The Impact of Small Scale Irrigation on Household Income in Bambasi Woreda, Benishangul-Gumuz Region, Ethiopia

Mr. Tsegazeab Gebremariam Yihdego[*], Dr. Surajit Ghosal[**]

[*]Faculty of Business and Economics, Department of Economics, Assosa University.
[**] Faculty of Business and Economics, Department of Economics, Assosa University.

Abstract- Small scale irrigation is one of the most useful irrigation systems designed to increase production and productivity and reduces risk related with rainfall variability and increasing income of rural farm households indeed. In fact, planners, researchers, development practitioners, and donors emphasized the importance of small sale irrigation in their policy recommendations and actual measures. So, the main objective of this paper is to investigate the impact of small scale irrigation on the income of rural households in Bambasi Woreda. This paper used a cross-sectional household level survey data and multistage sampling was employed to select the four kebeles from Bambasi woreda and the information obtained from a total sample of 363 randomly selected households of these total sample households 117 households are treated group whereas, 246 households are control group. Secondary data were also collected from different sources. As part of the study, the data collected were analyzed through propensity score matching. Besides, the estimates of the propensity score matching of the probit model exhibits that gender, the linear and non-linear age, education, plot size, social position participation, extension service, access to credit and total livestock unit are the statistically significant variables which significantly affects the income of small scale irrigation. And the region of common support is found between 0.0017 and 0.999. Furthermore, the nearest neighbor, radius, kernel and stratification matching methods of the outcome variable income shows a statistically significant result with bootstrapped standard errors and the Average treatment effect for treated of the radius, kernel and nearest neighbor matching is 2166.83 birr where as the ATT of the stratification matching is 1917.55 birr per as compared to the control groups. Thus, the result of ATT shows a significant income difference. And the ratio of the average income per family size of the household head per year is 1870.71 birr.

Index Terms- Small Scale irrigation income, Probit, Propensity Score Matching, ATT, Bambasi woreda.

I. INTRODUCTION

By large agriculture contributes substantially to the economic growth of many low-income countries like Ethiopia with the potential of irrigation. So, it is often the leading sector of the economy as source of income, employment and foreign exchange. Moreover, more than half of the less developed countries population gets their food from own-production. And agricultural output also is used as an input for industries so it can stimulate the growth of industrialization. Similarly, increasing the agricultural productivity thus contributes to income growth (UNDP, 2007).

Sub-Saharan African (SSA) countries, especially Ethiopia, is predominantly an agrarian country with the vast majority of its population directly or indirectly engaged in agriculture where around 95% of the country's agricultural output is produced by small holder farmers (MoARD, 2010). Thus, it is the backbone of Ethiopian economy; it contributes about 50 % of the GDP, 85% of the employment, 90% of the export earnings and 70% of the supply of industrial raw materials (World Bank, 2010).

Even though, the country is endowed with three main resources namely land, water and labor for agricultural production, the sector in the country is mostly small- scale, rainfall dependent, traditional and subsistence farming with limited access to technology and institutional support services. Thus, the ability of the nation to address food and nutritional insecurity, poverty, and to stimulate and sustain national economic growth and development is extremely dependent on the performance of agriculture. Nonetheless, achieving higher and sustained agricultural productivity growth remains one of the greatest challenges facing the nation (Spielman et al., 2010). Basically, rainfall is erratic and unevenly distributed between seasons and agro ecological regions lead to poor yields, low productivity, food insecurity and poverty within the farming population, accordingly it emphasizing the need for irrigation in the country.

Small-scale irrigation is irrigation that usually practiced on small plots where small farmers have the majority controlling influence, using a level of technologies which they can operate and maintain effectively. Hence, Small-scale irrigation is, therefore, farmer-managed that is farmers involved in the design process and, in specific, with decisions about boundaries, the layout of the canals, and the position of outlets and bridges. As a result, the preference for small-scale schemes is based on the perceived easy adaptability of the systems to local environmental and socioeconomic conditions (Vaishnav, 1994).

