Adoption and Impact of Micro Irrigation on Households Income: The case of Bambasi Woreda

Tsegazeab Gebremariam Yihdego
Assosa University

Abstract

Micro irrigation is one of the most useful irrigation systems designed to increase production and productivity; and reduces risk, related with rainfall variability and increases income of rural farm households too. Not surprisingly, planners, researchers, development practitioners, and donors emphasize the importance of micro irrigation in their policy recommendations and actual measures. So, this study examines the adoption and impact of micro irrigation on farm households' income in Bambasi Woreda. The main objective of this paper is to investigate the factors that determine the adoption and impact of micro irrigation on the income of rural households. This paper is used a cross-sectional household level survey data. Multistage sampling was employed to select the four kebeles from Bambasi woreda. The information is obtained from a total sample of 383 randomly selected households. Of these total sample households, 169 households are micro irrigation users, and 214 households are none users. Secondary data were collected from different sources. The data collected were analyzed through logit model and propensity score matching. As the result of the logit model reveals that gender, age, education, family size, non-farm participation, access to irrigation water, extension service, frequency of DAs(Department of Agriculture), total livestock unit, and market distance in kilometers are statistically significant and economically meaningful variables which significantly affect the probability of adoption of micro-irrigation of the households. Similarly, the estimates of the propensity score matching exhibits that gender, age, education, family size of the household heads, non-farm participation, social participation land size in hectare, access to irrigation water, extension service, frequency of DAs contact, total livestock unit and market distance in kilometer are the statistically significant variables which significantly affects income of micro-irrigation. Furthermore, the nearest neighbor, radius, kernel and stratification matching methods show a statistically significant result with bootstrapped standard errors and the average treatment effect for treatments of the radius and kernel matching is 14,431.78 birr where as the ATT of the nearest neighbor and stratification matching is 14,451.68 birr and 14,392.00 birr respectively as compared to the control groups. The result of ATT shows a significant income difference.

Keywords: Micro irrigation income, probit, propensity score matching, ATT, Bambasi woreda.

1. Introduction

Not surprisingly, Ethiopia is endowed with natural resources, especially in agriculture, which sustained its inhabitants for thousands of years without receiving any technological support from outside (Habtemariam, 2007).
Agriculture is the backbone of the Ethiopian economy. It contributes about 50 % of the GDP, 85% of the employment opportunity, 90% of the export earnings and 70% of the supply of industrial raw materials (World Bank, 2010). Eventhough, it showed a slight decline over the years, yet it has remained very high, at approximately 44% (Ftsum et al., 2009). As a result of the heavy reliance on rain fed agriculture, under conditions of very variable rainfall and recurrent droughts, affects agriculture and, hence, has adverse effects on the economy of Ethiopia.

In fact, as the World Bank (2006), estimated that hydrological variability currently costs the economy over one third of its growth potential, and has led to a 25% increase in poverty rates. Consequently, enhancing public and private investment in irrigation development has been identified as one of the core strategies to enable sustainable growth and development (World Bank 2006, MoFED, 2006). As government policy documents exhibit that, recently irrigation development has already been identified as a source of sustainable economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction (MoWR, 2002; MoFED, 2006).

Irrigation served as one key driver behind growth in agricultural productivity, increasing household income and alleviation of rural poverty, which highlights the various ways that irrigation could have an impact on poverty. Hence, according to Lipton et al., (2004) cited in by Haile (2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty. These are (i) increasing production and income, and reduction of food prices, that helps very poor households to meet their basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle.

Indeed, ensuring food security stands out as the most pressing agenda for Ethiopia now, and for the coming decades. Since, most settlement areas are degraded, per capita land availability is dwindled, productivity of land and labour are reduced, and agricultural production is also affected by variability of rainfall and drought (Sleshi et al, 2007). As a result, low farm production, widespread poverty, and poor health remain to be endemic problems in Ethiopia (Pendon, 2007). All these situations expose the country to exacerbate the problem of poverty. On the other hand, irrigation and water management practice could provide opportunities to cope with the problem of rainfall variability, enhance productivity per unit of land, and increase the volume of annual production significantly. Specifically, micro irrigation development benefits the poor households by promoting the production of high value crops, generation of farm and off farm income opportunities, and plays critical role in achieving household food security (Cornic et. al, 2003 cited in Azemer, 2006 and Mangisoni, 2008).

