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Full Length Research Paper

Small-scale irrigation and household wages relationship: Proof from Deder district, Ethiopia

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Investment in irrigation development is an important strategy in reducing risks associated with rainfall variability and achieving food security. This study examines the link between small-scale irrigation and household income. It also presents inherent institutional challenges in water allocation and the unintended outcomes. It used cross-sectional data obtained using a sample of 150 respondents selected through multi-stage sampling techniques from Deder district in eastern Ethiopia in 2009/2010 cropping year. The data were analyzed using Heckman-two step econometric models. The probit estimation shows that sex of the household head, access to credit and extension services have significant positive effect whereas the financial constraints restrains participation in irrigation water utilization. The ordinary least square using household income as outcome variable reveals that credit access, livestock holdings and proportion of land allocated to irrigation have significant positive effect on household income. This indicates that the more land is allocated to irrigation the higher will be the income. Moreover, the study pointed out that local institutional failure was a more important challenge than hydrological factors in managing the irrigation system. This has a policy implication in terms of strengthening the institutional environment.

Key words: Deder, irrigation, income, Heckman model, institutions.

INTRODUCTION

Farmers in poor areas have suffered from chronic poverty and severe food insecurity being vulnerable to climatic changes and dependant on variable rainfall. This is mainly attributed to a low level of agricultural productivity. Such low productivity areas are characterized by persistent rural poverty, and increasing population pressure has often resulted in a vicious circle of poverty and environmental degradation (Von Braun et al., 2008). As many of the low productivity areas have untapped water resources, irrigation development is being suggested as a key strategy to enhance agricultural productivity and to stimulate economic development (Bhattarai et al., 2002). In the contemporary literature, irrigated farming is recognized as central in increasing land productivity, enhancing food security, earning higher and more stable incomes and increasing prospects for multiple cropping and crop diversification (Hussain et al., 2001; Smith, 2004). In some places, cereal production more than doubled between 1995 and 2001 due to the combined effect of expansion of irrigation and the use of high-yielding varieties and fertilizers (Hussain and Hanjra, 2004). Further investment in complementary infrastructures (credits, extension and markets) can produce a spillover effects to neighboring farmers (Abonesh et al., 2006).

It was also claimed that Ethiopia cannot assure food

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security for its population with rain-fed agriculture alone without a substantive contribution of irrigation (Van Den Berg and Ruben, 2006). In the past 15 years, various efforts have been made by the country's government to expand community-based irrigation development, particularly small-scale irrigation. The country's government also prepared a Water Sector Development Program (WSDP) to be implemented in 15 years between 2002 and 2016. This program assigned a prominent role to the development of small-scale irrigation and its governance in the country for improved food production (MoWR, 2002). A heavy reliance on irrigation as a land-saving technology is often envisaged as an effective strategy in managing the risk associated with food production and in achieving food security. Modern small-scale irrigation schemes use technologies for irrigating up to 200 ha and are constructed by the regional governments or NGOs with active involvement of farmers. They are generally based on direct river diversions but they may also involve micro-dams for storage. The area equipped for modern small-scale irrigation in 2002 was about 48,300 ha in which 74,100 farmers were involved. In the same year, there were also traditional small-scale irrigation schemes covering 138,339 ha and involving 572,331 farmers (Awulachew et al., 2005). The operation and maintenance of the schemes in both types are the responsibility of the water users (Makombe et al., 2007). An increase in population and a relative potential land scarcity has created a huge pressure on farmers' access to land. This is particularly the case in Deder district of eastern Ethiopia (Lemma, 2003). Despite a heavy investment in irrigation, its effect of on farmers' income has not been assessed. Therefore, this paper attempts to examine the link between small-scale irrigation and household income by taking the case of Deder district irrigation scheme.

Common pool resources management: Theory and empirics

Common pool resources (CPR) are natural or human-made resources where one person's use of the commons subtracts from its use by others but there is difficulty in excluding access (Cousins, 2000; Ostrom, 2000; Dietz et al., 2002). They share two important characteristics: excludability and subtractability. The first attribute - difficulty of exclusion-arises from several factors including the cost of parceling or fencing the resource and the cost of designing and enforcing property rights to control access to the resource. The second attribute - subtractability - creates rivalry between different users (Cambell et al., 2001). If rights and duties are adequately enforced through common property regimes, CPRs would not always be subject to open-access regime resulting in degradation (Cousins, 2000; Dietz et al., 2002).

