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Factors Affecting Farm Households' Participation in Small Scale Irrigation in the Case of Hidabu Abote District, Ethiopia

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Abstract
The objective of the study was to examine factors affecting farm households' participation in small-scale irrigation in Hidabu Abote District, Ethiopia. A three (3) stage sampling technique was used to draw 212 sample households (97 irrigation farmers and 115 non-irrigation farmers) from three (3) *kebeles* of the study area. The *kebeles* were selected using a simple random sampling technique and farmers living in the *kebeles* were first grouped into two strata (irrigation farmers and non-irrigation farmers), and then the study households were randomly selected. The necessary data were collected through household surveys, field observations, focus group discussions and key informant interviews. Data was analyzed using both descriptive and econometrics statistics. Binary logistic regression was used to determine factors affecting the decision of households to participate in small- scale irrigation. The binary logit result revealed that education of household head, family size, off-farm, credit and training positively affect households' participation in small-scale irrigation. In contrast, farmland distance to the water source of the household head negatively affects the decision to participate. The research recommended that giving training, experience sharing, providing credit access for female household heads, developing ponds, spring and water harvesting are very important for smallholder farmers in the study area.
Keywords: Hidabu Abote, Ethiopia, Irrigation Participation, Logit Model, Small –Scale Irrigation
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INTRODUCTION

Irrigation has been practiced for a long period to respond to the bad agro-climatic situation in low rainfall areas such as in Egypt, China, India, and other parts of Asia. It has been promoted as a means to bring about socioeconomic transformation since the Second World War (Hamda, 2014). This is due to the fact that irrigation contributes to increase agricultural productivity through augmenting rainfall shortage, motivating farmers to use more inputs and harvest throughout the year and creating employment to members of the households, especially, women and Children (FAO, 2011). Likewise, irrigation plays an important role in food production and food security at the global level. FAO (2012) shows that about 30% of the world food production is obtained from about 18% of the total cultivated land under irrigation. Over the past 50 years, irrigated areas have almost doubled from 160 million ha in 1961 to 318 million ha in 2010 (FAO, 2013). However, there are wide variations in the proportion of irrigated agricultural land in the developing world, with 37% in Asia 15% in Latin America, 10% in Africa (FAO, 2012).

In Africa, agriculture forms the backbone of most of the continent's economy, providing about 60% of employment. However, during the past decades, per capital agriculture production has not kept pace with population growth. Africa's workforce is growing at a rate of about 3% per year, with at least 10 million young people entering the work force annually (Losch, 2016). Meanwhile, most agricultural land is rain-fed and subject to erratic rainfall and recurrent droughts, leading to low agricultural sector performance. In addition, the low resilience of rural people to climatic effects, irregular production and low productivity, low intensification and crop diversification, and weak value chain and market development have also negatively affected the agricultural sector. As a result, agriculture production has slowly increased in Africa. However, irrigation practices play an important role to cover the imbalance between food demand and supply, and to benefit farmers and generate jobs for the youth in Africa (Africa Progress Report, 2015).

Among other African countries, Ethiopia has great irrigation potential. It has been estimated that about 5.3 million hectares of land in Ethiopia is irrigable land, of which about 3.7million hectares can be developed using surface water sources and about 1.6 million hectares using ground water and rain water management. However, only about 640,000 ha are irrigated, of which about 241,000 ha are from small- scale, 315,000 ha from medium scale and 84,000 ha from large scale schemes. This implies that the contribution of irrigation practice to the national economy as compared to its potential is insignificant (Awulachew and Mekonin, 2011).This is due to the fact that existing irrigation schemes in the country are not operating at their full potential, whereas, others are not functioning as a result of poor infrastructure, limited management and misunderstanding of water uses among farmers.

