Factors Affecting Smallholder Farmers' Participation Decision in Small Scale Irrigation: The Case of Deder District, Eastern Hararghe Zone, Ethiopia

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This research was funded by Oromia Agricultural Research Institute

Abstract

Irrigation systems require active involvement of the community for sustainable operation to meet the intended objectives. However, farmers' participation in small-scale irrigation in Ethiopia has largely been peripheral. Therefore, this study was conducted to identify the socio- economic and institutional factors affecting participation of smallholder farmers in small-scale irrigation in Deder District of East Hararghe Zone. Two stage sampling procedure was used to select sample respondents. First, the total irrigation user kebeles of the district were identified and four sample kebeles were randomly selected. At the second stage, 150 sample respondents were selected using stratified sampling, probability proportion to size and simple random sampling method. A cross-sectional survey method was used and data was collected through semi-structured interview schedule. Descriptive statistics and probit model were used for data analysis. The analysis revealed that sex of the household head, availability of family labor force, total livestock holding, access to extension service, distance from household's residence to the water source, size of cultivated land and perceived soil fertility status are significant factors affecting smallholder farmers participation in small scale irrigation. Irrigation is one means by which agricultural production can be increased to meet the growing food demands. Therefore, smallholder farmers should be assisted and encouraged to participate in small-scale irrigation thereby improve their production and income.

Keywords: Smallholder farmers, Participation, Small-scale irrigation, Deder, Ethiopia

DOI: 10.7176/JNSR/15-2-02

Publication date: May 31st 2024

1. Introduction

Agriculture is the mainstay of the majority of the population living in Sub-Saharan Africa. However, Sub-Saharan Africa (SSA) countries are characterized by low agricultural productivity. This is related to the fact that the sector is predominantly rain fed, which is in most cases unreliable resulting poor yields and the changing weather conditions would further aggravate the situation, exposing small farmers to negative impact of climate change (Todaro, 2012).

Ethiopia is one of SSA countries, where its economy is dominated by rain fed agriculture in which large number of its population is directly or indirectly involved. The sector is contributing about 42% of GDP, 85% of the employment, 90% of the export earnings and 70% of the supply of industrial raw materials (UNDP, 2014 and World Bank, 2010). Nevertheless, Ethiopia's agriculture continues to face many challenges. Adverse climatic conditions, erratic distribution and unreliable rainfall are the major ones (Spielman et al., 2010).

To overcome these problems, it is crucial to expand irrigation agriculture (FAO, 2014). Many studies have argued that ensuring farmers' access to irrigation is important in developing countries and conclude that access to irrigation is a major tool for agricultural growth and poverty reduction. (Norton et al., 2010; Gebregziabher et al., 2009; Muller et al., 2009). Expanding small-scale irrigation is a policy priority in Ethiopia in general and Oromia region in particular for rural livelihood improvement, poverty alleviation and growth as well as climate adaptation (MoA, 2011). However, farmers' participation in small-scale irrigation has largely been peripheral (Awulachew and Ayana, 2011; FAO, 2015). A number of problems, such as poor marketing arrangements, limited access to water, inability to meet operational costs, limited household asset holding, financial viability and poor governance have occurred in irrigation systems (Rukuni et al., 2006). The weak participation of farmers left behind poor financial and technical capacity of farmers, weak water user associations as well as poor operation and maintenance practices that made smallholder irrigation schemes unsustainable (Namara et al., 2011 and Mutambara et al., 2014). As was concluded by Hope et al. (2008), enhancing smallholder farmers' participation in small scale irrigation through improved access to reliable irrigation water is very important to ensure better household livelihoods. Hence, this study identified the socio-economic and institutional factors that influence participation of smallholder farmers in small-scale irrigation in Deder Wereda of East Hararghe Zone.

2. Methodology of the study

2.1. Description of the Study Area

The study was conducted at Deder district of East Hararghe administrative zone which contains 37 rural kebeles and 3 urban kebeles. Geographically, the district is located in eastern part of Oromia National Regional State between 9°09'N – 9°24'N latitude and 41°16'E – 41°32'E longitude. The capital town of the district is Deder town, which located 112km west of Harar town, and 12km from the main road that takes from Harar to Addis Ababa (DANR, 2018). Agro-climatically, it encompasses highland (33%), midland (50%) and lowland (17%) with altitudes ranging from 1200 to 3138 meters above sea level. The temperature of the area ranges from 14°C Min. to 29°C Max and annual average rainfall ranges from 600mm in the lowland to nearly 1200mm in the highland. The district covers a total 67428ha land out of which 39.3% is used for cultivation, 0.7% for grazing, 21.4% for forest plantation, bush and shrubs, and 17.7% for residential and 20.9% is Rugged and mountains. (DANR, 2018).