Due to the high rainfall dependency of the agricultural production, drought is becoming frequent and many people have been repeatedly exposed to hunger and famine. Based on this, to alleviate the deep rooted food insecurity at household level, the Ethiopian government is practicing different drought proofing strategies. Among these strategies the introduction of different water harvesting schemes for the farmers to be able to produce enough for the whole year round is one. Hence, starting the last decade, both government and non-government organizations in Ethiopia have been initiating and implementing micro irrigation projects. Because, irrigation contributes to livelihood improvement through increased income, food security, and employment opportunity, social needs fulfillment and poverty reduction. It increases in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health as a result of balanced diet and easy access and utilization for medication, soil and ecology degradation prevention, and asset ownership are contributions of irrigation (Asayehegn, 2012). Similarly, irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor.

Accordingly, Bambasi woreda has constructed different small-scale irrigation schemes with the objective of increasing agricultural productivity to improve the food security situation of the farming communities and to reduce dependency on the erratic rainfall. As to the knowledge of the researcher no study has been conducted in the study area. Therefore, this paper emphasises on the factors that affect the adoption of decision and impact of micro irrigation on farm households' income.

Here, an important aspect of the promotion of small-scale irrigation has been to boost farmers' involvement in the planning, implementation, operation and management of irrigation systems. Thus, the participation of farmers as direct beneficiaries in the construction of the schemes and their responsibility in the operation and management could considerably reduce development and management costs and improve performance. For instance, a study conducted on the socio-economic impact of ten smallholders' irrigation schemes in Zimbabwe, proposed that projects that are planned with farmer participation perform better than that are planned by experts on their own (FAO, 2000).

As the empirical study conducted by Berhanu and Pender (2002) in Tigray Region, Ethiopia, exhibits that the impacts of irrigation development on input use and the productivity of farming practices controlling all other factors were insignificant. They revealed that, irrigation has limited impact on the use of fertilizer and improved seed leading to less gain productivity from irrigation.

Based on the study done by Ali and Pernia (2003) in Australia, depicted that a dollar worth of output generated in irrigated agriculture generates more than five dollars worth of value to the regional economy, which suggested irrigation development has a strong multiplier effect on other sectors of the economy.

Furthermore, another study done by Lire (2005) in eight publicly managed micro dams and 29 surrounding villages in Tigray, confirmed that agricultural yield and farm profit have significantly increased in villages with closer proximity to the dams than in those further away from the water resource. Then, based on the study the overall evidence proposes that, carefully designed irrigation dams could significantly improve agricultural production and the overall food security.

Therefore, a study done by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions. The result indicated that, the cash generated from selling vegetables and other produce is commonly used to buy food to cover the household food demand during the food deficit months. Additionally, as the same study further proposed that during an interview conducted with some farmers, it was disclosed that the hungry months reduced from 6 to 2 months particularly July and August due to the use of small scale irrigation. Likewise, the increase in diversity of crops across the schemes and the shift from cereal livestock system to cereal-vegetable-livestock system is starting to improve the diversity of household nutrition through making vegetables part of the daily diet.

2. Methodology of the Study

2.1 Description of the Study Area

This study emphasized on Benishangul-Gumuz Regional State particularly Bambasi woreda. According to the national census of 2007 done by Central Statistics Agency of Ethiopia, the total population of Bambasi woreda reported is 48,488. The total number of households living in the woreda is 11, 286. This leads to an average of 4.3 individuals to a household, and with 11,013 housing units and the households per housing unit account for 1.025.

Bambasi woreda is attributed by kola-agro-ecological zone and is relatively high temperature. Like other rural areas, in Bambasi woreda of the dwellers the primary source of the population livelihood depends on the practice of mixed agricultural farming system especially practice of micro-irrigation.