Ethiopian agricultural practice has been traditionally dominated for centuries by small- scale farmers and its performance has long been adversely affected by the shortage of rain and water that left many to sustain their lives on famine relief support. From the total production, about 97 % of Ethiopia's food crops are produced by rain- fed agriculture, whereas only 3% is from irrigated agriculture (FAO, 2015). According to the Ministry of Agriculture (MoA) (2011), the importance of irrigation development, particularly at the smallholders' level is needed to raise production and ensure food security at the household level in particular and national level at large. Moreover, irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall. In addition, irrigation development already has been identified as a source of sustainable economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction. Furthermore, about 62% of the area equipped for irrigation is located at the Rift Valley, while 29% is located in the Nile basin and, the remaining 9% is located in the Shebelle-Juba basin. Regarding regional wise, about 39% of the irrigated area is in Oromia in central Ethiopia, followed by 24% in Amhara in the Northern, 15% in Afar in the North East and 12% in SNNPR, while the remaining 10% is in the other region. Nearly 100% of the irrigated land is supplied from surface water, while ground water use has just been started on a pilot scale in the East Amhara. Moreover, sprinkler irrigation is practiced on about 2% of the irrigated area for sugarcane production by government enterprises, while localized irrigation has recently started in the Tigray and Amhara regions. Pump irrigation by a group of farm household and private farms is practiced in some areas, while human powered (treadle pump) irrigation has also recently started in the Tigray and Amhara region (FAO, 2018).

North Shewa Zone in general and Hidhabu Abote District in particular has been affected by the late onset and early cessation of rain in different years. For instance, the 2016 meher rains was late by three to four weeks in this Zone as well as in other Zone of Oromia Region (MoARD, 2017). Similarly, excessive rains and flooding were reported in the same years. As result, the zone experienced a reduction in crop production by 15.75% in 2016. For this, small- scale irrigation plays a great role. Despite various studies have been conducted in different parts of the country Hamda (2014), limited research has been conducted in the study area. According to a report obtained from Hidabu Abote District agriculture and Natural Resource Office (HAWANO) (2020), the study area has high water potential such as surface water and underground water. Farmers in the areas have a long history of traditional irrigation practices and by now there is an improved irrigation activity that gives the opportunity to the government in developing modern small-scale irrigation schemes. However, to some extent, households using irrigation practices were not well studied in the District. Hence, this study tried to fill the gap by analyzing factors determining farmers' participation in small- scale irrigation in the study area.

METHODS AND MATERIALS

Study area

This study was undertaken in Hidhabu Abote *Woreda.* The *Woreda* is located in North Shewa Zone, Oromia Region, Ethiopia. The *Woreda* capital town, Ejere, was located 42 km far from the town of North Shewa (Fiche) and 147 km far from the capital city of Addis Ababa. Geographically, the *Woreda* is located between $9^0$47′15″-10^0 0′45″North and $38^0$26′ 15″-$38^0$38′45″East.Most parts of the *Woreda* elevation varies from 1849 to 2067m a.sl. However, the soil types of the study area are: sandy soil 14%, clay soil 51% and silt soil 35%. The pH of the soils in the study area ranges between 4.5 and 6.8. The area is known for its moderately good productivity and is considered to be self-sufficient in grain production. The *woreda* average minimum and maximum temperature is 13^0C and 20^0C respectively, with mean annual rainfall of 800-1200mm (HAWANRO, 2021).

Data Types and Sources

This study used both primarily and secondary data sources. Primary data (both qualitative and quantitative) was collected directly from the respondents selected from irrigation farmers and non-irrigation farmers. Quantitative data was collected by administering pre-tested structured survey questionnaires. A household survey was used to obtain the demographic, socio-economic, institutional characteristics, and food security status of both groups of the households. Qualitative method was used to capture data pertaining to local perceptions and opinions on the effect of irrigation on household food security. This was done by using focus group discussion in each of the three (3) selected *kebeles* and through key informant interviews. Secondary data were also reviewed and organized from various documents both published and unpublished materials, which were relevant to the study.

Sampling Technique and Procedure

The study applied a three-stage sampling technique procedure to select the study households. In the first stage, the study district was purposely selected based on irrigation potential. In the second stage, three (3) sample *kebeles* were randomly selected from those *kebele* where small-scale irrigation has been practiced. In the third stage, households living in the selected sample *kebeles* were stratified in to two (2) groups, namely irrigation farmers and non –irrigation farmers and then 212 study households were randomly selected.