The total estimated population of the district is 244,638. Out of these, 124,129 are male and 120,509 are female. Out of 39742 total household of the district, 36,924 (93%) are male headed and 2818 (7%) are female headed. About 90.5% of the district populations are living in rural areas while the remaining is living in urban areas. Agriculture is the major economic activity in the rural area, mixed farming system being a common practice in all agro-climatic zones (highland, midland and lowland). Maize is a staple crop in the district followed by sorghum. Wheat and barley are also the second major category of food crops produced in the highland part of the district. Legumes such as haricot bean and faba bean are grown usually intercropped with maize and sorghum (DANR and DLA, 2018).

Besides rain fed agriculture, irrigation agriculture is being practiced in the district. The district has a wide range of water sources which are underutilization for both traditional and modern irrigation systems. Traditional irrigation systems have a long history in the district. However, modern irrigation systems were introduced during the Derg period, in the 1970s. Currently, there are a number of traditional and modern irrigation systems in the district. The modern scheme has cemented main irrigation canals which help to reduce water loss through seepage. There are 9771ha total irrigation coverage with 21437 irrigation user households in the district. 2165 households which are about 11% of total users have been using modern irrigation schemes. These cover only 554ha lands which are 6.7% of total irrigation land. Traditional irrigation systems cover 89% in terms of users and 93.7% in terms of area coverage. The main sources of the district irrigation water are river and spring water. The major vegetables and fruits produced under irrigation are: potato, sweet potato, papaya, banana, tomato, carrot, cabbage, coffee, khat, sugarcane and garlic (DIDA, 2018). Map of the study area was shown in figure 1 under appendices.

2.2. Sample Size and Sampling Method

Two stage sampling procedure was used for the selection of sample respondents. In the first stage, out of 37 rural kebeles that are found in Deder district, 28 irrigation user kebeles were purposively identified. Then, due to resource limitations, only four kebeles were selected out of irrigation user kebeles using simple random sampling method. In the second stage, first the household heads in the four sampled kebeles were identified and stratified into two strata: irrigation user and non-user. The sample size regarding each kebeles and stratum were determined using probability proportional to size of the identified households of the selected Kebeles and total users and non-users respectively. Then, the respondents from each stratum were selected using simple random sampling technique. A total of 150 rural households (determined using rule of thumb) were drawn as shown in table 1 under appendices.

2.3. Data Type, Source and Collection Methods

Both quantitative and qualitative data were collected from primary and secondary sources. Secondary data was obtained from District Office of Irrigation Development Authority (DIDA), District Agriculture and Natural Resource Office (DANR) and District Livestock Agency (DLA) as well as documentary sources such as published and unpublished documents. The primary data was obtained from primary data sources such as sampled household heads. A cross-sectional survey method was used to collect primary data through a carefully designed semi structured interview schedule. Prior to actual data collection, orientation was given to the enumerators to develop their understanding regarding the objectives of the study, the content of the interview schedule, how to approach the respondents and conduct the interview. Then, pilot-testing of the interview schedule was carried out with the enumerators and the interview schedule was modified. Then, data was collected through active involvement and close supervision of the researcher.

2.4. Methods of Data Analysis

2.4.1. Descriptive Statistics

Descriptive statistics such as mean, standard deviation and frequency of appearance were used to summarize data. The variables hypothesized to affect farmers' participation in small scale irrigation were tested whether they are statistically significant or not using t-test and chi-square ($\chi 2$) test. The t-test was used to test the significance of the mean value of continuous variables of the two groups of users and non-users. Likewise the potential discrete (dummy) explanatory variables were tested using the chi-square ($\chi 2$) test.