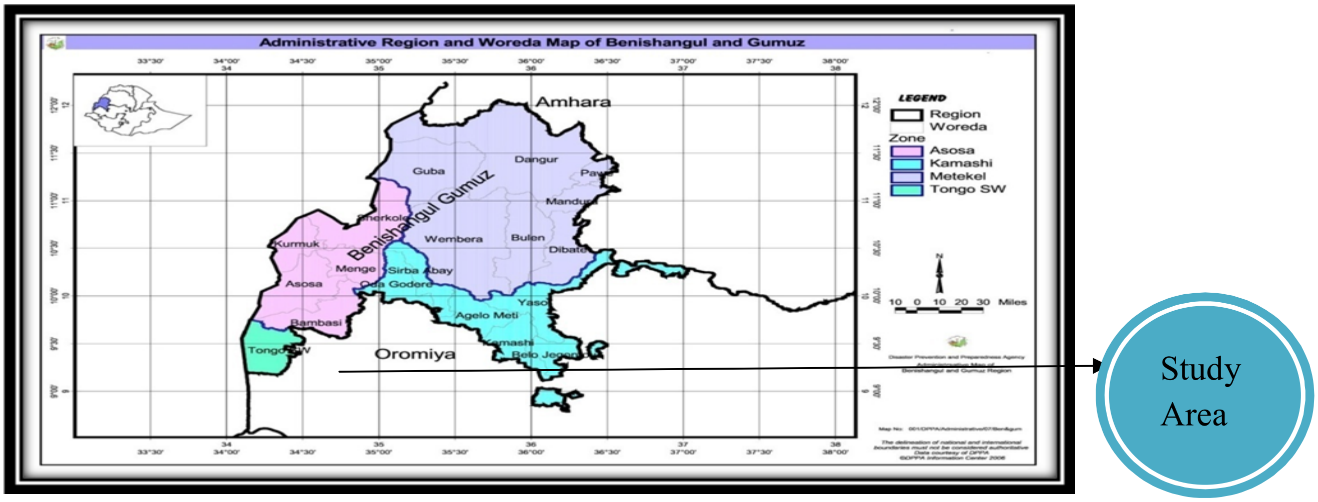


Figure 2.1: Map of the Study Area
Source: http://www.encyclopedia.com/Benishangul-Gumuz

2. 2 Source of Data Collection

As part of the study, both primary and secondary sources of data were employed. The primary source of data was collected by conducting a household level survey of data set using structured questionnaire, interview and focus group discussion for both the qualitative and the quantitative data types. Whereas, the secondary data was collected from Bureau of Agriculture, Woreda Office of Agriculture, Tabia Administration Offices and from published and unpublished related documents to enrich the primary data sources.

2.3 Sampling technique and sampling size

As part of the study, a multistage sampling technique was used to determine the sampling of households. Principally, Bambasi Woreda is selected purposively due to the extensive practice of the potential irrigation and various agricultural crops irrigated. Indeed, Bambasi woreda consists of 11,286 households and 38 kebeles. Furthermore, out of the 38 kebeles four kebeles were selected again using purposive sampling technique based on their irrigation access and utilization. The households of the four kebeles were also selected using simple random sampling technique. In order to minimize the sampling error, each household was stratified in to irrigation user and non-user in order to give them equal chance of the households' participation to be selected. Coincided with this the lists of total households in the four selected kebeles and the lists of irrigation user households in these kebeles were obtained from the District Office of Finance and Economic Development and District Office of Irrigation Development respectively. In addition, the non-users were selected within kebeles of irrigation users to ensure homogeneity of factors including proximity to irrigation access. Finally, the sample households from each stratum were selected using systematic random sampling technique. From a total sample of 383 rural households, 169 households from micro-irrigation users and 214 from micro- irrigation non-users and households have been drawn by taking in to account the proportional probability to size the identified households in each of the four selected kebeles. And the selected kebeles of the woreda are Dabus, Amba 16, Mender 46, and Mender 48.

2.4 Method of Data Analysis

To analyze the data both descriptive statistics and econometrics model were employed.

2.4.1 Descriptive Statistics

After the data has been collected, edited, coded and labeled, the descriptive statistics was employed to summarize the demographic and socioeconomic behavior of household characteristics using mean, standard deviation, and table and pie charts.

2.4.2. Econometric Model Specification

2.4.2.1. Theoretical Model Specification

2.4.2.1.1. Random Utility Model

The theoretical model of participating households in micro-irrigation is based on utility derive. Therefore, rural households with higher utility derived from practicing of irrigation would prefer to engage in small scale irrigation.

$$Ui = Xi\beta + \varepsilon i \qquad (1)$$

Where, Ui shows the utility derived from participation in micro-irrigation, Xi represents all the explanatory variables which affect the probability of participation in micro-irrigation, εi reveals the disturbance term which is unobservable for the researcher but observable for the farm household with zero mean and constant variance (δ^2).

