Determinants of Small-Scale Irrigation Use: The Case of Boloso Sore District, Wolaita Zone, Southern Ethiopia

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Abstract: This study was conducted at Boloso Sore district of Southern Ethiopia. The objective of this study was to identify determinants of Small-scale irrigation use. A total of 104 farmers were randomly selected and interviewed by using semi-structured questionnaire. To collect the required data several methods like interview schedule, focus group discussions and key informant interviews were used. Various documents were reviewed to collect the secondary data. Descriptive statistics, inferential statistics (chi-square and independent t-test) and econometric model analysis were used to analyze quantitative data. As the binary logistic regression model result indicates, four variables were found to be significant namely training, land size and labor which had significant and positive effect on the use of irrigation water use at less than 10% probability level, while, distance from the river had significant and negative effect on the use of irrigation water at 5% significant level. Governmental and non-governmental organizations should give emphasis on provision of training to create awareness creation and skill about irrigation technologies and increases their access to use irrigation water in the study area. They also should give emphasis on intensifying agricultural production in order to enhance the productivity of limited land. Therefore, to alleviate these problems and improve small-scale irrigation utilization, woreda (district) agricultural and rural development office and other concerned bodies should attempt to address those factors that hinder small-scale irrigation utilization in the study area.

Keywords: Use of Irrigation, Binary Logistic Model, Boloso Sore, Wolaita

1. Introduction

Ethiopia has untapped resource bases for agriculture development. The major resource bases for agriculture development are land, diverse agro-ecology, water resources, bio-diversity and human resources. The agriculture sector has promising opportunities to transform itself from subsistence to a level of modern and commercial sector. Nevertheless, the sector faces several challenges to produce adequate food supply for domestic consumption and export earnings. Furthermore, the agriculture sector is largely dependent on rain fed production and is dominated by smallholder farming systems [1].

To address subsistence farming problem, the economic performers designed a national strategic plan in 1991, Agricultural Development Led Industrialization (ADLI) that gives focus on irrigation, cooperative societies and agricultural technologies to answer the food demand and bring socioeconomic development in the country. Small scale irrigation development is one of the policies within this strategy. Based on this, the federal and the regional governments associated with other international and local NGOs have significantly supported to rural farmers to participate and use irrigation farming. As a result, the irrigated farmland, irrigation production and the number of farmers who use irrigation in the country have notably increased, up to 80%, between 1990 and 2010 [2]. Estimates showed that there is sufficient water in the country to develop about 4.5 million hectares of which only about 0.16 million ha (5% of the potential) is actually irrigated land under full irrigation in Ethiopia [3]. However, irrigated agriculture has realized only 5% of its estimated potential and in terms of output it accounts for approximately 3% of the total food crop production [4].

The development of small-scale irrigation is also one of the major intervention to increase agricultural production in the rural parts of a country. This helps farmers to overcome rainfall constraint by providing a sustainable supply of water for cultivation and livestock production [5]. Irrigation development is being suggested as a key strategy to improve the agricultural productivity and to encourage the economic development [6].

Irrigation in Ethiopia contributes to increase the farmers" income, household resilience and buffering livelihoods against shocks and stresses by producing higher value crops for sale at market and to harvest more than once per year. In turn, this provided them to build up their assets, buy more food and non-food household items, educate their children, and reinvest in further increasing their production by buying farm inputs or livestock. However, the benefits are very unevenly distributed among households [7].

Irrigation contributes to livelihood improvement through increased income, food security, employment opportunity, social needs fulfillment and poverty reduction. Increase 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 [8].

According to Haile [9], there are four interrelated mechanisms by which irrigated agriculture can reduce poverty, through: (i) increasing production and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle.

In the same way, Zhou and others [10] mentioned that irrigation contributes to agricultural production in two ways: increasing crop yields, and enabling farmers to increase cropping intensity and switch to high-value crops. Therefore, irrigation can be an indispensable technological intervention to increase household income. Irrigation can benefit the poor specifically through higher production, higher yields, lower risks of crop failure, and higher and all year round farm and non-farm employment [11].

Agricultural production in Ethiopia is primarily rain-fed, so it depends on erratic and often insufficient rainfall. As a result, there are frequent failures of agricultural production. Irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall. Irrigation contributes to agricultural production through increasing crop yields, and enabling farmers to increase cropping intensity and switch to high-value crops [10].

Even if Ethiopia has a huge potential in terms of surface and ground water availability and land which are in most cases suitable for irrigation the adoption of small-scale irrigation is in its infant stage. The major constraints that slow down the adoption of the sub-sector among others are predominantly primitive nature of the overall existing production system, shortage of agricultural inputs and low level of user participation in the development and management of irrigated agriculture, limited trained manpower and inadequate extension services [12].

The current government has undertaken various activities to expand irrigation in the country. The country's strategy Agricultural Development Led Industrialization (ADLI) considers irrigation development as a key input for sustainable development. Thus, irrigation development, particularly small-scale irrigation is planned to be accelerated [13]. Ethiopia is believed to have the potential of 5.1 million hectares of land that can be developed for irrigation through pump, gravity, pressure, underground water, water harvesting and other mechanisms [13].

