Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.7, No.21, 2016

Assessing the Impact of Small-Scale Irrigation Schemes on Household Income in Bahir Dar Zuria Woreda, Ethiopia

Ayana Anteneh Astatike
Department of Economics, College of Business and Economics, Wolaita Sodo University, Wolaita Sodo, Ethiopia

Abstract
This study presents an empirical analysis of the impact of access to irrigation on household income level in Bahir Dar Zuria Woreda, Ethiopia. The impact of irrigation access on household income was estimated by using Hackman two step model. The results of the second stage of Hackman two step model indicated that participation in irrigation has a significant impact on annual income of the households. Moreover, the study identified the factors that affect households to participate in irrigation and household's income level. The probit model indicated that owning irrigation land, having pumping motor and dissatisfaction with the existing irrigation schemes are key factors that influence irrigation participation. And irrigation participation, land size and livestock holding are the main factors that affect household's income level. Therefore, it is really important to pay some serious attention to mitigate the problems prevailed in the existing irrigation schemes and to expand the potential area under irrigation so as to bring higher and more stable income of the society.
Keywords: impact, irrigation access, Hackman two step model, Bahir Dar Zuria Woreda, Ethiopia

1. Introduction

Ethiopia has abundant water resources, including 12 river basins and 22 natural and artificial lakes. Annual surface runoff is estimated to be about 124.6 billion m³ of water (MoWR, 2002). Given the amount of water available, even while passing through the semi-arid, arid, and desert areas, it is evident that irrigation can provide an opportunity to improve the productivity of land and labor and increase production volumes (Awulachew et al, *2007*).

Although Ethiopia has abundant water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation (Awulachew et al, 2010). The study findings of Hagos et al. (2009) show that, in Ethiopia, the contribution of irrigation to agricultural and total national GDP was about 5.7 and 2.5 percent, respectively, during the 2005/06 cropping season. By the year 2009/2010, they estimated that the contribution of irrigation to agricultural GDP and the total GDP is estimated to be approximately 9 and 3.7%, respectively.

Irrigated agriculture is a vehicle for the provision of basic needs and the reduction of vulnerability to food insecurity (IPTRID, 1999). Irrigation has positive consequences on food security, asset ownership and income of households. It has a powerful factor in increasing crop productivity, enhancing food security, expanding opportunities for higher and more stable incomes and employment and for increasing prospects for multiple cropping and crop diversification. The expanded production has greatly improved incomes and welfare of households, and benefited the overall population by providing more food at reduced prices and by creating on/off/non-farm employment (Hussain and Wijerathna, 2004), (Asayehegn, 2012), (Ayele et al, 2011) and (Awulachew et al, *2007*).

Although various studies suggests that irrigation has an important influence on income and rural poverty alleviation, little scientific knowledge exists on the magnitude of the impacts of irrigation on household income in the study area in particular and in Ethiopia in general. According to Loiskandl et al understanding the impacts of past interventions and investments in irrigation is significantly contribute to the planning of new investments and the design of interventions for enhancing production of irrigation farming. Specifically, the findings of the investigated such kinds of case studies are relevance for an improved planning and managing of irrigation and water resources. Consequently, this study aims to contribute to filling this gap.

Therefore, the central aim of this study is to assess the impacts of selected small-scale irrigation schemes on household income in Bahir Dar Zuria Woreda, Ethiopia. Since Ethiopia is undertaken several irrigation development projects in the face of financial scarcity, the findings of this study are expected to provide timely input as an initiation for evaluating the impact of various irrigation schemes.

2. Research Methodology

2.1. The Study Area

The study was conducted in Bahir Dar Zuria Woreda by selecting three irrigation schemes namely Chilal Abay, Negida and Upper Andasa which covers Sebatamit, Yigoma Huletu and Bete Mariam Kebeles. The study area is located to the South of Bahir Dar via Tis Abay –Bahir Dar gravel road and it is about 10-18 km far from Bahir Dar, the capital city of Amhara Regional state of Ethiopia (ADSWE, 2012).

Bahir Dar Zuria Woreda is located in Amhara region in West Gojjam Zone. Its territory is facing Lake Tana and embracing Bahir Dar City. It covers an area of about 165,222 ha, shared into 44 kebeles. The population of the woreda mainly living on small scale farming activities. On average farmer's land is 1.5 ha. Bahir Dar Zuria has mainly Weina dega agro-climatic conditions, with altitudes that range from 1,345 to 2,355 m above sea level, and 70% of the territory with plain features (MoA, 2015).