2.4.2.2. Empirical models

This paper consists of two models for the participation equation and the outcome equation. As such, the participation equation was regressed using probit model since the dependent variable is a discrete variable; that is if the household participates (Yi = 1, otherwise = 0). This model is preferable than OLS, because the estimation using OLS results with biased parameter estimates in case of the binary response dependent variable. The probit model is used to estimate the result of participation due to its effectiveness in determining the unobservable dependent variables given the explanatory variables. But, the Logit model is also recommended for such study due to their indifference in model selection. However, the researchers' chosen the probit model in order to show the normal distribution behaviour of the data.

I. Participation equation using: Probit Model

$$z_i^* = \sum_{k=1}^{k} \gamma_k w_{ki} + u_i \qquad (2)$$

Where, Z^*_i reveals the participation decision which has dichotomous realization on un observed Z_i (Z_i = 1, if participate in irrigation, otherwise = 0), γ_k = unknown parameters of the k variables w_{ki} explanatory variables determining the probability of participation in irrigation utilization and u_i is the disturbance term with zero mean and constant variance.

II. Propensity Score Matching Model Specification

The Propensity Score Matching (PSM) is applied based on two assumptions: first the Conditional Independence Assumption (CIA) that is the key assumption made in PSM that selection into a program can be captured with observable data that are available to the evaluator. (Y0, Y1) ⊥T | X, where Y0 shows the outcome of the control groups, Y1 shows the outcome of the treated group, T shows the participation into the program, and X shows the set of pre-treatment explanatory variables.

Thus, based on Rosenbaum and Rubin (1983) using their assertion that 'treatment assignment is strongly ignorable', displayed that, for non-randomized observations, outcome and treatment are conditionally independent, given the propensity score, P(x), (Y0, Y1) ⊥ T|P(x). That is a balancing condition needs to be satisfied for propensity score matching. T ⊥ X | P(x).

Secondly, the common support or overlap condition: 0 < P (Ti = 1|Xi) < 1. According to Heckman et al., (1998) suggestion this assumption ensures that the treatment observations have comparison observations "nearby" in the propensity score distribution. Thus, in order to estimate the real impact of the irrigation participation on households' income propensity score matching is employed since OLS could not control the selection bias of the treatment and this model had this merit.

Denoting participation in micro irrigation adoption by T_i, (where T_i = 1 indicates treated, and T_i = 0 indicates none treated), Average Treated on the Treated (ATT) for the population can be computed as:

$$ATT = E(Y_{1i} - Y_{0i} \mid T_i = 1) \quad (4)$$

This is similar with;

$$ATT = [E(Y_{1i} \mid T_i = 1) - E(Y_{0i} \mid T_i = 1)] \quad (5)$$

Thus, the sample equivalence is given by:

$$ATT = {}^{1}/_{n} \sum_{i=1}^{n} (Y_{1i} - Y_{0i} \mid T_i = 1) \quad (6)$$

This is the same as;

$$ATT = {}^{1}/_{n} \sum_{i=1}^{n} [(Y_{1i} \mid T_i = 1) - (Y_{0i} \mid T_i = 1)] \quad (7)$$

Where; $(Y_{1i} \mid T_i = 1)$ indicates the amount of income from micro irrigation intervention. $(Y_{0i} \mid T_i = 1)$ indicates what would have been the amount of income without participation in micro irrigation.

For the consistency and robustness of the results, the study has applied four methods of matching. These are Nearest Neighbor matching, Radius Matching, Kernel Matching, and the Stratification or Interval Matching.

3. RESULTS AND DISCUSSION

3.1 Descriptive statistics

Table 3.1: Summary statistics of the household characteristics (continuous variables)

Variable	User = 169		Non-User = 214		t-test
	Mean	Std.err	Mean	Std.err	
Age	40.8	.579	35.67	.439	-3.82***
family size	5.3	.183	2.3	.14	-3.93***
Freq. ad	4.43	.091	2.9	.0917	-11.2***
Tlu	6.2	.0729	3.7	.2112	-18.8***
Mkt distance	1.4	.323	11.65	.35	8.8***
Hh income	21612.4	381.65	7270.6	215	-28.7***
Labour avail	2.218	.056	2.05	.05	-2.4**
Land holding size	4.112	.089	3.12	.08	-8.34***

Source: Own Survey, 2015

Note: **significant at 5%, ***significant at 1 percent probability level of significance.

