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Institutional Analysis of Water Management on Community Irrigation Systems in Ethiopia: "The Case of Kalu Wereda S/Wollo Zone Amhara Region,Harbu"

Economics

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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 district of kalu south wollo,Ethiopia. Results are based on data collected from survey of 169 community and 98 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 is used. Analysis of qualitative information supplemented the econometric results. The incorporation of data source is necessary to enrich the research by diversifying the source of the data to achieve the objective.

Introduction

Background of the Study

Ethiopia is the second most populous country in sub-Saharan Africa, with an estimated population of over 80 million. In order to meet the food needs of its rapidly growing population, the country needs to double the 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 mount, it was estimated that there would be about 1707 m3 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 demand in Ethiopia. Irrigation can also stabilize agricultural production. Ethiopia indeed has significant irrigation potentially. 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 (Gebremedhin and Peden, 2002).

Statement of the Problem

In rural Ethiopia, communities depend significantly on common property resources 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 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 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) and distributional (equity) 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 in developing countries.

General objective: To analyze the institutional and organizational aspects of irrigation water management in kalu district, Ethiopia.

Specific objectives:
To analyze institutional and organizational arrangements of irrigation water management

To evaluate agricultural returns at each irrigation scheme;

Investigating factors influencing collection action for irrigation water.

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 & 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 the capacity of water management organizations could help for efficient and equitable distribution of irrigation water for beneficiaries, thus contributing to increase 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.

In addition, the study also may have the following benefits:
Significance to Policy making and planning: - The issues of water management in community irrigation are the major policy challenge. In this study, by identifying the gaps of water management system in the study area, it will be used as a roadmap for the local government counsel to form the rules and regulations without contradicting institutions policy.

Significance to Academic:- The study will be seek to contribute to better theoretical understanding about the communal irrigation system in promoting better water irrigation management system in the town . The academic significance of the study is to transcend (additional inputs) for policy makers, administrators, city planners, kebele leaders and community members for existing literature on the subject matter and provides as comprehensive and scientific basis explanation on research for communal irrigation system.

Methods
Description of the Study Area's
The data for the analysis is obtained from a community-level survey in kalu wereda South Wollo zone amhara Region.

Kalu is one of the district in South Wollo zone Amhara region which is located about 364 km north of the capital Addis Ababa. This study relies on primary cross-sectional data collected in 2014/15cropping season that is obtained from five types of semi-structured community level questionnaires. All *tabias which* have irrigation projects operated during the study period, 2014/15cropping season were included in the study. In other words, during the study period, 15 irrigation projects ware operated in kalu district harbu. Irrigation schemes will included in the study. The questionnaires will administer at *tabia (kebele)*, scheme and group levels. There are 15 groups of beneficiary farmers [*mesnomahber in harbu]*. *Mesnomahber* 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 13-28 number of beneficiaries in the district. 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 is a community level questionnaire on 98 groups. 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 the woreda. 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.

As the study concerned on analysis of institutional management on community irrigation system only subjected to kalu wereda. To conduct the study thoroughly both probability and non-probability sampling techniques were used. From the probability sampling type, random sampling was used for the households living in communal irrigation area. This minimize biases and to ensure representativeness of the study. Non-probability sampling was used purposely to choose representative sample farm households.

Rural Population is a universe from that the sample frame,

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sample plan, and unit of analysis are extracted from total population 14181 of living in the area (*kalu* wereda, 2014 /2015). In this study, simple random sampling technique was employed to select a representative of sample household units. Therefore, this study used 205 sample households who are chosen randomly.

Primary and secondary data collected from sample households and appropriate published and unpublished data using semi-structured and pretested interview schedule and questionnaire. Data collected through a well prepared and pre-tested interview and questioners scheduled that well administered to the respondent by the train enumerators. The sample for the study selected in the three stages. The first way the purposive selection of sub metros followed by the random selection of electoral area within the selected sub metros.

Secondary data was collected from *kalu* wereda agricultural office regarding to institutional, organizational and socio-economic aspects of communal irrigation to support the primary data. Different officer and personal contact also use to obtain additional information.

Institutional analysis of community managed irrigation systems are very complex. Usually these kinds of resources are frequently characterized by multiple users. 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 a 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.

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.

The data was analyzed by using both descriptive statistics and econometric analysis techniques.

Variables used in the model

Description of Dependent variable; in this study the dependent variable used is the collective action of households for irrigation water measure in the amount of households contribution interims of cash, labour and kind for irrigation management, construction and maintenance in the community level scheme irrigation participation.

Description of Exogenous (explanatory variables); those are factors which determine the dependent variable communal farm household contribution for irrigation. Those variable can be grouped as: one, the demographic characteristics of the household which include age of household head, gender of household head (male vs female), household size, and educational status of household head. Economic variable includes farm size (land holding) value of live stock (in birr), annual years farm income (in birr), and participation in off-farm activities. Third institutional and other related variables including, access to market, access to credit, access to extension services, and other related variables.