2.4.2. Econometric Model

Regression models in which the regress evokes a yes or no or present or absent response are known as dichotomous or dummy dependent variable regression models. They are applicable in a wide variety of fields and are used extensively in survey or census-type data (Gujarati, 2004 and Green, 2003). The dependent variable in this study, which is SSI participation decision, is also a dummy variable, which takes a value of zero or one depending on whether or not the households participate in SSI farming. However, the independent variables are of both types that are continuous and categorical. When one or more of the explanatory variables in a regression model are binary, we can represent them as dummy variables and proceed to analysis. However, the application of the linear regression model when the dependent variable is binary is more complex and even not efficient (Pindyck and Rubinfeld, 1981). Because, individuals are faced with a choice between two alternatives and their choice depends on their behavior. Estimation of this type of relationship requires the use of qualitative response models.

The most widely used qualitative response models are the logit and probit models (Amemiya, 1981). The logit and probit models guarantee that the estimated probabilities will lie between the logical limit of 0 and 1. These two binary outcome models have an S-shaped relationship between the independent variables and the probability of an event which addresses the problem with functional form in the linear probability model (Long, 1997). Because the probit probability model is associated with the cumulative normal probability function, whereas, the logit model assumes cumulative logistic probability distribution are very close to each other, except at the tails, we are not likely to get very different results using the logit or the probit model. Therefore, choice between the logit and probit models revolves around practical concerns such as the availability and flexibility of computer programs, personal preference, experience and other facilities since the substantive results are generally indistinguishable (Maddala, 1983). Therefore, given the similarity between the two models, probit model was used for the analysis of the factors affecting SSI participation.

2.4.3. Specification of the Probit Model

The following functional form was used in order to achieve the research objective.

$$Pi = f(Z_1, Z_2, Z_3, Z_4 \ldots Z_K) \quad (1)$$

The functional equation for the probit model stated in above (1) can be specified as:

$$Pi = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \ldots + \alpha_K Z_K + \mu i \quad (2)$$

Where,

Pi = dichotomous variable representing participation of smallholder farmer households in SSI; and it is equal to one if the household participates in SSI and zero otherwise. Z_1, Z_2, Z_3, Z_4…Z_K are the vector of variables that affect smallholder farmer households' decision to participate in SSI. Parameters; α_0 is the constant term or intercept and α_1, α_2, α_3, $\alpha_{4\ldots}$ α_K represents coefficients for the row vectors to be estimated, and μi is the error term.

Let the selection model for household's participation in SSI be explained by the equation stated below. Here, the equation indicates that household's participation depends on some value pi* of a latent variable.

$$Pi^* = Zi\alpha + \mu i \quad \text{where} \quad \mu i \sim N(0, 1) \tag{3}$$

Thus, the participation in small-scale irrigation can be determined from the equation stated below.

$$Pi = \begin{cases} 1 \text{ if } Pi^* > 0 \\ 0 \text{ if } Pi^* \leq 0 \end{cases} \tag{4}$$

With the decision to participate in small scale irrigation given by pi=1 if household participate and pi=0 otherwise, where pi is a variable indicates participation in small-scale irrigation, Z is a vector of variables that affect households' decision to participate and μi is the corresponding error term.

3. Results and Discussion

This chapter presents the main findings of the study regarding smallholder farmers' participation in small scale irrigation. The results are presented and discussed in two main sections based on the objective of the study which are focused on identifying socio-economic, institutional and organizational factors affecting participation of smallholder farmers in small-scale irrigation. Section 3.1, presents descriptive statistical results on variables hypothesized to affect participation of smallholder farmers in small-scale irrigation. Tools such as frequency, percentage, mean, standard deviation, t-test and chi-square test are used under this section. Section 3.2 presents and discusses results of Econometric model that was used to identify the most important factors that affect smallholder farmers' participation small-scale irrigation.

3.1. Descriptive Results

Sample respondents were composed of both male and female household heads. Out of 76 irrigation user households, 22.4% are female headed and the remaining 77.6% are male headed. The corresponding figure for non-users is 37.8% and 62.2% respectively. The chi-square test for sex distribution indicates that there was statistically significant sex difference between irrigation users and non-users at 5% level of significance.

The comparison between user and non-user households showed that 59.2% of the users and 32.4% of the non-users have perceived their land as fertile. The chi square test revealed that there is a statistically significant difference between irrigation users and non-users in perceived soil fertility status at 1% level of significance.

The survey result revealed that 63.3% of the total sample households get extension service. According to the survey result, 85.5% of the users and 40.5% of the non-users get extension service. These figures show that majority of the users household heads get support from extension agents when compared to non-irrigators. The chi square test indicated that there is significant difference between irrigation users and non-users in accessing extension service at 1% level of significance.

