International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 2 (1), pp. 067- 074, January, 2012. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Irrigation versus rain-fed agriculture: Driving for households' income disparity- A study from central Tigray, Ethiopia

Kinfe Asayehegn

School of Environment, Gender and Development Studies, Awassa College of Agriculture, Hawassa University, P. O. Box: 271, Ethiopia. E-mail: kinfe85@gmail.com.

Received December 7, 2011; Accepted January 21, 2012

Ethiopia is endowed with three major resources (Land, Water and Human Labor), an opportunity for intensive agriculture such as irrigation farming. Although small-scale irrigation provides wider benefits for the livelihood improvement of rural farm households, some of them owned irrigation while others not yet, due to different reasons. This irrigation ownership difference leads to household income disparity. To this end, this paper is aimed to analyze the effect of small-scale irrigation on households' income. A two-stage sampling procedure was used to first select peasant associations and then sample respondents. Descriptive statistics and Heckman's two-stage estimation were used to estimate the effects of small-scale irrigation on households' income. The results of the study indicated that in addition to land and livestock, access and utilization to working capital is determinant for irrigation utilization decision that leads to better income. Irrigation users comparatively participate in social positions and owned comfortable residence homes than non-users. Formation of self-help cooperatives and saving-credit associations in rural areas bridges producers with their clientele solving the working capital deficiencies.

Key words: Ethiopia, household, income disparity, irrigation, small-scale.

INTRODUCTION

Ethiopia is the second most populous country in Sub-Saharan Africa with a population of 73.92 million in 2007 (CSA, 2007). It is predominantly an agrarian country with the vast majority of its population directly or indirectly involved in agriculture. It has reasonably good resource potential indispensable for the development of agriculture, biodiversity, water resource, minerals etc yet, it is faced with complex poverty, which is broad, deep and structural (MoFED, 2002 b). Agriculture in the country is mostly small- scale, rainfall dependent, traditional and subsistence farming with limited access to technology and institutional support services (Desta, 2004). Rainfall is erratic and unevenly distributed between seasons and agro ecological regions led to poor yields, low productivity, food insecurity and poverty within the farming population, thus emphasizing the need for irrigation in the region.

Currently, the country is in transition from traditional and manual, rain-fed, supply driven and production oriented agriculture to technology intensive and mechanized, irrigated, market oriented agriculture, through full packages of value addition and post-harvest technologies. To this end, the objective of the growth and transformation encompasses i) achieving a sustainable increase in agricultural productivity and production; ii) accelerating agricultural commercialization and agro-industrial development; iii) reducing degradation and improving productivity of natural resources; and iv) achieving universal food security and protecting vulnerable households from natural disasters (MoARD, 2010). This potentially and intensively utilizes the three major resources (land, labor, and water) for its productivity focused and intensive agriculture. The land resource potential as an opportunity is due to that all the agro ecologies (lowland, midland and highland) are found in which more than 80% of the country is potentially suitable for agriculture while the reasons for labor is that, the country is the second most populous country in Africa with unemployment, under employment and disguised un employment. Similarly, the country is endowed with numerous water sources including the twelve longest rivers such as the Blue Nile. Hence, irrigation is a means

by which agricultural production could be increased to meet the growing food demand. Increasing food demand could be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land and increasing cropping intensity. Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristics of large parts of the country's land and increasing population. Increasing yields in both rain-fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are therefore the most viable options for achieving food security (IWMI, 2005).

Small-scale irrigation is irrigation on small plots where farmers have the majority control, using technologies which they can effectively operate and maintain. The preference for small-scale schemes is based on the perceived easy adaptability of the systems to local environmental and socioeconomic conditions (Vaishnav, 1994). This is the recent shift in the development paradigm to 'development from below', an approach subsumed under 'sustainable development' (Adams, 1990). One of the most important reasons contributing to the current popularity of small-scale irrigation among development planners in much of sub-Saharan Africa are the frequency of drought (Adams et al., 1994).