Result and Discussions

Table.1. Summary Statistics of households socioeconomic attributes

Explanatory Variables	Obs	Mean	Std. Dev.	Min	Max
Age of household head	205	41.25854	14.50411	19	71
Family size	205	3.809756	1.75396	1	9
Gender of household head	205	.4097561	.4929925	0	1
Household marital status	205	1.468293	.6825698	1	3
Education level of household head	205	.3512195	.47852	0	1
Livestock value(birr)	205	8269.073	7513.498	213	35642
annual yield(birr)	205	20698.08	8088.554	4256	41320
Distance to market (minute)	205	28.19512	14.01018	5	67
Land holding (timad)	205	4.582927	2.145692	.75	9
Size of irrigated land (timad)	205	.8539106	.6686279	0	3
Irrigation experience(years)	205	5.026738	3.354396	0	13
Access to credit	205	.3902439	.488999	0	1
Farm households users of In organic fertilizer	205	.5686275	.4964863	0	1
Land certificate	205	.6146341	.487873	0	1
Household member participation on off-farm activities	205	. 4780488	. 5007407	0	1

Source: owns computation based on survey result, 2015

Irrigation Typology in the study area

In the study area majority of irrigation typology is river diversion which accounts 64.38 percent from the available irrigation scheme followed by spring water use (21 percent), communal leak (10.27 percent) and miro-dam which contributes a smaller proportion of irrigation scheme in the study area.

Table 2. Irrigation Typology in the study area

Irrigation Type	Freq.	Percent	Cum.
Micro-dam	5	3.42	3.42
River diversion	94	64.38	67.81
Spring water use	32	21.92	89.73
Common leak	15	10.27	100.00

Source: owns computation based on survey result, 2015

Institutional and organizational arrangements of irrigation water management in kalu district

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.

Also 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), controllers and other members. It also embraces a water distributor, 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. There are 16 irrigation unions (Mesnomehaber) in kalu wereda, who is working agricultural intensive production in cash crop such as Tomato, Potato, Onion and maize.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.

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.

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

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.

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.

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 districts, 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 district and tabia irrigation experts revealed that beneficiary farmers always try to over-irrigate their fields thinking that more water results more yields.

Agricultural returns from Community Irrigation system

Usually, community irrigation system provide relatively higher crop yield as compared to those households who have not access to community irrigation system. In order to see the statistical difference among irrigation user and non user with respect to annual average crop yield using two sample t-test statistical hypotheses. As we can see from the result below, even though there was a quantitative difference between average crop yield among groups, there is no statistically significant difference between irrigation user and non-user with relation to average crop yield in the study area because the (P-value is 0.57) which is greater than 5 percent confidence interval.

Table.3. Agricultural return (average crop yield per year) from community irrigation

Group	Observations	Mean	Std. Err	p-value
Irrigation user	168	20751.76	604.23	
Non-user	37	20454.35	1525.7	
Combined	205	20698.08	564.92	
Diff		297.4	1472.366	0.57

Source: owns computation based on survey result, 2015 **Econometric Analysis**

Determinants of collection action (contribution of households for communal irrigation water)

In the previous section, we have dealt mainly with description of sample households' socio economic characteristics in the study area. Identifications of these factors alone are however not enough unless the relative influence of each factor should be statistically determined. In this section, censored Tobit econometric model was used to see the relative influence of demographic, socio-economic and institutional variables on sample households' willingness to contribute (in cash, labour, and kind converted to local currency birr) for communal irrigation system in the study area. Tobit model used maximum likelihood estimation to explain the relative effect of independent variables on the dependent variable.

Out of the total hypothesized variables, three of them were found to be statistically significant in affecting contribution to communal irrigation system. Others which failed to discriminate the contribution of sample household for communal irrigation construction management and maintenance (collective action). All the above mentioned variables are found in line with our prior expectations.

Value of average annual crop yield: From the Tobit estimation result average annual crop yield value was found to be significant at 10% and positively related to collective action (contribution of construction and maintenance for communal irrigation). This implies that, on average, as the annual crop value increase by one birr, the contribution to collective action of communal irrigation is increases. In other words, as the value of crop yield increases by one birr, the amount of collective action contribution increased by 0.2 percent of marginal effect depicted the result below table (4.4). This is possible because, as farm income increases their contribution to communal irrigation is also increases through enhancing farm households' financial access and capacity to pay for mechanized form of agricultural activities.

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Access to credit: The estimation result also revealed that, access to credit was statistically significant at 1% probability level and negatively correlated with collective action to communal irrigation. This shows that, farm households who have not access to credit are less capable to contribute for collective action compared with farm households who have access to credit. The marginal effect with respect to access to credit depicts that, controlling other variables; lack of credit reduces the contribution to collective action by (71.186) marginal effects. This might be plausible reason lack of access to credit adversely affect payment for communal irrigation because of the fact that credit is an important input for agricultural intensification, irrigation expansion and purchase of other farm inputs.