Table1. Number of Household Two Strata from each *Kebele*

Sample *Kebele*	**Irrigation Farmers**		**Irrigation non-irrigation Farmers**		**Total Sample**
	Total	Sample	Total	Sample	
Dire Bantu	385	33	457	40	73
Debala bokolo	362	31	427	37	68
Abado Ariro	383	33	435	38	71
Total	1130	97	1319	115	212

Sample Determination

The sample size of the study was identified by using the rule of thumb given by Greene (2003). It shows that, n≥50+8m (n refers to sample size of the study area and m refers to number of independent variables). Based on the independent variables the minimum sample size of the study could be greater than or equal to162. Finally, to determine the representative sample household from the study area, the formula for sample size determination applied a degree of precision to 0.06 due to shortage of resources. However, for purpose of this study, 212 households (97 irrigation farmers and 115 non-irrigation farmers) were employed as a sample of the study. The major reason for obtaining greater number of sample size was to help minimize the sample error and to enable better generation on the research objective. Likewise, to determine household samples from the selected *kebeles* for each stratum, sampling proportion to population was used. The sample of the respondent household was selected using representative selection with ±6% precision level and 94% confidential interval. The desire sample size was obtained using Equation 1 as given by Kothari(2004):

$$n=\frac{z^2pq}{d^2} \text{ ....(1)}$$

Where: n = the desire sample size, Z = standard normal variable at the required level of confidence (1.75), P = the proportion in the target population participation in irrigation (0.5), d = desire degree of precision (0.06), and q = 1-p (0.5).

Finally, representative sample for each stratum was selected by using probability proportional to size which was applied across each category. Equation 2 as given by Kothari (2004) was employed to determine the sample size of each stratum in the selected *kebeles.*

$$Pi = {ni}/{N} \text{ ....(2)}$$

Where: Pi = Proportion of population included in stratum I, ni = Number of sample household, N Total number of the population, and Pi = 212/2449 = 0.087

Tools and Technique of Data Collection

The primary data of the study was collected using household surveys, focus group discussion, key informant interviews and field observations explained as follows:

Household Surveys

In order to generate qualitative and quantitative information at household level, household surveys with the selected 212 households were undertaken by using structured questionnaire. The questionnaire covered information related to the household demographic, socio-economic and institutional factors. Information related to household food security status was also collected using household surveys. In order to maintain the quality of data collected, scientific principles and guidelines during questionnaire designing, data collection, data filling, encoding, data entry and processing were applied. The questionnaire was prepared in English and translated to local language (*Afan oromo*). Hence, enumerators and respondents can easily understand the questions. Three enumerators, one from each *kebele*s, were employed based on their ability of local language, and experience in data collection. Training was provided to the enumerators on the procedure to follow while conducting interviews with respondents and deep discussion was also held for further clarification on the questionnaire.

Key Informant Interviews

Key informant interviews were carried out with experts and administration at district and *kebele* level as well as local NGOs operating in the area. Hence, key persons such as, agricultural office head, irrigation agronomy expert, World vision Ethiopia District area program, Development Agent, *kebele* leader and water use association team leader in sample *kebeles* and District were interviewed to obtain relevant information. The focus of organizing informant interviews with the selected key persons was to enrich data collected through household surveys. The researcher held the interviews. Open interaction between the key informant and researcher was facilitated through inviting key persons in the respective institutions relevant for the issue under discussion.

Focus Group Discussions

Focus Group Discussions (FGD) composed of both men and women were conducted in the study *kebele*. Similarly, three FGD (one in each study *Kebele*) were carried out with a mix of participation such as irrigation participation households, elders, female household heads, development agents, and the young. Each group has been comprised of six to eight members. The researcher facilitates the group discussion. During the discussions, the issue of small- scale irrigation and food security was widely discussed.

Field Observations

A field visit was executed by the researcher to substantiate and augment the information obtained through other primary and secondary data collection tools. The socioeconomic conditions of the area were explored through field observation. In the meantime, experts and administration in the Distric*t* and *kebele* were informally interviewed during the field visits.

