Effect Of Farm Irrigation On Rural Household's Income In West Wollega Zone: A Cross Sectional Approach From Kiremu Woreda

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Abstract: This study was conducted on effect of farm irrigation on rural households' income in Boke and burka Dhintu, and Habro woreda, West Hararghe zone, Ethiopia using cross sectional approach to investigated effect of farm irrigation on rural households' income in study area. Three stage sampling procedure was adopted for selection of sample respondents. Descriptive statistics and Heckman's two-stage estimation were used to evaluation. The analysis revealed out of the total thirteen explanatory variables, nine variables of which were continuous and the fives dummies, found to be significant like distance from household's farm to the nearest market center education level of household, distance from residence to water source, access to extension service, livestock in tropical livestock unit, access to information, availability of family labor force, access to credit, and gender of household head. Finally, descriptive and econometric results show, improving rural households to extension service and livestock sector, are recommended to enhance participation in small-scale irrigation thereby improve small rural farm household's total annual income.

Keywords: Irrigation, Income, Heckman model, West, Hararghe

1. Background of the Study

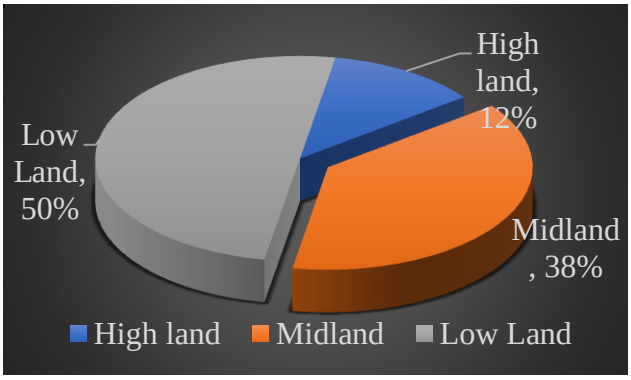
Agricultural sectors contribute economic growth of low-income countries. More than half of less developed countries population gets food from own-production. Agricultural output is used as input for industries to stimulate industrialization (UNDP,2007). Ethiopia, predominantly an agrarian country and majority of its population directly or indirectly involved in agriculture around 95% of country's agricultural output is produced by small holder farmers (MoARD, 2010). Hence it is backbone of Ethiopian economy; it contributes about 50 % of gross domestic product, 85% of employment, 90% of export earnings and 70 % raw materials. Increasing yields in rain-fed and irrigated agriculture cropping intensity in irrigated areas through various technologies are the most options for achieving food security. Increase in agricultural production diversification crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health and utilization for medication, soil ecology degradation prevention and contributions of irrigation (Asayehegn, 2012). Zhou et al., (2009) mentioned that irrigation contributes to agricultural production in two ways: increasing crop yields, and enabling farmers to increase cropping intensity and switch to high-value crops. Therefore, irrigation can be an indispensable technological intervention to increase household income. The Amhara region, with population of about 18 million, is most populous administrative region (CSA, 2007). Like other regions of Ethiopia, Amhara is largely dependent on agriculture with small holder cultivation of cereals, pulses, horticultural crops and oilseeds mainly characterized by subsistence farming mixed with livestock rearing. Some drought- prone areas of region are food insecure due to combination of factors such erratic and unreliable rainfall, degraded natural resource base, high population density and low productivity caused by poor agricultural management practices. In background, this study designed to analysis the effect of farm irrigation on rural households' income in Kiramu woreda.

2. Research Methodology

2.1. Description of the Study Area

West Hararghe zone is one of the 20 zones of Oromia Regional State, located at the Eastern part of the Ethiopia. The zone shares borders with Afar, Somali region, East Hararghe, Bale and Arsi, East Showa Zones. Population size of the zone is 2,110,611 of which 1,081,442 are male and 1,029,168 are females. Land size is estimated to be 17,300sq. kms with density of 126 persons per sq.km (CSA, 2007). The highest mountain in this zone is Arba Gugu (3574 meters). Agro-ecology of this zone consist; highland 12%, midland 38% and lowland 50% respectively.

Figure 1: Agro ecological zone of West Hararge



Source: West Hararghe Administrative office (WHAO), 2018

The livelihood structure of this zone consists of 55–65% crops (stable food, vegetable and fruit) production, 15–25 livestock production systems and the rest 10 – 20% consists of other non-farm and off-farm activities.