In line with the development policy of the country, the Zonal Government of Wolaita is promoting irrigation development so as to increase and stabilize food production in the zone. According to wolaita zone irrigation development department [14] report, the total area cultivated for irrigation in 2014 was 42,329 hectares and its production 4,952,493 quintals with 169,316 beneficiaries participated on first and second phase [14]. The study area Boloso Sore is endowed with considerable and diverse natural resources, with capacity to grow diverse annual crops. The altitude ranges from 1500 to 2300 m.a.s.l. The mean annual rainfall is 750 mm and ranges from 100 to 1400mm [15]. Therefore, the Woreda has a great potential for small-scale irrigation. According to WoADO for Boloso Sore, in 2014 a total of 3,784.3 hectares of land was covered with irrigation (irrigated) and a total of 582,782 Quintal of production benefiting 15,137 Households. Therefore the objective of this study is to assess the contribution of small-scale irrigation to household farm income.

In the *Boloso Sore Woreda (district)*the Government is implementing different agricultural development program in order to achieve the food security in rural households. Among these programs, irrigation development is primarily taken by the Government. In this program, Government organizations, international and local NGOs, micro-finance institutions, private sectors and farmers are involved at different levels with different tasks which are supply of inputs (fertilizer, improved seeds, pesticides, insecticides and farm equipments), access to credit and the others. But such interventions are encountering various social and technical problems (lack of technical person to maintain motor pump, impurity of improved seeds, non supply of input on time, unfairness of farmers demand and supply and lack of market access especially for vegetable crops) that have challenged the strategy and implementation approaches [16].

However, the *Woreda (study district)*lacks in-depth studies on identify the determinant factors that influence the use of irrigation water. The program is also not well supported by complete research which is able to examine the cropping practice and farm income variation of irrigated and non-irrigated household in the *Woreda*. That is, it is not well

known the contribution of irrigation on household farm income and to what extent the households using irrigation are better off than those who depend on rain-fed agriculture in the study area. Therefore, this study was tried to fill these gaps by analyzing the determinant of rural households" participation in small-scale irrigation and its contribution on rural household income.

2. Methodology

2.1. Description of the Study Area

Boloso Sore, the study area,is found in Wolaita Zone of Southern Ethioipia. The Woreda is located about 29 km north from Sodo town and has an altitude 1800 masl. The woreda is located between $6005'0''$ and $7011'0''$N Latitude and $3700'0''$and $37050'0''$E Longitude. The woreda (district) covers an area of about 33,600 hectare. Administratively, it is sub-divided into 29 rural kebeles (small administrative units). It has an annual rain fall ranges from 600 mm-1330mm. The short rainy season is extending from February to April. The mean annual maximum and minimum temperature of the area is 28.5 and 14.48co respectively [17].

Based on traditional zonation; the study area is divided into two agro-climatic regions on the base of temperature and altitudes. Recently the study area is divided into two traditional climatic zones such as *Dega* (high altitude) and *Woina-Dega* (mid altitude). The altitude of the *Dega*agro-ecological Zone is ranges from 2300 to 2950 m.a.s.l. Mean monthly temperatures vary from 16°C, during the coldest months and 26.5°C, during the hottest (warmest) month. Average annual rainfall is also found 1,659 mm. The *Woina-Dega,* on the other hand, the altitude ranges between 1500-2300m asl [15].

2.2. Sampling Technique and Sample Size Determination

In this study a multi- stage sampling procedure was employed. In the first stage, the study area selected purposively as small-scale irrigation practice is available in the Woreda. In the second stage, out of 11 irrigation using Kebeles five Kebeles which have high access of small-scale irrigation were selected purposively. In the third stage, sampling frame (complete village household lists) was obtained from each Kebeles administrative office. In the fourth stage, the total households in the five sample *Kebeles*was stratified into the two strata (irrigation water user and non-user households).In the fifth stage, simple random sampling techniques was applied to select the sample unit from each strata at each kebele via probability proportionate to size procedure. From the total 4498 household found in five samples Kebeles, 104 sample households were selected. Hence, sample size of irrigation user and non-user respondent households was 60 and 44 respectively.

The sample size for this study determinant by Yamane formula [18].

$$n = \frac{N}{1 + (e)^2}$$

Where: n = Sample size;
N= Total number of households in the selected Kebeles;
e = precision level or sampling of error 9.7% (0.097);

$$n = \frac{4498}{1 + 4494(0.097)^2} = 104$$

2.3. Data Source and Methods of Collection

Both qualitative and quantitative data were collected from primary and secondary sources. Primary data for the study were collected from selected sample households, Focus Group Discussion, and interview with Key Informants (committee members of water user's associations, peasant association executive committee members, Women development army, development agents and Woreda irrigation development experts) and field observations. Secondary data were collected from written documents from Woreda agricultural development office and from other published and unpublished materials.