Secondary Data

Data for this study was also obtained by reviewing secondary sources information. Both published and unpublished research thesis/dissertations, journals, articles and reports were reviewed and used for this study. Similarly, government documents obtained from various official websites such as Ministry of Agriculture and Natural Resource (MoANR), Ethiopia Institute of Agriculture Research (EIAR), Central Statistics Agency (CSA), and National Metrological Agency (NMA) were reviewed and used for this study.

Data Analysis

As the data for this study was generated through quantitative and qualitative techniques, both the quantitative and qualitative method of data analysis was used. The quantitative data obtained through household surveys and secondary sources of information were analyzed using descriptive statistics and econometric analysis. Quantitative data was processed and managed using "STATA Version 15" software

Descriptive Statistics

Descriptive statistics including mean, percentage frequencies and standard deviation were employed to describe the demographic, socio-economic, farm characteristics, and institutional characteristics of the study households. In addition, a t-test was used to compare mean differences between two groups across the study and a chi-square test was done to identify the association between categorical variables and independent variables.

Econometric Analysis

Binary choice models are appropriate when the decision- making choice is between two alternatives (Irrigation farmers and non-irrigation farmers). Irrigation participation is a dependent variable, which takes a value of zero or one depending on whether or not a household will be a participant or not (i.e. participant = 1 and non-participant= 0). Following Gujarati (2003) the logistic distribution for the decision of household on irrigation participation can be specified as:

$Pi = e^{zi}\ 1+ezi$ ……………………………………………………………………(3)

Where: pi = probability that individual is being participant for the i^{th} household and ranges from 0 to 1, e = represents the base of natural logarithms and zi = is the function of a vector of n- explanatory variable (x) and expressed as:

$Zi = \beta 0+\sum \beta iXi + ui$ ……………………………………………………………………(4)

Where: βo = is the intercept βi = is the regression coefficients to be estimated, xi = is variables and ui = is a disturbance term.

1-pi is represents the probability of not irrigation participant group and can be written as:

$1-Pi = 1/\ 1+ezi$ ……………………………………………………………………(5)

Then odds ratio can be written as:

$Pi\ /\ 1-pi = 1+e^{zi}/1 + e^{-zi} = e.^{zi}$ ……………………………………………………………(6)

Equation (6) is indicates simply the odds ratio. It is the ratio of the probability that the household is an irrigation participant to the probability that he/she was not a participant. Finally, by taking the natural logarism of equation (6) the log of odds ratio could be written as:

$Li = Ln\ (pi/\ 1-pi) = Ln\ (e^{\beta 0} + \sum_{j=1}^{n} \beta jXij + ui = Zi = \beta 0 + \sum_{j=1}^{n} \beta jxij + ui$ …………………………(7)

RESULTS AND DISCUSSION

Descriptive and Inferential Statistical Analysis

Tables 3 and 4 present the demographic and socio-economic characteristics of study farmers, which were hypothesized to positively or negatively influence their participation in irrigation practice. As shown in Table 3, the mean value of education of irrigation user household head was 3.8 grades while non-user was 2 grades. The result shows that the household head education level was higher for irrigation user households than non-user households at 1% significant level. The hypothesized households with higher education backgrounds were probability to use small -scale irrigation than non-users. Similarly, Asayehegn *et al*. (2011) found out that education is a key factor determining farmers' decision to adoption of irrigation technology. This might be due to the fact that education creates awareness of the benefits of irrigation, and helps with better innovation and invention for rural households.

Labor is one of the major resources on which the farming activities of the study households are established like in any other part of Ethiopia. The computed average adult equivalent family size of the study household as presented in Table 3 were; 5.40 for irrigation farmers and 4.56 for non-irrigation farmers. The result shows that irrigation farmers have higher available family labor compared to non-user at 1% significant level. This significant value shows that, small-scale irrigation users and non-irrigation farmers' households had different family size. Labor force availability is an important factor influencing household decisions to participate in irrigation practice. Furthermore, the finding also indicates, as the number of family size or labor force of a household in adult equivalent increase, the probability to participate in irrigation also increases by 1% and increases the total income of the households which contributed to improved well-being.

