local collective action. On the other hand, number of external organizations which are operating currently in the irrigation sites has a positive correlation with the number of penalty system applied. The most interesting implication of these results is that over time external organizations seem to understand their role in communal natural resource management. In stead of displacing local organizations, they are seeking to provide trainings and technical assistance to beneficiary farmers which are complementary to local collective action. Every unit change in number of external organizations in that specific site implies an expected change of a unit in application of penalty systems in groups that have already applied the penalty systems. It also results in 11% less probability of exercising the penalty system in groups with no penalty enforcement. With respect to irrigation system type, micro dam and river diversion dummies are positively associated with number of penalty system enforcement.

Note that the number in Table 7.4, 0.5731 is the fraction of the total effect of an independent variable that is attributable to the effect of being above the limit. Therefore, nearly, 57% of the total change in number of penalty system had been enforced, resulting from a change in the independent variables. It is generated by marginal changes of the positive penalty system exercised. While about 43% of the total effect of the independent variables is associated with changing the probability of enforcing penalty system in groups with no conflicts.

7.5. KEY FINDINGS AND IMPLICATIONS

Here we summarized key findings with regard to our hypothesis, the previous chapters and their implications.

Regional Characteristics

Our findings revealed that, collective action is more prevalent and more effective in irrigation water users of Atsbi than Ada'a. Irrigation water users in Atsbi have enforced the penalty system in more number of times than beneficiaries who live in Ada'a, even if the number of violation of restricted rules occurred less frequently than Ada'a. Moreover, groups which are found in Atsbi are strongly associated with having water distributor without payment. Instead voluntary labor compensation from beneficiary farmers during harvesting is common (an activity which demands higher labor use). This implies that how social capital reduce the cost of enforcing collective action in communal managed natural resources.

Group Characteristics

Our result is consistent with the hypothesis of an inverted U-shaped relationship between number of beneficiary farmers in the group and dependent variables- having and paying for guard and water distributor. It has also U-shaped relationship between beneficiary farmers in a group and average annual contribution per household. These findings give us evidence that at low levels of number of beneficiaries, the demand for collection action to manage resource will be low and average annual contribution per household is high. However, as number of beneficiaries' increases, increasing the resource scarcity will increase the benefits of improved resource management, for example by hiring guards and water distributor. Average annual contribution per household also declines. While, as number of irrigation water users grows to very high levels, beneficiaries begin to compete to use the resource, conflicts may arise frequently. Transaction costs for attending and enforcing rules also increases and becomes difficult. Violation of rules and regulations can be intensified and the 'free-rider' problem increases. In this case the gains from collective action may be outweighed by the incentive problems associated with it. Finally, beneficiaries start to give up and leave to co-operate. They only keep the title of water user, without getting the benefit.

Higher proportion of female headed households in a group is associated with less average value of household contribution. This suggests that both financial and labor constraint appears to be a greater concern for female headed households. On the other hand, in groups where there is high proportion of female headed households, number of violation and conflict occurrence decreases. In addition to this, higher proportion of women farm decision makers in the group increases the likelihood of having and contributing for guard. This is an indication of their attempt to compensate labor constraints by hiring guards. This suggests policy intervention is needed to encourage the participation of women in farm, forum (in WUA) and leadership level of WUA and conflict resolution committee.

Our evidence also shows that better education status and collective action have strong negative association, in both statistically and qualitatively. This finding is consistent with the hypothesis that better education status tend to undermine individuals incentives to co-operate by increasing the opportunity cost of labor or by offering more 'exit options'. Expectedly, we found that larger family size favors collective action. It is positively correlated with household contribution and negatively associated with conflict occurrence, since groups with larger family sizes can provide labor as much as the irrigation agriculture demands.

Previously, we hypothesized that agriculture extension and formal credit programme would encourage collective action. However the evidence presented that, it is access and using of formal credit that has positive and strong association with collective actions.

Probably because of credit is primarily used to purchase inputs like variety of seeds, fertilizer, pesticides, herbicides…, which are complementary inputs for irrigation water.

Of the various group level factors, total irrigated area is one of the variables, which were hypothesized to affect collective action. It has strong positive association with hiring of guard. In addition, it is positively associated with frequent occurrence of conflict. This indicates that as the irrigated land size increases the importance of hiring guard to protect the sites will be more crucial. However, as the same time monitoring and enforcing of transaction cost may rise, beneficiary farmers begin to shirk or to collude against the use of rules which leads to frequent conflict occurrence.

We also find that groups which have larger size of land for agriculture (rain-fed) and with higher TLU have positive association with having and contributing for both guard and water distributor. This suggests that contributing for guard and water distributor relates to affordability issue. Thus, groups with a better physical resource are more likely to employ guard and water distributor than those with few physical resources.