2.2. Data type and source

The data source for this study was obtained from primary sources. It was collected from a sample of three kebeles (Sebatamit, Yigoma Huletu and Bete Mariam) by using structural questionnaire.

2.3. Sample size and Sampling technique

The study used a multi-stage sampling procedures to select the representative respondents from the study area. In the first stage, from Bahir Dar Zuria Woreda, three Kebeles were purposively selected because of availability of irrigation water from Chilal Abay, Negida and/or Upper andasa irrigation schemes. In the second stage, household heads in the selected kebeles were stratified in to irrigation participants and non-participants.

For this study, irrigation participants are those household heads who use irrigation water from the selected schemes for at least one full year. While the non-participants were those households with no irrigation water access from the schemes in same kebeles. Finally, by applying proportional probability to the size of identified groups, 80 respondents from irrigation participants and 40 of them from non- participant group were selected randomly through simple random sampling technique, and a total of 120 household heads were interviewed in march 2015 based on the 2014/15 cropping year.

2.4. Methods of Data Analysis

Both descriptive statistics and econometric model are employed to analyze the data obtained in the survey. Descriptive statistics such as t-values and chi square are used to examine the difference between irrigation users and non-users. Heckman two step (treatment effect) model was used to assess the impact of irrigation access on household income. The first stage probit model serves as to generate the inverse mills ratio and to identify factors that affect irrigation participation and the second stage is involved in estimating outcome equation.

2.5. Model specification

Evaluating the effect of a program (e.g. an irrigation schemes) on an outcome variable (e.g. income and/or poverty reduction) using regression analysis can lead to biased estimates if the underlying process which governs selection into the program is not incorporated in the empirical framework. This is because due to certain unobservable characteristics, the effect of irrigation schemes may be over (under) estimated if program participants are more (less) able to derive these benefits compared to eligible nonparticipants (Zaman, 2001).

In econometric analysis, one common approach to this problem is the use of Heckman's (1976) two-step procedure. This approach involves estimation of a probit model for participation equation, followed by the insertion of a correction factor—the inverse Mills ratio, calculated from the probit model—into the second OLS model of interest (Bushway et al., 2007). If the coefficient of the inverse Mills ratio is significant then the hypothesis that the participation equation is governed by an unobservable selection process is confirmed. However, if its coefficient is insignificant, OLS estimates can safely be used for the model (Zaman, 2001).

Thus, irrigation participation equation (selection equation) can be specified as follows (Greene, 2003; Heckman, 1979 and Wooldridge, 2009):

$$Z_i = X_i\beta + \mu_i \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Where, Z_i is a latent (unobserved) dichotomous variable equal to 1 if the household head is participate in irrigation and 0 otherwise.

X_i is the socio-economic characteristics of the household that affect the probability of participation in irrigation.

β is coefficients of the explanatory variables.

μ_i is an error term.

The inverse mills ratio is calculated from the probit estimation result as follows:

$$\lambda_i(c) = \frac{\phi(c)}{1-\Phi(c)} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

Where, $C = \frac{X_i\beta}{\sigma}$

λ is the Inverse Mills ratio term

Φ is the density function of a standard normal variable and

Φ is the cumulative distribution function of a standard normal distribution

The second step is an ordinary least squares regression including the inverse Mills ratio as an additional regressor to the Income equation (outcome equation) which is specified as:

$$Y_i = \gamma_0 + \gamma_1 W_i + \gamma_2 Z_i + \gamma_3 \lambda_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where, Y_i is household income

W_i is socio-economics variables affecting households' income.

γ_i is coefficients of explanatory variables.

ε_i is an error term.

However, according to Bushway et al. (2007) and Wooldridge (2009) the inclusion of the inverse Mills ratio often results in multi-collinearity problem. The best solution to this problem is to incorporate exclusion restrictions. With a valid exclusion restriction, the inverse Mills ratio and the explanatory variables in the outcome equation will be less correlated, reducing multi-collinearity among predictors as well as the correlation between error terms. The probit equation must be influenced by at least one variable that is not a significant determinant of the second-stage outcome equation (Zaman, 2001 and Bushway et al., 2007). As a result, in this study the variable 'dissatisfaction with the existing irrigation schemes' is fulfilled this condition and thus used as an exclusion variable.

3. Results and Discussions

3.1. Descriptive statistics

In this section, data obtained in the survey is analyzed using t-test and chi-square statistics. Accordingly, the first part of this section presents whether the socioeconomic variables had a significance difference between irrigation participants and non-participants. The second part compares the level and source of income between the irrigation participants and non-participants.