A structured questionnaire was designed and pre-tested for household survey. The survey was to collect data related to household's demographic, socioeconomic characteristics, farming system, small scale irrigation practice and marketing situation, the possible factors determining the use of small scale irrigation, different activities and the contribution of irrigation on household income. The developed structured questionnaire was translated in to Amharic for the convenience of data collection during household survey. The secondary data was obtained from published and unpublished documents; CSA, governmental office and non-governmental reports, agricultural office, books, Journals, research report and other sources like websites are also important secondary data sources.

2.4. Methods of Data Analysis

The quantitative data was coded and entered into SPSSv16, then analyzed by using descriptive statistics such as frequency, mean, chart and percentage. 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.

Econometric Model: To identify the determinants that influence the use of irrigation water, the binary logistic regression analysis was employed. It is selected because of the model relevance to deal with dependent variables that are dichotomous in nature. The model assists in estimating the probability of irrigation water use status of a household that can take one of the two values, use of irrigation and non use. According to Gujarati [19], the functional form of the logit model is presented as follows:

$$P_i = \text{E}\left(Yi/Xi\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \tag{1}$$

$$P_i = \text{E}\left(\frac{Yi}{Xi}\right) = \frac{1}{1 + e^{-Z_i}}$$

Where Pi is a probability of a i[th]household being use of

irrigation and ranges from 0 to 1; Zi is a functional form ofmexplanatory variables(X) which is expressed as:

$$Z_i = \beta_0 + \sum_{i=1}^{m} \beta_i X_i \text{, i=1, 2, 3----------m} \qquad (2)$$

Where; β_0 is the intercept and β_i are the slope parameters in the model. The slope tells how the log-odds in favor of a given household using irrigation water status change as independent variables change. If P_i is the probability of a household being use of irrigation, then $1 - P_i$ indicates the probability of a given household is non using irrigation water, which can be given as:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \qquad (3)$$

Dividing equation (1) by equation (3) and simplifying gives

$$e^{Z_i} = \frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} \qquad (4)$$

Equation (4) indicates the odds ratio in favor/in terms of a given household using irrigation water. It is the ratio of the probability that a household will use irrigation water to the probability he will not use. Lastly, the logit model is obtained by taking the natural logarsim of equation (4) as follows:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_i \qquad (5)$$

Where; P_i =the probability that Y=1 (that a given household is using irrigation water);

$1 - P_i$ =the probability that Y=0 (that a given household does not use irrigation water);

L=the natural log of the odds ratio or logit;

β_i =the slope, measures the change in L (logit) for a unit change in explanatory variables (X);

β_0 =the intercept. It is the value of the log odd ratio, $\frac{P_i}{1 + P_i}$, when X or explanatory variable is zero.

Thus, if the stochastic disturbance term (U i) is taken into consideration the logit model becomes

$$L_i = \beta_0 + \beta_1 X_i + U^i$$

The Dependent Variable

Use of Irrigation Water (UIRRW): In this study, the dependent variable is the use of irrigation water. It is a dummy variable, 1 if a household used irrigation and 0 otherwise.

***Table 1.** The summary of independent variables, description their measurements and expected relationship with dependent variable.*

No	Independent Variables	Variable Types	Units of Measurement	Expected Relationship with dependent variables
1	Land holding size	Continuous	Hectare	+
2.	Agricultural labor.	Continuous	PE	+
3.	Education status	Continuous	Grade	+
4.	Sex	Dummy	0 and 1	+
5.	Age	Continuous	Year	-
6.	Farm distance	Continuous	Km	-
7.	Contact to DAs	Continuous	No of contact	+
8.	Livestock holding size	Continuous	TLU	+
9	Training	Dummy	0 and 1	+
10	Number of Oxen	Continuous	number	+
11	Use of Credit	Dummy	0 and 1	+
12	Membership in Coop.	Dummy	0 and 1	+

3. Results and Discussion

This section presents and discusses the results of the field data that has been conducted to address specific objectives of the study. The section also describes three core points. These include the status of irrigation practices; descriptive statistics results of explanatory variables; interpretation and discussions of model results.

3.1. The Status of Irrigation Practices in the Study Area

3.1.1. Farmers' Experience on Irrigation Practice in the Study Area

A Small-Scale Irrigation practice in the Woreda (district) is a recent history. However, the information gathered from Focus group discussion (FGD) participants revealed that in the area the Small-Scale Irrigation practices begun a decade ago. Now a day, the Small-Scale Irrigation practices in the area dramatically expanded and the farmers' cropping practices also changed from depending on production of field crops into mostly depending on production of vegetables especially cabbage, tomato and pepper. The expansions of Small-Scale Irrigation practice also increase farmers' cropping frequencies, use of improved farm inputs (improved seeds and chemical fertilizer) and also increased farm productivity.

3.1.2. Small-Scale Irrigation Performance of the Study Area

The study area has a great potential for small-scale irrigation. Information gathered from Woreda farm and natural resource office and water development office indicated that since 2014 there were 3,784.3 hectares of land

was covered with irrigation (irrigated farm) and 582,782 Quintal of yield was obtained by 15,137 Households. So, irrigation user farmers use water only from river by three water diversion methods such as concrete water diversion from river, traditional water diversion from river and using motorized pumps water diversion from river. This is because of most of water harvesting technologies are not functional due to problem of farmers attitude especially on water harvesting technology which was very low.