Our evidence shows that one of the most convincing reasons for collective action failure is large proportion of beneficiaries at tail-end. Perhaps the reason might be the increasing scarcity of the irrigation water at tail-end due to greater possibility of intervention of other irrigation users at the head and middle. In addition, there could be greater cumulative effect of seepage and evaporation losses of more distant plots from the water source. It suggests that intervention is needed in those irrigation schemes that have higher proportion of beneficiaries at the tail-end. Years of experience of irrigation water use increases the likelihood of having water distributor. This implies that through time beneficiaries have realized the importance of having water distributor.

The regression result also shows that provision of training is positively associated with employing both guard and water distributor. One more time training provision for farmers implies an expected decrease change of conflict experience by 2 units in a group. It also decreases the probability of experiencing a conflict by 3.9% in groups with no conflict occurrence. In addition, it is positively correlated with penalty system application. These findings are consistent with the argument that more frequent provision of training favors collective action. It helps beneficiaries to understand easily the whole purpose of imposing and enforcing rules and regulations. It also enables them to be aware of how to use the water more efficiently which has a positive effect on sustainable utilization of the resource. An important point that should be noted is, it is not being literate or not, that is leading to more collective action, rather it is provision of training that favors collective action. Thus, more frequent provision of trainings by governmental and non-governmental organizations for farmers will have a remarkable and positive impact in increasing the benefit of collective action.

Farm Characteristics

Higher proportion of land in good soil also contributes to lower frequent violation occurrence. The number of violation will be lower by 4 units per unit additional in proportion of land in good soil. It also increases the likelihood of employing water distributor, implying higher agricultural potential favors collective action.

Village Characteristics

The study found statistically significant evidence, in areas where there is adequate amount of rainfall, less use of the penalty system is observed. Probably because of divergence of interests in rain-fed agriculture, hence higher costs of collective action, This finding supports the hypothesis that higher agricultural potential may also lead to higher labor opportunities.

Mixed effect is observed, with respect to market access on collective action. Groups which are closer to village markets are correlated with higher number of conflict experience and violation occurrence. Possibly it is because of high demand of irrigation water. Being further by an hour from village market implies 15% less violation occurrence, 17% decrease in conflict occurrence in groups that have experienced a conflict. Moreover, groups which are closer to the town market are more likely to have guard and water distributor. In addition, being closer to village market and *tabia* development post have positive correlation with contributing for the payment of the guard and water distributor. Besides, groups closer to town market, village markets and *tabia* development post have higher tendency of applying the penalty system.

Scheme Level Characteristics

The study showed that initial involvement of external organization in the promotion of the irrigation scheme has negative association with number of penalty system exercised. Perhaps initially the external organizations in the irrigation sites might displace local collective action. Communities with greater number of external organizations make higher annual contribution per households. Average value of annual household contribution increases by 25 *Birr* per additional number of presence of external organization which is operating currently in that specific irrigation site. It also increases the likelihood of having water distributor. It suggests that the presence of external organization increases the benefit of collective action by increasing awareness of profit opportunities and new technologies in the irrigation scheme. Greater number of the presence of local organizations has high probability of having and contributing for both guard and water distributor. This finding supports the hypothesis that local organizations may favor collective action due to possible learning effects of how to enhance benefit from collective action.

As hypothesized previously, community participation during the construction of the irrigation scheme has a positive impact on collective action. It increases the likelihood of hiring and contributing for guard than communities who did not participate at all. That is an indication of the existence of stronger sense of ownership and belongingness. It is also negatively associated with frequent conflict occurrence. This suggests that it may serve as one type of policy instrument to increase effectiveness of community managed resources.

In terms of types of irrigation system dummies, groups that are located in river diversions contribute more than groups that are found in communal lakes. In addition, statistically significant positive correlation is depicted between groups which use micro-dam irrigation water and having guard and negative correlation with having water distributor. The expectation is that the structure of modern micro-dam needs higher protection of external as well as internal damage caused by individual and cattle, but less water distribution related problems exist because of the presence of modern structures that can be easily handled by group leaders.

CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATION

8.1. Conclusions

Improved access to agricultural water supply plays critical role in the sustainable livelihoods of rural people. Irrigation is one of the options which increases yield and output, facilitates diversification, reduces vulnerability and creates employment opportunities. Community natural resource management (for instance in the case of communal irrigation water) is increasingly recognized as a viable alternative to privatization or state ownership of the resource. As a result, local level resource management institutions and organizations to enforce them are receiving greater attention. Irrigation water development in Ethiopia during the imperial and military regimes focused on the development of large scale irrigation schemes. This trend was reversed by the current government, which emphasized the development of small-scale schemes. Since then many new small-scale communal irrigation schemes have been constructed. In addition, the old ones also have cleaned up and rehabilitated and handed over to the community. However, the history of irrigation development in Ethiopia has been characterized by emphasis on technical and engineering aspects, with inadequate attention accorded to policy, institutional and socio-economic factors.

In this study, methodologies including descriptive, qualitative and econometric analysis are used to analyze the institutional arrangement for water distribution mechanisms and to identify factors that determine collective action for provision and appropriation of irrigation water. Besides, group discussion has been undertaken at different levels to grasp more detailed information from beneficiaries. Interview has been done with experts on irrigation issues from different governmental and non-governmental organizations. In addition, woman participation at farm, association and leadership level was assessed.

In Atsbi, under 221.1 ha of land, there are 14 irrigation schemes which constitute 1855 beneficiary households. On the other hand, in Ada’a there are a total of 2059 irrigation water beneficiaries in 8 communal managed schemes, which covers on 960.5 ha of land. Each irrigation scheme is a common property resource that is owned and managed by the community. Each scheme has its water users association (WUA), which is administered by water users committee (WUC). In addition, there are water courses representatives at the outlet (block) level, which are called group leaders. They are 94 in Atsbi and 75 in Ada’a.

Collective action in managing irrigation water generally functions well in both study areas, which supports the role of community resource management as effective water distribution mechanisms. Our evidence revealed that farmers have started to grow crops which were not previously grown in the areas. It was also found that it has also a positive impact on their income as well as on the living standard of their families. In addition, through time beneficiary farm households depend more on the production from their irrigated fields, which enabled them to harvest more than once a year round.

Our finding is also consistent with the argument that irrigation agriculture demands more labor person-days than rain-fed agriculture. In year 2006/07, the average labor person-days used for households in the irrigation sites in Atsbi was around 98 person-days/ha and around 86 person days/ha in Ada'a. This figure is well above as compared to the average 55 person–days/ha and 53 person-days /ha labor needed for rain-fed agriculture in Atsbi and Ada'a, respectively.

Our findings revealed that, collective action is more effective in irrigation water users of Atsbi than Ada'a. They have enforced the penalty system in more number of times, even if the number of violations of restricted rules has occurred less frequently than among irrigation water users of Ada'a. Moreover, groups which are found in Atsbi are strongly associated with having water distributor without payment. Instead voluntary labor compensation from beneficiary farmers during times of harvesting is common (an activity which demands higher labor use). This implies that how social capital reduce the cost of attending and enforcing collective action in communal managed natural resources.

Our evidence is consistent with the hypothesis of an inverted U-shaped relationship between number of households in a group and collective action, for dependent variables-hiring of guard and water distributor. Moreover, we also found U-shaped correlation between household number in a group and annual average value of contribution per household.

Expectedly, collective action is more prevalent and more effective in groups with larger family size. The expected reason is that farm households with larger family size can supply more labor as much as the irrigation agriculture demands both individually (in farm activities) and collectively (in clearance and maintenance of canals and the whole infrastructure).

We also found that access to market is associated with higher probability of having guard and exercising the penalty system more frequently, which favors collective action and its effectiveness. However, on the other hand, higher number of conflicts and violation of rules are observed. The reason might be excess demand for irrigated land and water in those places, where they can enable to sell what they produce very easily.

Though women (wives) are found to be significantly involved in irrigated agriculture in male headed households, the revenue generated from irrigation agriculture is entirely controlled by men. On the other hand, large proportion of female headed households in the study areas quit to practice irrigation due to excess burden in the household, financial problem and unsafe timing of irrigation water use. This result also supports the econometric result. There is negative association between higher proportion of female headed households and annual average value of a household contribution for the resource management. It implies that financial and labor constraints appear to be a greater concern for women farm decision makers. Moreover, higher proportion of female household heads has significantly positive relationship with hiring guard and water distributor, indicating their attempt to compensate labor constraints they have by hiring labor. The participation of women in association and leadership level is very low, because of the prevailing gender ideology among the community, which women are considered to be less capable in their understanding. However, the estimation result reveals that higher proportion of female household heads has negative relationship with occurrence of conflict and violation of rules and regulations. This implies that women's higher capability to solve irrigated related problems through informal discussions.

In addition, the findings of the study imply that collective action for irrigation water management may be more beneficial and more effective in areas with intermediate number of beneficiaries, in areas that are close to market and credit access, in groups that have longer years of experience in irrigation water use, in groups with larger family size, in communities with larger number of local organizations, and in schemes where there was participation of beneficiaries during construction of the scheme.