Sorghum, maize, haricot bean, teff, wheat and the most important staple food crops whereas, coffee and chat are the major cash crops widely grown in area. Furthermore, zone is endowed with bulk rural labor force having good practices on communal work and collaboration with development agencies operating at grassroots level. Studies show that about 95% of the population depends on agricultural livelihood and remaining 5% on agro-pastoral livelihood. The annual mean temperature varies from 19^0c to 24^0c.The July –September and April-Mid May are recently either missing or erratic or inadequately registered (WHAO, 2018). The zone has 15 rural woredas and two urban administrative towns 449 rural kebeles. This zone is classified into two based on agro ecological activities which are non-pastoral and pastoral. The researchers became interested to conduct this study on the status and determinants of rural household poverty in West Hararge zone, specifically selecting Boke and Habro from non-pastoralist areas, whereas Burqa Dhintu is selected from pastorals. The Central Statistical Agency (CSA, 2007), total of 395,127 households were counted in this zone, which results in an average of 4.74 persons to a household, and 380,019 housing units. The three largest ethnic groups reported were the Oromo (90.12%), Amhara (7.24%) and the Somali (1.26%); all other ethnic groups contains 1.38% of the population. The majority of inhabitants were Muslim, with 85.44% of the population having reported they practiced that belief, while 11.28% professed Ethiopian Orthodox Christianity. Three enumerators in sampled kebeles were employed to conduct the survey under supervision of researcher. The enumerators were development agents of the study. Development agents were chosen as enumerators due to their knowledge and acceptance among the community that helped researcher get questionnaire. Pre-testing of questionnaire was carried out with enumerators and depending on results, some adjustments have been made to final version of the questionnaire and proper data collection was started with the day-to-day supervision of the researcher. Focus group discussion, key informant interview and direct personal observation were also used to collect qualitative primary data. This study was depending on both primary and secondary data. Data from primary sources were collected through field survey and instruments using questionnaires and interviews household are in rural areas of selected woredas. To data collection, simple random sampling techniques was applied to get specific sample of populations respondents for structured questionnaires. Target population was to rural areas of selected woreda from West Hararge zone such Burqa Dhintu, Habro and Boke woreda. Since the population from which a sample is drawn does not constitute a homogeneous group due to their economic basis are different from each other's, stratified sampling techniques were applied to obtain a representative sample for homogenous group. Stratification techniques are process by which population is divided into subgroups. Accordingly, to select sample households that represent the population of the study area to meet the objective of the study, multi stages sampling technique was used. Hence, in first stage, the zone was stratified into two strata based on agro-ecological zone activities as pastoral and non-pastoral having 4 and 11 woredas, respectively. In the second stage, 3-sample woreda were selected randomly taking two from non-pastoral and one from pastoral. Thirdly, 6 kebeles was selected randomly (four from non-pastoral woredas and two from pastoral woredas. Finally, after having list of total number of households in each kebeles, sample households were selected randomly based on proportional to size. This stratification in this study was used to obtain sample to representatives based on characteristics that use to stratify the sample (Abdi. K, 2015). According to West Hararge zone district administration office (2018) in the study area the total number of households were 5912. Pertaining to how sampled households was selected from each stratum to follow the method of proportional allocation under which size of sample from different strata are kept proportional to size of stratum. This means if Pi represents proportion of population included in stratum i and n represents the total sample size, the number of elements selected from stratum i is from Pi. Depend on the above mechanism of selecting sample from strata: n_1 is from pastoralist($P_{1)}$, n_2 is from non-pastoralist ($p_{2)}$.