Consequently at this time, the government is trying to transform from traditional and manual, rain-fed, supply driven and production oriented agriculture to technology intensive and mechanized, irrigated, market oriented agriculture, through full packages of value addition and postharvest technologies. Indeed, the objective of the growth and transformation encompasses i) achieving a sustainable increase in agricultural productivity and production; ii) accelerating agricultural commercialization and

agro-industrial development; iii) reducing degradation and improving productivity of natural resources; and iv) achieving universal food security and protecting vulnerable households from natural disasters (MoARD, 2010).

On aggregate the agriculture sector remains our Achilles heel and source of vulnerability for various shocks as a result of the high dependency on the seasonal rainfall. However, we remain convinced that agricultural based development remains the only source of hope for Ethiopia (Devereux et al., 2005)

Therefore, due to the visible merit of irrigation currently the government is giving a high emphasis on the expansion of small scale irrigation as a best viable option for achieving food security for the sake of improving yields in both rain-fed and irrigated agriculture and cropping intensity especially in irrigated areas security (IWMI, 2005).

Since, irrigation contributes to the overall livelihood improvement through increased income, food security, employment opportunity, social needs fulfillment and poverty reduction. It Increase 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 due to balanced diet and easy access and utilization for medication, soil and ecology degradation prevention and asset ownership are contributions of irrigation (Asayehegn, 2012).

Coincided with the irrigation investments leads to production and supply shifts, indirect linkages operate through regional and national level and have a strong positive effect on the national economy. Therefore, as the study conducted from Gambia proposed that irrigation provided smallholder farmers the chance for increasing income that was reflected on increased expenditure, investment in productive and household assets, saving and trade (Webb, 1991).

At large agricultural production in Ethiopia is primarily rainfed in which it mainly depends on erratic and often insufficient rainfall. Consequently, there are frequent failures of agricultural production. And irrigation has the potential to stabilize the agricultural production and minimize the negative impacts of the variability and insufficient rainfall. Thus, irrigation development also can help offset some of the negative effects of the rapid population growth (2.6 percent per year in Ethiopia; CSA 2007). Which in turn has a negative effect of the population growth on agricultural activities expands into marginal land, which leads to forest, land and water degradation that affects the food security and poverty status.

So, as per the knowledge of the researchers Benishangul-Gumuz Regional State have a potential of irrigation development but the actual coverage of irrigation on the region is at its infancy. However, some areas of the region especially Bambasi Woreda is highly irrigated land. Therefore, the purpose of this paper is to investigate the impact of small scale irrigation on the households' income.

II. Related Literature Review

Historically the practice of irrigation accounted for many years especially in Far East it accounted for 5000 years and in Egypt for around 4000 years (Peter, 1997). As FAO (1997) indicated that, 30-40 percent of the world food production comes from an estimated 260 million hectare of irrigated land or one–sixth of the world's farmlands. Thus, irrigated farms produce higher yield for most cereal crops and vegetables.

As Asayehegn et al., (2012) indicated that irrigation intensifies input especially labor throughout the year. And it motivates to self employment and decreases leisure time of active labors. This proposes off-farm income inspires to withdraw active labor force from irrigation activities and placing to off farm income driving activities reduces irrigation participation of farm households. Furthermore, farm households that have access to market information are able to compare, the net income from rain-fed and irrigation farming. Similarly, it assists purchasing of the right input at the right time from the right enterprise and supplying of the products to the right customer with a reasonable intermediary cost. Nevertheless, the gender difference of household heads in irrigation participation indicated female-headed households face shortage of labor and market information, made them rent/share out their land. In addition, networking of rural farm households with their customers through information sources such as mobile and telephone service is a determinant factor.