As one can see from the above result, statistically the average age, family size, frequency of DAs contact, total livestock unit, market distance, household irrigation income, active labour availability, and land size in hectare shows a significance difference of the micro-irrigation user and non-user. Therefore, as depicted in Table 3.1 above, the average age of the household heads in the study area is 40.8 years among the users and 35.7 years old among the non-user. On aggregate the average age of the user and non-user of micro-irrigation shows a statistically significant difference. It implies the users are too matured as compared to the non-users. And the average family size is 5.3 per household. This result shows a variation with the national family size of 4.7 in rural areas and it implies high family size but it helps the users to divide their tasks of irrigation and save their time.

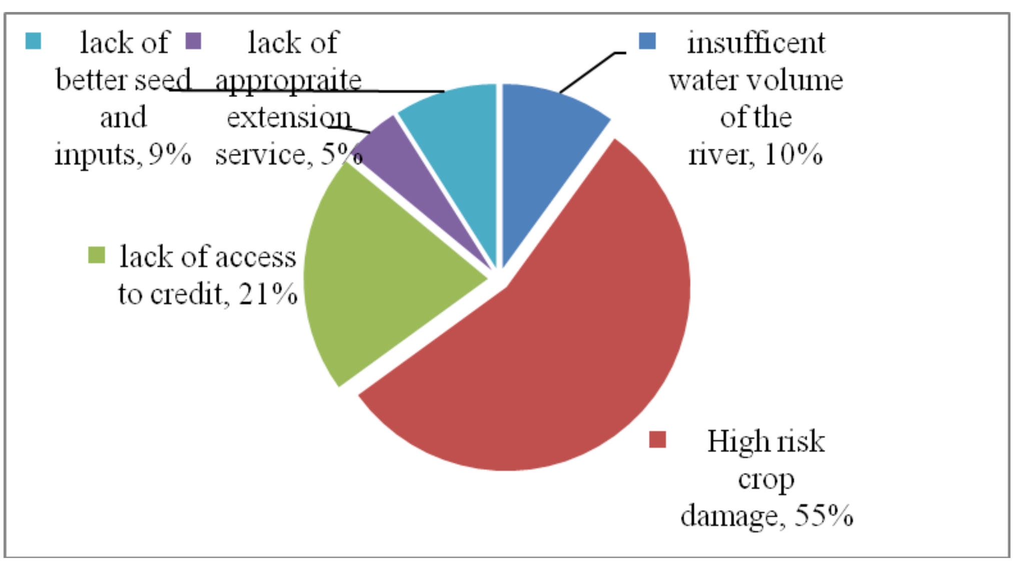
Table 3.2 summary statistics of household characteristics (dummy variables) of access to irrigation

Variables		User =169	Non-user = 214	p-value
		Percent	Percent	
Gender	Female	19.62	80.38	0.000***
	Male	65.96	34.04	
illiteracy	Illiterate	13	87	0.000***
	Literate	46	54	
Nonfarm part	No	39	61	0.207
	Yes	42	58	
access credit	No	33.33	66.7	0.303
	Yes	58.56	41.44	
social part	No	2.13	97.9	0.000***
	Yes	54.1	45.93	
use fertilizer	No	19.6	80.4	0.000***
	Yes	65.3	34.7	
irrigation water	No	1.3	98.7	0.000***
	Yes	76	24	
extension service	No	11.4	88.6	0.000***
	Yes	67.8	32.2	

Source: Own Survey, 2015

Note: ***significant at 1% probability level of significance

Based on the above result, gender of the household head exhibits a significant difference of the micro-irrigation user and non-user group at 1 percent probability level of significance. And the availability of irrigation water also shows a significant difference of the user and non-user of micro-irrigation. Households with social position and extension service are more likely to participate in micro-irrigation.



