# *Impact of Sub Watershed Management Program on Household Livelihoods of Humbo District in Southern Ethiopia: Instrumental Variable Approach,*

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## Abstract

*This study is aimed at assessing effect of watershed management program on livelihood of households of selected sub watersheds in Humbo District. To carry out the study objectives, from econometrics models instrumental variable (IV) method was applied from among different impact evaluation methods with the sample size of 330 households. The results of econometric estimation revealed that household age, education, adoption, consumption expenditure, material possession, extension contact, productivity of crops, upstream and downstream and employment were positively and significantly related with HHDI at 1%, 5% and 10% level of significance. To examine the validity of instrumental variables estimation, different diagnosis tests like normality tests of the model, endogeneity test, tests of weak instruments, tests of over identifying restriction, multicollinearity and heteroskedasticity were employed. After identification and testing of IV result, the 2SLS estimation was conducted for evaluating Impact. Accordingly, adoption of watershed program has positive and significant impact (31%) on HHDI of the sample households in the study area. Therefore, the result indicate that with adoption of watershed management program, household on livelihoods can improve.*

Keywords: adoption, HHDI, IV, 2SLS estimation, Watershed management, Ethiopia

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## Introduction

Trends in watershed management studies indicate that managing water and land resources in integrated way in watershed approach helps to achieve economic development without compromising the protection of environment. Worldwide, India, China, Nepal, Philippines and Indonesia, have achieved remarkably small scale and large scale watershed based development programs (Gebregziabher, 2012). Also in Africa, Kenya, Niger, Burkina Faso and Mali, have mainly used participatory conservation and watershed-based approaches (Wang et al, 2016).

Coming to Ethiopia, historically, development of watershed approach began in the 1980's. The initiative was first made in response to environmental degradation following the occurrence drought in 1970s (Tessema and Tripathi, 2015). Later, large watershed programs was implemented in about 40 thousand hectares (Desta et al, 2005). Studies in southern Ethiopia also indicate that community based participatory integrated watershed management was commonly implemented activities(Wolka, 2015). In the region particularly Wolaita Zone, watershed management activities were on improving trend to restore degraded lands revealed in terms of deep galleys. In this perspective, Humbo District was examplery as part of Wolyta Zone.

As far as studies on impact evaluation of watershed management, they were focused on PSM model for analysis. Halibo (2010) studied the impacts of integrated watershed management program on food security and Emily Schmidt and Tadesse (2012) studied Household and pilot level impact of sustainable land and watershed management practice in the Blue Nile. Some also studied other aspects of watershed management, Meta, et al (2018) studied factors affecting farmers participation in watershed management programs in the Northern Highlands of Ethiopia, Wolka and Negash (2014) studied Farmers' adoption of soil and water conservation technology, and Kerse (2017) studied factors affecting adoption of soil and water conservation practices. However, these studies did not clearly show and rigorously evaluate how water shed adoption can affect household livelihoods particularly using instrumental variable method. Thus, the objective of this study was to investigate impact of watershed management program on household livelihoods in adopters and non-adopters' sub-watersheds of Humbo Districts.

## Materials and Methods

### Study Area

The study was undertaken in Humbo District of southern Ethiopia located 400 km from capital city of the country, 180 km from Region town, 18 km away from Wolyta Zone capital. It was bounded by Mirababaya District in South, Sodo Zuria District in North, Damot Woyde and Lokabaya distracts in East, and by Ofa District in West. The total population of Humbo District was about 157,070 with a total area of 86,646 ha. With regard land distribution, area coverage of arable land 35,057 ha (40.47%), grazing land of 8,585 ha (9.9%), natural forest of 24,845 ha (28.64%), water 12,000 ha (13.84%), cultivable land of 1,010 ha (1.10%), and others land of 5149 ha (5.9%).