The Impact of Irrigation on Household Livelihoods

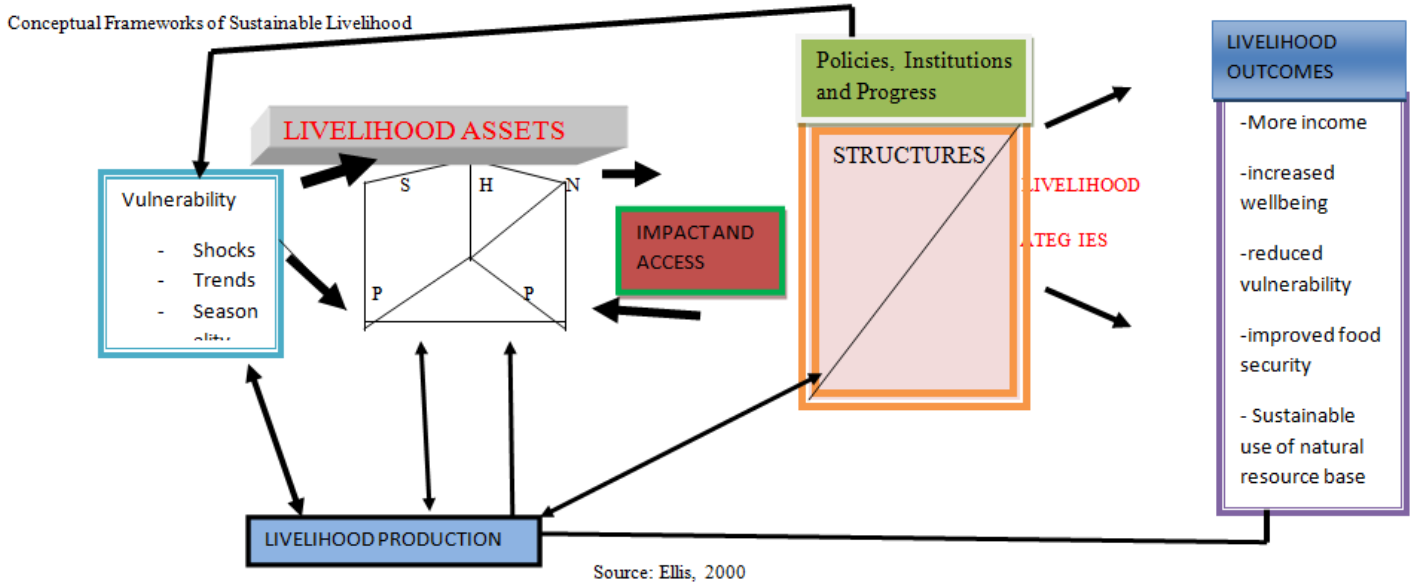
As various scholars like Burrow (1987) confirmed that, small holder irrigated agriculture had proven to be a viable and attractive alternative for poor farmers especially in developing countries. In addition, he asserted that returns from intensive irrigated agriculture even on tiny plots could greatly exceed returns from rain fed cereal production. As a result, in many developing countries such as Ethiopia, small scale irrigation schemes were counted on to increase production, reduce unpredictable rainfall and provide food security and employment to poor farmers. Hence, the same sentiments were echoed by Gor Cornist (1999) when he asserted that some of the small scale irrigation projects have been discovered primarily for income generating like the peri-urban areas in Benishangul-Gumuz and Vegetable growing in Bambasi woreda. Overall, irrigation farming is the source of income for the disadvantaged rural people that are mostly women, widows, and orphans. Similarly, some empirical results shows that irrigation farming enables the growing of green vegetables, wheat, tomatoes, cotton, maize and even sugar-cane among others.

In similar fashion, World Bank (2008) reported that more than 70% of the poor people in the world live in areas relying mostly on agricultural activities and sometimes mining and finishing for survival. Besides, as Makumbe (1996) proposed that, about half of the family heads in the informal sectors are employed as peasant farmers. And also population is ever increasing thus land set aside for irrigation farming has been excessively subdivided rendering most units sub-economic irrigation schemes. This author also postulates that, land is deteriorating very rapidly in Benishangul-Gumuz especially Bambasi woreda and in most cases farmers do not have access to or buying power to purchase certified seeds and fertilizers.