Accordingly depend on Yamane's (1967) sample size determination; $= \frac{N}{1+N(e^2)}$, Where n is the sample size, N is total population size, and e is the level of precision as follows;

$$n = 5912/1+5912(0.05^2) = 375$$

$$n1 = n * \frac{N_1}{N} = 375 * \frac{1300}{5912} = 82$$

$$n2 = n * \frac{N_2}{N} = 375 * \frac{4612}{5912} = 293$$

In this case N is total population size, ±5% is indicate precision levels where confidence level is 95% and P=5, Hence, total sample size of 375 households were taken for study purpose from each selected rural area in respective to each size of households from West Hararge zone. Regression models in which the regressand evokes yes or no, or present or absent response are known as dichotomous dependent variable regression models. They are applicable in variety of fields and used extensively in survey and in census data (Gujarati, 2004). One of the dependent variables in this study also dummy, which takes a value of zero or one depending on whether or not the households participate in small-scale irrigation. However, independent variables are types of continuous and categorical. Binary choice models assume that individuals are faced with choice between two alternatives and their choice depends on their behavior. Thus, one purpose of a qualitative choice model is to determine the probability that an individual with a given set of attributes will one choice. Small-scale irrigation participation is a dependent variable, which is dichotomous taking on two values, one if the household participate in small-scale irrigation and zero otherwise. In this regard, non-linear probability models, logit and probit models are possible alternatives. Several estimations arise particularly when Ordinary Least Squares regression and linear probability models employed (Aldrich and Nelson, 1984). The Ordinary Least Squares regression technique, when dependent variable is binary produces, parameter estimates that are inefficient and heteroscedasticity error results in structure.

To evaluate the effect of a program, a model commonly employed can be expressed as:

$Y = X\beta + \alpha i + \mu$……(1)

Where Y is the outcome/effect, X is a vector of personal exogenous characteristics and I is a dummy variable (I=1, if the individual participates in the program and 0 otherwise). From this model, the effect of the program is measured by the estimate of However, the dummy variable 'I' cannot be treated as exogenous if the likelihood of an individual to participate or not to participate based on unobserved selection process and unobservable factors (Madalla, 1983).

In order to fulfill objectives one and two the following functional form is used.

$Pi = f(Z_1, Z_2, Z_3, Z_4 \ldots Z_K)$…… (2)

The econometric model for the probit model stated in equation (2) can be specified as:

$Pi = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \ldots + \alpha_n Z_n$ …… (3)

Were,

Pi is dichotomous variable representing participation of smallholder farm households in small -scale irrigation; and one if the household participates in small scale irrigation and zero otherwise. Z1.Z2, Z3, Z4,…ZK are vectors of variables affect smallholder farm households' decision to participate in irrigation. Parameters; α0, α1, α2, α3, αn represents coefficients for row vectors to be estimated, and μi is error term.

$Yi = f(X_1, X_2, X_3, X_4 \ldots X_K)$…… (4)

The econometric model for outcome model stated in equation (4) can be specified as:

$Yi = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_k X_k + \lambda + \varepsilon i$……(5)

Where: Yi: represents the amount of income from small scale irrigation activities. X1, X2, X3, X4… XK are determinants of smallholder farm households small scale irrigation income.

Parameters; β0, β1, β2, β3, βk represent coefficients for the row vectors to be estimated, λ is the inverse mills ratio and is the error term with standard properties.

The small-scale irrigation income equation is present in equation (6).

$Yi = Xi\beta + \varepsilon i$……(6)

Where: Yi is the individual household's income from small scale irrigation. It is observable for participants and unobservable for nonparticipant households that is why we use Heckman sample selection. Xi is vector of factors that affect level of income from small scale irrigation. The selection model for household's participation in small scale irrigation was explained by the equation stated below. Here, the equation indicates that household's participation depends on some value pi* of a latent variable.

$pi^* = Zi\alpha + \mu i$ ... ...(7)

The researcher determines the participation and small-scale irrigation income from the selection equation as stated below.

$Pi = \begin{cases} 1 \text{ if } pi^* > 0 \\ 0 \text{ if } pi^* \leq 0 \end{cases}$

With the decision to participate in small scale irrigation given by pi equal to 1 if household participate and pi is equal to 0 otherwise, where pi indicates participants in irrigation, Z is vector of variables affect households' decision to participate and corresponding error.

