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Factor Affecting Rain-Water-Harvesting Technology Adoption and Farmers Practices against Drought and Water Shortage in Eastern Hararghe Low Land, Ethiopia

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Abstract

Rain-water-harvesting is one of the means by which agricultural production can be increased to meet the growing food demands in all regions. The study indentified the factor affecting rain-water-harvesting technology adoption for irrigation and farmers practice in water harvesting against drought in lowland woreda, Eastern Hararghe, Oromia Region. Both primary and secondary data were collected for the study. Primary data were collected from 190 sample households using questionnaire prepared during june15-july20/2014. The study implemented logistic regression model to identify factor affecting rain water harvesting adoption. Logistic regression estimation revealed that age of household head, education level, number of livestock in TLU, size of land holding, distance between home and farmers extension center and labor force the member are significantly affected the rain water harvesting adoption decision of household in study area. The results also show that on average rain water harvesting adopter households and non-adopter households had around 5043 and 2962 ETB respectively. This means, households that adopted rain-water-harvesting ponds were better off in total farm income compared to non-adopter households.

Keywords: Rain-water-harvesting, Logistic regression, Framers' practice

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1. Introduction

Ethiopia has a total population of 73.9 million and the rural population, which is predominantly dependent on agriculture, accounts for about 85 percent of the total (CSA, 2007). Ethiopia is among the low income countries of the world and ranks among the lowest for most human development indicators (World Bank, 2010). The Ethiopian economy is highly vulnerable to droughts and adverse terms of trade by virtue of its dependence on primary commodities and rain-fed agriculture. Thus the country's growth performance is highly correlated with weather conditions. A 1% change in average annual rainfall is associated with a change of 0.3% in real GDP in the following year (Mwanakatwe, 2010).

Ethiopia is an agrarian country where around 95% of the country's agricultural output is produced by smallholder farmers (MoARD, 2010). The contribution of agriculture to national GDP (50%), employment (85%), export earnings (90%), and supply of industrial raw materials (70%) has remained high (World Bank, 2010). Although the country is endowed with three main resources namely land, water and labor for production, agriculture in the country is mostly small- scale, rainfall dependent, traditional and of subsistent nature with limited access to technology and institutional support services.

Rainwater harvesting and its application to achieving higher crop yields encourages farmers to add value and diversify their enterprises. Rainwater harvesting created new/additional sources of water and helped in the provision and regulation of the water supply systems. Poor management of rainwater in rain fed systems generates excessive runoff and floods, causing soil erosion and poor yields. Availability of stored water in the farms through pans and ground tanks was found to be very useful in supplemental irrigation for crops planted during the rains in semi-arid areas. With the adoption of rainwater harvesting technologies, households had become food self-sufficient and the surplus was sold to generate income. Adoption of rainwater harvesting technology improves the quality of life by providing safe water for domestic use, livestock and agricultural production. Rainwater harvesting at the household or community level enables rainfed farms to access a source of supplementary irrigation, the economic security also improves (Ngigi, 2003).

Rainwater harvesting is a technique used for collection and storage of rainwater from catchments areas (Kun et al., 2004). The rain water harvesting techniques usually found in Asia and Africa originate from practices employed by ancient civilizations within these regions and these still serve as a major source of water supply in rural areas (Theib and Ahmed, 2006). Rainwater harvesting can be a very good option for the rural areas which are suffering from water scarcity (Nissen, 1982). The harvesting of rainwater in a particular region is highly dependent upon the amount and intensity of rainfall and some other factors like catchment area and type of catchment surface (Pacey and Cullis, 1989).

Due to population increase, more and more marginal areas are being used for agriculture which led to the degradation of the natural resources. One of the major challenges to rural development in the country is how to promote food production to meet the ever-increasing demand of the growing population. Rainfall in the arid and semi-arid areas is generally insufficient to meet the basic needs of crop production. In degraded areas with poor vegetation cover and infertile soil, rainfall is lost almost completely through direct evaporation or uncontrolled runoff. Thus, overcoming the limitations of these arid and semi-arid areas and making good use of the vast agricultural potential under the Ethiopian context, is a necessity rather than a choice. The issue of technological convenience and acceptance by the users for a proper promotion and adoption of water harvesting technology have been stressed. Thus, there is need for appropriate interventions to address the prevailing constraints using suitable technologies for improved and sustainable agricultural production (Ngiggi, 2003).

To mitigate the erratic nature of rain-fall in the arid and semi-arid parts of the country, which threatens the lives of millions of people, a national food security strategy based on the development and implementation of rainwater harvesting technologies either at a village or household level was adopted after 1991. The Federal Government had allocated a budget for food security programs in the regions, an amount equal to ETB 100 million and ETB one billion during the 2002 and 2003 fiscal years, respectively. Of the total budget, most of it was used by regional states for the construction of rainwater harvesting technologies including household ponds, in collaboration with the Federal Ministry of Agriculture and Rural Development (Rami, 2003).

People in some parts of the world where water shortage exists have successfully utilized water-harvesting systems. The application of water harvesting techniques, although potentially high, is still low in Ethiopia. Provided the huge amount money, time and effort which has been exerted so far for introducing and promoting RWH technology, many farmers do not adopt it still. As a result, the attempt made for rainwater harvesting in various localities of the study area to attain increased food production in sustainable manner didn’t yield the expected result. This observation initiated the author to work research on analyzing factors affecting adoption of RWH technology among smallholder farmers. The study aims at identifying factors affecting adoption of modern RWH technology recently introduced in the study area and farmers practice against drought and shortage of water. The aim of this study is therefore to generate information for policy makers and executive officials for intervention that can facilitate the adoption of RWH technology.