According, to FAO (2000), irrigation, especially surface irrigation systems are labor intensive than rain-fed agriculture keeping other things unchanged. Therefore, irrigation can increase employment opportunity and income. This, in turn, enables to get access to food by improving purchasing power of individuals. The existence of irrigation can increase income by creating more employment since it is labor intensive. Irrigation can create or increase employment opportunities especially, surface irrigation is found to be labor intensive (Meinzen–Dick, 1993; Web 1991). Farmers' income from irrigated agriculture is significantly higher than incomes from dry land farmers due to dual season production. The levels of input use in terms of quantity and quality are higher in irrigation schemes than in dry land areas, suggesting that there is more intensive crop production in irrigation schemes than in dry land agriculture (FAO, 1997). Similarly, implementation of the three irrigation schemes created equal opportunity of possession of irrigated land among the farmers of the study area in the exchange of rain-fed land, although some of the farm households disregarded to possess parcels in the irrigable section. Therefore, this study attempts to compare the living standard of irrigation users and non-users in terms of their total income, employment opportunity, socio-economic status and livelihood diversification.

RESEARCH METHODOLOGY

Description of the study area

The study was conducted in *Laelay Maichew Woreda*, Central Tigray Regional State, Ethiopia during 2009/2010. Axum, center of the district and the central zone of Tigray, is located at about 1000 km north of Addis Ababa. With an altitude range of 1200 to 2050 meters above sea level, the district is classified into two agro-climatic zones: mid altitude covers 82% and low land, area covers 18% of the total area of the district. According to CSA (2007), the population of the *Woreda* is estimated as 36,191 males and 36,420 females with a total population 72,611. The number of households is estimated 10,857 male and 4,144 female headed totally 15,001 households.

The major crops grown in the area includes teff, barley, wheat, faba bean, sorghum, finger millet, maize, chickpea, and others. Different vegetables and fruits such as tomato, potato, onion, pepper, lettuce, carrot, garlic, and etc. grow in the area using irrigation both at the rainy and dry seasons. Irrigation agriculture is practiced in the district with different sources of water for irrigation. In the year 2009/10 cropping season, a total of 1286 hectares of land has been cultivated through irrigation (BoARD). Three micro dams irrigated 475 hectares, one permanent diversion irrigated 145 hectares, 174 small temporary diversions irrigated 236 hectares, 1067 shallow wells irrigated 178 hectares and 804 ponds irrigated 28 hectares of land. In the irrigation water from micro dams 828 farmers, in one permanent diversion 128 farmers, small temporary diversions 864 farmers, shallow wells 1004 farmers and from ponds 795 farmers, totally 3609 farmers have participated in the practice of irrigation agriculture.

Sample and sampling design

A two stage sampling procedure was followed to first select peasant associations and then sample households. In the first stage, three peasant associations where the three micro-dams were found were selected purposively. Before selecting household heads to be included in the sample, the sampling frame was stratified into irrigation water user and non-user households. The stratum of irrigation user consists of households who own, rented/shared in/out or gifted in land for direct utilization. The second stratum referred to hereafter as non-users is composed of households who neither owned irrigated land nor involved in irrigation farming. In the second stage, 130 farm households consisting of 65 irrigation users and 65 non-users were selected from the identified list using simple random sampling technique taking into account probability proportional to size of the identified households in each of the three selected peasant associations.

Method of data collection and analysis

A structured interview schedule supported by personal observations of physical features was used to collect primary data. The structured interview schedule was triangulated using key informant interview of the irrigation and water resource experts and officers, peasant association managers, and development agents. Moreover focus group discussion of farmers taking one focus group from each scheme was the other approach of triangulating of the primary data. In addition to primary data, secondary data were collected from different sources, published and unpublished documents of respective offices and departments, related journals and books.

Descriptive statistics (mean, frequency, percentage and standard deviation) and Heckman's two stage estimation (Binary Probit at the first stage and Ordinary Least Squares at the second stage) were used to analyze the collected data. The statistical significance of the variables in the descriptive part was tested for both dummy and continuous variables using chi-square and t-test, respectively.

Evaluating the effect of a program, in this case participation in irrigation, on an outcome variable (income) using regression analysis such as logit and probit models can lead to biased

Table 1: Summary of demographic characteristics of household heads.

