Hindawi
Advances in Agriculture
Volume 2022, Article ID 4049868, 16 pages
https://doi.org/10.1155/2022/4049868

Research Article

Determinants of Small-Scale Irrigation Use for Poverty Reduction: The Case of Offa Woreda, Wolaita Zone, Southern Ethiopia

Zekarias Zemarku,[1] **Mulumels Abrham**,[2] **Elias Bojago**,[3] **and Tsegeye Bojago Dado**[4]

[1]*Department of Rural Development and Agricultural Extension, College of Agriculture and Natural Resources, Worabe University, Worabe, Ethiopia*
[2]*Department of Developmental Economics, College of Agriculture, Wachamo University, Hosana, Ethiopia*
[3]*Department of Environmental Science, College of Natural and Computational Science, Wolaita Sodo University, P.O. Box 138, Wolaita Sodo, Ethiopia*
[4]*Department of Physics, College of Natural and Computational Sciences, Wolaita Sodo University, Wolaita Sodo, Ethiopia*

Correspondence should be addressed to Tsegeye Bojago Dado; tsegayebojago@gmail.com

Received 15 March 2022; Revised 19 May 2022; Accepted 30 May 2022; Published 29 June 2022

Academic Editor: Xinqing XIAO

Small-scale irrigation is one of the agricultural activities used by rural farmers to improve the overall livelihood of the rural community by increasing income, securing food, meeting social requirements, and reducing poverty. The main objective of this study was to look into the factors that influence small-scale irrigation for poverty reduction among small-holder farmers in the Offa Woreda, Wolaita Zone. Government and nongovernmental organizations supplied small-scale irrigation and training to small-holder farmers in the study area at various times; however, the key determinants impacting small-scale irrigation use were not fully identified in the study area. The study location was chosen for this study purpose because no prior in-depth research had been conducted. Simple random sampling was used to select the three kebeles for the study. A total of 134 people were included in the study sample frame. The sample was chosen using simple random sampling and the proportional probability-to-size (pps) method, which was proportional to the size and used multistage sampling procedure. The primary data were collected using the interview schedule. Both quantitative and qualitative data were analyzed using descriptive and econometric analyzes in SPSS version 21. Qualitative data were also collected through focus groups and key informant interviews. A factor that influences small-scale irrigation use was investigated using a binary logistic regression model. The binary logistic regression model revealed that both the irrigation participants (37.3%) and the nonparticipant (62.7%) families had a combination of personal and demographic, economic, institutional, and social influencing factors that hinder their likelihood of using irrigation. HH age, annual income of the household, distance from the closest farm sight, farm experience, participation in training, access to irrigation, and sex of HH were positively and significantly influencing factors in the model, while total ownership of livestock of households and health status of households were negatively significant variables. As a result, the Agricultural and Natural Resources Development Office, as well as the Water Mining and Energy Offices, should devote scientific attention to the significant factors that influence irrigation use to boost farm family production and productivity.

1. Introduction

1.1. Background of the Study. Ethiopia's agricultural activity is dominated by small farmers, who produce more than 95% of the country's agricultural output [1–3]. Agriculture, which accounts for 41.4% of Ethiopia's GDP and 80% of total employment, is the country's economic backbone [4]. Ethiopian agriculture and the national economy as a whole are characterized by the country's inability to produce enough food to feed its population [5, 6]. Famines have occurred in Ethiopia in the past due to high population pressure, resource depletion, and drought, all of which have a significant impact on rainfed agriculture [7]. The primary causes of rural poverty and food insecurity have been proven to be low farm production and productivity as a result of the use of outdated technologies and other modern inputs that improve productivity [8, 9].

By growing crops of higher value for the market and harvesting more than once a year, irrigation in Ethiopia helps farmers improve their income and household's resilience and buffer their livelihoods against shocks and stressors [10, 11]. As a result, they were able to increase their assets, buy more food and nonfood household items, educate their children, and reinvest in farm input or livestock to improve their productivity. On the other hand, benefits are distributed fairly evenly among households. Furthermore, Ethiopia has abundant water resources that could be used for small-scale irrigation, among other things, to decouple economic performance from rainfall variability [12–14]. The Ethiopian government has launched an agriculture-led development program, with small-scale irrigation development as a key component, due to the importance of agriculture for the Ethiopian economy. Only about 5% of the 3.5 million acres of irrigated land have been developed, according to estimates [15, 16]. Despite potentially irrigable land and ample surface runoff, 52% of Ethiopia's population is considered food insecure, according to [17, 18]. Agriculture has contributed more to reducing poverty and reducing food security than any other intervention [19].

Africa's population is expected to reach 2.1 billion people by 2050, putting enormous pressure on agriculture to feed people and provide jobs [20].

Given the goals for small-scale irrigation development, it is critical to know how small-scale irrigation is now helping to alleviate poverty. As a result, small-scale irrigation significantly helps farmers' productive and livelihood activities to meet the issues of drought and rainfall variability. SSI also increases income and ensures food self-sufficiency (the ability to meet consumption needs, particularly for staple food crops, through own production rather than buying or importing) [21, 22]. This primarily relates to the production function (the production function is a functional relationship between input and output). It also reduces risk and uncertainty in the agriculture industry, which has the potential to greatly improve productivity and reduce poverty. As a result, increasing income and decreasing poverty have a direct and indirect impact on household living standards [23]. Expanding small-scale irrigation is a policy goal in Ethiopia, and particularly in the Oromia area, to improve rural lives, reduce and grow poverty, and adapt to climate change [24]. Irrigation improves people's lives by increasing income, food security, job opportunities, social needs, and poverty reduction [25]. Irrigated agriculture decreases crop failure and external shocks while also increasing production, resulting in higher income and food security [26]. As a result, one of the ways to increase production levels, particularly for small farmers, is to invest in small-scale irrigation. In Ethiopia, farmers' participation in small-scale irrigation has been minimal [19, 27].

Small-scale irrigation development receives special attention due to its low capital demand. Despite this, the amount of attention paid to irrigation development in this sector has not improved [28]. Additionally, current irrigation farms are operating at suboptimal levels, and many small-scale irrigation (SSI) projects are not operating at the required economic efficiency [29, 30]. Several studies have demonstrated the advantages and disadvantages of irrigation in terms of poverty reduction [31]. Irrigation, according to most, can increase production and productivity. This, in turn, offers new job opportunities on and off the farm, potentially increasing rural income, livelihoods, and quality of life [29, 31–33]. However, no research has been done on the effect of poverty on SSIs in the study area. Despite this, the sector has been unable to provide enough food for the people. It is also incapable of increasing the revenue for the individual involved and eradicating poverty. As a result, several researchers have advanced various causes for the sector's failure to reduce poverty, improve income, and achieve self-sufficiency. It is primarily concerned with the production function. The functional relationship that exists between input and output is called the production function. To raise agricultural output or productivity, we must either increase inputs (the number of factors of production) or apply better technologies. Increasing input involves employing more labor, land, human capital, physical capital, etc., whereas improved technology involves implementing production-enhancing techniques such as irrigation, genetic modeling, certain chemicals, extension programs, etc. However, increasing input is not an effective way to increase output because growing land and other limiting resources over an endless time horizon are problematic. The adoption of better technologies, such as irrigation, will undoubtedly reduce risk and uncertainty in the agriculture industry, perhaps increasing output and reducing poverty. Irrigation is particularly important in raising income and alleviating poverty due to its direct and indirect impact on household living conditions [23].

In addition, no research has been done to determine the relevant socioeconomic characteristics and the main factors that influence small-scale irrigation use in the study area are unknown. Although irrigation is available to many households in the study area, the impact it has had on poverty reduction and household influencing factors has not yet been well studied in the area.

The purpose of this research was to identify the primary factors that influence the use of small-scale irrigation to reduce poverty in the Offa Woreda. Because poverty reduction is the ultimate measure of development effectiveness, this study investigated the impact of small-scale irrigation on the reduction of rural poverty.

2. Research Methodology

2.1. Description of the Study Area. This research was carried out in Offa Woreda, which is located in the Southern Nations, Nationalities and Peoples' Region of Ethiopia. Offa Woreda is a Woreda in the Wolaita Zone and is bordered to the south by the Gamo Gofa Zone, to the west by Kindo Didaye, to the north by Kindo Koysha, to the northeast by Sodo Zuria, and to the east by Humbo. Offa's administrative center is Gesuba. It is situated at a latitude of $6°44' 59.99''$ N and a longitude of $37°29' 59.99''$ E. The Woreda is divided into 21 rural kebeles and four municipal administrative districts, with a total land area of 38,537 ha. The current study area, Offa Woreda, is one of the Woredas insecure in the Southern region due to the large number of people in chronic food insecurity who have benefited from the productive safety net program (PSNP) in recent years [34]. (Figure 1). Kolla (lowland), Weyna Dega (middle), and Wet Dega (highland) are the three main agro-ecological zones in the Woreda, covering 31%, 48%, and 21% of the total area, respectively. Maximum and minimum temperatures range from 34°C to 14°C, respectively [35]. The rainy season is bimodal, with the short rainy season (Belg) lasting from mid-February to May and the long rainy season (*Kiremt*) beginning in June and lasting until October. Annual rainfall ranges from 850 to 1450 mm, with June to September being the wettest month (OWARDO, 2015).