8.2. Recommendations

At the aggregate level, we found that producing crops using communal irrigation water has positive impact on the net revenue of the community. Therefore, to mitigate the erratic nature of rainfall and to cope up with the ever-increasing food demand of the population of the country, development and implementation of small-scale communal irrigation schemes will be helpful to promote productivity and production of farm households.

In addition, both qualitative and quantitative results of the study show that collective action in managing irrigation water generally functions well in both areas. This indicates that it can be one option to combat the risk of "tragedy of commons" in managing the common pool resource- irrigation water. Therefore, effort should be done to increase effectiveness of collective action in both areas to use the resource in more sustainable way.

From cost-benefit analysis, we still observe that productivity of irrigated land is also affected by input use such as variety of seeds, fertilizer, pesticides, herbicides and other important inputs. Hence, institutional interventions should be made on the availability of support services such as credit extension, input supply and marketing, especially in areas such as Atsbi which are remote from most infrastructures. The benefit found from the marketable crop started to be grown, depends on market and infrastructure accessibility. Thus, efforts should be made in improvement of infrastructure as well as in creating a market linkage.

In both study areas local routes such as associations and conflict resolution committees are preferred by local communities from formal ones. This is because of the existence of a stronger sense of identity and belongingness than in the formal set-ups. Therefore, attention should be given to such informal institutions to strengthen their capacity and in creating strong linkage with the formal institution arrangements. Through time the demand for irrigation water increases among beneficiary farmers. Therefore, assigning of water rights and strengthening organization and operation of WUAs will be very essential for further efficient use of the common pool resource.

Our evidence shows that number of provision of trainings favors collective action. Thus, more effort should be exerted by both governmental and non-governmental organizations to provide training more frequently to enhance the understanding of beneficiary farmers on how to use the irrigation water efficiently and to raise awareness towards the purpose of enforcing the rules and regulations.

The major factor for failure of collective action is high proportion of beneficiaries at the tail-end. It is highly correlated with frequent occurrence of conflict and violation of restrictions. Therefore, intervention should be needed in order to expand the capacity of the scheme, in those sites that have higher proportion of beneficiaries at the tail-end. Our findings also suggest that, in communities that are remote from markets or high group size, private –oriented approaches to resource management may be more effective.

In addition to active involvement of beneficiaries in the design and implementation stage, pre-feasibility and feasibility study is needed before the construction of a long-term infrastructure such as communal irrigation scheme. This helps to avoid frequent destruction and conflict occurrence among different interest groups and enables rapid cost recovery of the resource.

The most disadvantaged group of farmers are female headed households who are found in lower economic status of the community and have a problem of family labor constraints. Moreover, the participation of women in WUA and leadership levels is limited due to the wrong perception existed in the society. Thus, government support will be essential to improve the livelihood of women farm decision makers and effort should be made to raise awareness towards gender equality in the community. In addition, policy intervention is needed to encourage the participation of women at farm, forum (WUA) and leadership level of WUA and conflict resolution committee.

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ANNEX 1.The Written By-Laws in Atsbi

In Atsbi, in all the irrigation schemes the components of the by-law are the same, except the penalty system part. It varies scheme to scheme. The formulated written by-law constitutes three parts.

(i) *Rules and Regulations*- in this section the whole obligations of farmers are stated in the following manner:

1. All irrigation water beneficiary farmers should abide by the stated rules and regulations;
2. All members should cultivate vegetables, fruits, pulses and spices using irrigation water;
3. All farmers have to use fertilizer in order to enhance the fertility of the soil;
4. Every beneficiary must leave half a meter of land as boarder. In this piece of land each farmer must cultivate fruits and forage;
5. Planting eucalyptus and cactus trees is strictly forbidden because it consumes high amount of water;
6. Nobody can walk across the irrigated farm land with his/her cattle along side;
7. It is every farmer's responsibility to protect the whole structure of the irrigation, to clean and maintain the canal and use the water efficiently;
8. For every water distributor and irrigation water guard the payment should be done on the agreed time;
9. Each of the executive committee must handle his/her responsibility/duty efficiently.

(ii) The second section explains the rights beneficiary farmers have;

1. All farmers have the right to use every crop type they harvest;
2. Every beneficiary can sell his/ her products everywhere(market) he / she wants
3. Every water user has the right to vote and to be elected as an executive committee
4. In the general assembly, each beneficiary farmer can raise any irrigation-related issues and can comment on the rules and regulations.

(iii) The third part and the more detailed section is the penalty system for not abiding by the rules and regulations.