Most studies on CPRs till the mid-eighties relied on a similar set of assumptions (Savenije, 2002). Not only did they assume appropriators to be homogenous in terms of their assets, skills and discount rates but they also assumed them to be short-term, profit-maximizing actors who possessed complete information. Other assumptions were that the resource system was open access, appropriators acted independently and that they did not coordinate their activities (North, 1990; Ostrom, 2000). Analysis guided by such presumption consistently predicted that over-harvesting and resource degradation would occur dominated by the "Tragedy of the Commons" that has affected policy decisions in many circumstances. This was the conventional theory of a simple CPR until mounting empirical evidence from the field, contrary to theoretical predictions, suggested that there were many instances when resource users were able to coordinate and prevent the tragedy (Bromley, 1992; Campbell et al., 2001).

Evidence from the field indicated that families of appropriators living together in villages for generations and, expecting to live for more generations, would not have defection as their dominant strategy (Cousins, 2000; Cambell et al., 2001). Users of CPRs in such situations faced a repeated interaction rather than a one-shot prisoner's dilemma game where the likelihood for cooperation to emerge is high (Ostrom, 2001). The degree of communication *among resource users* was believed to be crucial in achieving cooperation in CPR management (Ostrom and Walker, 1997; Agrawal, 2002). Such communication can be vertical and horizontal where the former occurs between resource users and leadership whereas the latter considers communication among members to induce trust and transparency. Practical cases, however, reveal that resource users in many CPR situations have been able to change the structure of the social dilemma by devising a wide variety of rules that they themselves have been able to enforce (Bromley, 1992; Ostrom, 2001). Experimental results also point out that when subjects are given the opportunity to use a costly sanctioning mechanism, this option is frequently exercised and the use of sanctions also increases the level of cooperation (Ostrom, 2000; Dietz et al., 2002). Conventional theory is unable to explain why appropriators are willing and able to bear the costs in overcoming the structural dilemma (related to group size, face-to-face communication, exit options and heterogeneity among users) by monitoring and enforcing their own rules (Ostrom, 2001).

As a CPR, withdrawal of a volume of water from an irrigation canal means that there is less water for another to use and once the system is in place it is difficult to exclude users from its benefits (Bromely, 1992; Mehta et al., 2001). If exclusion cannot be achieved by some institutional design then the problem of free-riding arises. No rational actor would want to contribute to the provision or maintenance of a resource if non-contributors can gain the same benefits as the contributors do without making any contributions (Savenije, 2002). Similarly, the subtractability attribute generates strong incentives for rational actors to maximize appropriation from irrigation water where equity concerns remain unaddressed. Irrigation systems, like all other CPRs, face this fundamental commons dilemma (Ostrom, 2000).

Problems of non-cooperation can be minimized through giving strong emphasis to institutional arrangements which tend to be the outcome of collective choice (North, 1990; Ostrom, 2000; Cousins, 2000). Contemporary evidence on the commons dilemma has shown that resource users often create institutional arrangements and management regimes that help them to allocate the benefits equitably, over a long period of time with minimum efficiency loss (Ostrom et al., 1994; Agrawal, 2002). Institutions work to minimize transaction costs of management and reduce uncertainties by providing a framework through which decisions are made and individuals and organizations interact (North, 1990; Mehta et al., 2001).

Common pool resources are of crucial importance to the poor household to generate income in most rural areas in developing countries, if these are strongly governed by common property regimes (Cousins, 2000). Fitzgerald and Sovannarith (2007) have pointed out that the poor often depend heavily on these resources as their livelihood base, where irrigation as CPR has a redistributive and spillover effect. Common pool resource is also central to many cultural and social activities of poor rural communities (Ostrom et al., 1994; Agrawal, 2002).

A study conducted on distributional impacts of small-scale irrigation revealed that irrigation stimulates agricultural productivity and economic growth, but this comes at the cost of growing inequality. The results of the study concluded that fast development of irrigation stimulated growth without deepening inequality in the long-term (Van Den Berg and Ruben, 2006). A similar finding also revealed that irrigation increases both crop yields and application of mineral fertilizers, which in turn contributes to higher land productivity (Yilma and Berger, 2006). Research on farm-income diversification through improved irrigation shows the role of irrigation in providing substantial benefits for irrigators directly and non-irrigators indirectly. It concludes that irrigation increases households' income, which in turn enabled them to build up their assets (Eshetu et al., 2010). Improved rural infrastructures could reinforce such an outcome (Smith, 2004). Mixed results on household income have been reported. Small-scale irrigation effects on household income can be higher in irrigated than in rain-fed areas; but it can also be lower due to environmental costs (Amacher et al., 2004). This was supported by Lipton and Litchfield (2003) indicating that irrigation is associated with a number of negative externalities. It is important to ensure that these do disproportionately affect poor households ' income. The main negative impacts are on health (increased incidence of water-related diseases) and the environment (water logging and soil salinity) (Angood et al., 2003). In this regard, fundamental questions are being raised on the nature and extent of the effect of small-scale irrigation on household income. Previous research has largely focused on the impact of irrigation in increasing agricultural productivity where system performance was evaluated based on technical and physical interventions (attributes of resources) while ignoring the institutional and social dimensions (Hussain and Wijerathna, 2004). However, the success of an irrigation system is equally affected by the wider social and institutional systems (Haile et al., 2001; Smith, 2004), which can be referred to as 'attributes of users'. As this study aimed to examine the link between small-scale irrigation and household income, there was a need to have a framework to capture the essential elements, summarizing the link among different theoretical concepts (Figure 1).