Woreda's population is 134,259 people, with 65,733 men and 68,526 women. There are 37,273 households in Woreda, with an average of 6.3 family members per household [36]. Agriculture is the main source of income for the people of the study region, as is in many other parts of Ethiopia. It involves rainfed agriculture for crop production and livestock rearing at the subsistence level. Agriculture is a traditional ox-ploughing activity that is supplemented by occupations like pottery, carpentry, and the planting of root crops and some fruit crops in the vicinity of homesteads.

2.2. Research Design. The study used a mixed research methodology that combined an explanatory research design and a qualitative approach to collect relevant data. Using both qualitative and quantitative methodologies together yielded a better understanding of the research problem than using either method alone.

2.2.1. Sample and Sampling Techniques. The Offa Woreda was purposively selected because of its potential for irrigation. The kebeles were also purposively chosen in the second stage based on irrigation use. That is, three kebeles were chosen at random from a total of 21 in Woreda. Again, the sampling frame/list of households that practice small-scale irrigation was used to select the households for each sample from each kebele sample (Table 1). Using a multi-stage sampling technique, the sample households were chosen from a list/sample frame using the proportional probability to sample size.

2.2.2. The Sample Size Determination. Population refers to all study participants; a target population is the larger group to which one wishes to generalize or apply research findings [37]. There are numerous techniques to determine the sample size and imitate a sample size from previous research, including using public tables and algorithms to establish a sample size. Kothari [38] simplified formula was employed in this study. As a result, the 95% confidence level and ±5% precision level were used as a criterion to define and calculate the sample size.

Thus,

$$\mathbf{n} = \frac{\mathbf{z}^2 * \mathbf{p} * \mathbf{q}}{\mathbf{e}^2(\mathbf{N}-1) + \mathbf{Z}^2 * \mathbf{p} * \mathbf{q}}, \tag{1}$$

where n is the sample size; N is the population size, which is 1180 in this case; e is the accepted error or degree confidence desired, usually at 0.05; z is the standard variation, which is 1.96; p is the standard deviation, which is 0.11 (11%); and $q = 1\text{-}p = 0.89$; therefore,

$$n = \frac{z^2 * p * q}{e^2(N-1) + Z^2 * p * q},$$

$$n = \frac{1.96^2 * 0.11 * 0.89 * 1180}{0.05^2 * 1179 + 1.96^2 * 0.11 * 0.89} = \frac{381.73403}{2.9475 + 0.37609264},$$

$$n = \frac{443.7893152}{3.32359264} = 134. \tag{2}$$

The proportion of sampling to the population was utilized to determine the appropriate samples of the three kebeles for each stratum. Finally, a representative sample was chosen for each stratum using systematic random sampling approaches. The sample size for each stratum in the three kebeles will be determined using

$$\begin{gathered} i = n \cdot pi, \\ pi = N1/N, \\ \text{then}\, n = n = n \cdot pi, \end{gathered} \tag{3}$$

where the total population and the sample population of irrigation users are 399 and 67, respectively. $Pi = 152/399 = 0.38$, then $n = n.pi$, $67^* 0.38 = 25$; N represents the total population number of population, n represents the total sample size, i reflects the number of stratum items chosen, and pi represents the proportion of population included in the stratum.

2.3. Sampling Procedure for Qualitative Data

2.3.1. Selection of Key Informant Interviews. Include 6 individuals from each sample of kebeles that were selected using the objective method. In addition, the Director of the Agriculture and Natural Resources Development Office and two experts from the same office were among the participants.

2.3.2. Selection of Focus Group Discussion (FGD). Nine people from various backgrounds were chosen from each kebele sample to form the focus group. Furthermore, each focus group contained two women and seven men.

2.4. Types of Data. Primary and secondary sources were used to gather qualitative and quantitative data for this study.

2.5. Method of Data Analysis. The researchers used descriptive statistics and an econometric analysis approach.

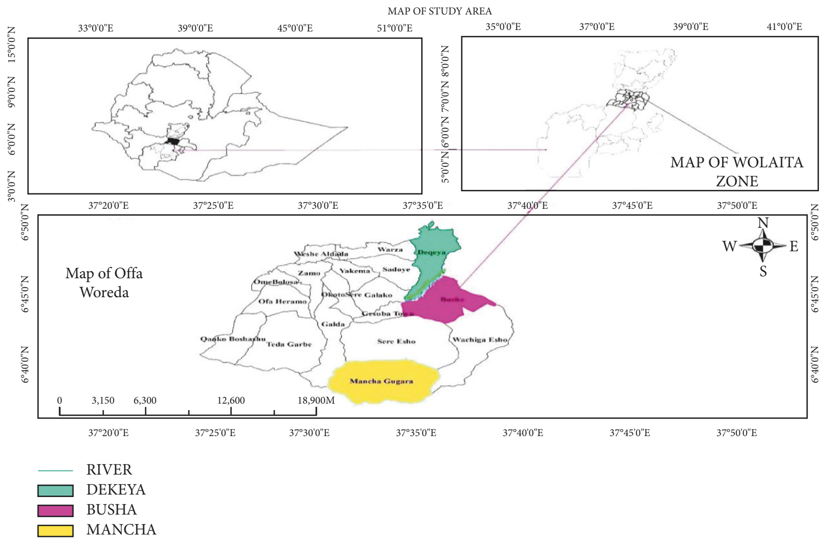

Figure 1: Map of the study area.

Table 1: Number of sample households from each kebele.

Name of sample kebele	Total households			Sample households		
	User	Nonuser	Total	User	Nonuser	Total
Dekeya	74	337	411	20	34	54
Busha	72	327	399	14	26	40
Mancha	58	312	370	16	24	40
Total	204	976	1180	50	84	134

Source: Own summary, 2020.

Percentages, means, and standard deviations are used in the descriptive data analysis method. The chi-square test was used to test the relationship of the dummy variables between the two groups, and the t-test was used to see if there was a significant mean difference between the two groups in the method of comparing the socioeconomic, demographic, and institutional characteristics of households in the study area. In the economic analysis, binary logistic models were used.

2.5.1. Binary Logit Econometric Model. In a regression study, a qualitative response (dependent) variable of the “Yes” or “No” type is typically encountered. Binary choice models are discrete choice models that deal with such binary responses. The binary logit econometric model was used to examine the factors that influence the use of small-scale irrigation. When dependent variables are not represented using ordinary least squares, the use of linear regression is limited. The dependent variable is represented as a linear function in the linear model; therefore, ordinary least squares works. The underlying assumption of binary choice is that individuals express their preference between two choices; that is, there is a chance of selecting one alternative over the other. As a result, inconsistency and bias in the estimate using the ordinary least squares (OLS) parameter will occur. The linear probability model, logistic model, and probit regression model were suggested as the best solutions to overcome the constraint in this case (Wooldridge, 2005). The error term in the equation is normally distributed in the probit model, with a mean of zero and a standard deviation of one. However, in logistic regression, the error term was supposed to have a normal distribution, while the standard deviation was more than one. Despite the fact that the logit and probit models are nearly identical and that the model choice is arbitrary, the logit model offers several advantages (simplicity and ease of interpretation).

2.5.2. Specification of the Logit Model. The logistic function is utilized because it is easier to work with and provides a close approximation to the cumulative normal distribution. Furthermore, as Train (1986) pointed out, a logistic distribution (logit) has an advantage over others in the analysis of dichotomous outcome variables in that it is a mathematically extremely flexible and easily used function (model) that lends itself to a meaningful interpretation and is relatively inexpensive to estimate. Additionally, the logit model was applied in a binary choice of outcomes (use versus nonuse of irrigation technology). The exogenous factors in the model are those currently provided by households. The model provides empirical estimates of how changes in these exogenous variables influence the likelihood of irrigation use, and it is used to assess the extent to which people use technology [39].

As a result, a logistic function with odds ratios was employed to calculate the coefficients of explanatory variables most likely to influence farmers’ views about irrigation use. The level of use of irrigation technology was the dependent variable in this analysis, while the independent variables were the 16 variables chosen (Table 2).

Because the dependent variable in this study was dichotomous, the econometric model assigned a value of 0 to nonusers and a value of 1 to users.

Gujarati [40] specifies the functional form of the logit model as follows:

Table 2: Description of dependent and independent variables.