The outcome equation is explained as:

$Pi = \begin{cases} Xi\beta + \varepsilon i \text{ if } pi * > 0 \\ \text{Unobservable if } pi^* \leq 0 \end{cases}$

The expected income of households who participate in small scale irrigation becomes,

$E\{yi/pi=1\} = Xi\beta + E(\varepsilon i/pi = \}$

$= Xi\beta + \frac{\rho\phi(zi\alpha i)}{\phi(zi\alpha i)}$

$= Xi\beta + p\lambda$

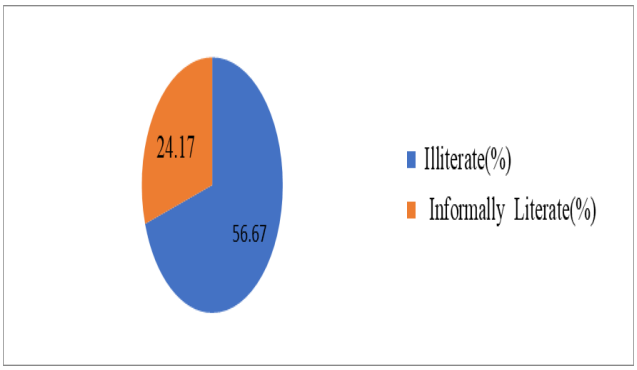
If the correlation coefficient ρ = 0, estimating model using ordinary least square gives unbiased result. The term $\frac{\rho\phi(zi\alpha i)}{\phi(zi\alpha i)}$ is known as inverse Mill's ratio; usually represented by lambda (λ) and reflects for selection variable that captures for selection bias. Therefore, in our two-stage choice context we simultaneously model participate in small scale irrigation and the effect of the irrigation schemes on household's income.

3. Results and Discussion

3.1. Respondents Background

The very majority of the respondents are were headed by males 80% and remaining about 20% were headed females. This is typical representative of developing countries where male headship is dominant.

Figure 1: Respondents Education Background



Source: Computed from own survey data, (2013)

When we see comparison by access to irrigation, out of the 128 irrigation user households 3.91% are headed by female and the remaining 96.09% is by male headed household. The results of study show non-users 38.39% and 61.61% by female and male respectively. In terms of literacy level has shown that, 56.67% were illiterate at least they cannot read and write, 24.17% informally

literate could read and write, 12.08% had attended formal education from grade 1 to 6, 5% were exposed to formal education from grade 7 to 8 and 2.08% have succeeded in reaching higher levels of grade 9 and above.

4 Heckman two stage Model Effect of Irrigation on Income

The study runs the Ordinary Least Square model to compare the result of the estimate with the Heckman two stage analyses. As expected, the model result identified that access to irrigation is significant determinant of household total annual income. But size of the coefficient for the Heckit model is higher than that of the OLS regression result. Thus, using OLS regression model underestimates the effect of small-scale irrigation on household total annual income level.

Table 2: Heckman two stage estimates for the outcome equation

Explanatory Variables	Coefficient	P-value
cons	28003.41	0.000***
livestock	1112.968	0.000***
dismkt	-60.332	0.768
cultland	1274.743	0.061*
educ	296.441	0.429
acinfo	1032.005	0.405
acirrig	29154.16	0.000***
soilfert	265.699	0.799
sexhead	6835.594	0.010***
famlabor	192.460	0.361
age	284.549	0.264
accredit	6634.947	0.000***
agesquare	-2.841	0.272
acexten	4371.16	0.016**
lambda	-3028.899	0.035**

Source: Computed from own survey data, (2013)