And irrigation farming contributes significantly for household especially in terms of income in rural areas. Due to most of the rural household are unemployed, most families' income levels are relatively low and possibly not enough to acquire their basic commodities and services. Therefore, the household in Bambasi Woreda confessed that their project

enables members to earn an income which enables them to meet some of their basic needs, (Makumbe, 1996). Since, the cash earned from the sale of food is used to cover household needs like cooking oil, paraffin and others. And it also enables members to meet their educational needs of their children such as exercise books and tuition fees and clothing fees as well as forage of animals. Thus, the data from previous time periods also revealed that irrigation farming has long term economic contribution on rural livelihoods.

Based on the study of Kundlande et al., (1994), food production from irrigated farms is a major source of wealth creation to the extent that it is the basis for economic growth in a number of localities. And the income generated provide funds for purchase of irrigation development to make up an important and growing proportion of the products used before by processing firms. Generally, irrigation agriculture is an essential component of any strategy to increase global food supply. As a result, the benefits of irrigation have resulted in lower food prices, higher employment and a more rapid agricultural and economic development. With regard to this, the spread of irrigation has been a key factor behind the rear tripling of global grain production since the 1950s. Furthermore, small scale irrigation schemes play an important role in augmenting government policy of reducing rural to urban migration.



III. Methodology of the Study

3.1 Source of Data collection

For this study both primary and secondary data sources has been employed to collect the qualitative as well as the quantitative data type. In using the primary data the conventional household survey was the key method employed to collect the quantitative information via a well designed structured scheduled questionnaire and interview which was prepared for the study. Information pertaining to households' demographic, socio-economic characteristics and institutional situations were obtained directly through the interview and sample household heads were the unit of analysis. Whereas, Focus group discussion, key informant interview and direct personal observation were also used to collect the qualitative primary data. Indeed, to enrich the primary data the secondary data source was also collected from the published and unpublished documents of the Weredas administration office and agricultural Bureau of Benishangul-Gumuz Region.

3.2 Sampling techniques and sample size

A multistage sampling technique was used to determine the sampling of households. First, Bambasi woreda is selected purposively because of the extensive practice of agriculture especially irrigation and it is the place where various agricultural crops irrigated. And Bambasi woreda consists of 11,286 households and 38 kebeles. Furthermore, three kebeles was also selected using purposive sampling technique based on their irrigation access and utilization and the households of the three kebeles was also selected using simple random sampling technique in order to give an equal chance of the households' participation to be selected and to minimize the sampling error too. Finally, the selection of the households was based on probability proportional sampling. Furthermore, to determine the sample size of this study Yamane's (1967) formula was utilized as:

$$n = \frac{N}{1 + N(e)^2}$$

Where, n is the required sample size; N is the total number of Bambasi woreda households; e is the level of precision at 95% degree of confidence. Specifically, in the four selected rural Kebeles, the total number of the households are 4030 (that is, Dabus =1800, Keshmando = 1250, Mender 46 = 980). Thus, the actual sample size determined is

$$n = \frac{4030}{1 + 4030(0.05)^2} = 363$$

The then, to determine each kebeles sample size using probability proportional sampling technique, is computed as follows

Table 3.1: Proportional Sample Size Determination

Kebeles	*Household no*	*How to compute*	*Sample size*
Dabus	1800	1800*363/4030	≈ 162
keshmando	1250	1250*383/4030	≈113
Mender 46	980	980*363/4030	≈88
Total	4,030	1800*363/4030 + 1250*383/4030 + 980*363/4030	**363**

Source: own computation, 2015

3.3 Methods of data Analysis

After the necessary data was collected from the farm household small scale irrigation users to analyze the data both descriptive statistics and econometrics model has been employed. And 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.