No	Variable code	Description	Measurement	Variable type	Expected sign
1	Age	Age of household head	Measured in years and put in to ranges	Continuous	—
2	EDUCLEV	Education level of household head	Measured in grade	Continuous	+
3	ACCS	Access to credit	Measured in availability	Dummy	+
4	Health	Health status of HHH	Measured in health condition	Dummy	+
5	Fertlyzr	Use of fertilizer	1 = user, 0 = not	Dummy	+
6	DST	Distance from farm	Measured in kilometers	Continuous	—
7	NONFRM	Engagement in nonfarm activities	1 = participate, 0 = not	Dummy	+
8	Food	Food aid	1 = get, 0 = not	Dummy	+
9	ACCESIRRG	Access to irrigation	1 = have access, 0 = not	Dummy	+
10	Train	Participation in training	1 = participate, 0 = not	Dummy	+
11	HHSIZE	Household size	Measured in number	Continuous	+
12	FRSZ	Farm size	1 = available, 0 = not	Dummy	+
13	TLU	Livestock ownership	Measured in number	Continuous	+
14	Sex	Sex of HHH	1 = male, 0 = female	Dummy	+
15	Income	Annual income	Measured in birr	Continuous	+
16	Farm experience	Farm experience	Measured in birr	Continuous	−/+

$$\mathbf{P_i} = \mathbf{E}\left(\mathbf{Y} = \frac{1}{xi}\right) = \frac{1}{1 + e^{-(\beta 0 + \beta 1 x 1)}}. \quad (4)$$

For the case of exposition, we write (1) as

$$\mathbf{P_i} = \frac{1}{1 + \mathbf{e}^{-\mathbf{zi}}}. \quad (5)$$

The probability of the farmer being a nonuser is expressed as (3), while the probability of the user is

$$1 - \mathbf{P_i} = \frac{1}{1 + e^{zi}}. \quad (6)$$

Therefore, we can write

$$\frac{\mathbf{P_i}}{1 - \mathbf{P_i}} = \frac{1 + e^{\mathbf{zi}}}{1 + e^{-\mathbf{zi}}}. \quad (7)$$

Now (P_i/1-P_i) is simply the odds ratio in favor of using irrigation, that is the ratio of the likelihood that a farmer would use to the likelihood that this would not use.

Finally, if we take the natural log of equation (5), we get

$$\mathbf{Li} = \mathbf{ln}\left(\frac{\mathbf{Pi}}{1 - \mathbf{Pi}}\right) = \mathbf{Zi} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1\mathbf{X}_1 + \boldsymbol{\beta}_2\mathbf{X}_2 + \cdots + \boldsymbol{\beta}_\mathbf{n}\mathbf{X}_\mathbf{n}, \quad (8)$$

where P_i is the probability of being a user, it ranges from 0 to 1; Z_i is a function of n explanatory variables (x), which is also expressed as

$$\mathbf{Z_i} = \boldsymbol{\beta}_\mathbf{o} + \boldsymbol{\beta}_1\mathbf{X}_1 + \boldsymbol{\beta}_2\mathbf{X}_2 + \cdots + \boldsymbol{\beta}_\mathbf{n}\mathbf{X}_\mathbf{n}, \quad (9)$$

where βo is an intercept; β_1, β_2, ---------------------β_n are the slopes of the equation in the model; L_i is the log of the odds ratio, which is linear in X_i, but also linear in the parameters; and X_i is the vector of relevant farmers' characteristics.

If the disturbance term (U_i) is introduced, the logit model becomes

$$\mathbf{Z_i} = \boldsymbol{\beta}_o + \boldsymbol{\beta}_1\mathbf{X}_1 + \boldsymbol{\beta}_2\mathbf{X}_2 + \cdots + \boldsymbol{\beta}_n\mathbf{X}_n + \mathbf{U_i}. \quad (10)$$

2.6. Summary of the Variables. The description of the dependent and independent variables is given in Table 2.

3. Results and Discussion

3.1. Descriptive Analysis. In 2021, 37.3% interviewed were users (small-scale irrigation participants), while 62.7% were nonusers (nonparticipants in small-scale irrigation). The current status of small-scale irrigation use was found to be very low when the number of users in the study area was compared to the number of nonusers. In addition to the survey results, the respondents in Figure 2 stated that small-scale irrigation is insufficient, especially in Dekeya compared to the other two kebeles.

3.1.1. Age of Household Head. The age of the household leader has a significant influence on agricultural productivity. Table 3 shows that the average age of the household heads of the sample was 27.17, with a standard deviation of 6.67. The average age of the household heads of the sample was 28.48 for users and 26.41 for nonusers, with standard deviations of 7.16 and 6.29, respectively. The user households had a different average age than the nonuser households. With a t-test value of 47.12 and a p-value of 0.027, the statistical study discovered a significant difference in the mean age of the heads of the households between the user and the nonuser households. As a result, age was the deciding factor in whether the household used small-scale irrigation. Another finding suggested that age had a positive and negative relationship with irrigation water access due to its nonlinearity [41, 42]. As a result, the demand for irrigation technology is expected to initially increase due to increased working capacity and then decrease as people age. It also has a positive and negative impact on household income. As a result, it would have an inverted U-shaped relationship in both cases. These findings are in line with those of [43], who found that respondents' age is positively significant in some areas and negatively significant in others, resulting in a U-shaped relationship in this case.

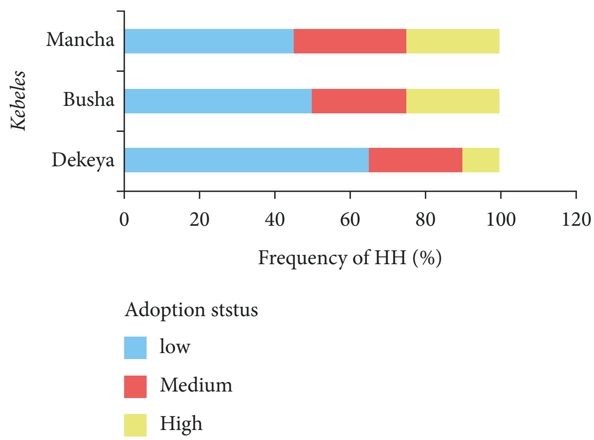

Figure 2: Adoption status of SSI in the study area.

Table 3: Statistical summary of users and nonusers sampled on continuous variables.

Variables	Users		Nonusers		t-value
	Mean	(Std. dev)	Mean	(Std. dev)	
Age	28.48	7.16	26.4167	6.29	47.122***
Farming experience	29.04	11.2	22.5	8.92	30.122***
Farmland size	.413	0.264	.397	0.278	1.229
Family size	4.94	1.85	4.79	1.77	1.53
Distance from farm	4.97	1.96	5.53	2.34	27.42***
Annual income	9123.80	4811.23	6689.5	4675	16.9***
TLU	2.76	0.9	3.47	0.56	31.212*

3.1.2. Sex of Household Head. In most of the rural parts of Ethiopia, men are expected to invest their labor in practical work than women. From the point of view of Das, this was also true in the study area that male household heads were more effective than female participation in agricultural activities, especially in irrigation activities. According to the statistics in Table 4, 67.16% of the 134 respondents were men, while 22.84% were women. Males led 77.4% of nonuser households, while females led 22.6%.

The chi-square test of 10.655 revealed that the sex of the households was strongly related to the use of irrigation. As a result, the use of small-scale irrigation is related to the gender of the heads of the households. Female-headed families, according to the literature cited in Astetkei [44], have less access to improved technologies, land, and extension than male-headed households. This finding is similar to those of Akudugu et al. [45] and Abbasi and Nawab [46], who both discovered significant gender differences in technology adoption in Ghana.

3.1.3. Educational Level of the Respondents. According to the findings in Table 4, 100% of the respondents in the area have a formal education and can read and write. In terms of upgraded households, 100% had formal education, while the remaining 0% had no formal education. This is not always the case, though older farmers are with no formal education dominate SISs, yet they are more knowledgeable of scheme governance. This indicates that households with a higher level of education were not more likely to engage in irrigation farming. The statistical analysis of the chi-square test revealed that the level of education of the head of the household did not have significant differences between the households of users and nonusers (Table 4). This contradicts the findings of [43, 47], who found that if the head of the household is literate, he is more likely to accept extension services, irrigation use, and other income-generating activities. Education has also been shown to have a positive impact on adoption in previous studies.

3.1.4. Access to Credit. Of the total of households sampled, 51% have access to credit services, while 49% do not. Similarly, 54% of the user families have access to a credit service, while 46% do not. To see if there was a significant difference in the use of credit services between the two groups, the chi-square test ($x^2 = 0.36$) was used. Table 4 shows that there was no statistically significant difference in credit availability between users and nonuser households. As a result, there is no correlation between household credit availability and irrigation usage.

3.1.5. Engagement in Nonfarm Activities. Table 4 shows a dummy variable for participation in off-farm activities. The availability of job opportunities outside the farm expands the possibility of using irrigation to increase household income. Off-farm employment opportunities in Offa Woreda included vegetable trading, cattle trading, grain trading, petty trade, and others, according to the study's findings. According to the chart, approximately 52% and 48% of user households have participated in off-farm employment and have no experience, respectively. However, about 52.4% and 47.6% of nonuser households, respectively, had participated and had not participated in off-farm employment to earn more revenue to improve their income status. In addition to that, when its relation with irrigation use was observed independently, the chi-square ($X^2 = 0.258$) result was also found not to be significant.

3.1.6. Food Aid. One of the explanatory variables is the amount of food aid in kilograms. Existing productive safety and other emergency programs were providing vulnerable households with access to food. As a result, households receiving food items would be able to meet their food gap demands. It provides an opportunity for creative approaches with the potential to close the food gap. According to Table 4, the percent of SSI users who receive food aid is 21 (42%), while the percent of who do not use SSIs is 43 (51%). Furthermore, the chi-square test shows that there is no link between food aid availability and irrigation use.