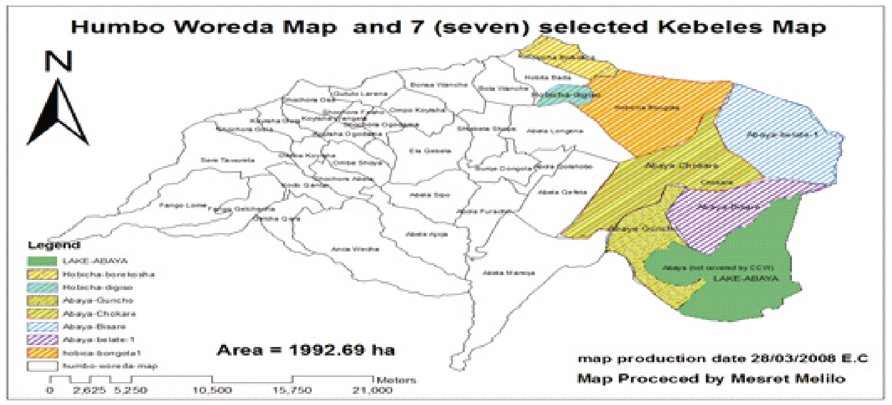
The District is divided in to two agro ecological zones; that is Weyna Dega (30%), Qola (70%). The study area located in Abaya-Chamo watershed management project Kebeles of Humbo District. The study is carried out in Arenguade Limat and Dogiso project and non-project sub watersheds of Hobicha Borkoshe Kebele respectively, and Bogota and Beda project and non-project sub watersheds of Hobicha Dogiso Kebele respectively.

### Data Collection Technique

Data were collected both from primary and secondary sources. Primary data are collected from selected households in the study area through schedule. Secondary data were collected from published and unpublished sources. A structured questionnaire is prepared and used to collect primary data through household survey.

### Sampling Framework

Project & non-project sub watersheds were selected using purposive sampling techniques. This was being based on the availability of baseline socio-economic and biophysical data. The non-project sub-watersheds selected being based on the neighboring with the project sub watersheds. But when sampling households cluster and systematic random sampling (upper stream and lower stream of the sub watersheds) techniques are used. From the total of






2,862 household populations,351 sample households were selected using Yamane (1967) formula. Being based on the sizes of the samples are proportional to the sizes of total household, (Kothari, 2004), the sample size was determined for project & non project sub watersheds.

### Model specification

### Theoretical Model

A watershed is as an area in which all water drains to a common point. Watershed management is effective use of both land and water. The major influences of watershed development program includes 1) improvement in productivity and production of crops, land cover & use change and cropping pattern , agricultural technologies, milk production, 2) attitude and participation of the communities in watershed management program, socio-economic condition like income, employment, assets, health, education and energy use, 3) environment, 4) use of land, water, human and livestock resources, 5) development of institutions for implementation of watershed development activities, and, 6) ensuring sustainability of improvements (Palanisami and Kumar, 2009). The major purpose of integrated watershed development is to improve the livelihoods of the community through comprehensive and integrated natural resource development (Desta et al, 2005).

Three classifications of livelihood strategies were identified within sustainable livelihoods framework. These include agricultural intensification, livelihood diversification and migration. Rural communities either gain livelihood from agriculture (including livestock rearing, aquaculture, forestry etc.) through processes of intensification (more output per unit area through capital investment or increases in labour inputs) or extensification (more land under cultivation), or diversify to a range of off-farm income earning activities, or move away and seek a livelihood, either temporarily or permanently, elsewhere. Or, more commonly, you pursue a combination of strategies together or in sequence (Scoones, 1998).

The study creates a comparing group using statistical design. Let Yi is dependent variable (livelihood) for household i.

For participant (program participant), $T_i$=1, and the value of $Y_i$ under treatment is represented as $Y_i(1)$.

For non-participant (non-program participant), $T_i$=0, and the value of $Y_i$ under non treatment is represented as $Y_i$ (0). Therefore, the mean impact of the program represented as: $D = E\langle Y_i(1)| T_i = 1 \rangle - E\langle Y_i(0)| T_i = 0 \rangle$

The challenge is that the treated and non-treated groups may not be the same prior to the intervention, so the expected difference between those groups may not be due entirely to program intervention. If then adds and subtracts the expected outcome for non-participants had they participated in the program (project in this study case), .

$$D = [E\langle Y_i(1)| T_i = 1 \rangle - E\langle Y_i(0)| T_i = 0 \rangle] + [E\langle Y_i(0)| T_i = 1\rangle - E\langle Y_i(0)| T_i = 1\rangle]$$

$$D = ATE + E\langle Y_i(0)| T_i = 1\rangle - E\langle Y_i(0)| T_i = 0 \rangle$$

$$D = ATE + B$$

Where, ATE is the average treatment effect$\langle E\langle Y_i(1)| T_i = 1 \rangle - E\langle Y_i(0)| T_i = 1 \rangle$ namely, the average of outcomes of participant relative to non participant, as if non participating households were also treated. The term B is the extent of selection bias. The basic objective of a sound impact assessment is then to find ways to get rid of selection bias (*B* = 0) or to find ways to account for it (Khandker et al, 2009).