The result shows that 36.7% of the total sample household heads access credit service, and the corresponding percentage of irrigation users and non-users who access credit service are 39.5% and 33.8% respectively. These figures show that farmers have low credit access in the study area. The chi square test of this variable indicated that there is no statistically significant difference between irrigation users and non-users in access to credit service. The results of dummy variables discussed above were presented in table 2 under appendices.

The mean age of the household heads of the sampled respondents is 39.98 years. The t-test for this variable indicates that there is no significant mean difference in age distribution of household head between irrigation users and non-users. The average schooling years of the total sample is 4.09. The t-test shows that there is no statistically significant mean difference in educational level between irrigators and non-irrigators. The average time taken to cover the distance to the nearest market center for the total sample household heads is 1.77hr. The t-test shows that there is no statistically significant mean difference in time taken to cover the distance to the nearest market center between users and non-users.

The economically active family labor force in adult equivalent was calculated for the sample respondents based on Haile (2008) as presented in table 5 under appendices. The average number of economically active family labor force for users and non-users are 7.57 and 3.86 adult equivalent, respectively and that of the total sample is 5.74. The mean difference in active family labor force between irrigation users and non-users is found to be statistically significant at 1% level of significance.

The average land holding of the sampled household is 0.313hectare. The mean land holding for users is 0.38ha and the corresponding figure for the non-users households is 0.24ha. These figures are by far smaller than the average national figure, which is 1.2ha (CSA, 2008) indicating the presence of relatively lesser land holdings in the study area. The probing question revealed that the major means of land acquisition was through land inheritance in the study area. The t-test revealed that the mean difference in size of cultivated land between irrigation users and non-users is statistically significant at 1% level of significance.

The variable irrigated land holding is pertinent to users only. Hence, the mean land size allocated for irrigation by user households is 0.192ha and that of non-user households is 0ha since they are non-participants of small scale irrigation. The t-test revealed that this mean difference between the two groups is statistically significant at 1% level of significance. This indicates that the mean land size allocated for irrigation by user households is statistically different from zero.

The average livestock holding of the total sample was 1.41TLU. The mean livestock holding of irrigation users was 2.13TLU while that of the non-users was 0.67TLU. The t-test result indicated that there is a significant mean difference in livestock holding between irrigation users and non-users at 1% significance level. This indicates that irrigation user households have a better livestock holding than non-user households. It could also indicate that users have better access to financial resources through sell of livestock which could be used to purchase farm inputs, such as high yielding variety seed and fertilizer. This implies that integrated crop and livestock production is being used as the major means of living in the study area. Livestock number was converted to tropical livestock unit based on Desale (2008) as presented in table 6 under appendices. The mean distance of the sample households' residence from the irrigation water source is 1.73km. The mean distance of the user households from the water source is 0.48km while the corresponding figure for non-users is 3.5km. The t-test result shows that mean difference in distance from the water source between small-scale irrigation users and non-users is statistically significant at 1% level of significance. This indicates that the small scale irrigation user households have better proximity to irrigation water sources. The descriptive results of continuous variables discussed above were presented in table 3 under appendices.

3.2. Results of Probit Model

The results of Probit Model showed that out of the total twelve explanatory variables included in the model, seven variables of which four are continuous and three are dummies, were found to be significantly determining the probability of irrigation participation decision. The variables found to be significant includes; sex of the household head, distance from households residence to the water source, access to extension service, total livestock holding in tropical livestock unit, availability of family labor force, Size of cultivated land and Perceived Soil fertility status as presented in table 4 under appendices.

Sex of the household head: The results of the econometric model indicate that sex of household head positively affects the probability of participation in SSI and significant at 1% significance level. The marginal effect of this variable indicates that those male-headed households have 8.7% more chance of participation in SSI than those female-headed households keeping all other variables constant at their mean value. The information obtained through probing, focus group discussion and key informant interview also revealed that this difference was due to physical, technological, and socio-cultural factors. Females have faced cultural and time constraints to participate in SSI. In addition, irrigation technologies and farm instruments were designed to fit male's conditions than females. This result is consistent with Kinfe et al. (2012) that women's access to irrigation is limited in Northern Ethiopia and contrary to the study conducted by Sikhulumile et al. (2014) which found that female headed households are more likely to participate in SSI.