3.1.7. Access to Irrigation. Irrigation is one of many technical options available to small farmers who want to grow directly edible food grains or diversify their crops while also addressing agriculture's moisture deficit. As a result, it helps to increase production. It is a dummy variable in the model because it is thought to have a direct relationship with the

Table 4: Statistical summary of users and nonusers sampled on dichotomous variables.

Variables	Description	Users		Nonusers		X^2-value
		No.	%	No.	%	
Credit access	No	23	46.0	41	49	0.306
	Yes	27	54.0	43	51	
Sex of the sample respondents	Male	25	50	65	77.4	10.655
	Female	25	50	19	22.6	
Off-farm activity participation (OFAP)	No	24	48.0	40	47.6	0.258
	Yes	26	52.0	44	52.4	
Food aid	No	29	58.0	41	49	1.805
	Yes	21	42.0	43	51	
Access to irrigation	No	16	32.0	65	77.4	26.9***
	Yes	34	68.0	19	22.6	
Participation in training	No	21	42.0	47	56	4.82*
	Yes	29	58.0	37	44	
Health status of the HHHs	No	11	22.0	29	34.5	2.348**
	Yes	39	78.0	55	65.5	
Use of fertilizer	No	25	50.0	44	52.4	0.237
	Yes	25	50.0	40	47.6	
Educational level	Description	User		Nonuser		1.49
		No	%	No	%	
	Illiterate	0	0	0	0	
	Grade 1–4	40	80	61	72.6	
	Grade 5–8	10	20	23	27.4	
	Grade 9–10	0	0	0	0	
	Above 10	0	0	0	0	
	Total	50	100	84	100	

Source: own data model output (2021).

availability of food in the home. As a result, it is expected that homes with access to irrigation will have a positive impact on the use of irrigation in the home. According to Table 4, 60.4% of the 134 total sampled households do not have access to irrigation, whereas 39.6% do. Sixty-eight percent of users' households have access, while 32% do not. Also, the chi-square test indicates that there is a link between irrigation access and irrigation use.

3.1.8. Participation in Training. Extension services play a vital role in providing guidance and information to rural farmers. Training is one of these services that are beneficial to introducing and developing current technology techniques (proper types and rates of fertilizer, improved varieties of seeds, agrochemicals, etc.). As a result, households that participated in FTC training or farm demonstrations are expected to implement their expertise to increase farm production. As a result, homes would be in a better position to use irrigation. Table 4 further demonstrates that of the total sample homes, 49.3% have participated in training, while 50.7% have not. Of the households of irrigation users, 58% participated, while 42% did not. Also, the chi-square test indicates that there is a link between training and irrigation use. As a result, the study's determinant variable was training participation.

3.1.9. Farming Experience. In this study, the total average farm experience of the selected households dating from the beginning of farming was 24.94 years. The average farm experience of the user and nonuser households was 29.04 years and 22.5 years, respectively, with standard deviations of 11.2 and 8.92, respectively. As seen in Table 3, there was a statistically significant mean difference between the two groups. The *t*-value (30.122) also provides sufficient evidence that there was a significant mean difference between the two groups. As a result, the association between agricultural experience and irrigation use is statistically significant. This finding is in line with Chekol et al. [48], who found that there is a statistically significant relationship between agricultural experience and irrigation use.

3.1.10. Health Status of the Household Head. The farmer's physical well-being was required to participate in agricultural activities. If the farmer is healthy, he or she can be involved in farm operations and farm management. As a result, the health of the family had influenced irrigation use. The number of days the head of the household was sick each year was calculated (out of farming work). Beneficiary irrigation use was expected to be positively influenced by its health status. According to Table 4, out of a total of 134 respondents, 70.1% stated that they were healthy throughout the year, while the remaining 29.9% stated that they were not in full health. Only 22% of irrigation users were determined to be ill, while 78% were judged healthy. Also, the chi-square test of 2.348 indicates that there is some relationship between health status and irrigation use. Therefore, being healthy was the determinant variable of the study.

3.1.11. Use of Fertilizer. The application of fertilizers to crops has a significant impact on yield and productivity. Irrigation requires the use of improved agricultural inputs, such as fertilizers, to grow high-value crops, such as vegetables, by definition. The availability of irrigation encourages farmers to use fertilizer in the cultivation of high-value crops most of the time. As a result, fertilizer-using households were more likely to use irrigation. According to Table 4, 48% of the respondents and 51.5% of the nonrespondents were identified as users and nonusers, respectively. Furthermore, the same proportions (50%) of irrigation user families were found to be fertilizer users and nonusers. This suggests that there is not much of a difference between those who use irrigation and those who do not.

3.1.12. Distance from the Farm. It refers to the distance between the residence of the family and the nearest cultivated ground. The closer a farmer is to farmland, the greater the chance of increasing productivity, lowering harvesting costs, and managing land and cropland [49]. As a result, residents closer to their farmland are projected to have cheaper harvesting and transportation costs and will be able to produce more easily thanks to irrigation alternatives. According to Table 3, the average distance from the farm to all houses was 5.138 miles, with a standard deviation of 2.16 miles. The average distance for irrigation users was 4.97 miles, while it was 5.53 miles for nonirrigating households. This shows the statistically significant mean difference between irrigators and nonirrigators (Stringer et al. [50]).

3.1.13. Farmland Size. The smallest and largest land holdings, according to Table 3, are 0.06 and 2.5 hectares, respectively. To see whether there was a significant mean difference in land holding between the two groups of respondents, the statistical *t*-test was used. Between the two groups, there was no significant difference in land ownership. There was no statistically significant difference. The irrigation users in the study area were found to have roughly the same land holdings as the nonusers. As a result, the size of the land holding was not a factor in this investigation.

3.1.14. Livestock Ownership (TLU). The ownership of livestock by rural farm households is critical for revenue production, food, tractor power, social security, organic fertilizer, and asset holding. This study was closely related to the identification of restrictions on farm household's production and productivity with the use of small-scale irrigation, by Sohoulande Djebou et al. [51] and Muhoyi and Mbonigaba [52]. For the sake of simplification, the number of cattle owned by respondent households was translated into tropical livestock units. According to Table 3, both sample respondents in the study area have (3.21) tropical livestock units on average. Irrigation users had an average tropical cattle unit of (2.76) while nonusers had (2.76) (3.47). In terms of the statistically significant level of significance of livestock, the statistical *t*-test (31.220) revealed a statistically significant mean difference between the two categories (irrigation users and nonusers).

3.1.15. Annual Income of the Household. It is the annual income of the household. Higher-income households were expected to use small-scale irrigation more frequently than lower-income households. Salazar and Rand [53] found a significant mean difference between households that used irrigation and those that did not. Furthermore, the *t*-value of 16.9 was statistically significant. As a result, farm income was determined to be significant at a level of significance less than 5% in Table 3.

3.1.16. Family Size. Converting the number of people at home to equivalent adult reveals the number of adults. The family size is required for the production of agricultural activities in irrigation. A household with a larger number of family members can share the labor load and contribute significantly to the security position of the unique household. As a result, it is expected that it will benefit household irrigation. According to Table 3, the average family size for all families was 5.134. The average family size among users was 4.94, while it was 4.79 among nonusers. The *t*-value was 1.53. This shows that the difference between irrigation users and nonusers is not statistically significant.

3.2. The Role of Irrigation in Production, Employment, and Poverty. Irrigation can help alleviate poverty by increasing crop yields, cropping areas, and higher value crops, all of which create jobs (directly from farm workers and indirectly from other workers if wages are bid up). Increased mean yields can result in more food supply, more calories consumed, and better nutrition. This study investigated whether there were significant differences in the levels of production, employment, asset endowment, consumption, and income between irrigation users and nonusers and discovered the following findings.

3.2.1. Irrigation Increased Production. Due to inconsistency in input use, a comparative yield analysis by crop type could not be performed. Figure 3 shows the gross yield for the main crops that have access to irrigation. Irrigation use has significantly contributed to households' goal of higher production, as predicted, and this finding is consistent with other data [29]. Data analysis of the major cereals and horticultural crops revealed that irrigation users produce more maize, green pepper, potato, tomato, red onion, cabbage, and barley per household than nonusers. This evidence shows that irrigation use increases food supply and security. Tomatoes, onions, peppers, and cabbage are all grown exclusively in irrigation homes. This also shows that irrigation encourages crop diversification and intensity.

3.2.2. Irrigation Enhanced Employment Opportunities. In theory, one of the most significant advantages of irrigation is the creation of jobs. Irrigation has increased the beneficiaries'

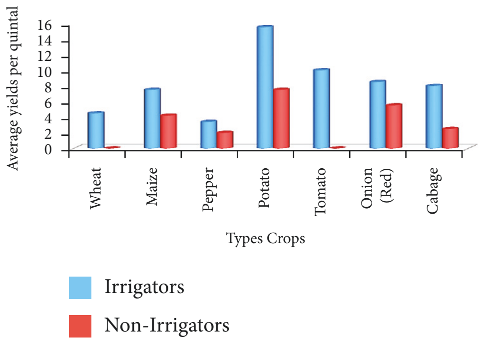

Figure 3: Average crop yields per quintal and per household (1 quintal = 100 kg).

harvests from once a year (rainy season) to two or three times a year, and labor efficiency has improved. Table 5 shows that the average hour spent on an irrigated farm for all activities, from plowing to disposal, is much higher than on a rainfed farm. Similarly, the average labor cost for irrigation users (including hired labor) is more than twice that of nonuser families. This implies that irrigation creates more job opportunities. Most small-holder activities rely on family labor, with neighbor help and casual labor supplementing specific operations. The development of irrigation schemes has created employment opportunities for nearby farmers and irrigation users during traditionally dry periods.