3.1.1. Socioeconomic and Demographic Characteristics

There were some differences between irrigation user households and non-users regarding their socioeconomic and demographic characteristics. The results of descriptive statistics are presented in Tables 1 and 2. The t-test results, presented in Table 1, show that irrigators have significantly higher in mean of family size and number of oxen than that of non-irrigators. This may indicate the labor absorption capacity of irrigation. However, no significant differences were observed between the two groups in the total cultivated land, livestock owned, age and education level of the household.

Regarding to categorical variables, higher percentage of irrigators had irrigable land and pumping motors as compared to non-irrigators (Table 2). Households who owned irrigable land as well as pumping motor would be more likely to participate in irrigation than households who haven't.

In the study area, concrete canals is constructed from the diversion up to some distances especially in Chilal Abay irrigation schemes. After that water is flows with the side of the gravel road and the way that farmers directed. Due to absence of prober cannel, most of the farmers forced to use pumping motor to irrigate their land.

Moreover, the chi-square value shows that irrigation users were significantly higher percentage of male headed as compared to non-irrigation users. There was also a significant difference between users and non-users about dissatisfaction with the existing irrigation schemes.

Table 1: Descriptive Statistics for Continuous Variables

Variables	Description	Irrigation users (80)		Non-users (40)		Combined (120)		t-value
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Land size	Land holding in Timad (0.25 hectare)	4.68	2.47	4.54	2.51	4.63	2.48	0.29
Education level	Education level of the household head	1.04	1.98	0.7	1.91	0.93	1.95	0.89
Family size	Family size	5.71	1.91	5.02	1.64	5.48	1.85	1.95**
Age	Age of the household head	42.63	11.65	44.65	15.72	43.3	13.12	-0.8
Livestock owned	Number of Livestock owned by the household	3.39	2.2	2.85	2.02	3.21	2.18	1.28
Ox	Number of oxen	1.81	0.93	1.43	0.84	1.68	0.92	2.23**

Source: Author's survey, 2015

** shows significant at 5% probability level

Table 2: Descriptive Statistics for Discrete Variables

Variables	Categories	Irrigators (%) N= 80	Non-Irrigators (%) N= 40	Combined (%) N= 120	chi-square
Sex of the household head	1= male headed	98.75	85	94.17	9.19***
	0= female headed	1.25	15	5.83	
Off-farm activities	1= off-farm activities	12.5	22.5	15.83	2.00
	0= otherwise	87.5	77.5	84.17	
Credit access	1= access to credit	4.25	47.5	43.33	0.42
	0= otherwise	58.75	52.5	56.67	
Having pumping motor	1= having pumping motor	91.25	5	62.5	84.64***
	0= otherwise	8.75	95	37.5	
dissatisfaction with the existing irrigation	1= dissatisfied	87.5	97.5	90.83	3.2*
	0= otherwise	12.5	2.5	9.17	
Having irrigable land	1= yes	93.75	45	77.5	36.3***
	0= no	6.25	55	22.5	

Source: Author's survey, 2015
*** and * shows significant at 1% and 10% probability level

3.1.2. Comparison of the level and source of income

In the study area households' source of income was both agricultural and non-agricultural activities. According to the survey results, the main non-agricultural activities were trade, Carpenter, and Daily laborer on construction or other on/non-farm activities. In the study area, compared to non-irrigators, the irrigators have more income sources due to their involvement in irrigation utilization and this significantly increased their level of income. As Table 3 show that cash crops, vegetables, and fruits were growing only by those households who have access to irrigation water.

On the other hand, the mean income obtained from off-farm activities, poultry, honey, and woodlot were higher for non-irrigators compared to irrigating households, although no significant difference was observed. However, non-irrigators had/obtained significantly higher income from cereal crops (Maize, Teff, Dagusa and others) as compared to irrigators; that is, on average, cereal crops yield birr 8,318 and 10,928 to irrigating and non-irrigating households, respectively. It makes clear that non-irrigators obtained more income than irrigators from cereal crops. This difference may be due to the shift of resources (land, labor and others) to irrigation practices by those who have access to irrigation since irrigation yields higher return than rain-fed agriculture.