Availability of family labor force: The model output shows that family labor force has positive influence on households' decision to participate in SSI and significant at 5% level of significance. The marginal effect of this variable reveals that as the family labor force increases by one in adult equivalent, the probability of the households' participation in SSI increases by 13.8%, keeping all other variables constant at their mean value. The positive relationship implies that like other parts of Ethiopia, labor is one of the most extensively used inputs of agricultural production in the study area. Participation in SSI demands additional labour force for different farming operations such as land preparation, planting, fertilizer application and watering. A household with large labor force can participate in small-scale irrigation more than a household with small number of labour force. Sikhulumile et al. (2014) and Kalkidan (2016) also reported that labor availability is crucial factor influencing households' decision to involve in SSI.

Distance of households' residence from the water source: This variable is statistically significant at 5% and influence SSI participation decision negatively. The marginal effect shows that as the distance from the farmers' residence to the water source decreases by one kilometer, the probability of participation in SSI increases by 17.8%, keeping all other variables constant at their mean value. This implies that the farther households' residence from the water source, the lesser would be farmers' probability to participate in SSI. Because, households who are farther to the irrigation scheme incur much cost of travelling and have less awareness of the associated irrigation technologies as compared to households that are located at close proximity. Kinfe et al.

(2012) also reported that household's residence to water sources have a significant and negative relationship to in participation in SSI.

Size of cultivated land: The result reveals that farm size positively influences the probability to participate in SSI and significant at 1% significance level. The marginal effect of this variable indicates that as the size of cultivated land increases by one hectare, the probability of participation in SSI increases by 28%, keeping all other variables constant at their mean value. This shows that size of cultivation land owned by households is a determining factor of SSI participation. This result is consistent with the finding of Mohammed and Jema (2013) who also obtained that farm size influenced the household heads decision to participate in SSI.

Perceived Soil fertility status: The results indicate that the perceived Soil fertility status has a positive influence on SSI participation and statistically significant at 5% level of significance. This means that only those farmers who perceived their land as fertile expect better yields and have motivation to participate in SSI farming as they incur cost in the process. The marginal effect reveals that those farmers who perceived their soil as fertile have 21% more chance of participation in SSI than those who felt that their soils were infertile keeping all other variables constant at their mean value. This result is consistent with results of Bacha et al. (2011) and Tesfaye et al. (2008) who found that farmers who perceived their land as fertile have more initiation to participate in SSI.

Total livestock holding: livestock holding, measured in tropical livestock unit, has a positive effect on the probability of participation in SSI and significant at 1% level of significance. This indicates that households with more livestock holding are able to participate in the irrigation activity as compared to those with less livestock holding. This implies that livestock is an important source of cash in rural areas to allow purchase of farm inputs that are needed to participate in SSI. The marginal effect shows that as the number of livestock in TLU increases by one, the probability to participate in SSI increases by 16.9%, keeping all other variables constant at their mean value. The same result was reported by Desale (2008) that livestock holding has positive influence on participation in SSI.

Access to extension services: The study result reveals that access to extension service influences smallholder farmers' decision to participate in SSI positively and statistically significant at 10% level of significance. This implies that agricultural extension services have a critical role to play in motivation of farmers towards the adoption of improved irrigation practices. The introduction of high valued crops, efficient use of water and proper use of inputs have all been considered as important factors for crop production and productivity. Moreover farmers that have frequent contact with DAs get access to new technologies more frequently and easily. This might increase their agricultural production and productivity. The marginal effect shows that those households who have access to extension service have 22% more chance of participation in SSI than households who have no access to extension service, keeping all other variables constant at their mean value. Gebregziabher et al. (2009) also reported that household heads with higher extension service are more likely to participate in SSI.

4. Conclusions and Recommendations

The study findings indicate a relationship between smallholder farmers' decision to participate in SSI and variables such as sex of household head, Family labor force, Distance of households' residence from the water source, Size of cultivated land, Perceived Soil fertility status, livestock holding measured in tropical livestock unit and Access to extension service. This suggests that smallholder farmers' decision to participate in small-scale irrigation is being affected by different factors. Based on these findings, the following recommendation can be drawn for further consideration and improvement of irrigation development in the study area.

