

# Determinants of Smallholder Farmers' Irrigation Adoption Decision in Afar Region: The Case of Asayta Woreda

Dr. Solomon Alemu Tesfaye

<sup>1</sup>Assistant Professor

Adama Science and Technology University, Adama, Ethiopia.

## ABSTRACT

The study was conducted in Asayta district of the Afar Regional State which has a good access to irrigation water source- Awash River. The main objective of this study is to investigate factors affecting smallholder farming households' decision to adopt irrigation technology. The major tool of enquiry in this study was questionnaire which was distributed to 162 households. Binary legit model was employed to determine major determinants of household irrigation adoption decision. It was noted that households farm experience, off-farm activity, land size, access to extension service and distance to market are major factors directly affecting households decision to adopt small scale irrigation technology. However, family size and access to food aid will negatively affect their irrigation adoption decision in the study area.

**Key words:** *Irrigation, Adoption, small farm, Households.*

## INTRODUCTION

Ethiopia, like other (SSA) countries, is predominantly an agrarian nation with the vast majority of population directly or indirectly involved in agricultural business and around 95% of the country's agricultural output came from small holder farmers (Mulat and Bekele, 2003). It is not exaggerated when one says agriculture is the backbone of Ethiopian economy and the sector is largely small-scale, rainfall dependent, traditional and subsistence farming with limited access to technology and institutional support services.

Cognizant this fact, the government is trying to transform the sector from traditional and rain-fed agriculture to technology intensive and with reduced dependency on rain through full packages of value addition and postharvest technologies. It has undertaken different activities to expand irrigation in the country. Irrigation is an important practice enabling small holder poor farmers to enhance their production, higher yields, and lower risk of crop failure Agerie (2013). In addition, it will lead to year-round farm and non-farm employment. The majority of people residing in the study area are poor and subsistence farm households who produce for their basic needs. The study area has access to Awash River which can be used for cultivation throughout the year. However, small holder farmers so far seems are not willing enough to engage in irrigation scheme. This study is, therefore, attempted to addresses the potential determinants adoption of small holder farm households' small-scale irrigation technology.

## OBJECTIVE OF THE STUDY

The major objective of the study is to assess the determinants of small scale irrigation adoption in Asayta Destrict. The study has specifically attempted

- to identify the Socio-economic, institutional &
- to identify to demographic factors that influence farmer's participation in irrigation.

## MATERIALS AND METHODOLOGY

### Method of Data collection

In order to achieve the objective of this research both primary and secondary data were employed. Primary data were collected from selected smallholders' farmers in the study area.

A multi-stage sampling procedure was applied to select representative sample farmers. First five Kebeles were purposively selected and then sample households were selected from each of these selected Kebeles. Before selecting household heads to be included in the sample, the target population was stratified into adopters (irrigation users) and non-adopters (non-users) households. A total 162 farm households were selected as a representative of the districts small holder farmers.

### Method of Data Analysis

Since the dependent variable ( Adoption) is a dummy variable, which takes a value of zero or one depending on whether or not the household is adopter or not. However, the independent variables are of both types that are continuous or categorical. Binary choice models assume that individuals are faced with a choice between two alternatives and their choice depends on their behavior. Thus, the purpose of a qualitative choice model is to determine the probability that an individual with a given set of attributes will make one choice.

A possible problem with the use of the dichotomous variable instead of the actual continuous variable is that it causes a loss of information in the dependent variable. In this case the models have in common a dependent variable as an indicator of discrete choice

such as yes or no decision. In this study the dependent variable is a binary choice, either the householders is adopter (Y=1) or non-adopter (Y=0). It is believed that a set of factors such as age, family size, education level, household income, farm land holdings, animal holdings, etc. gathered in a vector X affects the probability of being in either of the group.

$$prob(Y = 1 / X) = F(X, \beta)$$

$$prob(Y = 0 / X) = 1 - F(X, \beta) \dots\dots\dots(1)$$

The set of parameters  $\beta$  reflects the impact of changes in X on the probability. In this case what interests us is the marginal effect of explanatory variables on the probability of being adopter. Both Probit and Logit analysis are well-established approaches in the literature focusing on binary choices (Gujarati, 2004) . Whether to use Logit or Probit is a matter of computational convenience. Ayalneh, Hagedorn and Korf (2008) used an ordered Probit model which allows for multiple ordered values for the dependent variable and analysed the effect of each independent variable on the dependent variable.

The Logit model has been widely used in many fields, including economics (Gujarati, 1999)). Probit and Logit models are different due to the specification of the distribution of the error terms as Logit model assumes that the underlying distribution of the error terms is logistic while Probit assumes the distribution to be normal. But both are almost converges to each other with increase in sample size.

