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Small Scale Irrigation and its Effect on Poverty Reduction: the Case of Shabelle River Basin Gode Woreda, Somali Region, Ethiopia

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Abstract

This study was conducted at Gode district of Somali Region, Ethiopia. The objective of this study was to identify Small-scale irrigation use and its effect on poverty reduction. The data was collected from a total of 180 farmers by using semi-structured questionnaire. To collect the required data several methods like interview schedule, focus group discussions and key informant interviews were used. Various documents were reviewed to collect the secondary data. Descriptive statistics, inferential statistics (chi-square and t-test), frequency, percentage and econometric model analysis were used to analyze quantitative data. As the binary logistic regression model result indicates, eight variables were found to be significant namely Farming experience and membership to cooperative had significant effect on the use of irrigation water use at less than 1% probability level. Age, family size, water availability, and off-farm income had significant effect on the use of irrigation water at 5% significant level. Livestock holding size and access to credit had significant effect on the use of irrigation water use at less than 10% probability level. Water availability from rivers had a significant effect on the use of irrigation water and the main sources of irrigation water in the study area are rivers. Small scale irrigation reduces poverty by enhancing production, household consumption, annual expenditure, and by increasing employment. It is recommended that the concerned bodies such as government, NGO and other stakeholders should emphasis on construction of new canals and maintenance of existing canals so as to improve the performance of small scale irrigation.

Keywords: Small scale; irrigation; poverty; Gode.

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1. Introduction

Incompatibility of food production and alarming population growth coupled with climate change has become a challenge to the livelihoods of millions of people worldwide. Climate change driven unreliability of recurrent rainfall has constrained crop production that totally depends on rain fed agriculture [1]. As the global population continues to grow, agricultural production must also keep pace with it. In the upcoming 40 years, agricultural production should increase by 60% to supply the growing population with food in appropriate quantity and quality [2].

Satisfying the food demand of world population will not be possible depending on rain fed agriculture alone. I this regards, Utilization of water resources for agricultural development is the main strategy adopted by nations to narrow down the existing gap between demand and supply for food crops [3]. Irrigation practices do not only raise household food consumption but also increase household income and hence significant impact on household food security [4].

Globally, irrigation practice is one of the possible means of feeding the rapidly growing population in the world [5]. In the coming 35 to 45 years, the demand of food by world population will double, to meet the demand of food 90% of food production will come from existing lands and of which 70% of food will have supposed to come from irrigated land [6]. This shows that food security is impossible without irrigation farming [5]. Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty [1]. Reports show that Small-scale irrigation provides about 40% of the worlds' food production from 18% of worlds' cultivated land [2]. Irrigation influences not only agricultural productivity but also the income, employment and long run economic development [3]. Small scale irrigation contribute much to poverty reduction primarily by enhancing the productivity of labor and land leading to higher incomes, higher wages and lower food prices [6].

The current government of Ethiopia has set an agricultural strategy for accelerating agricultural development in its Agricultural led Industrialization Strategy (ADU) [3]. The strategy gives attention to the smallholder farmers [7]. However, though the government of Ethiopia has attempted to boost irrigated agricultural production through irrigation development, the country still could not exploit its irrigation potential efficiently and effectively. Instead, it is highly depend on traditional rain fed agricultural production system [5]. Various researches indicated that out of the total irrigable potential of 3.7 million hectares only 10 to 12% of the potential is under irrigation agriculture [8].

Ethiopian irrigation agriculture practice has encountered many problems such as lack of effective and efficient use of available irrigation water, inadequate knowledge about the use of irrigation, shortage of labor force, limited access to technology, poor time resource management system, and poor experience of farmers to adapt irrigation farming etc. at the irrigation scheme [1]. Similarly, even if the study area has its own irrigation potential, most of the households of the irrigation scheme have not used the irrigation opportunity and many of them still depend on rain fed agriculture rather than being the irrigation scheme beneficiaries do to the presence of those listed factors [9].