For instance, attributes of resources such as water scarcity and predictability (of availability) and users' characteristics (competition, heterogeneity along certain socioeconomic variables) can determine the nature of property rights to water and provision rules. The governance groups responsible for defining and enforcing rules could respond to internal demands for water and other environmental factors to refine allocation rules. The entire process could lead to an outcome manifested in terms of interrelated factors (incidence of conflict, equity and income) where fairness in water allocation reduces water-related disputes (Van den Berg and Ruben, 2006; Huang et al., 2009). In using this framework, how users' characteristics determined the structure of property rights and the impact this had on income and equitable water distribution were examined. Though environmental factors affect attributes of resources, analysis did not accommodate the impact of drought due to a data problem.

METHODOLOGY

The study site

The Deder district is located in the eastern part of Oromia regional state (9°09'N - 9°24' N latitude and 41°16'E - 41°32'E longitude). It is located at about 430 km east of Addis Ababa. Rainfall in the study area is characterized by a bimodal and erratic distribution pattern, which gives two cropping seasons, viz. the *Meher* (from July to the end of September) and the *Belg (*end of February to the middle of May*).* The annual average rainfall ranges from 600 to 1200 mm. This district has an estimated total population of 236,236, of which 90.5% live in rural areas. Deder district has a wide range of water sources, both traditional and modern irrigation systems. Traditional irrigation systems have a long history in the district. However, modern irrigation systems were introduced during the *Derg* period, in the 1970s'. Currently, there are a number of traditional and modern irrigation systems throughout the district. The modern scheme has cemented irrigation channels; a design introduced to reduce water loss through seepage. The total

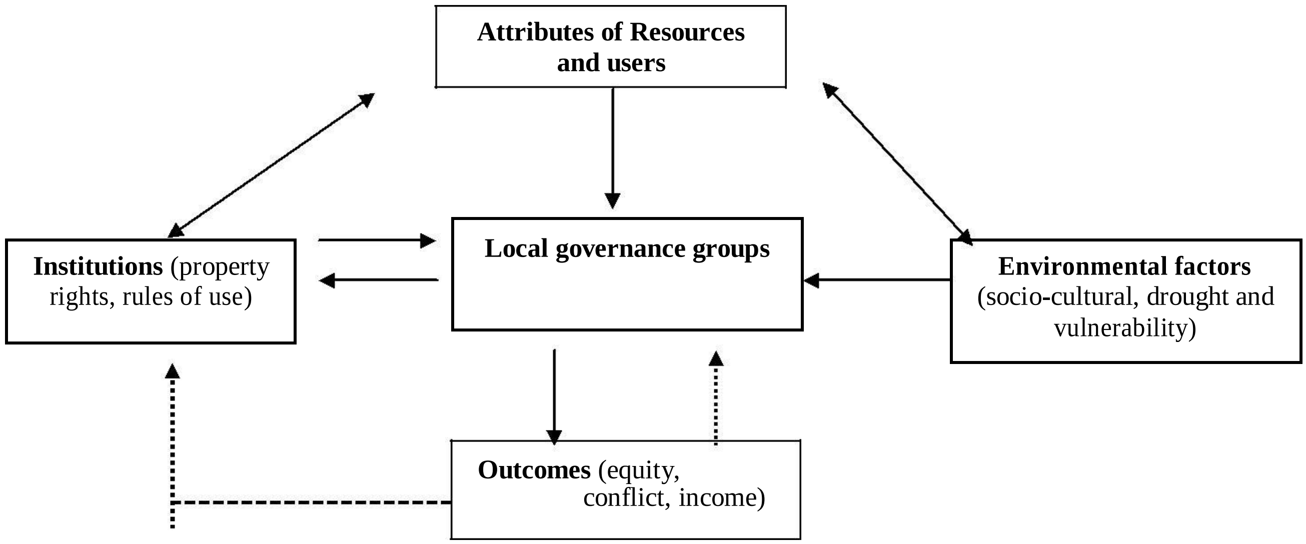

Figure 1. Framework for analyzing the influence of different factors on benefits from irrigation systems.