Sex	User		Nonuser		Total		$\chi 2$
	N	%	N	%	N	%	
Female	8	12.3	18	27.7	26	20	
Male	57	87.7	47	72.3	104	80	3.894**
	mean	**St. dev**	**mean**	**St. dev**	**Mean**	**St. dev**	**T-value**
Education (years)	2.26	2.917	1.49	2.646	1.88	2.801	1.575
Family size	6.43	2.038	5.15	1.946	5.79	2.086	3.653***
Family labor	3.71	1.665	2.57	1.468	3.14	1.665	4.135***

estimates if the underlying process which governs selection into the institution or a program is not incorporated in the empirical frame work. One solution to this problem in econometrics is the application of Heckman's two-step procedures through controlling of sample selection biases (Wooldridge, 2002; Zaman, 2001).

The first stage of Heckman's two stage model is 'irrigation participation equation' that captures the factors governing participation employing a binary probit equation which is not included in this paper, but yielded a precondition for the second stage. This equation is used to construct a selectivity term known as the 'Inverse Mills ratio (Lambda), which is added to the second stage 'outcome' equation or" income". If the coefficient of the 'selectivity' term is significant then the hypothesis that an unobserved selection process governs the participation equation is confirmed.

RESULTS AND DISCUSSION

Socio-demographic characteristics of the ouseholds

Gender of the household heads regardless of the age group is an important variable influencing the participation decision in irrigation. The total sample of the study is composed of 20% female headed households while the portion of female headed households who are irrigation users is reduced to 12% (Table1). Discussion with sample households revealed that male-headed households hardly faced labor shortage for irrigation as well as rain-fed farming due to physical, technological, socio-cultural and psychological fitness of farm instrument to males than females. Similarly, education plays a key role for household decision in technology adoption. It creates awareness and helps for better innovation and invention. The study revealed that 40% of the users and 60.8% of the nonusers of small-scale irrigation are illiterate (Table 1). It is also found that the number of irrigation users who completed nine years of schooling and above is twice as compared to nonusers. The average household size for the users and nonusers of small-scale irrigation is found to be 6.43 and 5.15, respectively (Table 1). This result is statistically significant suggesting labor availability is an important factor influencing households' decision to participate in small-scale irrigation schemes. The result also revealed, as active family labor or work force of a household in adult equivalent increases, the total income of the household increases, which in turn contributed to improved well-being, further providing an evidence for the importance of labor availability in influencing the participation decision of households in small-scale irrigation.

Livestock production and ownership of the households

The increasing in demand for meat, dairy products and eggs than the demand for crops, facilitate for livestock production to increase relatively more rapidly than crops. This is due to the wealth status improvement, purchasing power and basic needs fulfillment. Hence, wealth ranking of the survey and focus group discussions confirmed that rural farm households rank livestock as a key asset, which indicated 92.3% of the users and 70.8% of the non-users of small-scale irrigation rear different types of livestock (Table 1). Livestock mostly oxen serve dual purpose, source of income after sale and draft power that replaces the deficiency of family labor of farm households. It also serves as a source of wealth and reducing vulnerability to risk of drought and crop failure. Although the study area in specific and the country in general is endowed with different quantity and breeds of livestock, the quality and productivity of livestock is very low due to veterinary and health related problems. To this end, the study revealed that except an equal amount of 1.5% of the users and non-users of irrigation, who rear livestock, have an access of animal health service while the utilization is a maximum of 34%. This leads to the low production and productivity of livestock that reduces the returns from the sector.

The survey data also revealed that live grazing, crop residue; hay and fodder are common animal feed in the study area. The non-users of irrigation use fodder in dry seasons while users replaced it with irrigation by-products and feed trees grown as hedgerows and intercropping with the food crops. This increases the

Table 2: Livestock ownership of the farm households in total livestock unit (TLU).

	User	Non-user	t-value
Mean	4.732	2.338	
St. dev	2.802	1.898	**5.703****
Minimum	0.000	0.000	
Maximum	14.985	8.24	
Oxen (mean)	2	1	**4.742****

** Statistically significant at 5% probability level.

Table 3: Distribution of respondents by house type and ownership.