Distance of farm land from a water source was employed to analyze the characteristic of the farm household in the study area. The mean distance of farmland from water source for irrigation user was 0.45 kilometer while non-users were 0.56 kilometers. The statistical analysis shows that the mean distance of farm land from the water source was significantly shorter for irrigation users than non-users at 1% level. Similarly, Nugusse (2013) showed a positive relationship between the distance of water and farmlands and farmers participation in irrigation agriculture. They have concluded that the higher the distance between the river and cultivated land the less is the probability of the household to participating in irrigation agriculture, and vice versa.

The result in Table 3 further shows the number of contacts per month that the respondents made with development Agents. Hence, the average means of contact with small -scale irrigation user households were 1.67 times per month for irrigation user. For the non-irrigation user this was 1.44 times per month. The statistical analysis indicates that there was a significant mean difference of the contacts with development agents between user and non- user households at 1% significant level. Moreover, the result implies that, households who had more contact with *kebele* extension agents knew more about the use of irrigation practice than those who could not practice small -scale irrigation in the study area. The effort to disseminate new agricultural technologies was within the field of communication between the extension agent and the farmers at the grass root level. Here, the frequency of contact between the development agent and the farmers are hypothesized to be the potential force that accelerates the effect of dissemination of adequate agriculture information to the farmers. In addition, all KII and FGD expressed that ''having gotten extension service at least once per month about irrigation practice''.

The sex of the household head is one of the dummy variables that have a more likely mean difference between irrigation users and non-users. The result shows that from the total small-scale irrigation user households, 85.57 % were male while 14.43% were female-headed. Likewise, among the non-user households, 72.2% were male and 27.8% were female headed (Table 4). The chi-square test also indicated that the sex of households had a significant difference between being small- scale irrigation users and non-users at 1% significant level. The result implies that, small-scale irrigation practices were largely governed by men. This might be due to men having more responsibilities for crop production including livestock rearing in the study area, while women were for domestic tasks (food preparation and processing, cleaning, marketing, fetching of water, and firewood). The result of this study is also strengthened by Dillon (2011) who found out that the sex of the head is a variable that statistically and significantly explains the participation in irrigated agriculture.

Moreover, among irrigation users, 76.29% of the households participated in off-farm activities. From, non-user households 54.8% were engaged in off-farm activities. In addition, the chi-square result shows that there were significant differences between irrigation users and non-users at 1% significant level with X^2=0.001 (Table 4)). This result implies that households who engaged in off-farm activities increase the household decision to participate in small-scale irrigation. Also, Table 4 shows that 51.55 % of irrigation users had access to credit services, whereas only 26.96% of non-users had access to credit services. The chi-square test result shows a statistically significant difference between the two groups in access to credit service at 1% level. The result implies that participation in irrigation practices increases farmers' confidence to use credit services as it provides an opportunity to payback credit. The result of this study contradicts Girma (2011). Irrigation enables farmers to produce more than one time per year, and this in turn, brings a high returns to agriculture inputs, which build the capacity of farmers. Access to credit services as a financial capital provides an opportunity to engage in various income-generating activities. This, in turn could strengthen households' ability to purchase different agricultural inputs like improved seeds, fertilizers, and tools.

Moreover, from the total respondents, about 75.47% of households obtain training on irrigation issues and the remaining 24.53% did not. Likewise, about 89.69% of the small- scale irrigation users obtained training on issues related to irrigation, whereas, 63.5% of non-users obtained training on irrigation. The Chi-square test result also shows that there is a highly significant difference between irrigation users and non-users in terms of participation in training at 1% significance level. The result implies that, a higher number of irrigation participant households had obtained training on irrigation issues than non-participant households. Moreover, FGD and KII indicate that ‘’ training has been given by government and NGO on small- scale irrigation issue before land preparation, water management, harvesting and marketing.