potential area for irrigation was not exactly known but approximately 15,275 hectares are currently under irrigation with total beneficiaries of 16,590 households. This study was conducted at Babiali, which is one of the spring based modern small-scale irrigation scheme. It crosses Burqageba and Gelan-Sadi Peasant Associations (*Kebels*) and is located 20 km from the district's capital town Deder.

Sampling procedures

A multistage sampling technique was used to select sample households. Deder district was selected due to availability of modern small-scale irrigation schemes. In the second stage, from the modern irrigation schemes, one was selected through discussion with district irrigation experts. Total numbers of households in the irrigation scheme were listed and stratified into irrigation users and non-irrigation users based on the list of households which was obtained from the water users committee. Both irrigation users and non-users in the command area had an equal probability of being included in irrigation utilization. The irrigation project was initially designed to provide access to irrigation water for all community members within the command area. Irrigation users were again stratified in to upstream, middle and downstream beneficiaries based on their location with the basic assumption that there could be inequity in water distribution. This was done to make the sample more representative. Finally, 30% of irrigation users and an equal percentage of non-users were selected using probability proportional to size random sampling. A total of 150 respondents were interviewed based on the 2009/2010 cropping year.

Data collection and analysis methods

Semi-structured questionnaires, focus group discussions and key informant interviews were used to collect the data. Issues covered during the data collection were demographic features, land endowment (holding, leasing, crop sharing), income sources (irrigated and rain-fed farms, others), livestock ownership and access to public services. Focus-group discussions focused on questions related to the institutional dimension such as participation in water users' association, perceptions on operation and maintenance, conflict management over water use and water allocation (equity, rules, coordination).

To analyze data, both descriptive and econometric models were used. Descriptive statistical methods such as frequency, percentage, mean, and standard deviation were used. For categorical variables, a chi-square test was used to test for association. A t-test was used to examine the mean difference between irrigation users and non-users with respect to certain continuous variables. In practice, evaluating the impact of a project on an outcome variable using linear regression analysis can lead to biased estimate if the underlying process which governs selection into a project is not incorporated in the empirical framework. The reason for this is that the effect of the program may be over or underestimated if the program participants are more (or less) able (due to certain unobservable characteristics) to derive benefits compared to eligible non-participants (Zaman, 2001).

Therefore, the Heckman two-stage estimation procedure, which assumes probit in the first step and ordinary least square (OLS) in the second step, is recommended to detect and avoid sample selection biases (Heckman, 1979). Inverse Mill's ratio, or lambda, was obtained from the probit equation and considered as one explanatory variable in the second equation. If its coefficient is statistically significant, selectivity biases are confirmed (Heckman, 1979; Greene, 2000). Based on Greene (2000), the models were specified as:

(i) Participation/probit equation

$$Z_i^* = \sum_{k=1}^{k} \gamma_k W_{ki} + u_i ; \tag{1}$$

$Z_i = 1$ if $Z_i^* > 0$, and $Z_i = 0$ if $Z_i^* \leq 0$

Where Z_i^* = participation decision which has dichotomous realization on Z_i (unobserved), γ_k = unknown parameters of the

Table 1. Association of socio-economic and institutional factors with irrigation water use.

Variable definition	Categories	Users (%)	Non-users (%)	Total (%)	χ^2-test
Sex of the household head	0=female	10	62	27.3	36.79***
	1=male	90	48	72.7	
Perception on land fertility status	0=no	43	44	43.3	0.014
	1=yes	57	56	56.7	
Financial constraints	0=no	74	26	58.0	31.53***
	1=yes	26	74	42.0	
Access to Credit	0=no	36	74	48.0	19.26***
	1=yes	64	26	52.0	
Access to Extension services	0=no	18	68	25.0	16.81***
	1=yes	82	32	75.0	
Access to market information	0=no	64	70	66.0	0.535
	1=yes	36	30	34.0	

*** p< 1%, Source: Survey result (2010).

k_{th} variable to be estimated in the first equation, W_{ki} = variables determining probability of participation in irrigation utilization, u_i = disturbance term.