The result indicated that the likelihood of participation of female headed households are less than the male headed households. Therefore, it is better if both government and non-government organizations working in the study area mainstream gender to ensure gender equity and empowerment in order to enable female headed households participate in SSI and enhance their income. Family labor problems can be solved by introducing innovative and labor saving technologies through labor multiplication as a replacement of human labor for households with shortage of labor for intensive production. Therefore, it is good if agricultural engineering research centers, micro-finance institutions and extension organizations work together to generate and distribute those technologies to farmers in the study area in order to enhance irrigation participation.

Distance of the irrigation scheme affects use of irrigation negatively. Therefore, it is better if both government and non-government organizations, who are responsible for the construction of SSI schemes, consider the distance of residences during the construction and development of SSI schemes for a better use of irrigation water by users. Access to extension service was positively and significantly related to farmers' participation in SSI. Hence, it is good if agricultural faculties of Ethiopian Universities and colleges train development agents especially irrigation experts with best quality and in sufficient number to enhance extension services for farming societies.

The study revealed that the number of livestock holding in TLU influence participation decision in SSI positively and significantly. For that reason, it is virtuous if the livestock sector give due attention to feed resource improvement and management, genetic resource improvement as well as protection and prevention of animal diseases. Since expansion of cultivation land is impossible in the study area, it is better if farmers intensively use the existing land to mitigate the problem of land scarcity. In this regard, the current effort of the government to promote SSI and water harvesting technologies should be further expanded and strengthened in order to enhance production and productivity at farm level.

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6. Appendices

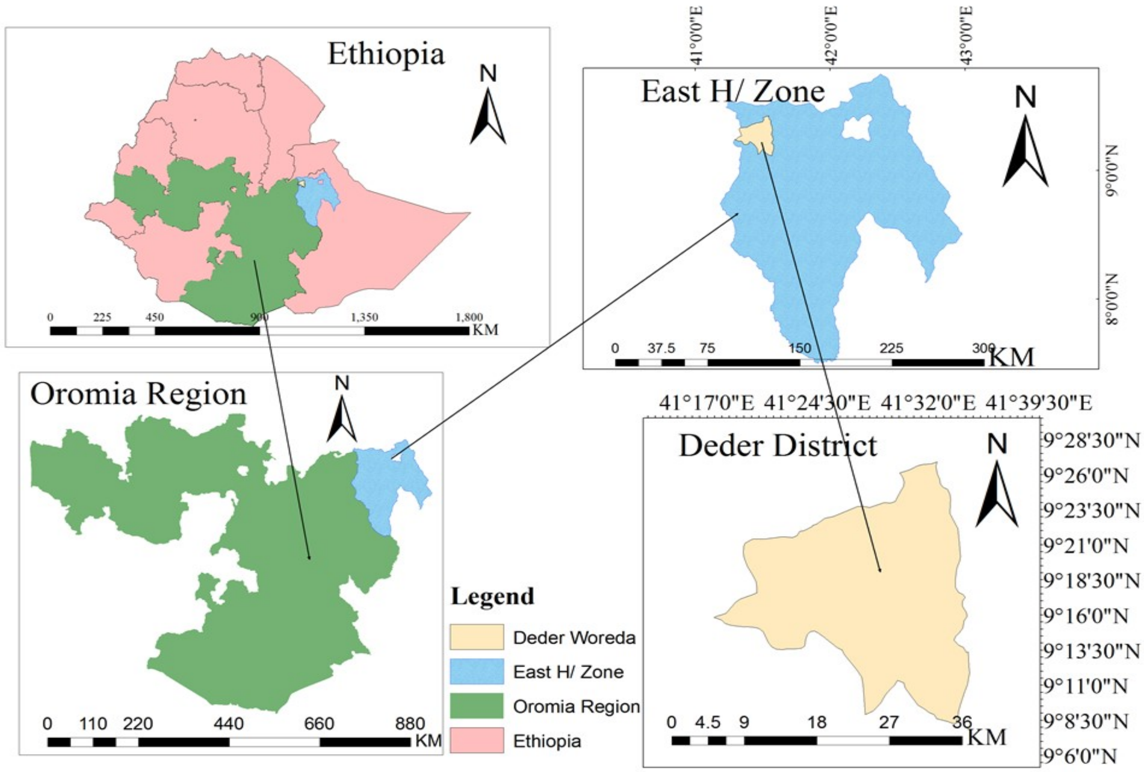

Figure 1. Map of the study area

Source: Own Sketch from GIS (2018).