Source: Own Survey, 2015

Figure 3.1 Problems encountered in Micro-irrigation scheme

Base on the above figure, the rural households face high risk of crop damage that account for 55 percent, lack of access to credit for around 21 percent and also insufficient water volume of the river for around 10 percent. So, majority of the rural households face high risk crop damage.

3.2 Econometric results

Table 3.3: Marginal effect Estimation of probit model of the participation equation

Variable	coefficient	Std. Err.	P>|z|
Gender	-.76	.32	0.002***
Age	.0140	.0058	0.02**
Education	.59	.0183	0.04**
Family size	.063	.026	0.018**
active labor	.0716	.0493	0.15
nonfarm part	.27	.12	0.033**
social part	.11	.072	0.10
Access irrigation water	.66	.1349	0.000***
Extension service	.29	.1220	0.019**
Frequda	.133	.079	0.073*
Tlu	.021	. 2305	0.050**
distance irrigation	-.029	.014	0.015**
Acces-creditt	-.042	.07401	0.637

Number of obs 383 LR chi2 (13) 316.33
Prob > chi2 0.0000 Pseudo R2 0.5705
Log likelihood -117.56

Source: Own Survey, 2015

Note: *, **, *** statistically significant at 10%, 5% and 1% probability level of significance. Robust standard error

As the result of the probit model indicates that, gender, age, education, family size of the household head, non-farm participation, access to irrigation water, extension service, frequency of DAs contact, total livestock unit and distance to irrigation water are statistically significant and economically meaning full results.

Here, the coefficients of gender, family size, access to irrigation water and distance to water irrigation are exciting. Since, female headed households are 76 percent of marginal effect less likely to participate in micro-irrigation; other things remain constant, as compared to their counterparts of male. The probable reason is due to cultural biases where female-headed households have limited resource access and males have more exposure to other social and economic activities and the above results coincide with this effect. And age of the household head is positively correlated with the probability of micro-irrigation participation. As age of the household head increases by one year the probability of micro-irrigation participation increases by 1.4 percent of marginal effect, other things remain constant at their mean value. It implies that young households have the energy and the effort to engage in micro-irrigation.

Similarly, education of the household head and family size are positively correlated with the probability of micro-irrigation adoption. As the year of schooling increases by one year the probability of micro-irrigation participation increases by 59 percent of marginal effect, other things remain constant at their mean value. Probably education serves as information to powerfully adopt new technologies, and diversify their livelihood sources of income. As the family size increases by one member the probability of participation in micro-irrigation increases by 6.3 percent of marginal effect, other things remain constant at their mean value. That is, households with more family size are more likely specializing off-farm participation and engage in various tasks as compared to households with less family size.

Households with access to irrigation water are 66 percent more likely to participate in micro-irrigation than their counter parts. This result is consistent with the theory. Besides, extension service of the household head was hypothesized to have a significant and positive relationship with the probability of micro-irrigation adoption and the result of the finding shows that extension service is significant and positively correlated with the probability of participation in micro irrigation practices. It implies that, households who get more extension service are more likely to participate in micro irrigation than households with no extension service of their counterparts. This result is consistent with the study done by Sikhulumile et al., (2014) confirmed that, farmers experience on extension service and access to updated information leads the probability of adopting new technology, because they can use the resources wisely with proper management of input for better production and productivity of high value crops. As the distance in kilometer of the access to micro-irrigation increases the probability of micro-irrigation adoption decreases by 2.9 percent, other things remain constant at their mean value. That is, households with very far distance are less likely to adopt micro-irrigation too.

3.2.1 Average Treatment Effect of the Treated

Based on Baker (2000), while we evaluate a treatment the major econometric problem we face is selection bias (Maddala, 1983). In the same manner, the author found that micro irrigation always aims the poor, but those who are reasonably without irrigation they are more probably to be poor. Hence, the expectation in theory is that households without treatment of micro irrigation would have had lower income as a result the sample selection bias occurs due to the self-election mechanism. Similarly, Bacha et al., (2011), proposed that the welfare variety between the treated as well as the control group would not be attributed to irrigation access as long as the selection bias exists. As Heckman (1979), proposed that estimation of the impact of irrigation on welfare of the treated and control group using the OLS model becomes biased and inconsistent estimation. Therefore, using the non-parametric matching estimation method to estimate the impact of micro irrigation on the household income would be proved whether using of micro irrigation have a significant difference between the treated and control group.