Several researchers [3; 10; 6] had studied the effect of small scale irrigation from household food security, household income and Gender involvement different perspectives. As to [3], irrigation has significantly increase farm production input compared to rain fed agriculture. The other researchers emphasize on the effect of small scale irrigation use on production levels of users and non-users [10;6]. However, identifying determinant factors affecting the use of small-scale irrigation and evaluating the poverty status of irrigation users and non-users is beyond the target of these studies.

Godey is one of the districts located in Somali region and the district has potential of small-scale irrigation. However, the living standard of the community is dependent on subsistence agriculture [9]. The attempt of utilizing available potentials mall scale irrigation and efforts to increase income level of the rural households least practiced. Hence, the knowledge regarding the contribution of irrigation to household income and its effect on poverty reduction is not inculcated to the expected level. Moreover, the contribution of irrigation on household production level and to what extent the households practicing irrigation agriculture are better off than those who depend on rain-fed agriculture is not well evaluated so far. Therefore, the main objective of this study is to explore the effect of small-scale irrigation use on poverty reduction and identification of determinant factors that hinder the use of small scale irrigation in Gode District, Shabelle River Catchment.

2. Research methodology

The study was conducted in Gode district, which is one of the nine districts of Shabelle zone of Ethiopian Somali Region. The study area is located at $5^0 57'$N and $43^0 27'$E (Figure1). Both primary and secondary data sources were used for this study. River Shabelle passes through this study area. 180 sample respondents were selected randomly through probability proportionate to sample size procedure from both the irrigation users and non-users from the study area. This study used both qualitative and quantitative data types.

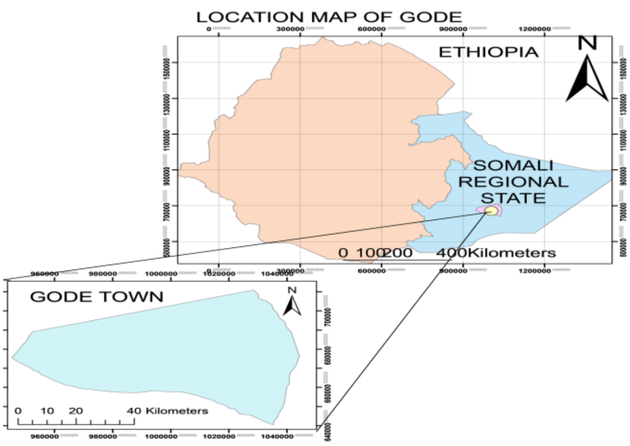

Figure1: Map of Gode district

The sample size was determined by using kothari (2004) sampling design formula

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

The analysis of the data employed both descriptive statistics and econometrics model. Finally, STATA 15 software was used to analyze most of quantitative data that were collected from field through survey. The strength and direction of a linear relationship between the two variables were analyzed using correlation coefficient. In addition to this propensity score matching was made for quantitative data analysis.

3. Results and discussions

3.1. Computation of contingency coefficients of dummy variables in the model

The result of the computation of contingency coefficients revealed that there was no a serious problem of association among 6 dummy explanatory. Therefore, all the 6 discrete variables were included in the logistic regression model.

Table 1: Computation of contingency coefficients of discrete variables in the model

Variables	Sex	Education	Access to credit	Water availability	Access to extension	Membership to cooperative
Sex	1.0000					
Educational	0.1120	1.0000				
Access to credit	0.0756	0.0946	1.0000			
Water availability	-0.0351	0.0710	0.0709	1.0000		
Access to extension	-0.0789	0.0740	0.2885	0.0742	1.0000	
Membership to cooperative	0.0369	0.1654	0.2647	-0.0543	0.3531	1.0000

Source: Model output, 2020

The estimated model appeared to perform well for our intended matching exercise. The pseudo-R^2 value was 0.26. A low R^2 value means that participant households do not have much distinct characteristics and as such, the finding shows a good match between participants and non-participants households.

The pseudo-R^2 indicated how well the regresses explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo- R^2 should be fairly low [11]. The p-value of 0.00 associated the chi-square with 13 degrees of freedom indicates that the model as a whole is statistically significant.