Table3: Demographic, Socioeconomic and Institutional Characteristics of Study Households (Continuous variables)

Name of Variables	Irrigation Farmers (N=97)	Non-Irrigation Farmers (N=115)	Total Households (N=212)	T-Value	P-Value
	Mean Value	Mean Value	Mean value		
Age (Year)	43.85	43.98	43.92	0.071	0.4714
	(11.39)	(13.98)	(12.79)		
Education (Grade)	3.8	2	2.8	-4.03	0.000***
	(3.49)	(3.02)	(3.36)		
Family Size (Adult equivalent)	5.46	4.56	4.97	-3.69	0.003***
	(1.81)	(1.72)	(1.81)		
TLU (conversion factor)	3.62	3.41	3.5	-0.78	0.7824
	(1.88)	(1.94)	(1.91)		
Land Size (Hectare)	1.47	1.34	1.4	-1.08	0.865
	(0.91)	(0.75)	(0.83)		
Experience (Year)	26.42	23.94	25.08	-1.65	0.9507
	(10.36)	(11.18)	(10.86)		
Water Distance (Kilometer)	0.456	0.567	0.517	3.4	0.004***
	(0.227)	(0.251)	(0.242)		
Market Distance (Kilometer)	10.94	10.77	10.85	-0.25	0.5981
	(5.06)	(4.66)	(4.83)		
Extension Frequency	1.67	1.44	1.54	-2.7	0.0025***

*Note: ***, show significance at p<0.01*

Table 4: Demographic, Socioeconomic and Institutional Characteristics of Study Households (Dummy Variables)

Variables	Category	Irrigation Farmers (N=97)		Non-Irrigation Farmers (N=115)		Total Households (N=212)		Chi^2 - Value (probability)
		Count	Percent	Count	Percent	Count	Percent	
Sex	Male	83	85.57	83	72.17	166	78.30	0.001***
	Female	14	14.43	32	27.83	46	21.70	
Offfarm	Yes	74	76.29	63	54.78	132	62.26	0.001***
	No	23	23.71	52	45.22	75	35.38	
Credit	Yes	50	51.55	31	26.96	81	38.21	0.000***
	No	47	48.45	84	73.04	131	61.79	
Training	Yes	87	89.69	73	63.48	160	75.47	0.000***
	No	10	10.31	42	36.52	52	24.53	
Foodaid	Yes	43	44.33	51	44.35	94	44.34	0.998
	No	54	55.67	64	55.65	118	55.66	

*Note: ***, shows p-value significant at 1%*

Econometric Analysis

Factors Determining Participation in Small -Scale Irrigation

The logistic regression model estimation results show that out of fourteen (14) factors that determine the participation in small -scale irrigation, six (6) variables were found to have a significant effect on the probability of participation decision of the farm households. These variables were the family size of household, household head education, engaging in off-farm activities, water distance, credit, and training. The logistic regression result in Table 5 also shows that six of the variables were statistically significant at p<0.01, p<0.01, p<0.05 p<0.01 and p<0.01 respectively.

Table5: Logistic Regression for Small -Scale Irrigation Participation

Variables	Coef.	Std. Err.	Marginal Effect(dy/dx)	Z	P>Z
Sex	0.5161069	0.45851	0.1228574	1.13	0.26
Age	-0.015557	0.027988	-0.0038161	-0.56	0.578
Educ	0.168968	0.060551	0.0414485	2.79	0.005***
Famsz	0.3313957	0.108941	0.0812926	3.04	0.002***
Tlu	-0.087115	0.111281	-0.0213696	-0.78	0.434
Landsze	0.2178112	0.248369	0.0534299	0.88	0.381
Experi	0.0458465	0.030471	0.0112463	1.5	0.132
Plotdist	-2.559612	0.869319	-0.627882	-2.94	0.003***
Offfarm	0.977314	0.407193	0.2299381	2.4	0.016**
Credit	1.177079	0.373224	0.2848299	3.15	0.002***
Marketdis	0.0080202	0.040519	0.0019674	0.2	0.843
Training	1.580349	0.464123	0.3407552	3.41	0.001***
Frextn	0.4262197	0.295268	0.1045532	1.44	0.149
Foodaid	-0.00792	0.404418	-0.0019427	-0.02	0.984
Constant	-4.964882	1.373321		-3.62	0