The study used IV approach, selection bias on unobserved characteristics is corrected by finding a variable (or instrument) that is correlated with participation but not correlated with unobserved characteristics affecting the outcome; this instrument is used to predict participation.

Considering the estimated equation that describes outcomes of program and non-program sub watersheds:

$$Y_i = \alpha X_i + \beta T_i + \varepsilon_i$$

Where, $T_i$ is a dummy equal to 1 for those who participate and 0 for those who do not participate. $X_i$ is a set of other observed characteristics of the individual, and an error term reflecting unobserved characteristics that also affect $Y_i$.

There will exist an endogeneity problem, because of deliberate placement of the program in the study area (no randomization). Therefore, selection bias is a problem. That is, cov($T$, ε) ≠ 0 implies violation of one of the key assumptions of OLS in obtaining unbiased estimates: independence of regressors from the disturbance term ε. The correlation between $T_i$ and naturally biases the other estimates in the equation, including the estimate of the program effect β.

The IV aims to clean up the correlation between $T$ and ε. That is, the variation in $T$ that is uncorrelated with ε needs to be isolated. To do so, one needs to find an instrumental variable, denoted $Z$, that satisfies the following conditions:

1. Correlated with $T$: cov($Z,T$ ) ≠ 0

2. Uncorrelated with ε: cov($Z$,ε) = 0

Thus, instrument $Z$ affects selection into the program but is not correlated with factors affecting the outcomes (also known as an *exclusion restriction*).

TWO-STAGE LEAST SQUARES APPROACH TO INSTRUMENTAL VARIABLES(IVs)

To isolate the part of the treatment variable that is independent of other unobserved characteristics affecting the outcome, one first regresses the treatment on the instrument Z (Khandker et al, 2009). This process is known as the *first-stage regression*:

$$T_i = \gamma Z_i + \varphi X_i + \mu_i$$

The predicted treatment from this regression , therefore reflects the part of the treatment affected only by $Z$ and thus embodies only exogenous variation in the treatment. is then substituted for treatment create the following reduced-form outcome regression:

$$Y_i = \alpha X_i + \beta[\gamma Z_i + \varphi X_i + \mu_i] + \varepsilon_i$$

Through instrumenting, therefore, $T$ is cleaned of its correlation with the error term. If the assumptions cov($T, Z$ ) ≠ 0 and cov($Z$ , ε) = 0 hold, then IV consistently identifies the mean impact of the program attributable to the instrument.

**Analysis of the Study**

The level of socio-economic and demographic characteristics were analyzed and explained using descriptive statistical analysis and the selected dependent and independent variables were analyzed using Instrumental Variable estimation (VI) to estimate the impact of watershed management. The analysis was done using Stata MP 13 software.

**Definition of Variables Used**

**Dependent Variable: Livelihoods:**

According to Lodha and Gosain (2008), to quantify the livelihoods of rural sub watersheds household development index (HHDI) is used. HHDI represents the position of particular household within a given population with respect to the set of four indicators- income($x_1$), literacy($x_2$), land holding($x_3$) and livestock holding($x_4$).



**Annual income**($x_1$)**:** It operationalize as the total income earned by the respondents from both agriculture and sources other than agriculture in the previous year as expressed by the respondents in birr.

**Literacy rate** ($x_2$)**:** Literacy is an important indicator judging the quality of human resource. It was calculated by deducting the population below five years of age (non-school going) from the total sampled population (Thakur, et al, 2014).

$$literacy\ Rate\ (\%) = \frac{total\ number\ of\ litrate\ persons}{total\ population - population\ below\ 5\ years} * 100$$

**Land holding** ($x_3$)**:** It refers to the size of hectares of land possessed by the sample households.

**Livestock possession** ($x_4$)**:** It refers to the number of herd size expressed in Tropical Livestock Unit (TLU).TLU is livestock numbers converted to a common unit. The conversion factors are for cattle=0.7, sheep and goats=0.1, and chicken=0.01 TLU (Ulrike, 2005).