Table 3: Income and its Source for the selected respondents

Income gained from	Irrigators (80)		Non-Irrigators (40)		Combined (120)		t-value
	Mean	SD	Mean	SD	Mean	SD	
Cereal Crops	8318	5065	10928	4887	9188	5137	-2.7***
Sale of Livestock	2201	4070	1865	4676	2089	4265	0.4
Dairy output	5984	5808	4148	3279	5372	5165	1.9**
Poultry	1116	3214	1158	2140	1130	2891	-0.07
Honey	516	1971	605	1536	546	1831	-0.3
Woodlot[2]	1794	3449	2120	5345	1903	4157	-0.4
Fruit[4]	361	752	-	-	241	636	4.1***
Vegetable[1]	8184	12498	-	-	5456	10895	3.03***
Cash crop[3]	21087	14337	-	-	14058	15366	9.3***
Off-farm income	1120	3495	1650	4165	1297	3722	-0.7
Total income	**50681**	**24635**	**22474**	**9248**	**41278**	**24682**	**6.9*** **

Source: Author's survey, 2015
*** and ** shows significant at 1% and 5% probability level
[1](Tomato, Potato, Pepper, Onion, Cabbage), [2](eucalyptus tree, Gesho), [3](chat, sugarcane, coffee), [4](avocado, mango, papaya)

Overall, irrigators had far higher annual income compared to non-irrigators. That is, the mean annual income of irrigators and non-irrigators was about 50,681and 22,474 Birr, respectively, in the 2014/15 cropping year, revealing a statistically significant (at 1% level) difference. This significance difference more or less indicates the impact of access to irrigation on households' income in the study area. And such differences in income between households who have and haven't access to irrigation supports the argument of Awulachew et al, (2010), Haji et al. (2013) and Tesfay (2008). They argued that investment in irrigation serve as a strategy to ensure food security and for poverty alleviation.

3.2. Econometrics model results

In this study Hackman two stage model was used to examine the impact of irrigation access on household annual income. The first stage is estimation of the probit model for participation equation and the second stage is estimation of outcome equation-total income- using OLS in which inverse mills ratio is included as an explanatory variable. Consequently, the second stage estimation result indicated that the coefficient of the inverse mills ratio was not significant even at 10 percent level, suggesting an absence of serious selection bias in this study. According to Zaman (2001) this result is conformed that the participation equation is not governed by an unobservable selection process and, with the inclusion of the inverse mills ratio, the coefficients in the second stage outcome equation are unbiased. The result of these estimation are presented in table 4 & 5.

Out of the total twelve explanatory variables only 3 variables were found statistically significant factors that affect household heads' decision to participate in irrigation. Specifically, having irrigable land, owning pumping motor and dissatisfaction with the existing irrigation system were found to be significant.

Owning irrigable land and having pumping motor are both found to be statistically significant at 1% level. The effect of these variables on household's irrigation participation decision are positive. The marginal effect for probit model shows that, citrus paribus, households who have irrigable land would be about 47 percent more likely to participate in irrigation utilization than those who haven't.

The marginal effect also shows that household heads who have pumping motor would be about 86 percent more likely to engage in irrigation farming than those who have not. The rationale behind this result is that due to absence of proper cannel and other problems in the study area, farmers forced to use motor pump to irrigate their land.

The variable dissatisfaction in the existing irrigation schemes is found to be negative and significant at 10 percent level. Its negative sign shows that, households who are not satisfied by the existing irrigation schemes would be about 23 percent less likely to participate in irrigation. This may be due to the problems which is prevailed in the existing irrigation schemes. In the study area, irrigation schemes have severe problems such as insufficient water supply, and absence of proper channels which leads to high water wastage and distribution problems.

Table 4: probit model estimation result about households' irrigation participation

Variables	Coef. (Robust Std. Err.)	Z	Marginal effect		
			dy/dx	Z	Mean (X)
Land size	-0.084 (0.11)	-0.74	-0.02	-0.75	4.63
Education level	0.071 (0.09)	0.78	0.02	0.76	0.93
Family size	0.182 (0.16)	1.15	0.05	1.24	5.48
Age	-0.019 (0.01)	-1.33	-0.01	-1.39	43.3
Sex of the household head	0.889 (0.55)	1.62	0.31	1.52	0.94
Off-farm activities	0.158 (0.52)	0.30	0.04	0.32	0.16
Number of livestock	0.147 (0.09)	1.52	0.04	1.61	3.21
Number of Oxen	-0.200 (0.29)	-0.67	-0.06	-0.72	1.68
Access to credit	-0.568 (0.37)	-1.52	-0.16	-1.33	0.43
Having pumping motor	3.21 (0.52)	6.21***	0.86	15.01	0.63***
Dissatisfaction with the existing irrigation schemes	-1.578 (0.86)	-1.83*	-0.23	-2.81	0.91***
Owning irrigable land	1.404 (0.44)	3.21***	0.47	3.61	0.78***
Constant term	-1.41 (1.24)	-1.14			
Dependent variable = irrigation participation Number of observation = 120 Pseudo R2 = 0.7362 Wald chi2(12) = 87.16 Prob > chi2 = 0.0000					