3.2. Descriptive Statistical Result of Factors Affecting Irrigation Use

In this section, the sample households' demographic, socio-economic and institutional factors are discussed so as to understand the characteristics the study households.

3.2.1. Demographic Factors
1) Sex of the respondent

In the study area sex determine the use of irrigation water. The results presented in Table 2 shows that out of the total irrigation user respondents 66% were males and 33% were females. From the total non-user respondents, about 34% were males and 67% were females. The proportion of males in the case of irrigation user respondents was more than that of non-irrigation user respondents. Male-headed households are in a better position to use irrigation than the female headed ones. Moreover, with regard to farming experience males are better than the female farmers. The literature cited in Mesfin [20] indicates that female-headed households have less access to improved technologies, land and extension than male headed household [21]. The Chi-square value also shows that, at 1% probability level, sex of respondents' had significant relationship with the use of irrigation water. This significance relationship shows that when the variation in sex between two groups has its own implications on the use of irrigation. Therefore, male farmers have better chance to use of irrigation water.

***Table 2.** Sex of the respondents.*

Sex	User		Non-user		Total		Chi-square value
	N	%	N	%	N	%	
Female	9	33	18	67	27	100	
Male	51	66	9	34	77	100	8.865***

Source: Own field survey 2016.P-value = 0.004***, Significant at 1% level.

2) Age of Respondents

The survey results indicates that from the total respondents 63.5% were aged ranges from 20-40 years old (Table 3). But out of the total irrigation user respondents 63.3% were aged ranges from 20-40 years old while from the total non-user 63.6% were aged ranges from 20-40 years old. The mean age of total respondents was 38.98. However, the mean age of irrigation user respondents' was 39.38 years old and non-user respondents' was 38.43 years old. The t-value shows that the mean age of the two groups were not significantly different. Other finding indicated that age has both positive and negative relationship with access to irrigation water due to its nonlinearity [22]. So, as the age increases, the demand for

irrigation technology would be expected to increase first due to working capacity and then after sometimes it decreases. It also affects households' income positively and then negatively. Therefore, it would have an inverted U-shaped relationship in both cases.

***Table 3.** Age of the respondents.*

Age category	User		Non-user		Total	
	N	%	N	%	N	%
20 – 40	38	63.3	28	63.6	66	63.5
41 – 60	21	35	14	31.8	35	33.7
61 – 80	1	1.7	2	4.6	3	2.9
Mean	39.38		38.43		38.98	
SD	9.71		10.64		10.07	
t-value						0.474

Source: Own field survey of 2016.P-value = 0.637

3.2.2. Socio-Economic Factors
1) Land Size

Land holding plays great role in using irrigation water in the study area. The study revealed that land size of irrigation user respondents was greater than non-user respondents(Table 4). The mean value of land holding of total respondents was 0.512 hectare. But the average land size of irrigation user was 0.63 hectares while it was only 0.35 hectares for non-user respondents. The t-value shows that there was significant mean difference of the land holding size between irrigation user and non-user respondents' household. This significance mean variation shows that the variation in the land holding size between two groups has its own implications on the utilization of irrigation water. Therefore, better land holder farmers have better chance to use irrigation. If small land holding, the only option is intensive production or producing two to three times a year. Land holding determines the type and amount of production in the context of small holders [9]. Therefore, it affects irrigation water utilization decision positively.

***Table 4.** Land size of the respondent households.*

Land size	User		Non-user		Total	
	N	%	N	%	N	%
≤0.5	28	46.7	39	88.6	67	64.4
0.51-1	28	46.7	5	11.4	33	31.7
1.1-1.5	4	6.7	-	-	4	3.8
Mean	0.63		0.35		0.512	
SD	0.35		0.24		0.339	
t-value						4.48***

Source: Own field survey of 2016.P-value = 0.000***, Significant at 1% level.

2) Oxen ownership

Like in most parts of Ethiopia, oxen are the engines for agricultural works in the study area. There is a symbolic relationship between crop production and oxen ownership in the mixed farming system. Oxen provide manure and draught power to crop cultivation, therefore used to boost crop production. Teressa and Heidhues [23] reported that adoption of improved technology is positively influenced by oxen

ownership. Particularly more oxen owner has more probability to use irrigation and ploughing more land on time. Asthe result in the table 16 shows that out of the total respondents 48.1% have no oxen in their household. However, out of the total user respondent 43.3% have 1-2 oxen. Whereas out of the total non-users 61.4 have no oxen. The mean for oxen ownership of total respondents was 0.692. However, the mean for user is 0.883 while the mean of non-user 0.431 (Table 5). The t-value shows that there is significant mean difference in the number of oxen owned between two groups. Therefore, this significant mean difference has its own implication on the use of irrigation water. So, the respondents who have large number of oxen have better opportunity to use irrigation.