House type	User		Non-user	
	N	%	N	%
Corrugated iron sheet	14	21.5	14	21.5
Soil & stone roofed	5	7.7	5	7.7
Corrugated iron sheet & thatch roofed	19	29.2	18	27.7
Thatch & soil &stone roofed	6	9.2	12	18.5
Corrugated iron sheet and soil &stone roofed	1	1.5	1	1.5
Corrugated, thatch and soil and stone roofed	20	30.8	5	7.7
Living in Rent house	0	0	10	15.4

income of user due to reducing the expenses for feed and improving in productivity as a result of quality feed. Moreover, 36.9% of the users introduced the improved cow breeds due to the reduced fear of risk in feed. The study also revealed that shortage of feed, recurrent drought, lower market prices of local breeds, higher prices of improved breeds and lower productivity of local breeds are the common problems of users and non-users of irrigation in livestock production. Although both users and non-users of small-scale irrigation have the problems of livestock production, the severity of the problems is different for the two groups. Severity of the livestock production problems of the users of irrigation is lower than, the non-user households by nearly half, due to the presence of irrigation by-products, which covered part of the feed expenses.

Housing condition of the sample households

Type and quantity of houses, be it in the village or town owned by farm households determine their level of wealth and livelihood. Corrugated iron sheet, soil and stone roofed and thatch roofed type of houses are common to both users and non-users of small-scale irrigation. Although with three of the house types in severance are similar, the proportion of irrigation user households who owned all the three types is four times higher than, the non-user households. The study also found that 66.2% of the users of irrigation constructed/improved different number of classes mainly corrugated iron sheet ranged 1 to 4 because of increasing income from irrigation after its start (Table 2). Moreover, the users of small-scale irrigation accumulated different wealth in different towns, for instance, nearly 19.2% of them have different levels of houses such as villa, building etc. in the capital of the district, Axum. It is also found that 15.4% of the non-users of irrigation have been living in rented house due to income deficient for land purchase and construction.

Social participation and access to infrastructural facilities

Among the constraints of smallholder farmers for technology adoption, shortage of working capital is the prime mover. Utilization of credit may enable farmers to purchase inputs or acquire physical capital, thus contributing to technology adoption. However, some farmers have access and utilization to credit while others may not have due to problems related to repayment and down payment in order to get input from formal sources. The survey result indicated 78.5% of the non-users and 89.2% of the users of irrigation had utilization to credit. This implies that irrigation users have better utilization to credit compared to non-users. However, the access is equal to all households without any difference. Therefore, credit use is expected to influence both irrigation participation and household total income positively. Most of the farm families use both micro finance institute, farmers cooperatives, friends and local money lenders as sources of credit; and major purposes of getting credit was: for purchasing fertilizer, seed, oxen and for farm implement and social obligation expenses (Table 3). This

Table 4: Access, utilization and sources of social services of farm households.

		Users		Non-users		χ 2
		N	%	N	%	
Credit utilization		58	89.2	51	78.9	2.045
	Cash	14	21.5	15	23.1	
Credit type	Kind	5	7.7	4	6.2	
	Both cash and kind	39	60	32	49.2	
Social position		43	66.2	12	18.5	33.9***
Access to market information		49	75.4			
Information source						
Telephone		5	7.7			
Person to person		44	67.7			
Access to transportation		32	49.2			

Credit source	**Users**	**Non-users**
Cooperatives	3.1	4.6
Microfinance institutions	56.9	58.5
Cooperatives and microfinance institutions	24.6	10.8
Local lenders and microfinance institutions	1.5	1.5
Neighbors and relatives	3.1	3.1

*** indicates significant at less than 1% probability level.

can be in the form of cash, kind or both cash and kind. Results contended that 7.7% of the users of irrigation, which shun credit utilization, hardly faced any problem due to their limited need. On the other hand, 6.2 and 7.7% of the non-users of irrigation avoid credit utilization due to their limited need and fear of failure to pay respectively. It is also found that 4.6% of the non-users of irrigation reserved from irrigation utilization due to expectations of high interest rates (Table 3). An equal amount 3.1% of the users and non-users of irrigation restricted themselves from credit utilization due to religion restrictions locally called *Haram*[1].

Rural farm households engage in different positions of formal and informal social institutions such as *Mahber, Idir*, *dabbo*, water user association, *kebele* association and *Woreda* representatives in their locality. The ratio of small-scale irrigation user households to non-user households who are in different positions of the community exceeds by 47.7% (Table 3). Although information in marketing of irrigation products and agricultural inputs is a determinant factor for producers, only 75.4% of the irrigation users have access to information. As a source of information 7.7% and 67.7% of them use mobile & telephone and person to person respectively. The findings also showed that 84.6% of the users of small-scale irrigation produce for market in addition to household consumption. The rest of 15.4% of the users of irrigation produce for household consumption only due to water and land insufficiency for surplus production. From the total producers for market, 73.8% always get reasonable prices by producing seasonal products (Table 3).