Maximum and minimum values of the indicators are identified for each indicator. The development measure then placed a household in the range of zero to one as defined by the difference between maximum and minimum.

Thus $I_{ij}$ is the development indicators for the j[th] household with respect to the i[th] indicator and it is defined as:

$$I_{ij} = \frac{x_{ij} - min x_{ij}}{max\ x_{ij} - min\ x_{ij}}$$

To measure the HHDI for the j[th] household, is by taking the simple average of all development indicators:

$(HHDI)_j = \sum_{i=1}^{n} I_{ij} /n$ , where n is the number of indicators

**HHDI values:** UNDP's Human Development Report (HDR) classifies all countries into four clusters depending up on their HDI. Countries with an HDI of 0.800 or above are considers high in human development; 0.500 – 0.799 are medium and less than 0.500 low in human development (UNDP, 2003). Lodha and Gosain(2008) introduced one more category within the low development segment. Therefore all household belonging to the study area grouped into four clusters, depending on the HHDI values. Stressed household if the HHDI index is less than 0.200 , Household with low development if the HHDI index is in the range 0.200 to 0.499, Medium developed household if the HHDI index is in the range 0.500 to 0.799 and High developed household HHDI index is in the range 0.800 to 1.000.

**Independent Variables**

**Adoption:** This has been operationally defined as the extent of adoption of watershed management projects. Respondents will classify accordingly as adopter and non adopter. On a two point continuum non adoption, and adoption. Each practice was given a score of zero, and one for non adoption, and adoption respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by Shambulingapappa B.G. (2011)

**Age:** It is refers to the chronological age of the respondents, in years completed at the time of investigation. The description of age of respondents was done as followed by Sebhatu Seyoum Halibo (2010).

**Education:** The continuous variable education operationalise as the number of years of formal education acquired by the respondents. The description of education of respondents was done as followed by Ziller et al (2003).

**Gender:** Gender is sexual characteristics of respondents. It is measured on two point continuum *i.e.*, male and female with score of 1 and 0 respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by Solomon Addisu et al (2013).

**Productivity of crops:** Productivity refers to the economic production of plant product of economic importance, expressed in standard units per unit area. The important crops of the area are selected for the study purpose. The yield data on the above crops are collected during interview with the farmers. The continuous measurement of productivity of crops was done as followed by Sebhatu Seyoum Halibo (2010) and Thakur et al (2014).

**Material possession:** It refers to the possession of major household materials and farm implements utilized for agricultural operations in the farm by an individual farmer**.** The scoring and categorization of respondents was done in accordance with the procedure followed by Lodha and K.Gosain (2008)

**Consumption expenditure:** It is Induced consumption by households on goods and services that varies with income and expressed in annual amount of birr. The continuous measurement of consumption expenditure was done as followed by Shambulingapappa(2011)

**Employment:** the number of employed people other than own farming activity. It measured on two point continuum *i.e.*, employed and unemployed with score of 1 and 0 respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by Deai et al (2009).

**Extension contact:** Extension contact is defined as the frequency of contact of respondent with the different extension personnel and extension agencies for seeking information about watershed practices. It will measured on three point continuum *i.e.*, regular, occasional and never with score of 2, 1 and 0 respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by Kerse (2017).

**Participation:** Participation is defined as the extent of respondents participated in soil and water conservation practice. It will measured on three point continuum *i.e.*, regular, occasional and never with score of 2, 1 and 0 respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by Pradeep Dogra (2012) and Maniyannan S. et al (2007).

**Upstream and Downstream (UAD)**: it is defined as the respondents permanent place of residents in the up and down stream of watersheds in the study area. It was measured on two point continuum *i.e.*, up and downstream with score of 1 and 0 respectively. The scoring and categorization of respondents was done in accordance with the procedure followed by FAO (2006).