3.3.1 Econometric Model Specification

3.3.1.1 Theoretical Model Specification

3.3.11.1Random Utility Model

The theoretical bench mark of participating in small scale irrigation is on the basis of utility derived. Therefore, rural households with higher utility derived from practicing of irrigation would prefer to engage in small scale irrigation.

$$Ui = Xi\beta + \varepsilon i \quad \text{.....(1)}$$

Where, Ui shows the utility derived from participation in small scale irrigation, Xi represents all the explanatory variables which affects the probability of participation in small scale 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).

3.3.1.2 Empirical Model Specification

This paper consists of two models for the participation equation and the outcome equation. Therefore, 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. Rather, 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 too in the model.

I. Participation equation using: Probit Model

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

.....(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.

3.3.1.2.1 Propensity Score Matching Model Specification

The PSM is applied based on two assumptions: first the Conditional Independence Assumption (CIA) that is the key assumption made in PSM is 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., (1999) 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 non treated), Average Treated on the Treated (ATT) for the population can be computed as:

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

This is similar with;

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

Thus, the sample equivalence is given by:

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

This is the same as;

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

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.

IV. Results and Discussion

1.1 Descriptive Statistics

Irrigation Income earning Distribution of the Study Area

As the Figure below depicts that, the income earning of Dabus kebele is 42 percent from engagement of small scale irrigation. And Keshmando also obtain for around 40.97 percent of income from small scale irrigation. Indeed, the sample kebeles are highly engaged in small scale irrigation and earn higher amount of income from their practice of irrigation.

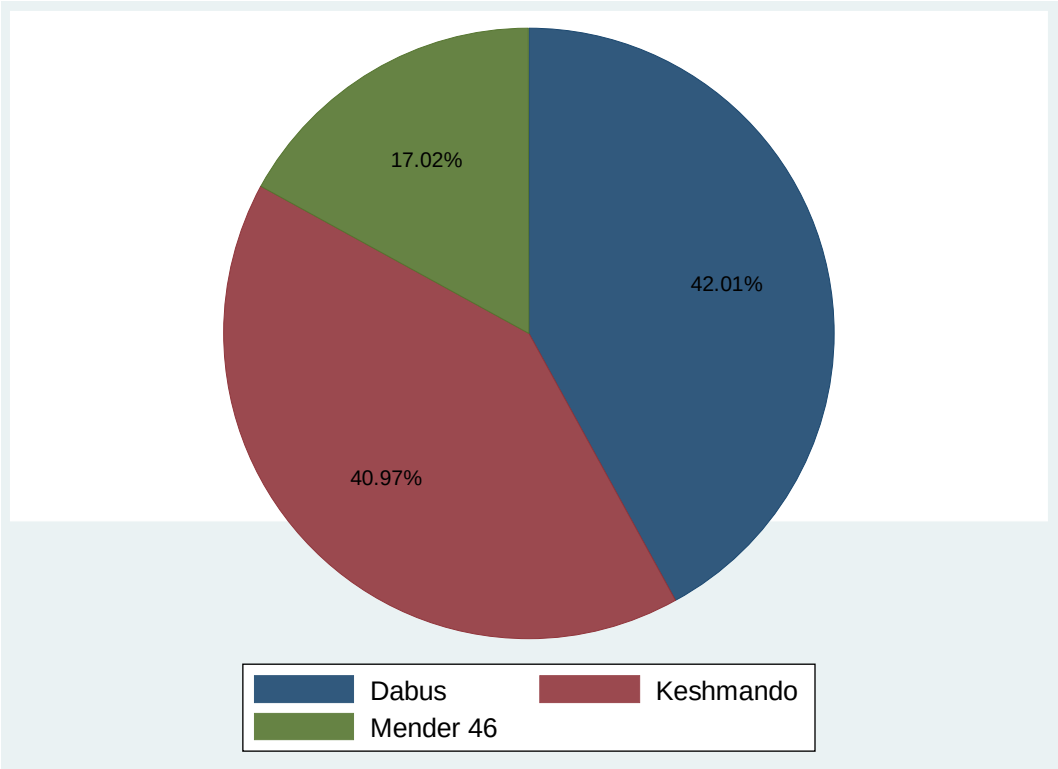


Fig 4.1: Income generating of kebeles from small scale irrigation

Econometrics Model results

As one can see from the Table below, sex of the household head, the linear and the non-linear age, education, plot size, total livestock unit, extension service and access to credit are statistically significant and economically meaning full results, that affects the probability of small scale irrigation participation.