**** P<0.01 and ** P<0.05*

Educational Level of Household Heads

The econometrics logit model result presented in Table 5 shows the literacy status of the household head. The result shows that, education status is positively associated with household irrigation participation. Hence, the positive association designates that, the coefficient of the probability of being an irrigation participant increase with an increase in household heads' literacy status. The coefficient of small-scale irrigation participation increases by a factor of 16.9% when the education status of household heads changes from illiterate to literate at 1% probability level, with other determinants being constant. Therefore, households who have literate heads were most likely to be participating in small-scale irrigation than their counterparts.

Household Family Size

Family labor was found to be positively related and had a significant effect on small-scale irrigation participation at 1% significant level. The result implies that, as the family size in adult equivalent increases, the probability of participation in small-scale irrigation also increases by 33.14% (Table 5). In addition, the result suggested that, households with larger family labor can perform various agronomic practices with more efficient use of water and other income-generating activities without labor shortage. This means that, households with large labor forces were participating in small- scale irrigation more than a household that had small labor force.

Distance of Farmland from Water Sources

This variable was significant at 1% level of significance and has a negative relationship with household participation decisions in small-scale irrigation practices (Table 5). The result indicates that as the distance of farmland from the irrigation water source increases by one kilometer, the probability of participating in small-scale irrigation decrease by 40.24%. Hence, households who have farmlands nearest to water sources are most likely to participate in small- scale irrigation than households far from water sources. An increase in the distance of off-farm land from irrigation water sources highly hinders irrigation practices due to the difficulty of bringing water to one's farm land.

In addition, FGD1and KII1 indicate that, having distant farm land from a water source further reduces the volume of water and the size of cultivated land also decreased.

Household Off- farm Activity

Off-farm activities significantly and positively influence household participation in small -scale irrigation with a p-value of (0.05) (Table 5). The coefficient increases by 0.977 indicating that the probability of participation to use small-scale irrigation increased by 97.73%. In addition, the related evidence also found that, household having access to off-farm activities were participating in irrigation practices more than those not having access to off-farm activities (Beyan *et al.,* 2014).

Credit Facility

This variable was one of the variables hypothesized to determine the household's participation decision in small-scale irrigation practice. As a hypothesis, this variable was positively associated with the participation of small-scale irrigation at 1% significance level (Table 5). Additionally, the result indicates that, as access to credit increases by one unit, the probability of participating in small -scale irrigation also increases by 17.29%. This implies that, the probability of participating in small-scale irrigation practices for the farmers that have credit access was higher by 17.29% as compared to those households that did not have credit access. Access to credit helps farmers to purchase inputs such as seeds, fertilizers and agriculture tools.

Access to Training

Results show that access to training has a significant effect on the participation of small- scale irrigation at 1% significance level (Table 5). Consistently, existing evidence indicate that, farmers that received training on irrigation issues were in a better position to participate in irrigation practice as compared to farmers that did not receive any training on irrigation issue (Abebaw *et al.,* 2015). Training can create awareness among farmers on the importance of irrigation practices, the management of water resources and knowhow and these enable the farmers to participate more in irrigated farming.