Table 5. *Oxen ownership of the respondents.*

	User		Non-user		Total	
	N	%	N	%	N	%
No oxen	23	38.3	27	61.4	50	48.1
1-2	26	43.3	15	34.1	41	39.4
3-5	11	18.3	2	4.5	13	12.5
Mean	0.883		0.431		0.692	
SD	0.94		0.586		0.836	
t-value						2.807***

Source: Own field survey of 2016.P-value = 0.006***, Significant at 1% level.

3) Education Level of the Respondents

Education is one of the important variables, which increases farmer's ability to acquire process and use information relevant to use irrigation technologies. As the results shown in table 6, about 51.9% attended primary education whereas 37.5% not attended. However, out of the total user respondents 61.7% attended primary education while out of the total irrigation non-user respondents 54.5% did not attended primary education. With respect to high school level education, irrigation users also share high proportion than non-users. Generally, these figures indicate users have better educational background than non-users. The t-value shows that there was significant mean deference in the education level of respondents between two groups at 10% significant level. This significance mean difference shows that the variation in the education level of farmers between two groups has its own implications on the utilization of irrigation water. Therefore, better educated farmers have better chance to use irrigation because education equips individuals with the necessary knowledge of how to make living. Literate individuals are very ambitious to get information and use it. As agriculture is a dynamic occupation, the conservation practices and agricultural production technologies are always coming up with better knowledge. So if the household head is literate he will be very prone to accept extension services and irrigation use including any other income generating activities. Previous research results have also revealed that education would influence adoption positively [24].

Table 6. *Education level of the respondents.*

Education Level	User		Non-user		Total	
	N	%	N	%	N	%
Not attended	15	25	24	54.5	39	37.5
1-8	37	61.7	17	38.6	54	51.9
9-12	7	11.7	2	4.5	9	8.7
>12	1	1.7	1	2.3	2	1.9
Mean	5.32		2.66		4.19	
SD	9.11		3.28		7.33	
t-value						1.848*

Source: Own field survey of 2016.P-value =0.068*, Significant at 10% level.

4) Livestock Holding

The survey results obtained from respondents' household in Table7 show that out of the overall respondent's majority (91.3%) of respondents own a maximum of 6 TLU. Out of the total irrigation user (90%) of them have maximum of 6 TLU while similarly 93.2% of non-user respondents' have maximum of 6 TLU. The irrigation user respondents' household mean livestock holding in TLU is 3.82 and that of non-user respondents' household mean livestock holding in TLU is 3.75. The t-value shows that, there was no significant mean difference of livestock holding in TLU between user and non-user.

Table 7. *Number of livestock holding in TLU by the respondents' household.*

Livestock Holding	User		Non-user		Total	
	N	%	N	%	N	%
≤6	54	90	41	93.2	95	91.3
>6	6	10	3	6.8	9	8.7
Mean	3.82		3.75		3.79	
SD	1.79		1.64		1.72	
t-value						0.19

Source: Own field survey of 2016.P-value = 0.847

5) Agricultural Labor

The results in Table 8 show that from the total respondent households about 56.8% had agricultural labor greater than 6 Persons days equivalent. However, the majority 98.3% of irrigation user respondents 'household had agricultural labor greater than 6 persons days equivalent while 93.2% of non-user respondents' household agricultural labor between 4.1-6 person days equivalent. While, the mean of user respondents 'household agricultural labor force was equal to 3.07 Person days equivalent and that of non-user respondents' household was equal to 2.31 Person days equivalent. The t-value shows that at 1% significant level, there was significant mean difference in agricultural labor between user and non-user respondents' household. This significance mean variation shows that the variation in agricultural labor between two groups has its own implications on the utilization of irrigation water. Therefore, farmers who have larger agricultural labor size have better chance to use irrigation. Family active labor force has strong positive relationship with household income [25].

Table 8. Agricultural labor in person day's equivalent.

Agricultural Labor	User		Non-user		Total	
	N	%	N	%	N	%
2.1 – 4	1	1.7	3	6.8	4	3.8
4.1 – 6	-	-	41	93.2	41	39.4
>6	59	98.3	-	-	59	56.8
Mean	3.07		2.31		2.75	
SD	1.32		0.60		1.13	
t-value						3.58***

Source: Own field survey of 2016.P-value = 0.001***, Significant at 1% level.

3.2.3. Institutional Factors

1) Use of Credit

The survey results in Table 9 show that in 2015/16 out of the total respondents, about 64.4% used credit. However, out of the total respondents, about 76.7% were irrigation user respondents and 47.7% were non-user respondents use credit last year. The Chi-square value shows that there was significant relationship between the use of credit and irrigation water use at 1% significant level. This significance relationship shows that the variation in the credit use between two groups has its own implications on the utilization of irrigation water. Those households, who have access to credit, have better possibility to use it and spend on activities they want. Either they purchase agricultural input (improved seed, fertilizer, irrigation equipments, etc.,) or they purchase livestock for resale after they fattened them. All these activities increase income of the household. Previous research result reported by Tesfaye and Alemu [26] confirmed that access to credit positively influence adoption of technology. The possible explanation is that, those households who have access to credit became capable of using irrigation than those who have no access to credit.Therefore, credit used farmers have better chance to use irrigation than non-used.