Source: Author's survey, 2015
*** and * shows significant at 1% and 10% probability level

The second stage estimation result also show that three explanatory variables- irrigation participation, land size, and household's livestock holding- are significant factor which influence total income of the household. As expected, households' participation in irrigation had significant impact on households' annual income at 1 percent level. The outcome model result show that total annual income of the irrigators would be higher than that of non-irrigators by about 23,546 Birr, other thing remaining constant. This is because, in the study area, irrigation access enable households to grow cash crops (mainly chat and sugarcane), vegetables and fruits which increased income of the irrigator households. This result is consistent with the finding of Asayehegn (2012) and Gebrehiwot et al. (2015).

The coefficient of land size variable shows that as the household gets one more timad (0.25 hectare) of land would be increased annual income of the household by about 1,648 Birr. Households with more land implies better opportunities to produce more and generate more income since land is a prominent input in agricultural activities. This result is consistent with the findings of Gebrehiwot et al. (2015).

Household's livestock holding had also significant influence on household's income at 1 percent level. Other things remaining constant, having one more livestock would be increased income of the household by about 3,311 Birr. Farmers have been obtained income from sold livestock and its byproduct. This result is consistent with the finding of Belay and Beyene (2013).

Table 5: the outcome equation estimation result

Variables	Coef.	Std. Err.	T
Irrigation participation	23546.81	7731.13	3.05***
Land size	1648.24	952.33	1.73*
Education level	1353.17	940.64	1.44
Family size	866.81	1156.11	0.75
Age of the household head	-216.56	169.43	-1.28
Sex of the household head	3580.61	10225.42	0.35
Off-farm activities	-1138.39	5529.96	-0.21
Livestock	3311.27	1005.55	3.29***
Ox	1267.18	2463.76	0.51
Credit access	-1331.87	4080.45	-0.33
Pumping motor	14720.66	10147.68	1.45
Irrigable land	10021.83	7915.77	1.27
Inverse Mills Ratio	8212.99	5982.99	1.37
Constant	-18013.19	22899.59	-0.79
Dependent variable = Total Income	Number of observation = 120		
F(13, 106) = 7.08	Prob > F = 0.0000		
R-squared = 0.4648	Adj R-squared = 0.3991		
Root MSE = 19133			

Source: Author's survey, 2015

*** and * shows significant at 1% and 10% probability level

4. Conclusion and policy implications

The importance of small scale irrigation for improving farmers' income and reducing rural poverty has been emphasized in various literatures. The objective of this study was to examine the impact of selected irrigation schemes on households' annual income in Bahir Dar Zuria Woreda of Ethiopia.

The descriptive statistics, in this study, show that the irrigators have more income sources as compared to non-irrigators due to their involvement in irrigation utilization. In the study area irrigation access enable households to grow cash crops, vegetables and fruits. As a result, Irrigators had far higher annual income compared to non-irrigators. That is, the mean annual income of irrigators and non-irrigators was about Birr 50,681and 22,474, respectively, in the 2014/15 cropping year. This significance difference more or less indicates the impact of access to irrigation on households' income in the study area.

In this study to examine the impact of irrigation access on household annual income, Hackman two stage model was used. The outcome model result show that households' participation in irrigation had significant impact on households' annual income. Other thing remaining constant, total annual income of the irrigators would be higher than that of non-irrigators by about 23,546 Birr.

The study also identified the factors affecting households' irrigation participation and households' annual income. The probit model indicated that owning irrigation land, having pumping motor and dissatisfaction with the existing irrigation schemes are key factors that influence irrigation participation. And irrigation participation, land size and livestock are the main factors that affect households' income.

Generally, small scale irrigation schemes in the study area play a huge role to increase income of the society. Mean annual income of the irrigators were twice more than that of non-irrigators. Therefore, it is really important to pay some serious attention to mitigate the problems prevailed in the existing irrigation schemes and to expand the potential area under irrigation so as to bring a substantial contribution to the attainment of food self-sufficiency and to alleviate poverty.

References

Amhara Design & Supervision Works Enterprise (2012): Upper Andassa Irrigation Development Project Socio-economic Feasibility Study Report. Amhara Regional State Water Resource Development Bureau.