Looking into the estimated coefficients presented in Table 2**,** the variables: Age of the household head, Family size of the household, Access to credit, Farming experience of the household head, water availability, livestock holding, membership to cooperative and off-farm income were found that they had significant effect on small scale irrigation adoption. Sex, Education, Land size, distance from river and access to extension have shown no significance relationship with the households' probability of being participant while the remaining variables were found to have a positive relationship with the dependent variable. Moreover, membership to cooperative and farming experience is found to have strong positive relationship with household participation in the small-scale irrigation.

The goodness-of-fit was tested by the Log likelihood ratio (LR) test of -92.28. The result showed the chi-square of 64.96 with p-value of zero. This meant that X^2 is statistically significant, and the model displays a good fit. The chi-square computed shows that, the model was significant at less than 1% significance level. This indicated that the null hypothesis stating the coefficients of explanatory variables less the intercept is equal to zero was rejected and the alternative hypothesis of non- zero slope was accepted. The Pseudo R^2 of the model is also 0.2603 which indicated that, 26.03% variation in the household irrigation adoption is explained by the independent variables included in the model. This low pseudo R-squared suggested that the proposed specification of the propensity score is fairly successful in terms of balancing the distribution of covariates between the two groups..

Among the total thirteen explanatory variables included in the model, eight variables were found to be statistically significant in determining small scale irrigation adoption, while the remaining five explanatory variables were found statistically insignificant on the irrigation adoption in the study area.

Table 2: The binary logit result of independent variables

Variables	Coefficient	Std. Err	P>[Z]	Marginal effect
SEXHH	.1517115	.4415658	0.731	.0378792
AGEHH	-.0557832**	.0216754	0.010	-.0139451**
Educational level	-.1653574	.3837421	0.666	-.0413146
Family Size	.3212849**	.1354753	0.018	.0803174**
Access to Credit	.6714853*	.4030038	0.088	.1658813*
Farm Experience	.0827597***	.030627	0.007	.020689***
Land Size	-.0182701	1896181	0.923	-.0045673
Water Availability	1.068998**	.5394693	0.031	.2557042**
Distance from river	-.1242837	.1189389	0.296	-.0310694
Access to Extension	.1737879	.4203082	0.679	.0434127
Livestock Holding Size	.026731*	.0156785	0.088	.0066824*
Membership to cooperative	1.017763***	.4093091	0.009	.2490112***
Off-farm income	.0046173**	.0018376	0.012	.0011543**
LR chi^2 (13)				64.96
Log likelihood				-92.28
Pseudo R^2				0.26

Source: Computed from field survey data, 2020.

Age of the household head: This variable was found to have a negative impact and significant (at less than 5% probability level) influence on the probability of being irrigation user. The interpretation of the marginal effect implies that, if other factors are held constant, the probability of being irrigation user decreases by 13.94 percent as the age of the household head increases by one year. This indicates that younger headed households have high probability to become irrigation user than the older headed households. This may be due to the fact that younger household heads have more energy and power to work in the farm with high energy to work. The results are in line with the findings of [12].

Family size the household head: This is the total number of family members in the household per adult equivalent to represent total family size. This is a continuous variable measuring the total number of the household members per adult equivalent. Based on the model result, it was found that family size is significant at less than 5% probability. The marginal effect indicated that, keeping other factors constant, if family size increases 1 adult equivalent, the probability of the household being irrigation user increases 8.03 factor. The study argued the impact of household size positively affects irrigation adoption of Household due the labour availability in larger size family. According to Focused Group Dissociation irrigation is the labor-intensive practice and it needs a high labor force for diversion of water from the river and the application of water on the farm. Similar to this study, [13] have reported in their study, irrigation farming is extremely labor intensive.

Access to credit: Credit is an important source of income. Those households who received the credit they wanted have better possibility to spend on activities they want. They purchase input for farm production. The results of the study revealed that the variable under consideration is positively related and significant at less than 10% probability level with the probability of being irrigation user. Holding other things constant, the marginal effect of the variable shows that probability of being irrigation user increases by 16.58% as the household gets access to credit. The possible explanation is that credit gives the household an opportunity to be involved in small scale irrigation activities. The result obtained from Focused group discussion revealed that, those households who have access to credit have better possibility to use irrigation and spend on activities they want either they purchase agricultural input (improved seed, fertilizer, irrigation equipment's, etc.,) or they purchase livestock for resale after they fattened them and also they explained that access to credit used to bought household materials such as solar light, motorized water pump or generator which is easier to distribute water in their irrigation farm than those respondents who did not get access to credit. Previous research result reported by [1] and [8] confirmed that access to credit positively influences the adoption of irrigation agriculture.