Table 9. Use of credit by the respondents' household in 2015/16.

Use of credit	User		Non-user		Total		Chi-square value
	N	%	N	%	N	%	
No	14	23.3	23	52.3	37	35.6	
Yes	46	76.7	21	47.7	67	64.4	9.27***

Source: Own field survey 2016.P-value = 0.004***, Significant at 1% level.

2) Contact with Agricultural Development Agents

Extension agents provide crucial farming information in the study area especially in the application of irrigation water for farming activities. The results in the Table 10 show that from the total respondents 47.1% of them have contact with DA more than 5 times per month. However, out of the total users 73.3% contacted more than 5 times per month with Development Agents while (72.7%) of non-user respondents' contacted 3-5 time per month with them in last cropping season. The mean contact of irrigation user respondents' household with Agricultural Development Agents was 3.75 times per month; while it was only 1.13 times per month for non-user respondents. The t-value shows that at 1%

significant level, there was significant mean difference in number of contact with Agricultural Development Agents between user and non-user respondents. Therefore, farmers who had better contact with DAs have better chance to use irrigation. Other similar studies also came up with positive and significant relationship [22].

Table 10. Number of contact of the respondents' household with Agricultural Development Agents per month.

Contact	User		Non-user		Total	
	N	%	N	%	N	%
≤2	15	25	7	15.9	22	21.2
3-5	1	1.7	32	72.7	33	31.7
>5	44	73.3	5	11.4	49	47.1
Mean	3.75		1.13		2.64	
SD	2.69		1.15		2.51	
t-value						6.04***

Source: Own field survey of 2016.P-value = 0.000***, Significant at 1% level.

3) Attending on Training

The survey results obtained from the respondents' household in the Table 11 show that in 2015/16 from the total respondents, 61.6% of them attended training on irrigation related practice. However, out of the total irrigation user respondents more than half (70%) attended training on irrigation related practice. However, from the total non-user respondents' household, about 52.3% did not attend training on irrigation related practice. The Chi-square value shows that there was significant relationship between farmers' participation in training and use of irrigation water at 1% probability level. This significance relationship shows that the variation in the attending of training between two groups has its own implications on the utilization of irrigation water. Therefore, better attended farmers have better chance to use irrigation.

Table 11. Farmers participation on training program 2015/16.

Attended on training.	User		Non-user		Total		Chi-square value
	N	%	N	%	N	%	
No	18	30	23	52.3	41	39.4	
Yes	42	70	21	47.7	63	61.6	24.934***

Source: Own field survey 2016.P-value = 0.004***, Significant at 1% level.

4) Membership in Cooperatives

The survey results in Table 12 show that out of the total respondents about, 35.6% was member in cooperative. However, comparing the two categories about 56.7% respondents from those users of irrigation were member in cooperative, while only 37% from non-users were the member in cooperative. The Chi-square value shows that there was significant relationship between the membership in cooperative and use of irrigation at 10% significant level. This significance relationship shows that farmers who are member in cooperative have more chance to use irrigation.

Table 12. Respondents membership in cooperatives 2015/16.

Membership	User		Non-user		Total		Chi-square value
	N	%	N	%	N	%	
No	34	43.3	33	75	67	64.4	
Yes	26	56.7	11	25	37	35.6	3.72*

Source: Own field survey 2016.P-value = 0.064*, Significant at 10% level.

5) Farm Distance from Rivers

The survey result shows that out of the total respondents household 43.3% of the respondents is located ≤0.5Km away from the river (Table 13). However, out of the total user respondents, about 73.3% found in farm distance of≤0.5Km away from rivers. While from the total non-user respondents, about 56.8% respondents found in farm distance of>1.5Km from rivers. The mean of user respondents' farm distance from rivers is 0.46Km and the mean of non-user respondents' farm distance from rivers is 1.82Km. The t-value shows that, at 1% significant level there was significant difference in mean farm distance from river between user and non-user household. This significance mean variation shows that the variation in distance from river between two groups has its own implications on the utilization of irrigation water. Therefore, farmers' farms near to the river have better chance to use irrigation. Hence, they can more likely produce two to three times a year. For instance, users have location advantage to exploit higher volume of irrigation water than the tail-end groups [6].

Table 13. Respondents' household farm distance from Rivers (Km).

Farm Distance	User		Non-user		Total	
	N	%	N	%	N	%
≤0.5	44	73.3	1	2.3	45	43.3
0.51-1	15	25	15	34.1	30	28.8
1.1-1.5	1	1.7	3	6.8	3	2.9
>1.5	-	-	25	56.8	25	25
Mean	0.46		1.82		1.03	
SD	0.29		0.91		0.921	
t-value						-10.86***

Source: Own field survey of 2016.P-value = 0.000***, Significant at 1% level.

4.3. Binary Logit Model Result of Irrigation Use in the Study Area

Farmers' decision to use irrigation is determined by various, socioeconomic, agro-ecological and institutional factors. Numerous literatures indicate a lot of explanatory variables, which have significance influence on irrigation use. In view of this, efforts were made to include variables found relevant in the model in order to try to learn the response of the farmers in the study area.