## Results and Discussion

### Descriptive Statistical Analysis

Descriptive statistical analysis was based on household survey through schedule from the adopters and non-adopters of watershed management program of Humbo Districts namely Arenguade Limat, Dogiso, Bogota, and Beda sub watersheds. The two sub watersheds of Arenguade Limat and Bogota are project areas where 180 household heads were interviewed whereas Dogiso and Beda are non project areas in which 150 non participants' household heads were interviewed.

The result showed that majorities (84%) of the respondents were male and 85% of the adopters and 83% of the non adopters were male. Average age of the respondents was 38 years (Table 1). The mean age of the adopters (39 years) years was not significantly different from non-adopters (38 years).

The 2SLS estimation result revealed that a household was found to be significant and positively related with HHDI. This can be explained by the fact that older farmers have relatively better experience and understanding about livelihood impact of participating on watershed development as compared to the younger ones. But this result was contrary to the finding of Sebhatu (2010) which found out older farmer labor capability was much lower than that of young generation.

*Table 1: Demographic characteristics by adoption status*

| Variable | Pooled data (N=330) | Adopters (N=180) | Non- adopters (N=150) |
|---|---|---|---|
| Gender in % | | | |
| Male | 84 | 85 | 83 |
| Female | 16 | 15 | 17 |
| Educational Background | | | |
| Illiterate | 49 | 33 | 68 |
| Primary | 12 | 12 | 11 |
| Secondary | 23 | 28 | 17 |
| High school | 10 | 16 | 4 |
| Collage | 6 | 12 | 0 |
| Average age of household heads | 38 | 39 | 38 |
| Average household size | 7 | 6 | 8 |

*Source: own survey result, 2019*

Table 2 summarizes descriptive statistics for all variable included in the analysis for 2017/18. The dependent variable, HHDI, has a mean of 0.407. This implies that the HHDI of both adopters and non-adopters fall under low development index (0.2-0.499). The main explanatory variable, adoption, has a mean value of about 0.55. The standard deviation is 0.49.

*Table 2: Summary Statistics of Adopters and Non-Adopter*

| Variables | Mean | Stad. Dev. | Min. | Max. | N |
|---|---|---|---|---|---|
| HHDI | 0.4073761 | 0.18067510 | 0.003 | 0.916 | 330 |
| Adoption | 0.5454545 | 0.4986858 | 0 | 1 | 330 |
| Gender | 0.8393939 | 0.3677248 | 0 | 1 | 330 |
| Age | 38.98182 | 7.389694 | 26 | 60 | 330 |
| Education | 3.839394 | 4.230619 | 0 | 12 | 330 |
| Consumption expenditure | 37,267.52 | 11,013.82 | 15537 | 75931 | 330 |
| Productivity of crops | 32.73636 | 2.395895 | 29 | 35 | 330 |
| Material possession | 0.5363636 | 0.4994332 | 0 | 1 | 330 |
| Extension contact | 0.530303 | 0.4998388 | 0 | 1 | 330 |
| Employment | 0.4939394 | 0.5007225 | 0 | 1 | 330 |
| Participation of SWC | 0.969697 | 0.8499901 | 0 | 1 | 330 |
| Training | 0.5393939 | 0.4992026 | 0 | 1 | 330 |
| Perception | 0.7151515 | 0.4520277 | 0 | 1 | 330 |
| Upstream and downstream | 0.5000000 | 0.5007593 | 0 | 1 | 330 |

*Source: own survey result, 2019*

### Econometric Result

The econometrics function was used to estimate the treatment effects of adoption on household livelihoods in terms of HHDI (Household Human Development Index). The potential IVs used in the estimation were: Household training of SWC, and household perception about soil erosion, which are stems from Mengiste (2009) and Mutuku (2017) respectively.

### Diagnostic Tests Of 2SLS Estimation

**Normality Tests of The Model**

The response of dependent variable for explanatory has to be normal distribution. The violation of this assumption occurs when there are outliers in data set, and leads to problems of wider confidence intervals and wrong hypothesis testing (Jeffery M. Wooldridge, 2012). SK tests for normality in table 4, revealed that the observations were normally distributed. That is, the regression is normally distributed.