Farming Experience of the Household Head: as per expectation the binary logistic regression result revealed that, the farming experience of household head measured by years and irrigation adoption had positively related. The farming engagement duration of the household head (number of years since he/she has involved on farm operations) positively affects the irrigation adoption status of the household by less than 1 percent probability level. The marginal effect showed that if the farming experience of household head increases 1 year the irrigation usage probability of the household increases 2.06 factor. According to key informant interview (KII) farmers with longer farming experience have better competence in assessing the characteristics and potential benefits of new technologies than farmers with shorter farming experience. Moreover, farmers with longer farming experiences have more knowledgeable and skilful. This in turn enables them to use irrigation water earlier than farmers with short farming experience. The findings are in line with [13].

Water availability: The model measures the relation between this variable and small-scale irrigation participation. This variable positively influenced the irrigation participation of the households. The study result also reveals that water availability is statistically significant at less than 5% level of significance. Especially, smallholders can enable to grow cash crops, hence increased income source of the household. The marginal effect reveals that those households who have access to irrigation water have 25.57 percentage more chance of participation in small-scale irrigation than their counter parts, while keeping all other variables constant. The results are in line with the findings of [12. Key informants explained that households who have access to irrigation scheme do not acquire additional costs of transportation and traveling time and also have a better opportunity to participate in irrigation activity.

Livestock holding: It was one of the constraints in small scale irrigation water use**.** The survey result shows that livestock ownership positively and significantly affects irrigation use, the result shows that respondent, who have more livestock were more likely to use irrigation The results of the study revealed that the variable under consideration is positively related and significant at less than 10% probability level with the probability of being irrigation user. Holding other things constant, the marginal effect of the variable shows that probability of being irrigation user increases by 0.66% as the household owns more livestock. While respondents who have no or less livestock were less likely to use irrigation and its affect negatively because livestock are the major engine for any agricultural activity on the study area. According to the focus group discussions (FGD) Livestock are one of the productive assets and every agricultural activity is done by livestock in the study area. Due to this most of irrigation users were livestock owners to perform irrigation activity. [13] confirmed that livestock holding positively influences the adoption of irrigation agriculture.

Membership to cooperative: Membership to cooperative is positively related with irrigation adoption. The model result showed that, Membership to cooperative is significant at less than 1% probability level. The marginal effect implied that, remaining other factors constant, the probability of being irrigation user increases by 24.90 factor as the Membership to cooperative of the household increases by 1 factor. key informant interview (KII) revealed that, those households who are member to cooperative have better possibility to use irrigation and spend on activities they want together which intern will be expensive by doing alone either they are purchasing fuel, seed, fertilizer, irrigation equipment's, or for transportation of agricultural products to market etc., Therefore, a household who is a member of cooperatives is more likely to participate in small scale irrigation. The findings are in line with [1].

None-farm and off-farm income: based on the revealed result of the model the amount of None-farm and off-farm income has positive relation with irrigation adoption. The significance level of less than 5% is appeared; the marginal effect of this variable implies that keeping other factors constant the possibility of the household being irrigation adopter increases 0.11 as the amount of off-farm received by household increases 1 factor. According to focus group discussions (FGD) household heads who get more off-farm income have more chance in participating in small scale irrigation use. As they can employ labor outside from household, purchase fuel, seed, fertilizer, irrigation equipment's by the off-farm income. [14] and confirmed that non-farm income positively influences the adoption of irrigation agriculture.