In this section, selected explanatory variables were used to estimate the logistic regression model to analyze the determinants of households' behavior on irrigation water use.A Logit model was fit to estimate the effects of the hypothesized explanatory variables on the probabilities of being irrigation user or not.

Before the estimation of the model parameters, it was found important to look into the problem of Multicolinearity or association among different selected explanatory variables. For this case, the VIF were used to test the association between continuous explanatory variables. To avoid serious problem of Multicolinearity, it is quite essential to omit the variable with the VIF value exceeds 10 (this will happen if R^2 exceeds 0.90 i.e. highly correlated) from the Logit analysis.

Likewise, the degree of association among discrete variables was measured with contingency coefficient test based on chi-square. The values of contingency ranges between 0 and 1, with zero indicating no association between the variables and values close to 1 indicating high degree of association.

Finally, a set of 12 explanatory variables (8 continuous and 4 discrete) were included in the logistic analysis. These variables were selected on the basis of theoretical explanations, personal observations and the results of the survey studies. To determine the best subset of explanatory variables that are good predictors of the dependent variable, the logistic regression was estimated using the method of maximum likelihood estimation, which is available in statistical software program (SPSS version 16). All the above-mentioned variables were entered in a single step. The definition and unit of measurement of the variables used in the model are presented in Table 1.

The various goodness of fit measures state that the model fits that data well. The value of Pearson chi-square test shows the overall goodness of fit the model is at less than 1% probability level.

Another measure of goodness of fit is based on a method that classifies the predicted value of the dependent variable, use of irrigation, as 1 if used and 0 otherwise. This classification is the result of cross-classifying the outcome variable, y, with a dichotomous variable whose values are derived from the estimated logistic probabilities. In this approach, estimated probabilities are used to predict group membership. They say that, if the model predicts group membership accurately according to some criteria, then this is thought to provide evidence that the model fits. The model explained about 98.1% of the total variation in the sample for use irrigation. Correctly predicted figures for users were about 100%; while correctly predicted sample size for non-users were 95.5%.

Table 14. The Binary Logistic Regression results of independent variables.

Variable	Coef	S.E	Wald	Sig	Odds ratio
DSWS	-8.672	3.816	5.165	.023**	.00016
SEX(1)	-3.442	2.163	2.531	.112	.032
Age	.145	.102	2.017	.156	1.155
LANS	10.595	5.090	4.332	.037**	3.9924
OX	.074	1.330	.003	.956	1.077
Coop(1)	-1.255	2.177	.332	.564	.285
TLU	.615	.598	1.057	.304	1.850
Labor	3.108	1.770	3.084	.079*	22.374
CODA	.012	.338	.001	.972	1.012
TIAN(1)	3.559	2.110	2.847	.092*	.028
USCR(1)	-.905	1.438	.396	.529	.405
EDUL	1.416	1.072	1.743	.187	4.120

Variable	Coef	S.E	Wald	Sig	Odds ratio
Constant	-12.137	8.146	2.220	.136	.00016
Correctly predicted user	100				
Correctly predicted non user	95.5				
Overall percentage	98.1				
Chi-square value	122.333***				
-2Loglikelhood	19.37				
Sample size	104				

a. Variable(s) entered on step 1: DSWS, SEX, Age, LANS, OX, Coop, TLU, Labor, CODA, TIAN, USCR, EDUL.
*, and ** represent significant at 10% and 5% level respectively.
Source: Computed from field survey data, 2016

Among the 12 variables used in the model, 4 variables were found significantly influencing the use of irrigation water at less than 10% probability level (Table 14).with respect to use irrigation with less than 10% of the probability level whereas 2 variables were significant with respect to use irrigation with less than 5% of the probability level. These variables include Farm size (LANS),Distance from the rivers (DSWS), Agricultural labor (Labor) and Training (TIAN) and whereas the rest 8 of the 12 explanatory variables were found to have no significant influence on use of irrigation. The effect of the significant explanatory variables on use of irrigation in study area is discussed below:

The agricultural labor (Labor):This variable had significant and positive effect on the use of irrigation water at 10% significant level. The model result indicated that those households who with large labor force had better chance to use irrigation water. The odd ratio also revealed that as the labor force in the household increases by 1 unit the probability of using irrigation increases by 2237.4 times. The information gathered from focus group discuss (FGD) participants revealed that, in the study area, irrigation is labor intensive practice and it needs high labor for construction of canals, diversion of water from rives and application of water on the farm. Similar study by Hodder [27] indicated that irrigation farming is extremely labour intensive.

Training (TIAN):This had significant and positive effects on the use of irrigation water at 10% significant level.As the result indicates those farmers who participated in the training had more chance to use irrigation water than non-trained. The result obtained from key informants interview revealed that in the study area the trained farmers easily understood the operation and adopt improve irrigation technologies which is increase their access to use of irrigation water through lifting with irrigation technologies (motorized water pump) from the sources even if their farm is not accessible to irrigate through gravity force. This may due to irrigation users who get technical advice and training or those are well aware of the advantage of agricultural technologies and adopt new technologies. The value of the odds ratio indicates that participation in irrigation related training program increases the probability of using irrigation by 2.8 percent. This result is consistent with findings by [28].