3.2.3. Irrigation Increased Income. Irrigation is expected to increase cash earnings and has been shown to do so in the past [29, 31, 54]. Similarly, irrigation recipients earned 10161.5 birr per home per year, 33.6% more than nonusers. Irrigation use benefits households that generate crop and livestock revenue, but nonusers earn more off-farm income. A closer look at the data reveals that irrigated agriculture generated remunerative off-farm revenue streams like transportation and commerce, whereas nonirrigators dominated inferior livelihood activities like fire wood and charcoal sales, and causal work. This finding is similar to Getaneh's [29] discovery that small-scale irrigation reduces nonfarm income.

Crop income accounts for 76 and 70.5% income for users and nonusers, respectively, with livestock and off-farm activities accounting for the remainder. Irrigators earned 47.4% more from crops than nonirrigators, a statistically significant difference (Table 6).

3.2.4. Irrigation-Improved Asset Endowment. Irrigation expands the amount of land available for agricultural use, and access to irrigation improves asset ownership [31]. This research looked at basic production resources, such as land and animals, as well as the overall value of household items (agricultural tools and equipment). Furniture costs are estimated at the time of purchase. As a result, irrigator assets are three times more valuable than nonirrigator assets. Irrigation increases livestock ownership by 0.91 tropical livestock units (TLU) and increases land ownership by 0.38 ha (Table 7).

3.2.5. Irrigation-Improved Household Consumption. To assess the impact of irrigation on household consumption, the expenditure pattern was used as a proxy indicator of standard of living. This typically refers to the household's ability to produce/purchase a basket of low-calorie and nonfood commodities. As a result, irrigators' average annual consumption expenditure per adult equivalent (AE) is more than double that of nonirrigators.

Similarly, nonusers' home consumption, food, and nonfood expenses are significantly higher than those of users. Nonirrigators, for example, consume only about 51% of the food that irrigation recipients consume. This implies that having access to irrigation improves food security by increasing the frequency of production. It also increases food availability by 50.7%. As a result, there is a link between nutritional status and access to irrigation. It also has a positive impact on nonfood intake. Nonfood consumption of nonusers was 60.8% that of irrigators (Table 8). As a result, this study could show that irrigation availability improves the overall welfare of rural households by improving food access, nonfood consumption, and asset accumulation. This finding is consistent with the findings of [55–57], who discovered that irrigation availability improves the commune's resilience to drought and improves user assistance.

3.2.6. Irrigation Contributed to the Reduction of Poverty. Poverty is increasingly understood to be a multidimensional concept that includes everything from low income and expenditure to a lack of education and poor health, as well as other social dimensions such as powerlessness, insecurity, vulnerability, isolation, social exclusion, and gender disparities. In this study, the cost of necessities was used to establish poverty lines. The first step in this approach is to identify a package of food and nonfood products typically consumed by the 20% lowest income quartile and estimate the cost of meeting this need [58–60]. As a result, the food poverty level (FPL) for this study is 1016.49 ETB per AE per year, while total nonfood expenditure (including clothes, medication, taxes and social obligations) is 310.64 birr per AE per year. When all expenditures from the lowest income group are added together, the total poverty line is reached, above which an individual is considered nonpoor. As a result, the annual poverty line was established at 1016.49 birr per AE.

3.2.7. Poverty Status and Indices by Access to Irrigation. Table 9 shows that 30.4% of the 313 sample families are poor, accounting for 47.6% of nonusers and 10.3% of users, implying that the incidence of poverty in rainfed farms is 37.3% higher than in irrigation farms. The remaining 89.7% of users and 52.3% of nonusers are not poor. This demonstrates the importance of irrigation development in alleviating poverty. The fact that 10.3% of irrigation beneficiaries are poor implies that, on the one hand, access to irrigation is a necessary but not sufficient condition for alleviation of poverty and, on the other hand, poverty can be negatively impacted if irrigation is mismanaged, and it could be the root cause of poverty; this finding is consistent with the findings of other studies [59, 61].

Table 5: Labor hour and cost of irrigation use.

Average labor hour	Irrigation use	Mean	Standard deviation	t/p
Plowing	User	76.90	84.38	8.464/0.001**
	Nonuser	21.71	25.61	
Weeding	User	90.79	116.18	7.085/0.001***
	Nonuser	26.51	38.11	
Harvesting	User	87.31	97.74	7.445/0.001***
	Nonuser	28.33	39.66	
Trashing	User	70.98	76.12	7.113/0.001***
	Nonuser	24.23	38.81	
Labor cost per ha in Ethiopian birr (ETB)	User	535.94	800.95	2.988/0.003**
	Nonuser	305.92	495.36	

Source: own survey, 2021.

Table 6: Income earned by households with and without irrigation.

Income source (ETB)	Irrigation use						T
	User			Nonuser			
	Mean	Standard deviation	% Share	Mean	Standard deviation	% Share	
Livestock	1451.6	2826.6	13.5	1070.2	2150.3	13.7	1.324
Crop	8138.5	6012.1	76.0	5520.9	3879.3	70.5	4.635***
Off farm	1125.2	2549.6	10.5	1234.7	2239.9	15.8	−0.0.4
Total	10161.5	5612.7	100	7606.0	4280.6	100	4.562***

Source: own survey, 2021.

Table 7: Endowment of assets of households with and without irrigation.

Assets owned	Irrigation use	Mean	Standard deviation	T
Total value of asset (ETB)	User	2060.16	6510.74	2.500**
	Nonuser	597.58	3450.67	
Total size of plots (ha)	User	1.5	1	3.84
	Nonuser	1.12	0.76	
Total livestock (TLU)	User	5.45	3.80	2.008
	Nonuser	4.55	3.88	

Source: own survey, 2021.

Table 8: Expenditure pattern of households with and without irrigation.

Expenditure (ETB)	User		Nonuser		F	P
	Mean	Standard dev	Mean	Standard dev		
Food	3467.8	2965.2	1715.6	1813.6	40.934	$P \leq 0.01$***
Nonfood	2540.6	4725.5	1546.5	2052.2	6.073	0.014**
VOC	5968.9	19828.1	3047.1	2660.7	3.57	0.060*

Source: own survey, 2021.

Furthermore, poverty must be recognized as a multifaceted phenomenon. According to the survey, per head count, 48% of nonuser households and 10% of user households lived below the locally designated poverty threshold. The associated poverty gap by irrigation use was 0.042 and 0.17 for users and nonusers, respectively, while the poverty severity index was 0.02 and 0.09 for users and nonusers, respectively (Table 9). As a result, poverty is worse and more widespread among nonirrigators than among irrigators. This finding is consistent with [59, 62], who discovered that poverty is worse and more widespread among nonirrigators than among irrigators.

3.3. Determinants of Small-Scale Irrigation Use by Farm Households

3.3.1. The Age of Farm Household Heads. The age of the household heads has a positive effect on their decision to use small-scale irrigation to improve income and products at a significant level of 5%; with increased age, the probability of using irrigation increases by 1.14 compared to those in their youth hood level to use small-scale irrigation to improve income and products (Table 10). As a result, the decision on age and irrigation use was positively associated at a significance level of less than 5%. The findings contradict those of Yenealem (2013) and Tale

Table 9: Poverty status and indices by access to irrigation

Irrigation usage	Poverty status				X^2	P
	Poor		Nonpoor			
	N	%	N	%		
User	130	89.7	15	10.3	51.152	$P \leq 0.01^{***}$
Nonuser	88	52.3	80	47.6		
Total	218	69.6	95	30.4		

Irrigation usage	Head count index ($\alpha = 0$)	Poverty gap ($\alpha = 1$)	Squared poverty gap ($\alpha = 2$)
User	0.1	0.042	0.02
Nonuser	0.48	0.17	0.09

Source: own survey, 2021.

Table 10: Parameter estimation of binary logistic regression on the use of small-scale irrigation by farmers in Offa Woreda 2020.