3.2. Propensity Scores Matching (PSM)

According to [15] propensity score matching is a tool that creates a comparison group with the treatment group based on factors that affect peoples' propensity to participate in the program. And also, it allows finding of a comparison group from a sample of non-participants closest to the treatment group in terms of observable characteristics, so that both groups are matched on the basis of the propensity score, which is a predicted probability of participation given observed characteristics. This propensity value is estimated based on a statistical model, like Logit or probit model, and thereby estimate the average treatment effect of the outcome difference of income, between the treated as well as the control groups using nearest-neighbor, caliper radius and kernel density matching methods [16].

In addition, PSM doesn't require randomization or baseline (pre-intervention) data which makes it preferable than the difference in different method. Furthermore, it is useful when there are many potential characteristics to match between program participants and non-participants. Particularly, it is more robust as compared to other techniques.

3.2.1. Matching irrigation users and non-user households

In this study, the propensity score of each household measures his/her chance to participate the small-scale irrigation. The magnitude of a propensity score is between 0 and 1; the larger the score, the more likely the household would be to participate irrigation program. The following three steps needs to be followed before implementing the matching task. The first step is to predict the values of propensity scores for all treated and control households. The second step is that a common support condition should be imposed on the propensity score distributions of household with and without the program.

As shown in the following Table 3, observations whose predicted propensity vary between 0.1174 and 0.9663 (mean = 0.2983) are the treatment households (users) and between 0.0120 and 0.9644 (mean = 0.2741) for control households (non-users). The common support region would then lie between 0.1174 and 0.9644. This means, households whose estimated propensity scores are less than 0.1174 or greater than 0.9477 were not considered for the matching exercise. Before matching the sample size of 180 households were taken (90 from users and the rest 90 from non-users). Based on the estimated propensity score, from 180 sample households, only 162 (72 non-users and 90 users) households were considered in the estimation process. This shows that the study dropped 18 non-users.

Table 3: Distribution of estimated propensity scores

Group	Obs	Mean	Std. Dev	Minimum	Maximum
Total HHs	180	0.5	0.2838	0.1205	0.9644
User HHs	90	0.662	0.2983	0.1174	0.9633
Non-user HHs	90	0.338	0.2741	0.0120	0.9644

Source: Computed from field survey data, 2020.

3.2.2. Choice of matching algorithm

After households' propensity scores are estimated, the second step is to use the most used matching methods such as the nearest neighbor, kernel and radius matching depending on the designation of a closeness criterion used to identify the impact of interventions. In this study, three of the most common matching methods were used to identify the effect of participation in irrigation on household income.

The final choice of a matching estimator was guided by different criteria such as equal means test referred to as the balancing test, pseudo-R^2 and matched sample size [17]. Specifically, a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), bears a low R^2 value and also results in large, matched sample size is preferable.

Table 4: performance of matching estimators

Matching Estimator	**Performance Criteria**		
	Balancing test*	Pseudo-R^2	Matched sample size
Nearest neighbor			
NN(1)	10	0.105	162
NN(2)	12	0.088	162
NN(3)	12	0.089	162
NN(4)	14	0.072	162
Caliper			
0.01	14	0.058	113
0.25	10	0.105	162
0.5	10	0.105	162
Kernel			
band width of 0.1	10	0.105	162
band width of 0.25	**10**	0.105	**162**
band width of 0.5	10	0.105	162

Source: Computed from field survey data, 2020.

3.2.3. Balancing test

Table (5) illustrates the estimated results of tests of matching quality based on the selected best estimator Nearest Neighbor (4). The balancing test of covariates after the matching showed insignificant difference in the variables between irrigation users and non-users.

Table 5: Results of the balancing tests of covariates using Nearest Neighbor (4)

Variable	Mean		% bias		t-test
	Treated	Control		T	P>(t)
_PSCORE	.66174	.64466	7.3	0.53	0.595
SEX OF THE HH	.8	.74722	12.8	0.84	0.400
Age	40.578	43.206	-22.0	-1.57	0.118
Educational level	.55556	.50833	9.4	0.63	0.528
Family size	5.5578	5.4244	9.1	0.61	0.544
Access to credit	.76667	.74722	4.2	0.30	0.763
Farm experience	16.522	17.336	-9.9	-0.62	0.533
Land holding size	2.7444	2.5167	22.9	1.63	0.104
Water availability	.86667	.89722	-7.4	-0.63	0.528
Distance from river	2.7222	2.9083	-9.7	-0.79	0.431
Access to extension	.64444	.69722	-10.7	-0.75	0.454
Livestock holding size	28.089	25.156	23.5	1.61	0.109
Membership to cooperative	.65556	.64722	1.7	0.12	0.907
Off-farm income	349.67	361.94	-11.4	-0.78	0.434

Source: Computed from field survey data, 2020.