(ii) Selection /outcome equation

$$y_i = \sum_{s=1}^{s} B_s X_{si} + \varepsilon_i \; ; \qquad (2)$$

y_i is observed only if $Z_i^* > 0$, and the disturbances u_i and ε_i follows a normal distribution with zero means and constant variances and covariance's (σ_{ue}). Where, y_i = the observed value of household income, X_{si} = s^{th} variables determining household income, B_s = vector of unknown parameters of the household income, ε_i = disturbance term.

Lambda was constructed as; $\lambda(-\gamma W_i) = -\phi(\gamma W_i)/1-\varphi(\gamma W_i)$

Where, $\phi(W_i \gamma)$ = probability density function, $1-\varphi(W_i \gamma)$ = cumulative normal distribution function.

RESULTS AND DISCUSSION

Descriptive results

The result shows that greater proportion of non-users is female-headed households, indicating the gender-based bias disfavoring women (Table 1). This is due to cultural biases where female-headed households have limited resource access. Irrigated farming requires the necessary financial capital. A few (26%) irrigation users were constrained financially. Conversely, most of the non-users (74%) were reported as financially constrained. A greater proportion of irrigation users have access to input credit (62%), which was twice higher than that of non-users (26%). Access to input credits can help irrigators to cope up with risks of production failure. However, discussions reveal that some farmers have limited interest in credit due to fear of untimely requests for repayment.

Agricultural extension increases awareness among farmers about new farm activities through demonstrations and discussions. Although extension agents working in the study area were more often engaged in administrative activities than in their real profession, they helped irrigators (82%) more than non-irrigators (32%) in providing technical assistance. The role of extension agents in providing improved varieties of crops and practical training to innovative farmers was crucial. Contrary to the expectation, there was no significant association between participation in irrigation and access to market information. This indicates that an increase in price for fruits and vegetables may not motivate participation as long as farmers grow these crops for subsistence. The overall impression was that improving access to market information could be required to motivate the users to allocate more land for irrigation and

Table 2. Descriptive statistics for continuous variables.

Variable definition	Users (N=100)		Non-users (N=50)		Total (N=150)		t-test
	Mean	SD	Mean	SD	Mean	SD	
Demographic issues							
Age (years)	35.80	6.58	39.80	7.36	37.8	7.08	0.95
Family size (Adult equivalent)	2.40	0.72	2.26	0.49	2.33	0.56	1.84**
Active labor (Adult equivalent)	0.75	0.47	0.71	0.12	0.73	0.39	0.61
Resource endowments							
Educational level(school year)	0.74	1.90	0.98	1.86	0.82	1.95	0.71
Land holding (hectare)	0.89	0.59	0.81	0.39	0.84	0.45	1.34*
Irrigated land holding (hectare)	0.83	0.52	NA	NA	0.83	0.52	
Livestock holding(TLU)	2.63	1.28	1.85	1.10	2.38	1.26	3.74***
Income indicators							
Off-farm income(Birr)	164.30	205.75	270.50	153.26	199	208	0.84
Non-farm income(Birr)	457.33	587.36	323.00	333.63	435	554	0.99
Proximity							
Average plot distance from the water source (km)	0.44	0.32	0.56	0.14	0.49	0.27	0.69

***p < 1%, **p < 5% and *p <10%, NA = not applicable; TLU = Tropical Livestock Unit, Source: Survey result (2010).

non-users to use irrigation.

The results also provide the mean value of some variables for irrigation users and non-users (Table 2). Households with younger, more active labor force had aspirations to adopt new production systems, whereas, older household heads relinquished their irrigable land to their younger descendent and became non-users. The average family size of irrigation users (2.40) was greater than non-users (2.26). This implies that the motivation to invest in irrigation might come from the desire to achieve food security among those with relatively higher family size. Significantly more land as a basic input for farming in this densely populated region was held by users than by non-users of irrigation. This is contrary to the expectation since those with less land were expected to be more sensitive to irrigation to cope with limited land and the need to increase land productivity. The average area of land held by the sample respondents was 0.84 ha. This was far less than the national average holding (1.24 ha) (CSA, 2005).

A further probing disclosed that despite limited landholding, irrigators often obtained additional land through leasing and sharecropping arrangements. Limited availability of grazing land (due to population pressure) could have motivated investment in irrigation in order to grow fodder and use crop residue as animal feed. Such a strategy reduces the pressure on little grazing land. Irrigated crop residues created a good opportunity for large livestock holding. Involvement in livestock fattening (especially oxen) was an important income source. Average distance from the water source had an implication for access to irrigation water. Most farmers used motor pumps to access water, incurring additional costs in purchasing pumps and hose. Because much water was diverted by up-stream motor pump users, there was a decrease in water available to downstream users. Households which were closer to the irrigation source did not incur much labor cost to irrigate their farms. Discussions with the water users' committee members and local leaders indicate that distance of the farm (or plots) from the water source was greater for downstream users than for the upstream users (Table 3). This has an implication on water availability for users with different positions along the course of the irrigation scheme.