Size of irrigable land: Also Tobit estimation result shows that, size of irrigable land is statistically significant at less than 1% significance level and positively related with farm households' contribution to communal irrigation system. As the size of irrigable land increases by one timad, the contribution for communal irrigation increases by 149. 294 marginal effects. This implies that farm households who have large size of irrigable land are expected to pay relatively large amount of money to communal irrigation. Consequently, contribution to communal irrigation is directly related with the size of irrigable land those farm households have using for different crop production such as potato, tomato and paper.

Table.4. Tobit estimation result for determinants of collective action for communal irrigation

Dependant variable: farm household Collective action measured in birr						
Explanatory variables	Coeff.	Marginal effects	Std Err.	t	P>|z|	
genderhh*	20.414		16.557	28.949	0.71	0.482
Agehh	.112		.091	1.029	0.11	0.913
Hhsize	.-5.061		-4.093	8.251	-0.61	0.541
hheduclevel*	8.246		6.680	27.966	0.29	0.769
Avannyild	.002		.002	.001	1.71	0.089 **
Tlvalue	-.00005		.0004	.0016	-0.03	0.976
hhpart~m*	-37.889		-30.678	27.019	-1.40	0.163
credit~s*	-90.002		-71.186	27.882	-3.23	0.002*
infert~r*	8.353		6.753	26.729	0.31	0.755
distto~e	-.558		-.451	.989	-0.56	0.573
irriga~d*	223.642		149.294	39.224	5.7	0.000*
Irrigexper	-.975		-.788	4.162	-0.23	0.815
_cons	88.851	-	-	80.851	1.11	0.269
Tobit regression Log likelihood = -1031.0312 sigma 163.28 9.207 145.0869 181.48 Obs. summary: 0 left-censored observations 158 uncensored observations 1 right-censored observation at collective~n>=895				Numbers of observation 159 LR chi2(12) = 43.17 Prob > chi2 = 0.0000 Pseudo R2 = 0.0205		

Source: owns computation based on survey result, 2015

* Significant at 1 percent ** significant at 10 percent

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Conclusions

According to the result of descriptive analysis, the average age of sample household is 41.2 years; the average family size of farm household is 3 individuals. And also, on average the value of crop yield and livestock is 20698.08 and 8269.07 birr respectively. Also, the average distance to the nearest market is 28.12 minute which is short to transport farm output and inputs. From the result also, farm size (land holding) is the single most important endowment, as it is a base for any economic activity especially in rural and agricultural sector. The survey result showed that, the average land holding of sample households was found to be 4.5timad (1.125 hectares) with a standard deviation of 2.1timad. This figure lowers than the national figure, which is 1.5 hectare implying in the study area land holding is low. However, farm households access to irrigation on average is (0.81) timad which is very small amount of land size which used communal irrigation. Out of the total sample household, only (0.61) of them has land certificate on average to secure their land security and sustainability status.

Irrigation experiences also affect the collective action of community irrigation system and also affect farm households' willingness to pay for construction, maintenance, and management of communal irrigation system. On average sample household head have almost 5 years irrigation experiences which may help them to keep construction of new communal irrigation system and enhancing their collective action on irrigation systems.

As stated in many empirical literatures, access to modern farm input such as in organic fertilizer (DAP and UREA) enhance farm productivity. From the survey result, the average farm households who are using in organic fertilizer are (0.56). Similarly, access to credit is another important input for agricultural productivity and also helps farm household to pay the debt for contribution of collective action. Since, farm households usually face credit rationing due to short fall of finance and farm households are subject to lack of collateral and riskiness of agricultural investment. On average (0.47) members of farm household participate on off-farm activity to support their farm activities and household consumption expenditures.

The econometric result of Tobit model analysis on collective action (contribution to communal irrigation) indicated that, average annual crop yield and size of irrigation land are positively correlated to contribution to communal irrigation. However, credit accesses are negatively related to communal irrigation system.

Thus, it is possible to conclude that; as the value of crop yield increases by one birr, the amount of collective action contribution increased by 0.2 percent of marginal effect. This is possible because, as farm income increases their contribution to communal irrigation is also increases through enhancing farm households' financial access and capacity to pay for mechanized form of agricultural activities. And also, irrigable farm size increases by one timad, the contribution to collective action increase by 149. 294 marginal effects. However, lacks of credit inversely affect communal irrigation contribution.

Recommendations

Average annual crop yield are positively and significantly determine the contribution of collective action for communal irrigation. Since contribution to collective action mainly requires farm income which supports the financial need for farm households. Therefore, government and other development partners support other income generating activity

in supporting farm household which enhance contribution for collective action payment.

As discussed in the result section, lack of access to credit negatively and statistically affect the collective action contribution for communal irrigation system. Therefore, financial access should be promoted and making smooth rules and regulations in taking credit.

The result also revealed that size of irrigable land increase contribution to collective action. This means a one timad increase on an irrigable land results an increase contribution to collective action for communal irrigation system. Thus, it is recommended that other than contributing equal amount of money for collective action progressive payment has been made according to the size of the land that individual farm household behave.

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