1) Each beneficiary farmer is not allowed to cultivate any new types of crops in the irrigated fields[36], without permission from the WUC and/or DA. If so, she/he shall be dismissed from membership immediately;
2) If a farmer is not willing to use inputs on his/her irrigated farm, for the first time he/she shall receive advice. If he/she refuses to accept the advice, complete dismissal of membership shall be followed ;
3) If a water user violates a half meter common border. For the first time she/ he shall be penalized a cash fine. If he/ she refuses, the case shall be discussed in local court;
4) Fruits and forages should be planted on the border's of once plot; otherwise, for the first time he/she shall receive advice. If he/she refuses, he /she shall be penalized in cash. For the third time, the case shall be discussed in front of the general assembly of WUA and decided accordingly;
5) If a beneficiary plants eucalyptus and cactus trees, the case shall be seen in front of the *tabia* court;
6) Walking across the irrigated land with cattle is strictly forbidden. Otherwise, for each kind of cattle or animal there are different levels of penalty systems in cash. If he/she did it consciously the case would be discussed in the general assembly and decide accordingly;
7) Every beneficiary in the scheme has to participate in the clearance as well as maintenance of canals. If not, for the first time he/she shall be penalized in cash and clean the same length of canal as other farmers do. If she/he refuses and do it again, he/ she shall be penalized more amount of money and clean double length of canal. Finally, complete dismissal from membership shall be followed;
8) Beneficiaries must use the irrigation water appropriately. If not, for the first time she/he shall be penalized in cash. For the second time, the case will be seen in local court.
9) All members of WUA should contribute for the salary of water distributor and guards. If not, for the first time he/she will receive advice. If he/she refuses,

[36] *The permission is needed due to farmers can plant new kinds of crops without much knowledge of it. The new type of crop might have a capacity of consuming more amount of water. As a result, the nearby cultivated crops can wither.*

he/she will be forced to pay the double amount and the case will be discussed in front of the general assembly;

10) If the guard fails to protect the irrigation site and similarly if water distributor fails to administer the operation of the water distribution, for the first time the penalty shall be in cash (which varies from scheme to scheme). But afterwards, he shall be fired for good;
11) The executive committee has the responsibility to meet and discuss the operation of the irrigation scheme once a month. If a member of the committee is absent, the penalty shall be in cash. If he/she does it again, complete dismissal from WUC shall be followed;
12) Each beneficiary must attend every meeting. Otherwise, he/she shall be penalized in cash for being late as well as for being absent.

ANNEX-2- The Written By-Laws in Ada'a

In Ada'a the presentation of the written rules and regulations is a bit different from Atsbi. It was also observed that in all schemes the by-laws are the same. The by-laws are divided into seven articles:-

Article 1- states the name of the Water Users Association (WUA),

Article 2- identifies the address of the association,

Article 3–states when it was established and the aims, objectives and vision of the association,

Article 4- duties, responsibilities and obligations of member beneficiaries

This article includes issues such as:

- The beneficiaries have right and obligation to comment, give suggestions and finally decide on the issues forwarded by the executive committee and the performance of the committee.
- Above half of the members should be present to decide on the forwarded issues. If they refuse to do so, the decision shall be done by members who are present.

Article 5- Explains about the rights members have as a beneficiary of irrigation water user. Any beneficiary can-

- vote or can be elected as a executive committee and
- Among members of the executive committee, if a member misuse the available resource of the association for his/her individual need, she/he shall be judged in front of the general assembly and local court.

Article 6- (1) *obligations of beneficiaries as the water user*

All members-

- should abide by the rules and regulations;
- have to contribute (money) annually within agreed time;
- If a farmer refuses to participate in any provision of collective action (cleaning, maintenance and construction of canals), he/she shall be penalized a cash fine set by the WUA.
- If any beneficiary refuses to abide by the rules and regulation, she/he shall be dismissed from membership for good.

(2) Duties and responsibilities of the executive committee.

The WUC has 5-7 committee members with their own duties and responsibilities. These are:

1. Chairperson
2. Treasurer
3. Auditor
4. Secretary
5. Cashier
6. Members.

And finally, article 7 states that -

a) Every beneficiary farmer should contribute 12 Birr/year. If she/he fails to do so, he /she shall be forced to pay with penalty.
b) Every 15 days, the committee members have a meeting and the general meeting will be held quarterly. The penalty system in cash exists in absence or being late from meetings.

Declaration

I, the undersigned, declared that this theses is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

Declared by

Name__________________________

Signature______________________

Date___________________________

Confirmed by Advisor:

Name _________________________

Signature _____________________

Date___________________________

January 2008