Factors Constraining the Use of Irrigation by Households

The survey results indicate that small-scale irrigation had a great potential to improve the incomes of poor households. Table 6 shows that incidents of insect pest and disease outbreak was major constraint in the study area which affect a low 27.8%, moderately 71.7%, and highly 0.5% of the irrigation user respondents. So, in the study area farmers, most farmers are affected by insect pests and disease outbreaks frequently. Hence, it decreased crop production and productivity, and income. This implies the number of participants and irrigation practices would be reduced as a result of crop damage due to pests and diseases as they cannot cover the cost of irrigation use. Inadequate extension services indicate low 17.5%, moderately 76.4%, and highly 6.6%, so farmers in the study area require frequent extension service. Additionally, weed management was moderately affected by 87.7%, due to farmers' less attention to agronomic practices in the study area. Availability of farm oxen indicates low 14.6%, moderately 62.7%, and highly 22.6% suggesting that farmers who participate in small-scale irrigation need oxen for land preparation. Furthermore, the survey result shows that farm holdings were insufficient indicating low 14.6%, moderately 66%, and highly 19.3%. This suggests that insufficient irrigation land size was the main problem to participate in small-scale irrigation in the study area. Regarding level of sufficiency of irrigation water, the responses indicate low 41%, moderate 9.9%, and 49.1%; this suggests that in the study area farmers are mostly affected by the shortage of water which affected their participation to practice small-scale irrigation. Lack of access to appropriate technology indicates low 7.1%, 50%, and 42.2%, suggesting that lack of access of farmers to technology is one of the main challenges in the study area that needed attention to increase productivity and income of the household. More importantly, the inability to apply sufficient modern farm inputs indicates low 6.1%, moderately 51.4%, and highly 42.5% respectively. The survey result indicated that farmers with no or little capital to buy irrigation technologies and farm inputs such as seeds, fertilizers, and chemicals, could not be engaged in irrigation activities. Shortage of cash income indicates low 7.5%, moderately 45.3 and moderately 47.2%, suggesting that problems of cash income moderately irrigation practices in the study area.

Table 6: Constraints of Small- scale Irrigation Use by Households

Constraints	**Low**		**Moderate**		**High**		
	Count	**%**	**Count**	**%**	**Count**	**%**	**Total**
Drought	161	75.9	51	24.1	0	0	100
Pests and disease	59	27.8	152	71.7	1	0.5	100
Inadequate extension services	37	17.5	162	76.4	14	6.6	100
Weeds	186	87.7	25	11.8	1	0.5	100
Shortage of farm oxen	31	14.6	133	62.7	48	22.6	100
Insufficient farm holdings	31	14.6	140	66.0	41	19.3	100
Poor soil fertility	166	78.3	43	20.3	3	1.4	100
Lack access to appropriate technology	15	7.1	106	50.0	91	42.9	100
Limited awareness	46	21.7	149	70.3	17	8.0	100
Inability to apply sufficient modern farm inputs	13	6.1	109	51.4	90	42.5	100
Shortage of cash income	16	7.5	96	45.3	100	47.2	100
Shortage of water	87	41.0	21	9.9	104	49.1	100

CONCLUSIONS

The study aimed to analyze participation in small-scale irrigation status in HidabuAbote District, Ethiopia. A binary logistic regression was used to identify the factors that determine the participation in small-scale irrigation by farmers. The binary logistic regression result shows that education of households, family size, engagement of off-farm activities, credit service, and access to training have positive and statistically significant effects to determine the household participation decision small -scale irrigation. Likewise, the distance of water source from farmland had a negatively related to household participation in small-scale irrigation. The positive association of credit access and training facilities with small-scale irrigation participation is explained by the fact that the institution of credit and training access allow households to participate in small-scale irrigation. The study also revealed that households near water sources allow them to participate in small-scale irrigation and improve farm income more than non-irrigation farmers. Similarly, households engaged in off-farm activities are essential for the diversification and intensification of the source off-farm households' livelihoods. More importantly, it enables households to enhance their income, and gives them a chance to purchase necessary agricultural inputs and tools thereby modernizing the mean of production, and reducing the risk of food shortage during the period of crop failure through food purchased. Therefore, it needs to call upon this stakeholder to take part in enhancing the irrigation farm by reducing the hindrance and strengthening available enabling factors in the study area.

RECOMMENDATIONS

- Based on the study, off-farm should be promoted by district and zonal concerned offices especially during off-season to increase the farmers' income which enables farmers to participate in irrigation.
- The study also implies the distance of farmland from the water source was made to be influenced participation in irrigation significantly and negatively. So, the development of ponds, springs, and water harvesting should be encouraged for households to use for irrigation.

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CONFLICT OF INTEREST

There is no conflict of interest regarding the publication of this paper.

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