Econometric analysis

Results of the econometric analysis using Heckman's two-step model is provided here. The probit results show that gender of the household head had a significant positive effect on the use of irrigation water. Male-headed households had relatively more active labor and were economically better-off. The marginal effect shows that probability of participation in irrigation utilization for male-headed household increased by 27.1% as compared totheir female counterparts, *ceteris paribus*. Previous research results also indicated a similar positive effect of gender on participation in irrigation (Smith, 2004; Van Den Berg and Rubin, 2006), which falls within the broader context of access to productive resources being

Table 3. Characteristics of irrigators with respect to positions along the scheme.

Themes	Positions		
	Upstream users	**Middle**	**Downstream d users**
Type of production	Mainly cash crop producers	Mixed crop producers (both cash and staple crop producers to some extent)	Mostly staple crop producers
Types of crops	Cash crops like; khat, coffee, vegetables, potatoes, tomatoes, onions	Sorghum, khat and vegetables	Maize and sorghum
Household Income	Monthly income greater than 6000 Birr	Monthly income between 3000 and 6000 Birr	Monthly income less than 3000 Birr
Farm distance from the main water source	Less than 120 m from the water sources	120 to 400 m	Greater than or equal to 400 m

1 Birr=0.054 US Dollars.

discriminated along gender in many parts of Africa. Irrigation activities are more capital-and labor-intensive compared to rain-fed farming and needs sufficient cash at hand to increase water use efficiency and land productivity. The marginal effect also showed that the probability of participation in irrigation water use for households which were constrained financially decreased by 47.2% as compared to others which were not. A related study indicated that financial constraint had a negative effect on participation in water harvesting (Molla, 2005) (Table 4).

One means of overcoming financial constraint is improving access to credit because credit access has a direct effect on investment in irrigation. For instance, credit access increases the capacity of irrigators to purchase agricultural inputs and mitigate risks of crop failures. It serves as a crop insurance which helps farmers to be strongly engaged in such costly farming activities. Therefore, it provides startup capital to begin more profitable business to generate higher income. The model predicted that income of irrigators who had access to credit were higher by about 30.3% as compared to others who did not have access. The survey result had shown that income of households which had access to credit was higher by about 413 Birr compared to farmers who did not receive credit.

Provision of agricultural extension services, such as practical training and technical advice on improved production techniques help smallholders to increase their knowhow and access to information. Participants of the field demonstrations are well aware of the advantage of new agricultural technologies and produces. The marginal effect showed that the probability of participation in irrigation for households which had access to extension services increased by 47.3% compared to other households which did not get extension services. This is consistent with others findings regarding the positive relationship between the use of irrigation and access to extension services (Yilma and Berger, 2006; Abonesh et al., 2006). The conditions for access to extension services were not very clear, since the extension agents may have had their own ways of approaching farmers. However, the reason that 68% of the non-users did not have access to extension services remains surprising since such a service is expected to be a public service for which no farmer pays (Table 1).

Considering the result of the ordinary least squares (OLS), the inverse Mills' ratio was not significant, confirming that there was no sample selection bias. This suggests that there was no serious unobservable factor which affected both participation and selection equations simultaneously. This implies that the dependant variables were observed for unrestricted random samples (Table 5).

Households with large livestock holdings could obtain more income from the sale of live animals, animal products and renting. This came from the training received on improved livestock management practices. Moreover, increased availability of crop residues in irrigated lands improved the productivity of livestock where higher livestock holding directly contributed to household income. In this case, a unit increase in livestock holding (TLU) increased the household income by 476 Ethiopian Birr keeping the effect of all other variables constant. A similar effect of livestock holding on household income was observed elsewhere (Bahattarai et al., 2002).

Irrigating large tracts of land also helps to boost agricultural output through intensive production and minimizes the risks through growing two or more crops within a year. The coefficient of the variable also confirmed that an increase in proportion of irrigated land by one hectare increased households' income by about 3826 Birr. A wide range of empirical literature also reported that, where conditions are favorable, irrigation raises the incomes of those farmers with access greater

Table 4. Maximum likelihood estimates of probit model and its marginal effects.