To examine determinants of irrigation adoption, binary logistic regression model was used. The dependent variable is dichotomous and has only two values: The model enable us the determination of the factors affecting small scale irrigation adoption. Respondents are classified as adopters and non-adopter.

Therefore, the cumulative logistic probability model is econometrically specified as follows: According to Gujarati (2004), the Logit model, for binary choice, variable  $Y_i$  takes value 1( $Y_i = 1$ ) if the household is default,  $Y_i = 0$  ( $Y_i = 0$ ) otherwise. The Probability of being adoption is a function of  $Z_i$ . Where  $Z_i = \beta_0 + \beta_i X_i$

In explaining occurrence of an event given the explanatory variables, the LPM is

$$P_i = E(Y=1|X_i) = \beta_i + \beta_i X_i \dots\dots\dots(2)$$

Where  $X_i$  is the different determinants of repayment and  $Y = 1$  when a the person is adopter. For the ease of exposition we consider logit model, (Gujarati, 1999)

$$P_i = \frac{1}{1 + \frac{1}{e^{Z_i}}} = \frac{e^{Z_i}}{1 + e^{Z_i}} \dots\dots\dots(3)$$

$$\text{Given } Z_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots\dots\dots + \beta_{15} X_{i15} + u_i \dots\dots\dots(4)$$

Where  $P_i$  is the probability that an individual will make a certain choice (adopt or not adopt) where  $X_i$  denotes the base of natural logarithms, which is approximately equal to 2.718;  $\beta_0, \beta_1, \beta_2 \dots \beta_{11}$  are parameters to be estimated,  $U_i$  is error term and  $X_i$  is explanatory variables

Equation 3 represents what is known as the (cumulative) logistic distribution function. It is easy to verify that as  $Z_i$  ranges from  $-\infty$  to  $+\infty$ ,  $P_i$  ranges between 0 and 1 and that  $P_i$  is nonlinearly related to  $Z_i$  (i.e.,  $X_i$ ). This may create an estimation problem because  $P_i$  is nonlinear not only in  $X$  but also in the  $\beta$ 's as can be seen clearly from (equation 4). This means that it the familiar OLS cannot be used to estimate the parameters. But this problem is more apparent than real because it can be literalized as follows. Where,  $P_i$ , the probability of being adopter, is given by (equation 5), then  $(1 - P_i)$ , the probability of being not adopter, is  $1 - P_i$ .

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \dots\dots\dots(5)$$

Therefore, we can write

$$\frac{P_i}{1 - P_i} = \frac{e^{Z_i}}{1 + e^{Z_i}} \cdot \frac{1 + e^{Z_i}}{1} = e^{Z_i} \dots\dots\dots(6)$$

Now  $P_i / (1 - P_i)$  is simply the **odds ratio** in favor of being adopter is the ratio of the probability that a person is adopter to the probability that he/she is non-adopter. If we take the natural log of this equation, we obtain very interesting results shown as below:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = Z_i \dots\dots\dots(7)$$

$$Z_i = \beta_1 + \beta_2 X_i$$

$L_i$  is the log of the odds ratio and it is not only linear in x, but also linear in parameters. The intercept  $\beta_1$  is the value of log odds in favor of being default.  $\beta_2$ , the slope of coefficient, measures the change in L for  $\alpha$  unit change in X, that is, it tells how the log odds

ratio in favor of being adopter.

Table 1: Description of Variables

Variables	Definition of variables	Expected Value
Sex of household	Dummy (1=male, 0=female)	+
Educational status	Dummy (1=literate, 0=illiterate)	+/-
Household family size	Number of household members	+
Farm land size	Hectare	+
Livestock	Number of animals(TLU)	-
Extension service	Dummy (1= access, 0=no access)	+
Access to market	Measured in kilometres	+/-
Access to Credit	Dummy (1= access, 0=no access)	+
Access to food aid	Dummy (1=access,0 otherwise)	-
Off farm activity	Dummy(1=participated, 0 = otherwise)	-
Farming experience	Dummy(1=experienced, 0 = other wise)	+

## RESULT AND DISCUSSION

### Characteristics of Respondents

The smallholders' farm households' socio-economic characteristics were analyzed and the result is summarized below. Table 1 summarizes the sex distribution of adopters and non-adopters farm households and it show that there is no difference in small scale irrigation adoption decision between male and female headed households in the study area

Table 1 the distribution of household heads based on gender

Gender	Users		Non- users		Chi- (X <sup>2</sup> )	P=Value
	Frequency	Percent	Frequency	Percent		
Male	54	90.0	88	86.3	0.3809	0.537
Female	6	10.0	14	13.7		
Total	60	100.0	102	100.0		

Source: - Survey data

Adoption of irrigation technology might be affected by the level of education of head of households. Those who are literate are expected to be more open to new technology and they most likely to adopt small scale irrigation technology than their illiterate counterparts.