3.2.4. Effect of irrigation on household poverty reduction

The estimation result presented in Table 6 provides supportive evidence for the effect of irrigation on household poverty reduction. In order to attain the stated objective of measuring the effect of irrigation on household annual expenditure, the following impact indicator of the treatment effect has been performed using the already mentioned PSM model and selected algorithm. The estimation result provides supportive evidence of statistically significant effect of the irrigation utilization on household annual expenditure measured in terms of Birr. It was found that, on average, the irrigation utilization has increased the annual expenditure of participating households by 888.46 birr per adult equivalent and this shows that due to irrigation utilization in the study area, the irrigation user household annual expenditure increased compared to the non-user households.

Table 6: average treatment effect on the treated (ATT) for annual expenditure

	Treated (users)	Controls (non-user)	Difference	S.E.	T-stat
ATT	4826.77	3938.31	888.46	316.05	2.81**

** Significant at 5% probability level

3.2.5. Irrigation increased production

According to the key informant interview (KII), irrigation use has significantly contributed towards achieving household's goal of increased production and irrigation use is a guarantee for increased food supply. According to the focus group discussion (FGD) having access to irrigation had significantly improved the living standards of user households. Small scale irrigation played an important role in increasing production, as well as poverty reduction. This result is similar to other reports.

3.2.6. Irrigation increased income

It is expected and revealed that irrigation would improve income earning [19] Similarly, according to the focus group discussion irrigation beneficiaries' annual income was higher for user household, than that of non-users. Irrigation use has a positive impact on households earning from crop and livestock.

3.2.7. *Irrigation* ***improved household consumption***

In order to measure the impact of irrigation on household consumption, expenditure pattern was used as a proxy indicator for standard of living. This usually refers to the ability of the household to produce/purchase a basket of goods containing the minimum quantity of calories and non-food commodities. Accordingly, according to the focus group discussion (FGD) the average consumption expenditure for irrigators is more than of non-irrigators. The findings are in line with.

3.2.8. Irrigation enhanced employment opportunities

According to FGD, among the many benefits of irrigation, employment generation is crucial. The beneficiaries have shifted from once a year (rainy season) to two and three harvests and labor use efficiency were improved due to irrigation. The development of the irrigation schemes has created job opportunities for the nearby farmers in addition to the irrigation users in the traditionally slack dry times. This implies that, irrigation is a stimulus to increased employment opportunity. The findings are in line with.

Table 7: Results of the multiple linear regression model for annual expenditure

Variables	Coef.	Std. Err.	T	P>t
SEX OF THE HH	162.5195	328.526	0.49	0.622
AGE	21.02947	19.00957	1.11	0.272
EDUCATIONAL LEVEL	-264.9121	329.9765	-0.80	0.425
FAMILY SIZE	-760.1946	95.08654	-7.99	0.000
ACCESS TO CREDIT	-124.8979	342.805	-0.36	0.717
FARM EXPERIENCE	-28.35982	27.63599	-1.03	0.308
LAND HOLDING SIZE	-30.55551	130.7974	-0.23	0.816
WATER AVAILABILITY	371.9199	401.8219	0.93	0.358
DISTANCE FROM RIVER	50.03322	88.53295	0.57	0.574
ACCESS TO EXTENSION	317.0166	308.585	1.03	0.308
LIVESTOCK HOLDING SIXE	22.99367	9.060102	2.54	0.013
MEMBERSHIP TO COOPERATIVE	324.7049	310.0053	1.05	0.298
OFF-FARM INCOME	.5234501	1.357644	0.39	0.701
_cons	7159.181	1340.238	5.34	0.000
Sample size	90			
F-stat (13, 76)	6.94			
R^2	0.5428			
Adj R-squared	0.4646			
Root MSE	1178.3			

Source: Computed from field survey data, 2020.