Table 1. Distribution of sample respondents by Kebele

Kebele	Total households	Strata		Sample Users		Sample users	Non-	Total samples	
		Users	Non-users	N	%	N	%	N	%
Nedi gelan sedi	1561	1155	406	37	48.7	13	17.6	50	33.3
Golu	1342	624	718	20	26.3	23	31.1	43	28.7
Nano jalela	1060	343	717	11	14.5	23	31.1	34	22.7
Burka geba	719	250	469	8	10.5	15	20.3	23	15.3
Total	4682	2372	2310	76	100	74	100	150	100

Source: Computed from own data (2018)

Table 2. Distribution of sample respondents for dummy variables and chi-square test

Variables	Values	Users (76)		Non-users (74)		Total sample		χ2 value
		No.	%	No.	%	No.	%	
Sexhead	Female	17	22.4	28	37.8	45	30	4.273**
	Male	59	77.6	46	62.2	105	70	
persoilfert	infertile	31	40.8	50	67.6	81	54	
	Fertile	45	59.2	24	32.4	69	46	10.823***
Acexten	not accessed	11	14.5	44	59.5	55	36.7	
	accessed	65	85.5	30	40.5	95	63.3	32.674***
Accredit	not accessed	46	60.5	49	66.2	95	63.3	
	accessed	30	39.5	25	33.8	55	36.7	.523

Source: Computed from own data, (2018)
Note: ** and *** represent statistically significant at 5% and 1% significance level respectively

Table 3. The t-test for mean difference of continuous variables

Variables	Non-users (74)		Users(76)		Total sample		
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	T-value
Age	40.74	8.53	39.24	10.49	39.98	9.57	-.966
Educ	3.81	3.195	4.37	2.371	4.09	2.813	1.216
Famlabor	3.86	1.5	7.57	2.4	5.74	2.72	11.395***
sorcinfo	1.19	.99	1.43	.85	1.3	.93	1.623
dishom	3.5	1.14	.48	.51	1.94	1.73	-20.715***
lundirg	.0000	NA	.192	.171	.0971	.155	9.628***
cultland	.24	.12	.38	.35	.313	.273	3.24***
dismkt	1.84	.68	1.7	.51	1.77	.6	-1.405
livestock	.67	.69	2.13	1.19	1.41	1.22	9.124***

Source: Computed from own survey data, (2018)
Note: *** represent statistically significant at 1% significance level

Table 4. Results of Probit model and its marginal effect

Explanatory variables	Coefficient	Std. Err.	Z Value	Marginal effects
Age	-.0971777	.0711394	-1.37	-.0306586
Sexhead	.2196424	.0773617	2.84***	.0874255
Educ	.5340534	.3268422	1.63	.2111861
Famlabor	.3480337	.1758089	1.98**	.1376265
Sorcinfo	.1641883	.2502226	0.66	.0653528
Dishom	-.4514538	.2149736	-2.10**	-.1785229
Cultland	.7072309	.2177767	3.25***	.2815031
Dismkt	-.0648006	.0729858	-0.89	-.025793
Persoilfert	.5419949	.2743735	1.98**	.2111345
Livestock	.4278142	.1358	3.15***	.1691749
Acexten	.5587219	.3015168	1.85*	.2200123
Accredit	.0540651	.3420169	0.16	.0213259
Cons	-4.524617	1.064891	-4.25***	

Dependent variable	Irrigation Participation Decision
Number of observations	150
LR chi2 (12)	71.70
Prob > chi^2	0.0000

Pseudo R^2	0.3449
Log likelihood	-68.106835

Source: model output (2018)
Note: *, **and ***: refers to significance at 10, 5% and 1% level, respectively.

Table 5. Conversion factors used to estimate adult equivalent

Age categories (Years)	Men	Women
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
14-16	1.06	0.86
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
60plus	0.84	0.74

Source: Haile (2008)

Table 6. Conversion factors used to estimate Tropical Livestock Unit (TLU)

Livestock	TLU
Calf	0. 2
Bull	1.0
Donkey	0.7
Heifer	0.75
Sheep and goat	0.13
Cow and ox	1.0
Horse/Mule	1.1
Chicken	0.013

Source: Desale (2008)