Dependent variable $Y = 0$, $Y = 1$ Explanatory variables	B	Wald	Sig.	Exp (B)
Age of HH	0.131	4.892	0.027**	1.140
Sex of HH	2.567	7.511	0.006***	13.027
Education level of HH	0.152	0.017	0.897	1.164
Credit access	−0.608	0.503	0.478	0.545
Engagement in off-farm activity	0.972	1.496	.221	2.643
Food aid	0.411	0.293	0.588	1.508
Access to irrigation	**4.834**	**15.374**	**0.000*****	**125.712**
Participation in training	**1.816**	**3.138**	**0.076***	**6.147**
Farm experience	**0.185**	**11.902**	**0.001*****	**1.203**
Health status	**−3.354**	**7.925**	**0.005****	**0.035**
Use of fertilizer	0.291	0.150	0.699	1.338
Distance to nearest farm sight	**1.532**	**2.378**	**0.0827***	**1.040**
Farmland size	−1.172	1.112	0.292	0.310
TLU	**−0.598**	**3.179**	**0.075***	**0.550**
Income	**2.001**	**4.379**	**0.0538***	**1.000**
Family size	−0.131	0.337	0.561	0.878

***Significant at less than 1% probability level; **significant at less than 5% probability level; *significant at less than 10% probability level. Observation: $N = 134$ −2log likelihood 67.1; model chi-square = 109.941; sensitivity/correct prediction of user = 90; specificity/correct prediction of nonuser = 96.4; and overall cases correctly predicted = 94 (source: model output (2021)).

et al. [63], who discovered that age and small-scale irrigation have no relationship.

3.3.2. Sex of Household Head. Sex was significant at the 5% significance level, with a beneficial effect on household irrigation use decisions. The probability of using irrigation increases in the unit of 13 as the probability that the household is male increases. As a result, at a level of significance of less than 5%, the gender of farm households and the decision about irrigation use were positively connected. The results are similar to those of the results of the binary logit model of Yenealem (2013) and Tale et al. [63]. They suggest that gender influences the adoption of improved maize varieties, and adoption of improved agricultural technology is less intense in female-headed households where decisions are made jointly by men and women than in male-headed households where decisions are made jointly (Table 10).

3.3.3. TLU (Livestock Holdings of Agriculture Households). The Tropical Livestock Unit (TLU) in rural areas was used to count the number of animals, which indicates an accumulation of wealth, security against emergencies, gift, and cultural privilege. They can also be swiftly converted into cash if the need arises. It was expected to have a positive relationship with the dependent variable because the household would be more inclined to use small-scale irrigation to supplement their income as the total number of animals at home increased. This can be attributed to a growth in agricultural households' wealth and income base, which results in more money accessible to the households. When all other factors are kept constant, it is strongly associated with a probability of less than 10%, and the odds ratio in favor of being an irrigation user decreases by a factor of 0.55. The inverse relationship implies that households with a large herd size are more likely to be nonirrigators because they can earn more money from livestock production and have other options for survival (Table 10).

3.3.4. Distance to Nearest Farm Sight. Physical infrastructure access indicators are good predictors of institutional conditions that influence irrigation access and other concerns. Farmers in rural locations, isolated from agriculture, and with inadequate transportation infrastructure were projected to have fewer opportunities. The long distance to the agricultural center was also considered to reduce the need for irrigation. The distance was significant at the 10% level and had a positive influence on the irrigation decision-making of farmers' households. When the farm distance increases by 1 km in comparison to the nearby farm, the likelihood of using small-scale irrigation also increases by 1 km. As shown in Table 10, the distance from the farm and the decision to use irrigation were positively related at a level of significance less than 10%. The results of FGD and KII support the preceding premise. Households near the farm field had easier access to and from the farm. Furthermore, because all activities in the research area are performed by hand, increasing agricultural distance from an irrigation water source exposed households to significant costs due to the difficulty of transporting water to one's farmland. This finding is consistent with the findings of [54, 64–66].

3.3.5. Farming Experience. The number of years the small farmer engaged in farming activities after the irrigation system was installed in the area was used to determine the farming experience. It was projected that there would be a direct relationship between farm experience and the use of tiny amounts of irrigation (Table 10). Farmers with substantial farming experience should be willing to experiment/use small-scale irrigation after learning about the benefits of different irrigation technologies. The farming experience was significant at the 10% significance level, with a favorable effect on farm household irrigation use decisions; the chance of using small-scale irrigation improves by 1.2 compared to nonusers. As a result, at a level of significance less than 10%, farm experience and irrigation use decisions were positively associated. The results of FGD and KII also confirm the previous conclusion. Farmers who have been farming for a long time are more knowledgeable about the benefits of improved irrigation techniques. They were shown to benefit from better types of seeds from irrigable crops. The finding of [67–70] all came to the same conclusion.

3.3.6. Annual Income of the Household. Small-scale irrigation is more common in higher-income households than in lower-income households. As a result, the expected sign of this variable was positive. This indicates that increased agricultural income may increase the likelihood of employing small-scale irrigation. This finding can be explained by the fact that higher affluence provides a better opportunity to finance key supplies for small-scale irrigation. As a result, at a level of significance less than 10%, the total annual income and the decision on irrigation use were positively connected. That is, for every Ethiopian birr increase, the likelihood of agricultural households becoming irrigation users increases by one. Sufdar et al. [71] found that households with higher incomes are more likely to use biogas technology than those with lower incomes (Table 10).

3.3.7. Access to Irrigation. It is included in the model as a dummy variable because it is thought to have a direct relationship with the availability of household food. As a result, it was expected that homes with access to irrigation would have a positive impact on household irrigation use. At the 1% level, it was significant and had a positive impact on the use of household irrigation. When access to irrigation sources increases by one unit, the likelihood that families will become irrigation users increases by 126 units. Furthermore, the FGD and KII findings show that farmers with access to irrigation sources outperformed those without [72] (Table 10).

3.3.8. Participation in Training. Extension programs are critical in providing rural farmers with assistance and information. Training is an important service for introducing and developing new technology (proper types and rate of fertilizer, improved varieties of seeds, agrochemicals, etc.). As a result, households that participated in FTC training or farm demos are expected to put their knowledge to use to boost farm production. As a result, homes would be better able to use irrigation [73, 74]. Training had a positive effect on modest irrigation use at a level of likelihood less than 10%. The probability of a farm home becoming an irrigation user increased six times after training access/chance increased one time (Table 10).

3.3.9. Health Status of the Household Head. To engage in agricultural activity, the farmer's physical well-being was essential [75]. The health problem was statistically significant at less than 1% and had a detrimental influence on irrigation use. As a consequence, it negatively related to irrigation usage when all other factors were kept constant. This implies that farmers can spend their off-season doing anything other than irrigation (Table 10).

4. Conclusions and Recommendations

The objectives of this article were to investigate the factors that influence small-holder farmers' use of small-scale irrigation for poverty reduction among small-holder farmers in the Offa Woreda, Southern Ethiopia. To collect data, a multistage sampling technique was used, and 134 families were interviewed. The study indicates that the current status of small-scale irrigation use was very low when the number of users was compared with the number of nonusers in the study area. That is, the number of irrigation farmers who used was only about 37.3%, while the number of nonusers was more than half present in the study area. Even those who used irrigation technologies of different kinds did not fully utilize small-scale irrigation technologies of all types, but tried to use at least some of the improved irrigation technologies. The results of the descriptive analysis suggest that nine explanatory variables, including yearly income, TLU (livestock ownership), farm distance, health status, farming experience, training, irrigation access, sex, and age, had a significant impact on the adoption of small-scale irrigation by small-holder farmers. The parameters that influence the use of small-scale irrigation by small-holder farmers were discovered using a binary logistic regression model. The model's findings revealed that of the 16 explanatory variables considered, in the binary logit regression, nine variables had a significant influence on small-holder farmers' use of small-scale irrigation. This is based on economic research and the results of this investigation. These findings have substantial policy implications that should be considered:

(I) By incorporating income-generating technologies, the Woreda Office of Agriculture and Rural Development should provide technical assistance to increase farm productivity and improve household farm income. Furthermore, the Woreda Office of Water, Minerals, and Energy should pay special attention to households with very low income.

(II) The Woreda Office of Agriculture and Natural Resource Development in collaboration with different NGOs should strengthen modern and better training for farm housekeepers who have little farm experience in the study area.

(III) In addition, experience sharing and field visit programs in the fields of the first experienced irrigator/user/farmers should be prepared in the area.

(IV) The office development of water, mining, and energy should try to invite different NGOs and government bodies to construct different irrigation choices for farmers who do not have access. Additionally, the same office should raise awareness of farmers who do not use existing sources in the far area by using other techniques. Moreover, capital investment/budgeting/by local/Woreda/government for the use of small-scale irrigation is needed.

(V) As a result, special training should be provided for households with children under the age of 18. In addition, the Woreda Office of Agriculture and Natural Resource Development should plan field trips and share experience to teach nonuser youth about farm households.

(VI) By providing various training and related activities, the Woreda Office of Agriculture and Natural Resource Development should pay special attention to the use of small-scale irrigation.

(VII) Woreda's government should pay special attention to the use of small-scale irrigation, particularly during the off-season, so that farmers do not waste time.

(VIII) The Woreda Office of the Woreda Office of Agriculture and Natural Resource Development should focus on special annual training on the use of small-scale irrigation. This includes training farmers, agricultural experts, and other interested parties to pay more attention to the use of small-scale irrigation.

(IX) As a result, the Office of Agriculture and Natural Resource Development as well as other concerned bodies, such as the Woreda government and NGOs in the study area, were required to introduce and use more improved small-scale irrigation technologies by farm households to improve agricultural production and productivity.