Contribution of small-scale irrigation

Irrigation and irrigation dams have both positive consequences on food security, asset ownership and income of households. Increased in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health due to balanced diet and easy access and utilization for medication, soil and ecology degradation prevention and asset ownership are contributions of irrigation. The results of the survey compared that the ratio of mean income of irrigation users to non-users exceeds by 37.03% and nutritional status and standard of living of the users also increased by the same factor as income. Comparisons with regard to the timelines before and after construction of the dams showed that on-farm income of 90.77% of the irrigation user households is increased after irrigation utilization despite of the figure difference. Moreover, irrigation utilization greatly supports the livelihood of the non-users through employment opportunity: nearly 46.15% of the daily laborers work in the irrigation-farms of the users fully or partly. It created job opportunity for virtually, 53.85% of the dwellers depend their livelihood on off-farm activities (Table 4).

The users of small-scale irrigation invest the additional income gained from irrigation in different activities. Some

[1] *Haram*- religionaly, culturally and socially forbidden

Table 5: Positive and negative effect of irrigation on-farm households

Positive effect		Frequency	Percent
Improved health	Capacity of medication	40	61.54
	Balanced nutrition and diet	25	38.46
Job opportunity for non-users	Off-farm recruitment	30	46.15
	Off-farm trade	35	53.85
Reduction in soil degradation		58	89.2
Source of animal feed		65	100
Increased production		65	100
Diversification of crops		65	100

of them invest in community service while others are in educating their children. Findings from this research showed that irrigation have positive effect on education. As the result of the survey, 90.8% of the users of small-scale irrigation send their children to school and 16.9% of them spend more than 60% of the income from irrigation in educating their children at different levels (Table 4). Increasing income from irrigation made them to access materials for their children and replaced the labor of their children engaged on-farm by hired labor. It decreased the number of dropout schooling.

Irrigation and irrigation dams have a great role in improving health condition of farm households through the supply of nutritional balanced diet. It improves the hygiene and sanitation of the people around. Recreation through bath and moving around for refreshment is the other value. Generally, the health condition of 61.54% of the users of irrigation is improved due to capacity of the farm households for medication and purchasing power of medicines while for the rest is due to improved feeding system and hygiene.

Besides, improving production and productivity, irrigation dams help in soil degradation prevention and ecology conservation through reduction or blocking of runoff and supplying water during dry seasons. Out of the total respondents, 89.2% of the farm households residing below the dams near the drainage replied the damage of flooding became nearly nil that leads to reduction of soil degradation and rehabilitation of gullies. Average yearly soil conservation expenses of the farm households converted to cash value is reduced by 50%, but 50% of the expenses shifted and replaced by yearly irrigation canal maintenance (Table 4).

Farm households wealth difference

Well-being is a combination of different factors. Consequently, its measurement comprises different assessment methods and the different techniques should be triangulated. Hence, self-assessment wealth ranking of the households revealed that 63.8% of the total households in which 78.5% of the users and 49.2% of the non-users considered themselves as well-off while 36.2% of the total households in which 21.5% of the users and 50.8% of the non users considered themselves as lower well-being (Table 5). Wealth ranking of households based on proxy methods of asset ownership such as land, houses and livestock owned, level of education, health status, social position, employment opportunity weather self employed or not and level of food aid reception of the users and non-users of irrigation is assessed. The result is found that 92.3% of the users and 29.2% of the non-users are well- off while 7.7% of the users and 70.8% of the non-users are ranked as a lower well-being (Table 5).

Classification of households as higher or lower standard of living also performed using the total income of households with mean total income as cut-off between the two groups. The results expressed 56.9% of the users and 16.9% of the non-users categorized as better well-being but 43.1% of the users and 83.1% of the non-users classified as lower. The wealth of the households also analyzed and compared using wealth category scale developed by USAID and other research organizations taking yearly income of each household member Ethiopian ETB 5600 as a cut off. Consequently, 78.5% of the irrigation users and 33.8% of non-users are in a higher well-being while the rest are classified, as lower well-being due to yearly income of each household member is less than 5600 ETB (Table 5).