Variable	Coefficient	t-value	Marginal effect
Constant	-0.164	-1.17	-0.0341
Age	-0.3123	-0.75	-0.0923
Age Square	0.018	0.36	0.0091
Gender	0.8419	2.11**	0.2711
Educational level	0.0191	0.21	0.0054
Active labor force	0.3635	0.95	0.1038
Average plot distance from water source	-0.2948	-0.60	-0.0812
Access to extension services	1.4956	3.78***	0.4726
Access to credit	1.0613	3.01***	0.3029
Market information access	0.0549	0.16	0.0155
Farm size in hectare	0.0093	0.04	0.0026
Livestock holding	0.2318	1.64	0.0662
Non-farm income	-0.0012	- 1.62	-0.0003
Land fertility status	0.1623	0.47	0.0464
Financial constraints	-1.3642	-3.82***	-0.4724

Dependant Variable= Participation in irrigation, Number of observations (N) =150, Chi-square = 113.47***, Log-likelihood = -38.74, Restricted log-likelihood=-39.86, Pseudo R^2 = 0.793, ***p< 1%, **p<5%, Source: Household Survey, 2010.

Table 5. Ordinary least square estimates of selection model/outcome equation.

Variable	Coefficient	t-value
Constant	2641.37	1.90
Age of the household head	-16.83	-0.48
Age Square	6.32	0.54
Gender	547.87	0.82
Educational level	53.29	0.52
Active labor force	66.64	0.16
Average plot distance from water source	254.11	0.37
Access to extension services	524.81	0.81
Access to credit	413.34	2.59**
Market information access	207.52	0.51
Farm size in hectare	417.82	0.99
Livestock holding	476.05	2.95***
Non-farm income	0.63	0.58
Land fertility status	29.28	0.09
Financial constraints	-127.82	-0.20
Proportion of irrigated land size	3825.80	4.36***
Inverse Mills ratio	230.91	1.17

Dependant Variable= Household income, Number of observations (N) =150, F-value= 24.04***, R-squared=0.715, Adjusted R-squared = 0.685, *** p<1%, ** p< 5%, Source: Household Survey, 2010.

areas of land (Smith, 2004). In our context, irrigation development boosted productivity and incomes by ensuring adequate water throughout the growing season. This contributed to higher yields and quality (higher farm-gate prices) by eliminating water deficits, providing a means to adapt to climate change (where rainfall is inadequate or too variable) and allowing two to three harvests per year. Irrigation favored the growing of new crops or varieties for which market opportunities exist by improving growing time. Farmers adapt production time to market demand and higher prices through reducing production risks. This would have a consumption smoothening effect and reduce the need to borrow thereby avoiding costs of credit access and indebtedness. It also increased variance in income due to concentration of a higher proportion of output by crop type in the irrigated area. It reduced climate-induced risks and increased returns in the use of complementary inputs, such as improved seed and fertilizer, causing effectiveness in combining multiple farm enterprises around livestock and crops. This situation further increased farm income. In general, further benefits arising from irrigation for smallholders was the appreciation of the value of the land that is being irrigated and enhanced access to credit if the benefit from irrigation had to be reinvested. A further strategy devised by irrigators was to form a cooperative on the bases of types of crops grown, which would enhance their market access and expansion of the irrigation scheme. This was one of the rural development strategies of the country where farmers were organized into cooperatives. This helps to improve marketing services and has been the area of focus in the national growth and transformation plan of Ethiopia. In general, the result was also consistent with the others' findings which indicate the role of irrigation in income diversification, reducing inequality and a general increase in land productivity (Amacher et al., 2004; Eshetu et al., 2010).

DISCUSSION

Based on the evidence from the field, though the benefits from irrigation and the factors determining participation are explained earlier, the role that different social mechanisms play in influencing institutional performance for the irrigation systems management is crucial. As a strategy to manage the irrigation system, each beneficiary in the study scheme was expected to contribute labor for canal cleaning and overall scheme maintenance. Evidence from discussions with water users revealed that variation in users' contribution was observed while corrupt and rent-seeking behavior of committee members further aggravated this variation. This means that those who did not contribute consistently tended to have access to water.

Stealing of irrigation water during night and market days, when the majority of irrigators were off-site, aggravated inequitable distribution of water within each irrigation scheme, reflecting the absence of strict monitoring, which is one of the principles in managing CPRs. This activity was extremely severe at the downstream where turn-takers were far apart and lesser amounts of water were distributed. In this case, weak monitoring, while contributing to trust deterioration, threatened the safety (due to poor maintenance) and sustainability of irrigation schemes. This problem tends to persist as offenders were not held accountable through legal means, mainly due to existing local institutional failure. This indicates that designing institutions (rules of the game) for governing irrigation systems is challenging. It requires skills in understanding how rules produce incentives and outcomes when combined with specific physical, economic and cultural environments. Otherwise the existence of dual structures with respect to property rights arrangements, where some benefit more than others without actually contributing more to the scheme maintenance, will undermine the incentive to invest.