Table 3.4: ATT estimation of micro irrigation of the treated and control group

Matching type	No. Treated	No. Control	ATT	Std.Err	t-value
Nearest neighbor	**169**	**156**	**14451.68**	**393.213**	**36.75*****
Radius	**169**	**214**	**14431.78**	**346.770**	**41.62*****
Kernel	**169**	**214**	**14431.78**	**315.933**	**45.68*****
Stratification	**169**	**166**	**14392.00**	**358.213**	**40.18 *****

Source: own survey, 2015

Note: ***, significant at 1% probability level of significance. Bootstrapped standard errors

As the result depicted that, all the matching algorithm methods are statistically significant at 1 percent of probability level of significance. Therefore, the nearest neighbor, radius, kernel and stratification matching methods shows a statistically significant result with bootstrapped standard errors, and the average treatment effect for treated of the radius and kernel matching is 14,431.78 Birr where as the ATT of the nearest neighbor and stratification matching is 14,451.68 Birr and 14,392.00 Birr respectively as compared to the control groups. So, the result of ATT shows a significant income difference of the treated and control group.

Table 3.5: The Actual Average Income Difference of the Treated

Variable	Obs	Mean	Std. Dev
Irrigation-income	117	1870.707	1736.86

Source: own Survey, 2015

As the result of the above indicates that, the average income difference of the treated with the control group shows an 1870.71 Birr difference with a standard deviation of 1736.86 Birr. This average difference of income is the ratio of the actual irrigation income to the family size of the household head. Therefore, households with micro-irrigation are better in their welfare.

4. Conclusion and Recommendations

4.1 Conclusion

As part of the study , primary and secondary data sources were utilized to collect data and 383 sample households were used with 169 micro-irrigation users and 214 non-users selected using simple random sampling after multiple process has been employed.

As the descriptive statistics result shows that, the average age, family size, frequency of DAs contact, total livestock unit, market distance, household irrigation income, active labour availability, and land size in hectare shows a significance difference of the micro-irrigation user and non-user. The average age of the user and non-user of micro-irrigation shows a statistically significant difference. Similarly, households with larger number of family size are more likely to participate in micro-irrigation.

Above and beyond, gender of the household head exhibits a significant difference of the micro-irrigation user and non-user group. Households with social position and extension service are more likely to participate in micro-irrigation.

The probit model estimation reflects that, gender, age, education, family size of the household head, non-farm participation, access to irrigation water, extension service, frequency of DAs contact, total livestock unit, and distance to irrigation water are statistically significant and economically meaning full results. The coefficients of gender, family size, access to irrigation water and distance to water irrigation are exciting. Female headed households are less likely to participate in micro-irrigation adoption as compared to their counter parts of male headed households.

Education affects positively with the probability of micro-irrigation adoption. And also households with more family size are more likely to adopt micro-irrigation. Besides, households who get more extension service are more likely to adopt micro irrigation than households with no extension service of their counterparts.

As the result of ATT estimation revealed that the nearest neighbor, radius, kernel and stratification matching methods are statistically significant results with bootstrapped standard errors and the average treatment effect for treated of the radius and kernel matching is 14,431.78 Birr where as the ATT of the nearest neighbor and stratification matching is 14,451.68 Birr and 14,392.00 Birr respectively as compared to the control groups. So, the result of ATT shows a significant income difference of the treated and control group. Therefore, households with micro-irrigation are better in their welfare.

4.2 Recommendations

Based on the result analyzed, the following policy implication becomes as follows:

- It is necessary to promote the micro-irrigation to small and medium scale irrigation. Therefore, it is required to expand the capacity of micro irrigation and creating additional access through integrated water investment which is crucial to increase irrigation income and hence leading to improved household's welfare.
- The planners or the local administrators should substitute the traditional system of irrigation (flood irrigation) with modern and efficient type of irrigation methods.
- The local administrators should work with the family planning of the rural dwellers.
- Infrastructures facilities like road, farmer training centers and access to credit systems in the rural areas should be in place with a minimum interest for purchase of inputs and low cost technologies.
- The concerned body should emphasized on capacity building like training, experience of visit to model sites and field days are also required to scale the technologies.
- Further research and development and practice should continue to investigate the overall impact of such programs.

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