3.3. Sensitivity Analysis

The third and final step of the PSM analysis is testing the robustness of the estimated results to possible failures of the Conditional Independence Assumption (CIA). The sensitivity analysis proposed by [18] and the Stata program written by [19] were deployed to check robustness of the estimates.

To be precise, an unobserved confounder was simulated using reasonable values for p_{ij}. The matching estimation was repeated 100 times and the simulated average estimate of the ATT was retrieved. The comparison between the simulated and the baseline estimates gives an idea of the robustness of ATT estimation results to possible failures of the Conditional Independence Assumption (CIA).

As it is shown in table 8, even though U is associated with a large selection and outcome effects, the simulated ATTs are still very close to the baseline ATTs. This implies it is only when U is simulated to provide implausibly large outcome effect, that the ATT can be driven closer to zero. Thus, it can be concluded that impact estimates (ATT) of this study are not sensitive to unobserved selection bias and are a pure effect of

Irrigation program

Table 8: Result of based sensitivity analysis for annual expenditure

Matching algorithm	Baseline ATT (1)	Selection effect	Outcome effect	Simulated ATT (2)	Absolute difference (1-2)	Percentage difference (1-2)/(2)
Nearest Neighbor	752.25	3.04	2.000	847.27	-95.02	-47.51
Radius caliper	842.44	2.67	1.70	827.13	15.31	7.66
Kernel	897.77	2.91	1.33	850.93	46.84	23.42

Source: Computed from field survey data, 2020.

3.3.1. Poverty Measurement

Following Haji and [20] and [21], this study used consumption expenditure as the metric to measure poverty. Consumption is a better measure of long term household poverty because it is subject to less temporal variation than income. Also, in Ethiopia as elsewhere in LDCs, consumption is likely to be measured more accurately than income. While consumption per capita is the most commonly used measure of welfare, some analysts use consumption per adult equivalent, in order to capture differences in need by age, and economies of scale in consumption. This study adopted adult equivalent scales to compare consumption expenditures between irrigating and non-irrigating households in the study area.

3.3.2. Poverty line Determination

The minimum food poverty line is determined using the minimum level of kilocalorie consumption, which is 2,200 kilo calories per adult per day, taking into account the typical food diet of poorest half of the sample households in the study area. Accordingly, the estimated food poverty line provides the minimum food requirement which is calculated from the surveyed data available and was found to be Birr 4268.36 per adult per annum shown in Table 9. The food poverty line obtained has to be translated and incorporate the expenditure required to attain basic non-food needs.

The total poverty line was obtained after adjusting for non-food expenditure using the average food share of the poorest half of the sampled pastoral households. The food share of the half of the poorest households was 81.94 percent. Dividing the food poverty line of Birr 4268.36 by 0.8194 gives a total poverty line of Birr 5209.13 per adult per year.

3.3.3. Poverty Indices

Based on the poverty line, the poverty indices were calculated applying the FGT measures; the three most common indices, namely: the incidence of poverty (head count ratio (FGT^0)), the poverty gap (FGT^1) and poverty severity index (FGT^2), and found out to be 0.6111, 0.2163 and 0.0879 for poverty head count index, poverty gap index and poverty severity index respectively. The poverty absolute head count index indicated that 61.11% of the sample households are deemed poor. poverty depth (Poverty Gap Index) of 0.2163 which means that if resources are mobilized equal to 21.63% of the poverty line (Birr 1126.48) from non-poor individuals and transferred to the poor is the amount needed to bring each individual up to the poverty line, then at least in principle, poverty could be eliminated. Likewise, poverty severity index of 0.0879 shows that 8.79% of Sampled Households fall below the threshold line implies severe inequality among the poorest households of the sample. Thus, it can be inferred that there is a high degree of inequality among the poorest population. This index indicated the percentage of the population which was unable to meet the minimum amount of consumption expenditure required (i.e., Birr **5209.13** per adult equivalent per year) to meet the minimum calorie for healthy life (2200kcalorie)