*Note: ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively*

Access to irrigation, as one of the technology options available, enables the farmers to diversify their production, practice multiple cropping and supplement moisture deficiency in agriculture. In doing so, it helps the farmer to increase production and income. Therefore, access to irrigation influences the household total income significantly with positive sign as expected. It is statistically significant at 1% level of significance. The result shows that, in the study area those who have access to irrigation have the chance of producing twice or more in a year as, a result increased and stable production income and consumption. The coefficient of this variable revealed that, keeping all other variables constant, on average total annual income of irrigation user households would be higher by Birr 29154.16 than households who do not participate in irrigation farming. Participation in small-scale irrigation, therefore, enables farm households to improve their well-being not only allowing income but also minimizing risk and smoothening household consumption. The livestock holding measured in Tropical Livestock Unit is found to have a positive and significant influence on income of households, and it is statistically significant at 1% level of significance. Livestock holding in tropical livestock unit contributes to total household income directly through the sale of livestock and their products, and indirectly through use as a source of draught power for crop production activities. Moreover, Livestock, besides its direct role in raising agricultural productivity, helps households stabilize consumption by absorbing income shocks that might arise from crop failures triggered by natural disasters. Oxen are the sole draught power sources and hence lack of oxen besides its negative effect on land productivity signifies a lower economic status of farm households. Households with larger number of livestock particularly oxen, therefore, are likely to raise farm income for they can use other farm inputs more efficiently by bringing additional land into cultivation through either cash rent or share cropping basis. The study result revealed that, a unit in tropical livestock unit increase in livestock holding would increase on average total income of a household by Birr 1112.97, while keeping all other variables constant at their mean value. Male household heads have higher income compared to female household heads because of better labor inputs used in male-headed households than the female headed ones. In addition, females of the study area as females of elsewhere have triple burden (production, reproductive and childcare), and also, they have less access to information about the technology then due to the case of sex difference of household head has influence in the level of income of households. Moreover, with regard to farming experience males are better than the female farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the small-scale irrigation as early as possible and their income is higher than their counterpart. The study result revealed that this variable is statistically significant at 1% significance level and the coefficient of this variable also shows keeping all other variables constant, on average income of those male headed households exceeded by birr 6835.59 compared to those households headed by female. Size of cultivated land is key asset of rural farm households and this asset is a prerequisite in the productive activities. The study revealed that land is positively associated with household total income as expected and is statistically significant at 10% level of significance. The result discloses that, as the cultivated land size increases, household is able to increase and diversify the quantity and type of crop produced on the cultivated land this may in turn imply increased income of the household. Generally, land is important fixed input to increase production and income. The coefficient of the variable also shows that as the household gets one more hectare of land on averages the total annual income of the households' increases by Birr 1274.74 keeping all other variables constant. Access to extension service is statistically significant at 5% level of significance and expected positive sign. The positive relationship may indicate that in the study area, those households who get technical advice, training or those who participated on field demonstrations are well aware of the advantage of agricultural technologies and willing to adopt new technologies and produce more, thereby improving the household level of income. The coefficient of the variable indicates keeping all other variables constant, on average income of who have access to extension service would be higher by Birr 4371.16 compared to households who do not have access to extension service. The study also runs Ordinary Least Square model to compare result of estimate with Heckman

two stage analyses. As expected, the model result identified that access to irrigation is significant determinant of annual income. But the size of the coefficient for Heckit model is higher than that of OLS regression result. Thus, using OLS regression model underestimates the effect of small-scale irrigation on household total annual income level.

Table 3: Ordinary Least Square estimation of model variables

Explanatory Variables	Coefficient	P-value
cons	17179.77	0.000***
livestock	615.673	0.085*
dismkt	-89.741	0.502
cultland	675.495	0.063*
educ	474.198	0.192
acinfo	-426.758	0.550
acirrig	24735.91	0.000***
soilfert	-700.924	0.315
sexhead	2327.517	0.011**
accredit	3795.75	0.000***
famlabor	-31.850	0.825
age	209.101	0.257
acexten	2453.094	0.009***
agesquare	-2.212	0.238
Dependent Variable	household total annual income	
Number of observation 240 F(13,226) 177.63 Prob > F 0.0000 R-squared 0.9109 Adj R-squared 0.9057		

Source: Computed from own survey data, (2013)

*Note: ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively*

5 Conclusion and Recommendation

This study attempts to identify and analyze determinants of smallholder rural farm households' participation in small-scale irrigation and its effect on income in one study area. The variables that turned out to be statistically significant include: total livestock holding, size of cultivated land, access to extension service, distance from households' farm to the nearest market, level of education of the household head, availability of family labor force, distance from households' residence to the water source, gender of household head and access to credit facility. Households with large number of family size in adult equivalent have higher probability of participation in small-scale irrigation. Male-headed households have higher probability of participation in small-scale irrigation compared to female headed households. The most important problem in practicing irrigation in the study revealed that participation in small-scale irrigation increases household income, there are no sufficient sources of water even for those who take part in irrigation. Local government has to incentivize farmers to undergo water conservation practices and surface water regional water enterprise to dig underground water for small-scale irrigation is likely to future irrigation development. Moreover, some of the irrigating households reported that they face a problem of crop failure while using irrigation recommended to responsible body to work hard on the prevention and/or protection of crop disease. Households in collaboration with local leaders and stake holders should invest in the expansion of formal and informal schools' education is found to be statistically significant in increasing participation in small-scale irrigation.

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