Model results

Labor requirement for irrigation and rain-fed activities differs significantly. Even irrigation needs different type and magnitude of labor. For instance, vegetable production requires labor more than double than crop production. Therefore, in this study family labor is found to have a positive and significant association with household income at 10% probability level suggesting

Table 6: Household well-being measures using different parameters.

	Users				Non-users				Ch-square value
	Higher		Lower		Higher		Lower		
	N	%	N	%	N	%	N	%	
Self assessment	51	78.5	14	21.5	32	49.23	33	50.77	10.797***
Asset ownership	60	92.3	5	7.7	19	29.23	46	70.77	21.95***
Mean Income	37	56.9	28	43.1	11	16.9	54	83.1	20.643***
MOARD category	51	78.5	14	21.5	22	33.8	43	66.2	24.494***

*** indicates significant at less than 1% probability level.

active family labor or work force of a family in adult equivalent increases the total income of the household which in turn contributed to improved household income. The results further indicate one unit increase in the active labor force of an average household would raise the total income of the household by ETB[2] 3987.14 (Table 6). However, in rural areas, land be it rain-fed or irrigable is a determinant factor for labor productivity. To this end, the significant positive relationship between irrigable land holding and household well-being, keeping other variables constant at their respective mean values, a unit increase in irrigable land of a household increases total income by ETB 23,327.8. In other words, irrigation user households with one-hectare irrigable land are better off in well-being by ETB 23,327.8 than non-user households (Table 6). Access to irrigable land by allowing households to use family labor and other farm resources more intensively makes households more productive and hence better. Equally to the land resource, Livestock holding contributes its share to the livelihood development, food security, reduction of poverty and vulnerability and then to the improvement of household well-being. Livestock, besides its direct role in raising agricultural productivity, it helps households stabilize consumption by absorbing income shocks that might arise from crop failures triggered by natural disasters. As in most of the developing countries, in the study area, animal power mostly oxen are the sole draught power sources and hence lack of oxen besides its negative effect on land productivity signifies a lower economic status of farm households. This creates shortage of power and creates burden in the family labor. Hence, households who do not own oxen either acquire the much needed pair of oxen at a cost or forced to share/ rent out their land, which means a substantial reduction in income. Households with larger number of livestock particularly oxen, therefore, are likely to raise farm income for they can use other farm inputs more efficiently by bringing additional land into cultivation through either cash rent or share cropping basis. This proves a unit Total Livestock Unit(TLU) increase in livestock holding would increase the total income of a household by ETB 8446.62, other factors being constant (Table 6).

[2] ETB=Ethiopian Birr, which is equal to 17.156 USD as of October, 2011

The econometric results of the probit model confirmed that there is a positive and significant relationship between on-farm income of households and irrigation participation at less than 1% significant level. The positive effect suggests that income derived from on-farm activities enables households to pay for farm inputs required for profitable irrigation farming. The marginal effect shows that as on-farm income of households increases by 100 ETB, the probability of a household's participation in small-scale irrigation increases by 1%. Moreover, the results of the outcome equation provide evidence that participation in irrigation schemes is positively and significantly associated with household total income and hence well-being at less than 10% probability level. This proves irrigation participation of farm households increases the household income on one hand and the improvement and availability of households' total income facilitates the households' participation decision to use irrigation. Therefore, other things kept constant, the total income of irrigation user household would be higher by ETB 26,593.60 than households who do not participate in irrigation farming (Table 6). This is due to that irrigation allows farm households to use farm resource in a more productive way in at least three ways. First, it enables the production of vegetables and cereal crops twice and sometimes three times a year. Second, it helps improve livestock productivity by providing feed during the dry seasons and minimizing the cost of paying for fodder. Third, it saves environment from degradation and improves the microclimate. Participation in small-scale irrigation, therefore, enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption.

The probit model result indicates that access to market information positively and significantly associated with probability of participation in small-scale irrigation at less than 1% probability level. Higher market prices of irrigation products are likely to motivate farm households to participate in small-scale irrigation schemes. The marginal effect revealed that the probability of participation in irrigation for a household, with a reasonably good access to market information would by nearly twice than households who do not have access to market information. This leads to the second stage that

Table 7: Estimates of the probit and ordinary least square model.