Table 9: Food consumption of the poorest half of the sampled households and value of food poverty line

Food items	Mean Kcal /Kg/lt	Gram/ml consumed/ day/AE	Kcal/ day/AE	Kcal/ day/AE needed	Mean price/ Kg/lt (Birr)	Price per Kcal(Br)	Value of food poverty line /yr (Birr)	Expenditure Share %
Sorghum	3805	9	342.45	661.81	12	0.0032	761.53	17.84
Maize	3751	6.56	246.07	475.36	12	0.0032	555.07	13.00
Rice	3923	2.3	90.23	174.36	23	0.0059	373.01	8.74
Wheat	3623	3.92	142.02	274.36	12	0.0033	331.69	7.77
Milk	737	3.2	23.58	45.56	25	0.0339	564.09	13.22
Meat	1148	0.75	8.61	16.63	60	0.0523	317.30	7.43
Tea	1190	0.36	4.28	8.28	35	0.0294	88.34	2.08
Oil	8964	0.85	76.19	147.19	50	0.0056	299.68	7.02
Sugar	3850	4.96	190.96	368.90	25	0.0065	874.35	20.48
Salt	1780	0.81	14.42	27.85	18	0.0101	102.81	2.41
Total				2200			4268.36	100

Source: Computed from field survey data, 2020.

3.3.4. Poverty level comparison between irrigation users and non-users

Based on the poverty indices comparison, the study was found that 25% irrigation users live below the poverty line, while for the corresponding group 36% fall under the poverty line. Moreover the poverty depth and poverty severity were found 8.4% and 3.3% for of the irrigation users and 13.2% and 5.5% for non-users. This means that poverty is much worse for non-irrigation users than irrigation users, hence using irrigation. These findings might appear due to the high income generated from the irrigating farming by the irrigation users than their counterpart.

Table 10: Poverty status between the irrigation users and non-users in the study area

Index	Poverty Status			
	Treated	Percentage	Control	Percentage
Poverty Incidence [P_0]	0.25	25%	0.361	36.1%
Poverty Depth [P_1]	0.084	8.4%	0.132	13.2%
Poverty Severity [P_2]	0.033	3.3%	0.055	5.5%

Source: Computed from field survey data, 2020.

4. Conclusions

Access to irrigation increases the opportunity for crop intensity and diversification, which increase cropping income and reduce poverty. Even if irrigation practice has various benefits, there are various factors that influence on the use of irrigation. This study identifies key factors that influence use of irrigation in the study area. This insight is also useful to rethink about the barriers of use of irrigation. The result of the Logit regression model revealed that out of 13 variables included in the model, eight explanatory variables were found to be significant determinants of participation of irrigation. Farming experience, membership to cooperative were found to have strong positive association with irrigation participation of the household and significant at less than 1% probability levels. Meanwhile, age of the household head, family size, water availability and off-farm income were found out to have positive relationship with the irrigation participation of the household at less than 5% probability levels. Access to credit and livestock holding size of the household head were found to have positive relationship at less than 10% significance level.

From the poverty analysis based on expenditure per adult equivalent, the poverty line of the sampled households was found 5209.13 ETB, poverty incidence, poverty gap and poverty severity also were found 0.61, 0.22, 0.0879, respectively. Non irrigating households were below the poverty line in many numbers (36%) while the corresponding number is less (25%). Similarly, the depth and severity of poverty were significantly higher for the non-irrigation users than irrigation users. Households' poverty depth and poverty severity were found 8.4% and 3.3% for of the irrigation users and 13.2% and 5.5% for non-users. These results suggest that access to irrigation has a deep impact on reducing rural poverty. Besides from the positive contributions of the irrigation usage, the study has revealed some problems that affect the performance of small-scale irrigation. Following results, the main challenges identified include lack of water distribution, water conveyance, and lack of coordination, crop disease and lack of storage.

The irrigation system was poorly managed in terms of water distribution and conveyance systems, conflict management and communication between irrigators and WUAs (water users association's) committee. This is due to lack of enough irrigation management and maintenance skills of irrigators.

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