Table 2 Distribution of household heads based on educational status

Educational status	Users		Non-users		Chi- (X <sup>2</sup> )	P=Value
	Frequency	Percent	Frequency	Percent		
Illiterate	24	40.0	70	68	8.5060	0.004
Literate	36	60.0	32	32		
Total	60	100.0	102	100		

Source: - Survey data

From table 2, it can be noted that, as expected, there is a significance difference between the two groups. This implies that, literate households most likely participate in small scale irrigation scheme than illiterate households in the study area. From this it can be concluded that education can change the behavior of households and may induce them to engage in irrigation practices.

Table 3 Distribution of household heads access to extension service and training

Households access to extension	Users		Non-users		Chi-(X <sup>2</sup> )	P=Value
	Freq.	Percent	Freq.	Percent		
No access	32	53	88	86	17.1532	0.000
Have access	28	47	14	14		
Total	60	100.0	102	100.0		

Source: - Survey data

Extension service supposed to introduce modern technology to the farmers' society and facilitate their adoption. Farmers having access to extension services and the frequency of visit of extension agents expected to induce farmers to adopt new technology

including irrigation technology.

As expected the result in table 3 show that, there is a difference in irrigation adoption behavior between farmers having access to extension services and farmers having no access to extension service. Those households having access to extension service most likely adopt small scale irrigation technology than their non-adopter counterparts. Access to financial resource is an important factor that may significantly affect the ability of farm households to acquire farm input. Table 4 presents households distribution by credit access in the study area.

Table4: Households distribution by access to credit

Households access to credit	Users		Non-users		Chi-( X <sup>2</sup> )	P=Value
	Frequency	Percent	Frequency	Percent		
No access	24	40.0	80	78		
Access	36	60.0	22	22	17.8705	0.000
Total	60	100.0	102	100.0		

Source : Survey data

As expected majority of non-adopters (80%) do not have access to credit while majority of adopters do have access to credit. In other words there is a significant difference in small scale irrigation adoption decision between farm households having access to credit and those households with no credit access.

### Determinants of Smallholder Farmers Irrigation Adoption Decision

As mentioned above, Logistic regression was employed to estimate the determinants of smallholder farmer households' irrigation adoption decision in the study area. The result of regression in table 5 showed that out of the total of eleven explanatory variables (determinants) included in the model, seven of them are found to be major factors significantly affecting the probability of rural farm households' adoption decision of small-scale irrigation practices in the study area

Logistic regression	Number of obs = 162
	LR chi2(16) = 119.74
	Prob > chi2 = 0.0000
Log likelihood = -23.344047	Pseudo R2 = 0.7195

Table 4: Determinants of smallholders' farmers' adoption to irrigation

Determinants	Coefficients	Std. Err.	P>z	Odds ratio
Sex	-1.890	2.117	0.372	0.151
Farm Experience	4.599***	1.535	0.003	9.416
Off Farm activity	4.546**	1.893	0.016	7.228
Family size	-3.984**	1.614	0.014	0.020
Land size	1.632**	0.602	0.007	5.115
Distance to Market	1.213**	0.603	0.044	3.365
Access to aid	-7.401***	2.186	0.001	0.001
Access extension service	2.990**	1.484	0.044	6.895
Education status	-1.403	1.262	0.266	0.246
Access to credit	0.046	1.132	0.968	1.047
TLU	-0.465	0.477	0.332	0.628

Source : STATA output based on survey data

**Household Farming Experience:** It is found to important factor positively affecting households decision to adopt small scale irrigation technology than farms with little experience. The odds ratio result 9.41 indicate that other things holding constant the as the farming experience of household farmers increases by one more year the probability of adopting small scale irrigation technology increases by about 9.4 factor.

**Off farm activity:** Off-farm activity enables farmers to generate additional income which may enhance their capacity to acquire improved farm inputs including irrigation facilities. As expected, the study result revealed the fact that there is a significant and a positive relationship between irrigation adoption decision of farm households and their engagement in off-farm activities

**Household Family size:** Larger family size expected to increase farmers participation in irrigation activities as it will supply them necessary manpower to the households. However, the study result is not consistent with expectation and it rather indicates that, increase in the household size decreases the probability of household decision to adopt small scale irrigation technology in the study area. The result is statistically significant at 5% significance level with the odd ratio 0.02 implying that as the size of the family increases by one member the probability of their small scale irrigation adoption decision decreases by 0.02 factor, ceteris paribus.