Variable	Probit Model			OLS	
	Coefficients	**t-value**	**Marginal effect**	**Coefficients**	**t-value**
CONSTANT	-4.75882	-2.32099**	-1.5668	-14126.4	-0.77609
EDULEVEL	0.012903	0.137887	0.0042	301.33	0.264576
FAMLABFOR	0.168341	0.866935	0.0554	3987.14	1.83902*
AGEHEADT	0.0335619	1.18129	0.0111	-245.765	-0.882815
ONFARMIN	0.000172252	2.81975***	0.0001	NA	NA
OFFARMIN	-0.000378195	-1.87574*	-0.0001	NA	NA
NONFARMIN	-0.000149225	-1.26935	.0001	NA	NA
REMITANC	-0.000193725	-0.901888	-0.0001	-1.06985	-0.480205
PROPERTY	7.08725e-006	0.704812	0.0000	NA	NA
DISIRRIM	0.0357116	0.612217	0.0118	NA	NA
NEARNESS	-0.598272	-3.01655***	-0.1970	1640.1	1.06658
RAINLAND	-1.48404	-1.44643	-0.4886	NA	NA
IRRILAND	**NA**	**NA**	**NA**	23327.8	1.77496*
TLU	-0.0461839	-0.306553	-0.0152	8446.62	5.81036***
IRRIGATIO	**NA**	**NA**	**NA**	26593.6	1.68018*
SEXHEAD	1.15819	1.70084*	0.3813	4401.14	0.52642
MARKETIN	4.73361	4.18098***	1.5585	23749.8	1.98626**
CREDIT AC	-0.460747	-0.589819	-0.1517	23783.8	2.70915***
HEALTHCO	1.54415	1.98631**	0.5084	-8071.85	-1.08897
LAMBDA	**NA**	**NA**	**NA**	-18982.9	-1.72542*
Dependent variable	**Irrigation participation decision**			**Household total income**	
Weighting Variable	One			None	
Number of Observations	130			130	
Log Likelihood Function	-19.87096			-1533.6329	
Restricted Log Likelihood	-90.10913			-1572.8541	
Chi-Square	140.4763				
Degree of Freedom	16				
R-square	0.685043			0.453052	
Significance Level	0.00000			0.000000	

***, **, and * indicates significant at less than 1, 5 and 10% probability level respectively. NA- not applicable for the model.

deals the relationship between irrigation products market information and household income. To this end, access to market information is found to influence income and hence well-being, positively and significantly at 5% probability level. It also indicates total income of farm households who have access to market information exceeds by ETB 23,749.8 than households deficient in market information. This is due to that market information helps farm households to market perishable farm products at the right time without loss of quality. Access to market information would also play a key role by providing accurate information on the demand and supply of farm inputs and outputs. However, farmers with sufficient market information, opportunities to irrigation resource and technology, labor etc., may face shortage of working capital. For such type of problems the access and utilization of credit is a determinant factor. Hence, a number of studies have shown the importance of access and utilization of credit in enhancing the adoption of new agricultural technologies including irrigation among farm household. The econometric results revealed a positive and significant association between access and utilization to credit and total income at less than 1% probability level. According to the results, the income of a household who have access to and utilized credit would be higher by ETB 23,783.8 compared to households who do not have access to credit (Table 7). It has been observed that households who have had access to credit in the study area not only engage in the production of vegetables but also use external inputs properly and as a result achieved higher output.

CONCLUSIONS AND POLICY IMPLICATIONS

Market information plays a significant role in small-scale

irrigation participation and mounting total income. Farm households that have access to market information are able to compare, the net income of a product deducting the overhead costs for delivering to markets. Moreover, purchasing of the right input at the right time from the right enterprise and supplying of the products to the right customer with a reasonable intermediary cost is possible when there is market information. However, farm households may constrain a working capital for better production, transporting and processing as irrigation intensifies labor and input. Hence, credit is an important institutional service to finance poor farmers for input purchase and ultimately to pay for labor. This saves livestock from sale and land from rent out or shared out, at uncertain seasons. Moreover, a household with larger size of active labor force induces income from on/off or non-farm livelihood activities and reduces the expenses for labor that adds to the total income. As active labor force of the household increases, the dependency ratio and power constraint decreases. On the other hand, family labor problems can be solved and replaced by the livestock owned, serves as a source of income and draft power. Wealth of households also determined by the livestock, owned mainly oxen. Therefore, networking households with customers through information sources such as mobile and telephone service is a determinant factor. Formation of self-help cooperatives and saving and credit associations in rural areas also bridges producers with their clientele solving the working capital deficiencies. It is also crucial the introduction and promotion of labor saving instruments and technologies through labor multiplication as a replacement of human labor for households with shortage labor for intensive production.