The farm distance from the rivers (DSWS): had significant and negative effect on the use of irrigation water at 5% significant level. The result indicated that as distance to the water sourse increases by 1Km the probability of using irrigation water decrease by 0.01 percent. The model result indicated that those households whose farm is located far from the rivers had less chance to use irrigation water and vice versa. Because, in the study area the major water source for irrigation is rivers. When the farm is far from main irrigation canals which was constructed from the rivers, it needs high labor, financial and time costs to construct sub-canals towards individual farm and minimize the chances to use irrigation water.Similar study conducted by Abonesh [22] in which the household heads that live near the irrigation scheme have more chance to use irrigation water than those household heads who are far from irrigation water considering that households near the irrigation scheme do not incur additional costs of transportation and traveling time.

Farm size (FRMSZ): It was found that farm size had positively and significantly influenced the probability of use of irrigation at 5% significant level.This result implies that farmers with large farm size are more likely to use irrigation than those farmers who have small land size. As observed in study area farm size is very important resource to use irrigation, because farmers on their small land grow different crops, rear different animals, and thereby likely to generate sufficient income, which could help them to buy agricultural inputs. The odds ratio of 3.9924 for farm size indicates that, other things being constant, the odds ratio in favor of using irrigation increases by a factor of 399.24 as the farm size increases by one hectare. The result of this study confirms the earlier findings of Nkonyaet and others [29].

4. Conclusions and Recommendations

This study has identified key factors that influence use of irrigation in the study area. This insight is also useful to rethink about the barriers of use of irrigation.Therefore, the result can be used by policy makers to promote technological change that is directly needed for the economic development of the country.

In the study area one of main constraints for irrigation non-user respondents' household are distance from rivers and main irrigation canals. These factors were negatively and significantly affected the use of irrigation water at 5% significant level. The major sources of irrigation water in the study area are rivers. The availability of water from rivers is decreases during dry season so it was not reliable even for irrigation users' farm that located far distance from the rivers. Moreover, in the study area there is an opportunity to use Shallow Well due to favorable agro-ecology and location.

Some farmers in the study area have used Motorized Water Pumps for irrigation purposes and it creates access to them to use irrigation water through lifting from water sources even if their farms are not accessible to irrigate through gravity force. However, the access to use such equipment is limited due to high purchasing, maintenance, fuel and hose cost.

The Committees have high responsibility to manage

irrigation water used from rivers. However, these committees have not well function their responsibilities. Therefore, it was negatively affects the fair distribution of irrigation water for the users in sample Kebeles.

Small-scale irrigation is important development effort to ensure farm income if properly implemented. Based on the empirical findings reported in this thesis, the following recommendations are forwarded.

a) Distance from rivers had significant and negative effect on the use of irrigation water and the major sources of irrigation water in the study area are rivers. It is recommended that government, NGO and other stakeholders should focus on construction of new main irrigation canals for farmers whose land is far from the rivers. Because it minimizes distance from rivers and main irrigation canals, consequently, creates an opportunity to shift non-users to use irrigation water in the study area. Therefore, in addition to river water it is better to initiate farmers to develop and use water harvesting technology at (pond and spring development) community and household level and shallow well at household. It is likely to be valuable for future irrigation development.

b) Training had significant and positive effect on the use of irrigation water. Therefore, governmental and non-governmental organizations should give emphasis on provision of training about awareness creation and operation of irrigation technologies for the farmers and that improves farmers' awareness and skill about irrigation technologies and increases their access to use irrigation water in the study area. Training should be given continuously; otherwise, a one-time training, an irregular and partial training cannot bring about a desired effect on the use of irrigation.

c) Agricultural labor had significant and positive effect on the use of irrigation water. Therefore, governmental and non-governmental organizations should give emphasis on provision of credit for farmers and that improves their financial capital to purchase improved equipments and rent labor and that fill the gap of family labor shortage. Consequently, creates an opportunity to shift non-users to use irrigation water in the study area.

d) The results of this study showed that size of cultivated land is positively and significantly influenced the probability of use of irrigation and it was one of the most constraining factors. The possibility of its expansion mechanism is very difficult in the study area due to the absence of bleak land. Thus, to mitigate the problem of cultivated land scarcity, the existing land must be intensively used. For this purpose, farmers should rather be encouraged to use intensive agricultural production methods. In this regard, the current effort of the government to promote small-scale irrigation scheme and water harvesting technologies should be further expanded and strengthened in order to enhance farm households' income level.

e) Expanding the capacity of the micro irrigation users and creating additional access through integrated water investment is important to increase agricultural income and hence leads to improve household's welfare.

f) Adding to the quality, expansion in its quantity and distribution, solving or at least mitigating the problems it faces, creating awareness through training and extension and expansion of credit services are important factors to increase and improve in quality and amount of irrigation, and results to increase income.

g) Expanding the capacity of small-scale irrigation agriculture and creating additional access through integrated water investment is important to increase agricultural production and productivity which leads to increase household's income.

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