(X) Not only is the utilization of improved irrigation technologies essential, but also the improvement in favorable supporting systems of institutions, especially educational and training institutions. That is to say, the provision of appropriate and modernized training and extension services is needed to improve the use of small-scale irrigation.

Data Availability

The data will be provided from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

ZZ, TB, D, and MA conceptualized and designed the study, collected and analyzed the data, and wrote the article. EB assisted with statistics and read, revised, and shaped the manuscript into its current state. The version of the manuscript has been read by all authors and has agreed to publish it.

References

[1] G. Zerssa, D. Feyssa, D. G. Kim, and B. Eichler-Löbermann, "Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture," *Agriculture*, vol. 11, no. 3, p. 192, 2021.

[2] B. Tadesse, Y. Tilahun, T. Bekele, and G. Mekonen, "Assessment of challenges of crop production and marketing in Bench-Sheko, Kaffa, Sheka, and West-Omo zones of southwest Ethiopia," *Heliyon*, vol. 7, no. 6, Article ID e07319, 2021.

[3] D. Welteji, "A critical review of rural development policy of Ethiopia: access, utilization and coverage," *Agriculture & Food Security*, vol. 7, no. 1, pp. 1–6, 2018.

[4] P. Matouš, Y. Todo, and D. Mojo, "Roles of extension and ethno-religious networks in acceptance of resource-conserving agriculture among Ethiopian farmers," *International Journal of Agricultural Sustainability*, vol. 11, no. 4, pp. 301–316, 2013.

[5] A. M. A. Agidew and K. N. Singh, "Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed," *Agricultural and Food Economics*, vol. 6, no. 1, p. 10, 2018.

[6] FAO, "The future of food and agriculture-trends and challenges," *Annual Report*, vol. 296, pp. 1–180, 2017.

[7] F. Taheri and H. Azadi, "Understanding famine in Ethiopia: bio-physical and socio-economic drivers," in *Handbook of Famine, Starvation, and Nutrient Deprivation*, V. Preedy and V. Patel, Eds., Springer, Berlin, Germany, 2018.

[8] T. Ferede and D. Gemechu, *An Econometric Analysis of the Link between Irrigation, Markets and Poverty in Ethiopia: The*

Case of Smallholder Vegetable and Fruit Production in the North Omo Zone, SNNP Region, 2006.

[9] K. Pawlak, L. Smutka, and P. Kotyza, "Agricultural potential of the EU countries: how far are they from the USA?" *Agriculture*, vol. 11, no. 4, p. 282, 2021.

[10] A. Belay, J. W. Recha, T. Woldeamanuel, and J. F. Morton, "Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia," *Agriculture & Food Security*, vol. 6, no. 1, p. 24, 2017.

[11] N. Tefera, M. Demeke, and F. Kayitakire, *Building Sustainable Resilience for Food Security and Livelihood Dynamics: The Case of Farming Rural Households in Ethiopia*, JRC European Commission, Ispra, Italy, 2017.

[12] S. B. Awulachew, D. Merrey, B. Van Koopen, and A. Kamara, "Roles, constraints and opportunities of small-scale irrigation and water harvesting in Ethiopian agricultural development: assessment of existing situation," in *Proceedings of the ILRI Workshop*, Addis Ababa, Ethiopia, 2010.

[13] S. B. Wassie, "Natural resource degradation tendencies in Ethiopia: a review," *Environmental systems research*, vol. 9, no. 1, p. 33, 2020.

[14] E. Yitna, "Utilization of water resources and food security in Seka Woreda, Jimma Zone," *Ethiopian Journal of Education and Sciences*, vol. 9, no. 1, pp. 39–50, 2013.

[15] S. B. Awulachew, D. J. Merrey, A. B. Kamara et al., *Experiences and Opportunities for Promoting Small-Scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia*, IWMI, Addis Ababa, Ethiopia, 2005.

[16] S. K. Lowder, J. Skoet, and T. Raney, "The number, size, and distribution of farms, smallholder farms, and family farms worldwide," *World Development*, vol. 87, pp. 16–29, 2016.

[17] D. Kassahun, *Rainwater Harvesting in Ethiopia Capturing the Realities and Exploring Opportunities*, Forum for Social Studies (FSS), Addis Ababa, Ethiopia, 2007.

[18] G. Makombe, D. Kelemework, and D. Aredo, "A comparative analysis of rainfed and irrigated agricultural production in Ethiopia," *Irrigation and Drainage Systems*, vol. 21, no. 1, pp. 35–44, 2007.

[19] FAO (Food and Agricultural Organization), *A Review of Ethiopian Agriculture: Roles, Policy and Small-Scale Farming Systems*, Ministry of Agriculture, Addis Ababa, Ethiopia, 2015.

[20] T. S. Jayne, K. Chance, and I. Minde, "Enhancing united states efforts to develop sustainable agri-food systems in Africa," 2017, http://www.farmersfeedingtheworld.org/policy-briefing/.

[21] N. Mango, C. Makate, L. Tamene, P. Mponela, and G. Ndengu, "Adoption of small-scale irrigation farming as a climate-smart agriculture practice and its influence on household income in the Chinyanja Triangle, Southern Africa," *Land*, vol. 7, no. 2, p. 49, 2018.

[22] D. Mengistie and D. Kidane, "Assessment of the impact of small-scale irrigation on household livelihood improvement at Gubalafto District, North Wollo, Ethiopia," *Agriculture*, vol. 6, no. 3, p. 27, 2016.

[23] M. A. Hanjra and F. Gichuki, "Investments in agricultural water management for poverty reduction in Africa: case studies of Limpopo, Nile and Volta river basins," *Natural Resources Forum*, vol. 32, no. 3, pp. 185–202, 2008.

[24] MoA (Ministry of Agriculture), *Small-Scale Irrigation Capacity Building Strategy for Ethiopia*, Natural Resources Management Directorate, Ministry of Agriculture, Addis Ababa, Ethiopia, 2011.

[25] K. Asayehegn, "Negative impact of small-scale irrigation schemes: a case study of central tigray regional state, Ethiopia," *Journal of Agricultural Research and Reviews*, vol. 1, no. 3, pp. 80–85, 2012.

[26] A. Pinstrup and D. Watson, *The Role of Government in Global, National and Local food Systems: Food Policy for Developing Countries*, Cornell University, Ithaca, NY, USA, 2011.

[27] S. B. Awulachew and M. Ayana, "Performance of irrigation: an assessment at different scales in Ethiopia," *Experimental Agriculture*, vol. 47, no. S1, pp. 57–69, 2011.

[28] C. Bont, H. C. Komakech, and G. J. Veldwisch, "Neither modern nor traditional: Farmer-led irrigation development in Kilimanjaro Region, Tanzania," *World Development*, vol. 116, pp. 15–27, 2019.

[29] K. A. Getaneh, "The impact of selected small-scale irrigation schemes on household income and the likelihood of poverty in the Lake Tana basin of Ethiopia," M.Sc Thesis, Cornell University, Ithaca, NY, USA, 2011.

[30] T. Mekuria, *Small Scale Irrigation for Food Security in Sub Saharan Africa*, 2003.

[31] I. Hussain and M. A. Hanjra, "Irrigation and poverty alleviation: review of the empirical evidence," *Irrigation and Drainage*, vol. 53, pp. 1–15, 2004.

[32] V. T. Elijah and J. O. Odiyo, "Perception of environmental spillovers across scale in climate change adaptation planning: the case of small-scale farmers' irrigation strategies, Kenya," *Climate*, vol. 8, no. 1, p. 3, 2019.

[33] L. Mdoda, A. Obi, Z. Ncoyini-Manciya, M. Christian, and A. Mayekiso, "Assessment of profit efficiency for spinach production under small-scale irrigated agriculture in the Eastern Cape Province, South Africa," *Sustainability*, vol. 14, no. 5, p. 2991, 2022.

[34] Food and Agricultural Organization (FAO), *The State of Food Insecurity in the World 2013. The Multiple Dimensions of Food Security*, FAO, Rome, Italy, 2013.

[35] T. Tera and Z. abu Wolde, "Climate change impacts on agriculture and adaptive strategies of the farming community in Offa Woreda, Wolaita zone SNNPR," *Canadian Journal of Agriculture and Crops*, vol. 1, no. 2, pp. 50–59, 2016.

[36] CAS, "Projected-population-of-Ethiopia," 2019, https://www.statsethiopia.gov.et/wp-content/uploads/2019/11/Projected-Population-of-Ethiopia-20112019.pdf.

[37] R. J. Fraenkel and E. N. Wallen, *How to Design and Evaluate Research in Education*, McGraw Hill, New York, NY, USA, 1993.

[38] C. Kothari, *Research Methodology*, 2nd edition, 2004.

[39] E. Nkonya, T. Schroeder, and D. Norman, "Factors affecting adoption of improved maize seed and fertilizer in north Tanzania," *Journal of Agricultural Economics*, vol. 48, no. 1-3, pp. 1–12, 1997.

[40] D. N. Gujirati, *Basic Econometrics*, McGraw - Hill Co, New York, NY, USA, 3rd edition, 1995.