Irrigable land produces two and/or three times per year intensively even in drought prone years and areas through water banking systems of the previous years/areas. Due to artificial management of water and balance of crop water intakes, the shift of staple/common crops to high value cash crops, vegetables and fruits is achievable. Moreover, better access to irrigation enables rural people to diversify their income sources, including non-farm and off farm livelihood activities, and to make savings at dry seasons. Although increasing the total land size is unfeasible, replacement of the rain-fed land by irrigable land through development of new dams and applying different irrigation technologies is crucial.

Abbreviations: EDULEVEL, Education level of the household heads; **FAMLABFOR,** family labor force of the households; **AGEHEADT,** age of the household head; **ONFARMIN,** on-farm income of the households; **OFFARMIN,** off-farm income of the households; **NONFARMIN,** non-farm income of the households; **REMITANC,** remittances received by the households; **PROPERTY,** property income of the households; **DISIRRIM,** distance of irrigation from the dame site; **NEARNESS,** nearness of the irrigation farm from residence home of households; **RAINLAND,** irrigation landholding of the households; **IRRILAND,** irrigable landholding of households; **TLU,** livestock holding in total livestock unit; **IRRIGATIO,** irrigation participation of households; **SEXHEAD,** sex of the household heads; **MARKETIN,** access to market information of households; **CREDITAC,** access and utilization of credit; **HEALTHCO,** health condition of the households; **BoARD,** bureau of agriculture and rural development; **FAO,** food and agricultural organization; **MOARD,** ministry of agriculture and rural development; **MOFED,** ministry of finance and economic development.

REFERENCES

Adams MW, Potkanski T, Sutton GEG (1994). Indigenous Farmer Managed Irrigation in Sonjo, Tanzania. The Geogr. J. 16: 17-32.

Adams MW (1990). How Beautiful is Small Scale, Control and Success in Kenyan Irrigation World Development, The Geogr. J. 18, (1): 309-323

CSA (Central Statistics Authority) (2007). Population and Housing Census: Ethiopia's Population. Census report: Addis Ababa, Ethiopia.

Desta Beyera, 2004. Impact of Community Managed Irrigation on Farm Efficiency and Household Income; the case Weliso and Wenchi Districts of Oromia. An M.Sc Thesis presented to the School of Graduate Studies of Haramaya University

FAO (Food and Agricultural Organization), 1997. Irrigation Potential in Africa; A basin approach, FAO Land and Water Bulletin 4. FAO: Rome

FAO (Food and Agricultural Organization) (2000). Socio –Economic Effect of Smallholder Irrigation Development in Zimbabwe: Case studies of ten irrigation schemes. FAO: Harare.

IWMI (International Water Management Institute), 2005.Experiences and opportunities for promoting small-scale micro irrigation and rain water harvesting for food security in Ethiopia, Working paper 98. IWMI : Addis Ababa.

Meinzen-Dick R (1993). Water Rights and Multiple Water Uses: framework and application to Kirindi Oya irrigation scheme Irrigation and Drainage Systems, Sri Lanka. 2(1): 89-95.

MoARD (Ministry of Agriculture and Rural Development). (2010). Ethiopia's Agriculture

MoFED (Ministry of Finance and Economic Development), 2002b. Development and Poverty Profile of Ethiopia. MoFED: Addis Ababa.

Sector Policy and Investment Framework: Ten Year Road Map (2010-2020).

Vaishnav T (1994). Increasing Food Production in Sub-Saharan Africa through Farmer Managed Small-Scale Irrigation Development Ambo 23, 524-64.

Webb P (1991). When Projects Collapse, Irrigation Failure in the Gambia from Household Perspective. J. Int. Dev. 3(4): 54-59

Wooldridge, M., 2002. Econometric Analysis of Cross Section and Panel Data. Massachusetts Institute of Technology: London.

Zaman H (2001). Assessing the Poverty and Vulnerability Effect of Micro Credit in Bangladesh. pp. 34-36. A case study of BRAC. Office of the chief economist and senior vice president (DECVP), The World Bank: Dhaka.