**Households Land size:** As expected, the farm size has a significant and direct effect on the households' irrigation adoption decision in the study area. Larger farm size enable farmers to cultivate different types of crops including cash crops which require irrigation technology. Therefore, households with larger farm size most likely to adopt small scale irrigation technology than their counterparts with smaller farm size households. The odds ratio result implied that other factors being constant as the size of the farm increase by one more unit the probability of participating in irrigation practices increases by a factor of 5.1.

**Distance to market:** The distances of farm households from the market is important factor directly related to their irrigation adoption decision. When farmers are closer to the market, the probability of engaging in the production of marketable products like cash crop will increase and this in turn induce them to adopt irrigation technology.

**Household heads Access to Aid:** Access to food aid will negatively and significantly affect households' decision to adopt small scale irrigation scheme. This can be explained by the fact that most if not all households who have access to food aid are poor that cannot afford to feed themselves. Such households do not have the capacity to buy farm inputs including irrigation technology.

**Access to Extension Service:** In the study area, access to extension service is not adequately developed as a result most agricultural activities were practiced traditionally. The findings indicate that access to extension services is a significant factor positively affecting households irrigation adoption decision. Those households having access to extension services will be aware of modern agricultural technologies including irrigation technology. Awareness and benefit of modern technology will increase the probability of adopting small scale irrigation decision. The finding is consistent studies such as Haruna, S. (2003), who have concluded that, the adoption rate would be high, if farmers are regularly advised by competent extension agents, with adequate support materials provided in a coordinated way.

## CONCLUSION

The study has tried to identify major determinants of small farm holders households adoption decision of small scale irrigation technology in the Asayta District. It was noted that there is no difference in adoption decision between men and female headed households. However, the irrigation adoption decision differs by education level, access to credit and extension service.

Farm experience, off-farm activity, land size, distance to market and access to extension services are important determinants of small scale irrigation adoption decision of farm households in the study area. However, family and farm size, and access to aid are factors that will reduces the probability of adoption of irrigation technology in the study area.

Therefore, creating opportunity of off-farm activities and access to extension service are important aspect to be considered so as to ensure the households participation in irrigation scheme in the study area.

## REFERENCE

1. Abonesh Tesfaye et al., (2006), The Impact of Small scale Irrigation on household food security: the case of Filtino and Godino irrigation schemes in Ethiopia.
2. Agerie Nega Wassihun,(2013) Determinants of Smallholder Rural Farm Households' Participation in Small Scale Irrigation and Its Effect on Income in North Gondar Zone: A Cross-Sectional Approach (Evidence from Dembia Woreda)
3. Ayalneh Belay, Hagedorn K. and Korf B. (2008) Analysis of poverty and its covariates among smallholder farmers in eastern Hararge highlands of Ethiopia: An application of ordered model probit, Alemaya University
4. Gujarati, D., (2004), *Basic Econometrics*, McGraw-Hill International Editions, (4th Edition).
5. Gujarati, D.N. (1995). *Basic Econometrics*. Third Edition. Mc.Graw-Hill Book Company, New York, USA.
6. Bembridge, T.J., 2000. Guideline for rehabilitation of small-scale irrigation schemes in South Africa. Water Research Commission, Report no. 891/00, Pretoria, South Africa.
7. CARE (2001). Design report of done irrigation scheme Terminal and evaluation report, Shewa project, care international in Ethiopia.
8. Christopher B. Barrett(2006), Food Aid's Intended and Unintended Consequences Background Paper for FAO *State of Food and Agriculture, cornel university,2006* revised version
9. FAO (1997), Irrigation Potential in Africa: Basin approach: land and water bulletin 4, FAO, Rome, Italy
10. Gholam Hosein Zamani,( 2008), Farmer participation in irrigation management: The case of Doroodzan Dam Irrigation Network, Iran
11. Haruna, S. Kura (2003), Socio- economic analysis of factors affecting, farmers' Participation in large-scale irrigation scheme Management in Kano River irrigation project
12. Hillel Danel (1997), Small Scale Irrigation for arid zones, principles and options, FAO
13. Hussain, intizer, Anmd Munir , and A.Hanjra. (2004), irrigation and poverty alleviation; Review of the empirical evidence. Irrigation and drainage.
14. Magazire,M.(1993).Appraisal of Small Scale Irrigation Scheme in semi-arid areas of Zimbabwe, Agricultural University of Norway.
15. Zimbabwe/Michigan State University Conference on Food Security in Southern Africa
16. Workneh Negatu. 2004. Determinants of rural livelihood diversification: Evidence from South Ethiopia. Quarterly Journal of International Agriculture 43 (3): 267–88.