*Table 3: Skewness/Kurtosis Tests for Normality*

| Variable | Obs | Pr(Skewness) | Pr(Kurtosis) | adj chi2(2) | Prob>chi2 |
|---|---|---|---|---|---|
| Resid | 330 | 0.9447 | 0.3484 | 0.89 | 0.6407 |

**Tests of endogeneity:** Stata has a command "estat endog" that performs an F-test and chi-square test following method=logies called the Wu- Hausman test and Durbin test, respectively. The null hypothesis is that variables are exogenous.

Ho: variables are exogenous

Durbin (score) chi2(1) = 3.47517 (p = 0.0623)

Wu-Hausman F(1,318) = 3.38444 (p = 0.0667)

The result shows that the null hypothesis is rejected at 10% level, implying that IV is better model than OLS. In other words, the explanatory variable adoption of watershed management is endogenous variable.

**Tests of weak instruments**: Stata has a command "estat firststage" that performs an F-test. The null hypothesis is that the instruments are weak. The partial R-square (0.523) in the result measures the correlation between the instruments and the endogenous variable. It indicated good correlation and satisfies instrument relevancy condition. The F-statistic in result is 28.77, which is larger than any of the critical values of Wald test shown in Table 5. Therefore, the null hypothesis is rejected which says the null hypothesis are weak.

*Table 4: First-stage regression summary statistics*

| Variable | R-sq. | Adjusted R-sq. | Partial R-sq. | F(2,318) | Prob > F |
|---|---|---|---|---|---|
| adoption | 0.9004 | 0.8969 | 0.523 | 28.76925 | 0.0002 |

Minimum eigenvalue statistic = 28.76925

| Critical Values | # of endogenous regressors: 1 | | | |
|---|---|---|---|---|
| Ho: Instruments are weak | # of excluded instruments: 2 | | | |
| | 5% | 10% | 20% | 30% |
| 2SLS relative bias | (not available) | | | |
| | 10% | 15% | 20% | 25% |
| 2SLS Size of nominal 5% Wald test | 19.93 | 11.59 | 8.75 | 7.25 |
| LIML Size of nominal 5% Wald test | 8.68 | 5.33 | 4.42 | 3.92 |

**Tests of over identifying restriction:** Stata has a command "estat overid" that performs an chi-square following methodologies called the Sargan test and Basmann test. The null hypothesis is that the instruments set are valid and the model is correctly specified. The test result showed that both Sargan test and Basmann test p-value are not significant, implying that the instruments are valid.

Tests of overidentifying restrictions:

Sargan (score) chi2(1) = .157221 (p = 0.6917)

Basmann chi2(1) = .151577 (p = 0.6970)

**2SLS Estimation Result**

The findings of the 2sls IV estimation are presented in table 3. The result revealed that, watershed management program had a significant impact (31 percent) on household livelihoods

Instrumental variables (2SLS) regression

Number of obs = 330
Wald chi2(10) = 493.17
Prob > chi2 = 0.0000
R-squared = 0.6005
Root MSE = 0.11541

*Table 5: The 2SLS estimation result*

| Variables | Estimated coefficients | (S.E) | (Z) | P>\|z\| |
|---|---|---|---|---|
| Adoption | 0.3092 | 0.1833 | 1.69 | 0.092* |
| Gender | -0.0456 | 0.0292 | -1.56 | 0.118 |
| Age | 0.0282 | 0.0169 | 1.66 | 0.096* |
| Education | 0.6199 | 0.0078 | 7.92 | 0.000*** |
| Consumption | 0.6282 | 0.6490 | 9.70 | 0.000*** |
| Productivity | 0.0177 | 0.0106 | 1.67 | 0.095* |
| Possession | 0.0701 | 0.0256 | 2.74 | 0.006*** |
| Extension | 0.1004 | 0.0491 | 2.04 | 0.041** |
| Employment | 0.1168 | 0.0602 | 1.94 | 0.052** |
| Participation | 0.0475 | 0.0291 | 1.63 | 0.102 |
| UAD | -0.1078 | 0.0351 | 3.07 | 0.024** |
| Constant | -0.5147 | 0.3135 | -1.64 | 0.101 |

*, **, and *** significant at 10%,5% and 1% probability level.
Source: own survey result, 2019

Among the hypothesized explanatory variables included in the model, extension contact, upstream and downstream and employment variables were found affecting the dependent variable at 5% significant level. Whereas, adoption, age and productivity were influencing livelihood at 10% significant level. The remaining education, consumption expenditure and material possession have influence at 1% significant level. The discussion of each variable will be given in accordance with their characteristics presented as follows.