With regard to the sex of the household head male headed households are 46.46 percent less likely to participate in small scale irrigation participation. The probable reason is that, male headed households prefer to shift from irrigation participation to other income generating activities like trade and daily labourer as well as governmental employees as compared to female headed households. Similarly, the linear age of the household is positively correlated with the probability of participation in irrigation. Therefore, age of the household head exhibits a hill shaped relationship with the probability of participation in irrigation. This result is consistent with the theory of the life cycle hypothesis. Since irrigation requires high energy and effort. Besides, the increase in one years of schooling increases the probability of participation in small scale irrigation by 19.71 percent of marginal effect, other variables remain constant at their mean value. Because, education enables the farm households to engage in small scale irrigation due to the benefit they derive from irrigation participation too.

On the other hand, access to extension service is the surprising result in which it negatively correlates with the probability participation in small scale irrigation. The probable reason is that, households with more extension service are less likely to participate in irrigation rather they shift to diversified agricultural crops during the rainy season because of the sufficient extension service by agricultural experts.

Table 4.1: Marginal Effect Estimation of the probit maximum Likelihood of Parameters

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
hhsex1*	-.4645779	.11025	-4.21	0.000	-.680668	-.248488	.81
age1	.0823115	.03881	2.12	0.034	.006249	.158374	46.8633
age_sq	-.0007318	.00039	-1.90	0.058	-.001489	.000025	2287.87
educ_hh	.197103	.04036	4.88	0.000	.117999	.276207	1.08333
family~e	-.0535991	.03658	-1.47	0.143	-.125291	.018093	5.37333
labora~l	-.0216898	.04465	-0.49	0.627	-.109208	.065828	2.10333
plotsize	1.188168	.2241	5.30	0.000	.748943	1.62739	.569167
offarm~n*	.0693748	.08733	0.79	0.427	-.101787	.240536	.726667
TLU	.0236817	.01029	2.30	0.021	.003515	.043848	6.3573
mktdis~e	.0080283	.00682	1.18	0.239	-.005342	.021399	10.3117
extens~e*	-.2384913	.08124	-2.94	0.003	-.397722	-.07926	.52
accesc~t*	.1199435	.06477	1.85	0.064	-.006996	.246883	.523333
social~t*	-.1720782	.08345	-2.06	0.039	-.335631	-.008526	.69

Source: Own Survey, 2015

4.1 Impact Evaluation

As one can see from the below Table, all the results of the matching estimation techniques are statistically significant at 1 percent probability level of significance. Hence, the ATT result reveals that households practicing small scale irrigation are significantly different in their welfare based on income indicator. Furthermore, the ATT estimation result of the Nearest Neighbour, Kernel and Radius matching type of the treated group shows a 2,166.83 Birr difference with their counterfactual whereas, the ATT Stratification matching algorithm of the treated reveals 1917.55 Birr difference with the control group. Therefore, the empirical investigation of the impact evaluation of the main objective is proved due to the overall significance of the matching algorithms and the alternative hypothesis decision is accepted.

Table 4.2: Average Treatment Effect of the treated (ATT) estimation result of the impact of Irrigation on Households Income: with Bootstrapped standard errors

Matching Algorithms Type	***Treated***	***Control***	***ATT***	***Std. Err.***	t-value
Nearest Neighbour	117	246	2166.83	156.00	13.86***
Kernel	117	246	2166.83	149.01	14.54***
Stratification	85	212	1917.55	196.29	9.77***
Radius	117	246	2166.83	153.37	14.13***

Source: Own Survey, 2015
Note: *** statistically significant at 1 percent probability of significance.