Insights from discussions with water users indicate that an alternative institutional arrangement that provides the right to trade the rights of water use to others without violating the rules of provision and appropriation can prevent the irrigation water from having a public good nature. Such an option to capture the benefit streams from investment in jointly used CPRs enhances member contribution in managing the scheme. Empirical evidence elsewhere indicates that there is no "one best way" to organize irrigation activities, because rules governing the supply and use of any particular physical system must be devised, tried and modified over time (Lam, 1998; Dayton-Johnson, 1999; Makombe et al., 2007; Plunkett et al., 2010).

Clearly defined water rights can easily determine water requirements of different crops and provide for measurement of yearly water supply. In the case of Deder irrigation scheme, appropriation was based on a rotational schedule with limited attention to the amount of water required for different crops. Water was distributed for each turn-taker irrespective of the soil type and time. Complaints of overuse and underuse usually came by simply counting the number of days a particular household used the water. An internal challenge was that socially and economically powerful groups resisted the actions of water users' association committee to clearly enforce the existing bylaws. Hence, it is necessary to invest considerable time and resources in learning more about how various institutional rules affect the users' behavior where these users become heterogeneous in their attributes and capacity to bargain for change in rules.

The contemporary literature shows that when institutions are well-crafted, opportunism is substantially reduced. The temptation to free-ride, emergence of rent-seeking and corruption can never be totally purged, but institutions can be devised in order to hold those factors under control (Ostrom, 1992). In the case of Deder, committee members undertook coordination (monitoring and sanctioning) to reduce opportunistic behavior. Nevertheless, the high cost of monitoring and unfair share of monitoring cost can undermine the complex system of mutual expectations and commitments to manage the resource because all these transaction costs have an implication for the household income from the irrigation system. In addition, water users' experiences showed that social balances of power resulted in resistance to exercising explicit legal frameworks and disturbed the status quo. This shows that heterogeneity within and between groups significantly affects water distribution systems in terms of social and financial asset possessions. This situation further deepens inequality and difficulty in governing irrigation water. The existence of a common set of values is extremely useful in increasing the institutional performance and in controlling free-ride behaviors (Cohen and Pearson, 1998; Trawick, 2001).

A wide range of studies has recently shown that successful CPR management implies inherent institutional arrangements taking into account adequately the role of different factors, all falling into the nature of property rights, attributes of the resource and attributes of resource users including the norms and values shared among them. These values are indeed the "vehicle" of collective learning and the foundations of social order inside the community of water users, as well as instruments of consciousness regarding the necessary institutional adaptation and flexibility (Ostrom and Walker, 2003; Ostrom, 2005; Ostrom and Ahn, 2008). Such values and norms can help address the role of markets and access to improved technologies (such as crop varieties and postharvest facilities) depending on conditions. For instance, relative land scarcity and increase in population motivate adoption of improved varieties, so also does access to markets for vegetables and fruits collectively prompt water users to invest in the postharvest facilities. Hence, while institutions enforced using existing norms and values are serving as transmitters of incentives, so too does market-based technology adoption generate additional incentives to invest in irrigation scheme maintenance. The econometric results display the importance of credit and extension services both paving the path to technology adoption, thus increasing the prospect of income rise from irrigated-farming. An important lesson from this study is that creating efficient irrigation institutions in enhancing farmers' income cannot be realized without addressing the market and technological dimension.

Conclusion

Complementary investment in access to services (credit and extension) plays a substantial and direct role in the use of irrigation water. But differences in financial asset possession, which theoretically are presumed to constrain involvement, adversely affect participation in the use of irrigation water. Credit access, livestock holding and proportion of irrigated land size were critical in having a positive impact in terms of increasing household income. The results suggested that there is an urgent need for overcoming institutional failure as it remains a prime challenge in irrigation water management. There is evidence for the need to strengthen economic capability of female-headed households through improved access to irrigation water. Problems of income inequality and poverty reduction can be tackled if such bias against female-headed households is prevented. The limited capacity of committee members who were expected to enforce allocation rules, urges the intervention of district level decision-makers to correct for the distributional imbalances among water users. These were found to be serious, based on power relations and gender at the community level. Thus, redesigning of institutions to overcome corruption and nepotism in water allocation at community level will contribute to the sustainable management of the scheme. It will also address equity concerns which could otherwise create disincentives for labor contribution.

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