Asayehegn, K. (2012): Irrigation versus rain-fed agriculture: Driving for households' income disparity- A study from central Tigray, Ethiopia; *International Journal of Agricultural Sciences.* Vol. 2 (1), pp. 067- 074.

Awulachew, B.S., Erkossa, T. and Namara, R. E. (2010): Irrigation potential in Ethiopia; Constraints and opportunities for enhancing the system; *International water management institute*, Addis Ababa, Ethiopia.

Awulachew, B.S., Yilma, A. D., Loulseged, M., Loiskandl, W., Ayana, M. and Alamirew, T. (2007): Water Resources and Irrigation Development in Ethiopia, *International Water Management Institute*, Working Paper 123. Addis Ababa, Ethiopia.

Ayele, G.K., Nicholson, C.F., Collick, A.S., Tilahun, S.A. and Steenhuis, T.S. (2013): Impact of small-scale irrigation schemes on household income and the likelihood of poverty in the Lake Tana basin of Ethiopia. In: Wolde Mekuria. (ed). *Rainwater management for resilient livelihoods in Ethiopia: Proceedings of the Nile Basin Development Challenge science meeting, Addis Ababa, 9–10 July 2013.* NBDC Technical Report 5. Nairobi, Kenya: International Livestock Research Institute.

Belay, S. and Beyene, F. (2013): Small-scale irrigation and household income linkage: Evidence from Deder district, Ethiopia. *African Journal of Agricultural Research.* Vol. 8(34), pp. 4441-4451.

Bushway, S., Johnson, B. D. and Slocum, L. A. (2007): Is the Magic Still There? The Use of the Heckman; *J Quant Criminol* 23:pp.151–178.

Gebrehiwot, A., Adera, A. and Tilahun, M. (2015): The Impact of Small – Scale Irrigation on Income of Rural Farm Households: Evidence from Ahferom Woreda in Tigray, Ethiopia. *International Journal of Business and Economics Research*. Vol. 4(4), pp. 217-228.

Greene, W. H. (2003); Econometric Analysis. Fifth edition New York University Pearson Education, Inc., publishing at Prentice Hall.

Hagos, F., Makombe, G., Namara, R. E. and Awulachew, S. B. (2009): Importance of irrigated agriculture to the Ethiopian economy: Capturing the direct net benefits of irrigation. Colombo, Sri Lanka: International Water Management Institute. 37p. (IWMI Research Report 128).

Haji, J., Aman, M. and Hailu, T (2013): Impact Analysis of Mede Telila Small Scale Irrigation Scheme on House Poverty Alleviation: Case of Gorogutu District In Eastern Haratghe Oromia National Regional State Ethiopia. *International Journal of Development and Economic Sustainability*. Vol.1 (1), pp.15-30.

Heckman, J. (1979); Sample Selection Bias as a Specification Error. Econometrica, vol. 47 (1) 153-162.

Hussain, I. and Wijerathna, D. (2004); Irrigation and Income-Poverty Alleviation: A Comparative Analysis of Irrigation Systems in Developing Asia; *International Water Management Institute*. Colombo, Seri Lanka.

International Program for Technology and Research in Irrigation and Drainage, IPTRID (1999); Poverty reduction and irrigated agriculture. Issues Paper No. 1.

Loiskandl, W., Ruffeis, D., Schönerklee M., Spendlingwimmer R., Awulachew, S. B. and Boelee, E.: Case study review of investigated irrigation projects in Ethiopia; *International Water Management Institute*. IWMI, Addis Ababa, Ethiopia. http://publications.iwmi.org/pdf/H044102.pdf.

Ministry of Agriculture (2015): Developing Small Holders Horticulture in Ethiopia; The experience SupHort (Capacity building of agricultural services for Supporting Horticultural sector development in selected woredas).

Ministry of Water Resources (2002): Water Sector Development Program, Main Report Volume II.

Tesfay, H. (2008): Impact of Irrigation Development on Poverty Reduction in Northern Ethiopia. A PHD dissertation presented to the Department of Food Business and Development, National University of Ireland, Cork.

Wooldridge, J. (2009): Introductory to econometrics, modern approach, Michigan State University. 4th edition South-Western, a part of Cengage Learning.

Zaman, H. (2001): Assessing the Impact of Micro-credit on Poverty and Vulnerability in Bangladesh; A case study of BRAC; Office of the Chief Economist and Senior Vice-President (DECVP) The World Bank.