As the result of the below indicates that, the average income difference of the treated with the control group shows a 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.

Table 4.3: The Actual Average Income Difference

Variable	Obs	Mean	Std. Dev
Irrigation_income	117	1870.707	1736.86

Source: own Survey, 2015

V. Conclusion

The study was based on a cross-sectional household survey data collected using primary and secondary data sources. And samples of 363 households were randomly selected after long process of using multistage sampling technique.

As the empirical result of the probit model of the propensity score matching indicates that sex of the household head, the linear and the non-linear age, education, plot size, total livestock unit, extension service and access to credit are statistically significant and economically meaning full variables, that affects the probability of small scale irrigation participation. Indeed, male headed households with higher extension service shift from irrigation participation to other income generating activities like trade and daily labourer as well as governmental employees as compared to female headed households.

And age of the household head exhibits a hill shaped relationship with the probability of participation in small scale irrigation. And also education enables the farm households to engage in small scale irrigation due to the benefit they derive from irrigation participation too.

Besides, as the four matching estimators revealed that all are statistically significant at 1 percent probability level of significance and the impact is confirmed between the treated and control group. Furthermore, the ATT estimation result of the Nearest Neighbour, Kernel and Radius matching type of the treated group shows a 2,166.83 Birr difference with their counterfactual whereas, the ATT Stratification matching

algorithm of the treated reveals 1917.55 Birr difference with the control group.

Finally, the average income difference of the treated with the control group shows a 1870.71 Birr difference with a standard deviation of 1736.86 birr. This result shows the ratio of the average income per family size of the household head per year.

REFERENCES

[1] Asayehegn, K.,(2012). Negative impact of small-scale irrigation schemes: A case study of Central Tigray regional state, Ethiopia. Agricultural Research and Reviews Vol. 1(3), pp. 80 – 85.

[2] CSA (Central Statistics Agency) (2007). Summery and statistical report of 2007 population and housing census of Ethiopia: Population size by age and sex [internet][cited 2012 Dec 29]. Available from: http://www.csa.gov.et.

[3] FAO (Food and Agricultural Organization) (1997). Irrigation technology transfer in support of food security proceeding of a sub regional workshop, Harare, Zimbabwe, 14-17 April, water report 14.

[4] IWMI (International Water Management Institute) (2005). Experiences and opportunities for promoting small-scale micro irrigation and rain water harvesting for food security in Ethiopia, Working paper 98. IWMI: Addis Ababa.

[5] MoARD (Ministry of Agriculture and Rural Development) (2010). Ethiopia's Agriculture Sector Policy and Investment Framework: Ten-year Road Map (2010-2020).

[6] Peter, S., (1997). Small scale irrigation. Intermediate technology publication Ltd., Irrigation information center, Nottingham. 27p.

[7] Spielman D., Byerlee D., Avid J., Alemu D., Kelemework D., (2010).Policies to promote cereal intensification in Ethiopia: The search for appropriate public and private roles, Food Policy, 35: 185-194.

[8] UNDP, (2007). Globalization, Agriculture and the Least Developed Countries [Internet]. Issues Paper, Istanbul. 9-11 July 2007. Available from: http://www.unohrlls.org.

[9] Vaishnav T., (1994). Increasing Food Production in Sub-Saharan Africa through Farmer Managed Small-Scale Irrigation Development Ambo 23: 524-64.

[10] World Bank, (2010). Ethiopian Agricultural Growth Project. Project appraisal document. Addis Ababa: Ethiopia.

AUTHORS

First Author – Tsegazeab Gebremariam, MSc, Head of Department, Lecturer, Assosa University, tsegazeabgebremariam@gmail.com.
Second Author – Surajit Ghosal, MA. MPhil, PhD, Assosa University, drghosals@gmail.com.

Corresponding Author - Surajit Ghosal, PhD, drghosals@gmail.com, cell phone: +251919307883.