[41] A. Tesfaye, "The impact of small scale irrigation on household food security and assessment of its management system: the case of filinto and godino irrigation scheme in ada Liban District East Showa Zone," M.Sc Thesis, p. 123p, School of Graduate Studies of Haramaya University, Dire Dawa, Ethiopia, 2006.

[42] S. La Bella, G. Virga, N. Iacuzzi et al., "Effects of irrigation, peat-alternative substrate and plant habitus on the morphological and production characteristics of Sicilian rosemary (Rosmarinus officinalis L.) biotypes grown in pot," *Agriculture*, vol. 11, no. 1, p. 13, 2020.

[43] P. Woldemariam and Y. Gecho, "Determinants of small-scale irrigation use: the case of boloso sore district, Wolaita zone, southern Ethiopia," *American Journal of Agriculture and Forestry*, vol. 5, no. 3, p. 49, 2017.
[44] M. Astetkei, "Analysis of factors influencing adoption of triticale(x-triticosecale witmack) and its impact: the case of ferta woreda," M.Sc. Thesis, School of Graduate Studies of Haramaya University, Dire Dawa, Ethiopia, 2005.
[45] M. A. Akudugu, E. Guo, and S. K. Dadzie, "Adoption of modern agricultural production technologies by farm households in Ghana: what factors influence their decision?" *Journal of Biology, Agriculture and Healthcare*, vol. 2, no. 3, pp. 1–13, 2012.
[46] S. Abbasi and K. Nawab, "Determinants of the dairy technology adoption by the rural milk producers in district muzaffarabad, azad Jammu and Kashmir," *Sarhad Journal of Agriculture*, vol. 37, no. 3, 2021.
[47] H. Hando, M. Senapathy, and E. Bojago, "Determinants of member participation in activities of multipurpose primary cooperatives: the case of Kindo Koysha district, southern Ethiopia," *Advances in Agriculture*, vol. 2022, Article ID 3569016, 21 pages, 2022.
[48] M. Chekol, S. Van Passel, D. Berihun et al., "Direct and indirect effect of irrigation water availability on crop revenue: a structural equation model," in *Institutional University Cooperation with Bahir Dar University: Year 3 Joint Steering Committee Meeting: Excursion Guide*, pp. 26–28, Bahir Dar University, Bahir Dar, Ethiopia, 2019.
[49] S. Van der Esch, B. ten Brink, E. Stehfest et al., *Exploring Future Changes in Land Use and Land Condition and the Impacts on Food, Water, Climate Change and Biodiversity: Scenarios for the UNCCD Global Land Outlook*, PBL Netherlands Environmental Assessment Agency, Geneva, Switzerland, 2017.
[50] L. C. Stringer, E. D. Fraser, D. Harris et al., "Adaptation and development pathways for different types of farmers," *Environmental Science & Policy*, vol. 104, pp. 174–189, 2020.
[51] D. C. Sohoulande Djebou, E. Price, S. Kibriya, and J. Ahn, "Comparative analysis of agricultural assets, incomes and food security of rural households in Ghana, Senegal and Liberia," *Agriculture*, vol. 7, no. 5, p. 38, 2017.
[52] E. Muhoyi and J. Mbonigaba, "Stakeholder consultations on small-scale irrigation schemes' constraints in Zimbabwe," *Environment, Development and Sustainability*, pp. 1–20, 2021.
[53] C. Salazar and J. Rand, "Production risk and adoption of irrigation technology: evidence from small-scale farmers in Chile," *Latin American Economic Review*, vol. 25, no. 1, p. 2, 2016.
[54] K. Aseyehegu, C. Yirga, and S. Rajan, "Effect of small-scale irrigation on the income of rural farm households: the case of Laelay Maichew district, central Tigray, Ethiopia," *Journal of Agricultural Sciences*, vol. 7, no. 1, p. 43, 2012.
[55] A. K. Hamda, "Impact of small-scale irrigation on household's food security in Fentale district east Showa zone of Oromia national regional state, Ethiopia," MSc. Thesis, Haramaya University, Dire Dawa, Ethiopia, 2016.
[56] T. T. Nguyen, T. T. Nguyen, V. H. Le, S. Managi, and U. Grote, "Reported weather shocks and rural household welfare: evidence from panel data in Northeast Thailand and Central Vietnam," *Weather and Climate Extremes*, vol. 30, Article ID 100286, 2020.
[57] T. Ramilan, S. Kumar, A. Haileslassie et al., "Quantifying farm household resilience and the implications of livelihood heterogeneity in the semi-arid tropics of India," *Agriculture*, vol. 12, no. 4, p. 466, 2022.
[58] S. Corral, A. S. Díaz, M. D. C. Monagas, and E. C. García, "Agricultural policies and their impact on poverty reduction in developing countries: lessons learned from three water basins in cape verde," *Sustainability*, vol. 9, no. 10, p. 1841, 2017.
[59] B. Inthakesone and P. Syphoxay, "Public investment on irrigation and poverty alleviation in rural Laos," *Journal of Risk and Financial Management*, vol. 14, no. 8, p. 352, 2021.
[60] M. Ravallion, *Poverty Comparisons*, Harwood Academic Publishers, Chur, Switzerland, 1994.
[61] M. Hussain, Z. Hussain, and M. Ashfaq, "Impact of small scale irrigation schemeson poverty alleviation in marginal areas of Punjab, Pakistan," *International Research Journal of Finance and Economics*, vol. 6, no. 6, 2006.
[62] O. Gbenga, R. Olanrewaju, A. Henry, and F. Iyabo, "Irrigation and income-poverty alleviation: An assessment study of kampe irrigation dam in Kogi State, Nigeria," *Journal of Agricultural Sciences*, vol. 10, 2015.
[63] T. Geddafa, E. Abera, and F. Gedefa, "Determinants of smallholder farmers' participation and level of participation in small-scale irrigation practice in Gemechis district, West Hararghe Zone, Ethiopia," *Cogent Engineering*, vol. 8, p. 1, Article ID 1960250, 2021.
[64] B. Ahmed, J. Haji, and A. Kedir, "Effect of small-scale irrigation on the farm households' income of rural farmers: the case of Girawa district, east Hararghe, Oromia, Ethiopia," *Asian Journal of Agriculture and Rural Development*, vol. 4, no. 3, pp. 257–266, 2014.
[65] T. Hirko, M. Ketema, and F. Beyene, "Participation in small-scale irrigation practice: the case of abay chomen district of Oromia national regional state, Ethiopia," *International Journal of Agricultural Economics*, vol. 3, no. 6, pp. 135–144, 2018.
[66] N. L. Sithole, J. K. Lagat, and M. B. Masuku, "Factors influencing farmers participation in smallholder irrigation schemes: the case of Ntfonjeni rural development area, Kenya," *Journal of Economics and Sustainable Development*, vol. 5, no. 22, pp. 157–167, 2014.
[67] M. H. Ahmed, H. M. Mesfin, S. Abady, W. Mesfin, and A. Kebede, "Adoption of improved groundnut seed and its impact on rural households' welfare in Eastern Ethiopia," *Congent Economics and Finance*, vol. 4, 2016.
[68] E. Bojago, M. Senapathy, I. Ngare, and T. B. Dado, "Assessment of the effectiveness of biophysical soil and water conservation structures: a case study of Offa Woreda, Wolaita Zone, Ethiopia," *Applied and Environmental Soil Science*, vol. 2022, Article ID 6910901, 11 pages, 2022.
[69] A. Mulatu, S. Marisennayya, and E. Bojago, "Adoption of modern hive beekeeping technology: the case of Kacha-Birra Woreda, Kembata Tembaro Zone, Southern Ethiopia," *Advances in Agriculture*, vol. 2021, Article ID 4714020, 20 pages, 2021.
[70] A. Tufa and T. Tefera, "Determinants of improved barley adoption intensity in Malga district of Sidama Zone, Ethiopia," *International Journal of Agricultural Economics*, vol. 1, no. 3, pp. 78–83, 2016.
[71] I. Sufdar, A. Sofia, A. Waqar, and I. Muhammad, "Factors leading to adoption of biogas technology: a case of Faisalabad, Punjab, Pakistan," *International Journal of*

Academic Research in Business and Social Sciences, vol. 3, no. 11, p. 571, 2013.

[72] C. Sareth, R. Cramb, and S. Fukai, "The role of irrigation in the commercialisation of rice farming in southern Cambodia," in *White Gold: The Commercialisation of Rice Farming in the Lower Mekong Basin*, pp. 261–289, Palgrave Macmillan, Singapore, 2020.

[73] A. Chinasho, B. Bedadi, T. Lemma, T. Tana, T. Hordofa, and B. Elias, "Farmers' perceptions about irrigation roles in climate change adaptation and determinants of the choices to WUE-improving practices in southern Ethiopia," *Air, Soil and Water Research*, vol. 15, Article ID 117862212210924, 2022.

[74] S. Eshetu, B. Belete, D. Goshu et al., "Income diversification through improved irrigation schemes: evidence from Gorogutu district, eastern Ethiopia," *A Research Report Presented to RiPPLE*, 2010.

[75] S. Kirkhorn and M. B. Schenker, "Human health effects of agriculture: physical diseases and illnesses," in *Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions*, 200.