**Age of the Households**

Age of the household was hypothesizing to be negatively associated with HHDI. But the 2SLS estimation result revealed that it was found to be positively associated with HHDI. This can be explained by the fact that older farmers have relatively low capacity to deliver works since water shade was found to be too laborious. This result was consistent with the finding of Sebhatu Seyoum Halibo(2010) by which older farmer labor capability was much lower than that of young generation.

**Educational Status of the Household Head**

As hypothesized, having formal education improves the HHDI of households. Education was found to affect HHDI of household positively at 1% significant level. The coefficient of education suggests for a unit increase in education, average HHDI increase by 61.99% per additional year of education. The positive association shows that a better educated household seems to have better HHDI through managing development indicators for HHD than low level of the uneducated household. This



result was in lined with the findings of Ziller et al (2003).

**Extension Contact**

Agricultural extension services in Ethiopia are carried out at the kebele level using extension officers. There are three extension officers, also known as development agents (DAs) in each kebele specializing in plant sciences/crop protection, natural resources management, and livestock production. In this study, agricultural extension services are intended to educate farmers and assist in resolving their agriculture-related problems, thereby motivating them to decide to participate in watershed management programs hence increased production. In the same line of study expectation, the regression analysis of this variable revealed that frequency of agricultural extension service is found to be statistically positive and significant at 5% significant level. This means the frequency of extension contact increases farmers decision to participate in the watershed management program rises. The coefficient of this variable shows that a unit increase in extension contact on average increases HHDI by 10.04%. Belete Limani Kerse (2017) study also revealed that better access to extension has strong and positive influence on the livelihoods of the household. This implies that farmers who have access to extension service are more likely to aware of various management practices.

**Productivity of Crops**

As hypothesized, productivity of crops found to affect the HHDI significantly positive at 10% significant level. This was due to increase in the land productivity which resulted from continuous watershed management activities. The coefficient of this variable suggests that a unit increase productivity of crops, average HHDI increase by 1.8%. This result was in lined with the findings of Sebhatu Seyoum Halibo (2010) and Thakur D.R. et al (2014).

**Household Consumption Expenditure**

Consumption expenditure of household was hypothesized as to have significant positive relationship with HHDI. According to the 2SLS regression result, household consumption expenditure found significantly positive at 1% level of significance. The effect on HHDI was 62.82%. this could be due to the fact that the livelihood has direct relation with consumption expenditure. This result has been supported by Shambulingapappa (2011).

**Material Possession**

The possession of farm implements found significantly positive at 1% significance level. The effect on HHDI was 7%; which was due to application of farm equipment in agricultural production. This finding was supported by Pradeep P.Lodha and Ashuin K.Gosain (2008).

**Employment**

Household employment found significantly positive at 5% level of significance. The coefficients of the employment in 2SLS estimation result suggested that a unit increase in employment of household, average HHDI increases by 11.68%. this was because in better managed watershed area there would be more opportunity of employment. This finding was supported by Rajeshawari Deai et al (2009).

**Upstream and Downstream (UAD)**

As hypothesized, Upstream and downstream found to affect the HHDI significantly negative at 5% significant level. This was due to the fact that downstream households had better HHDI values than that of upstream and better watershed program adoption.. The coefficient of this variable suggests that being an upstream, average HHDI decrease by 10.78%. This result was in lined with the findings of Mena (2018).

## Conclusion & Recommendation

This study analysed the impact of watershed management program on livelihoods of households. The IV (instrumental variable) estimation method was used to account selection bias due to observable and unobservable variables that influence the outcome variable, using training of SWC and perception about soil erosion variables as an instrumental variable for the endogenous variable. With this approach, it was found out that participating on watershed management has a positive and significant impact on livelihood of households. Thus, the program participants have enjoyed a 31% impact on their livelihoods. Since training and awareness creation was as a compliment to participating on watershed programs, strategy which maintains continuous participation and enhancing the willingness and ability of farmers is very crucial. Therefore, strengthening learning opportunities pertaining to integrated watershed management through facilitating programs via establishing farmers' training centers and strengthening extension contact are vital.

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