Generally, this study was conducted in Gursum, Fadis and Babile districts, which are moisture stress districts of the Eastern Harerghe zone. These districts are area in which rain water harvesting has been practiced. However, there was no adequate study to analyze factor affecting rain water harvesting technology and other mechanism farmer are using against drought and water shortage season in the years. Thus, it is important to identify the factor affecting rain-water-harvesting technology adoption for irrigation and farmers practice in water harvesting and other mechanism to minimize water lose from perennial crop. The main objectives of the study is to analysis factor affecting rain water harvesting technology adoption for irrigation purpose and to identify farmers practice against drought and water shortage in the study area.

2. Materials and Methods

2.1 Sampling method

Eastern Hararghe zone is one of the 17 zones of the Oromia National Regional State. It is located in the eastern part of the country. It divided into 19 districts and Harar is the capital town of the zone and is located at the distance of 525 kms from Addis Ababa. The agro climatic range of Zone includes lowland (*kolla*, 30-40%), midland (*weyna dega*, 35-45%) and highland areas (*dega*, 15-20%), with lowest elevations at around 1,000 m a.s.l, culminating at 3,405 m, at the top of Gara Muleta mountain.

The study was conducted in Gursum and its neighbor woreda of Eatern Hararghe, which is purposively selected due to availability of potential rain-water-harvesting practice. The climate of the area is characterized by warm and dry weather with relatively low precipitation. It receives a bimodal type of rainfall, *Belg* and *Maher* rain. Agriculture is the major source of livelihood of the community. However, its productivity is dependent on the rain-fed agriculture.

The farming system is subsistence type dominated by smallholder farmers. Sorghum and maize crops take the largest proportion of crop production and chat is the main cash crop in the area. Total rural kebeles that are practicing water harvesting and using for irrigation purpose was identified. Out of the 39 rural *kebeles* that are found in the Gursum district, two rural *kebeles(muyadin and harashi)* were randamly selected. *Muyadin and Harashi kebeles have* 720 and 304 plastic pvc to harvest rain-water respectively.

To select sample respondents from two *kebeles*, first the household heads in the both *kebeles* ware identified and stratified into two strata: farmer harvesting rain water and non-harvesters. Then the sample from each stratum was selected randomly using simple random sampling technique. Since the number of household heads in the two groups were proportional, equal number of sample was drawn from each group, *i.e*., 95 household heads was selected from each group. Total of 190 respondents were interviewed using questionnaire prepared for this purpose during june15-july20, 2014. In the case of farmers' good practice against drought and water shortage Gursum and Fadis districts ware among selected site.

2.2 Data analysis techniques

Based on the objectives of study, both descriptive statistics and econometric models were employed to analyze qualitative and quantitative data. From econometric model, logistic regression was also used for analyzing the factor affecting rain-water-harvesting pond adoption. To analyze the factor affecting rain-water-harvesting adoption for irrigation, dependent variable is dichotomous in nature and represents the observed rain-water-harvesting ponds. It was represented in the model as rain-water-harvest adopter (RWH) =1 for a household that use pond to harvest rain water and non-adopter =0 for a household that do not use pond to harvest rain water.

The logit and probit are the two most commonly used models for assessing the effects of various factors that affect the probability of adoption of a given technology. These models can also provide the predicted probability of adoption. However, the logit model is simpler in estimation than probit model (Aldrich and Nelson, 1984) hence; the logit model was used in this study to analyze the factors affecting adoption Rain-Water-harvesting ponds. Following Liao (1994), Gujarati (2003) and Aldrich and Nelson (1984) the logistic distribution function for adoption of rain-water-harvesting:

$$P_i=\frac{1}{1+e^{-z_i}}=\frac{e^{z_i}}{1+e^{z_i}} \quad (1)$$

Where, P_i = is the probability of adopting rain-water-harvesting ponds for the i^{th} farmer and it ranges from 0-1.

e^{zi} = stands for the irrational number e to the power of Z_i.

Z_i = a function of n-explanatory variables which is also expressed as:

$$Z_i=b_0+b_1X_1+b_2X_2+\ldots+b_nX_n \quad (2)$$

Where, X_1, X_2… X_n are explanatory variables. b_0- is the intercept, b_1, b_2 … b_n are the logit parameters (slopes) of the equation in the model. The slopes tell how the log-odds ratio in favor of adopting rain-water-harvesting pond changes as an independent variable changes. The unobservable stimulus index Z_i assumes any values and is actually a linear function of factors influencing adoption decision of Rain water harvesting ponds for irrigation purpose. It is easy to verify that Z_i ranges from $-\infty$ to ∞, P_i ranges between 0 and 1 and that P_i is non-linear related to the explanatory variables, thus satisfying two requirements: As X_i increases P_i increases but never steps outside the 0 and 1 interval; and The relationship between P_i and X_i is non-linear, i.e., one which approaches zero at slower and slower rates as X_i gets small and approaches one at slower and slower rate as X_i gets very large. But it seems that in satisfying these requirements, an estimation problem has been created because P_i is not only non-linear in X_i but also in the B's as well, as can be seen clearly below.

$$P_i=\frac{1}{1+e^{-(b_0+b_1X_1+b_2X_2+\ldots+b_n)}} \quad (3)$$

This means the familiar OLS procedure cannot be used to estimate the parameters. But this problem is more apparent than real because this equation is intrinsically linear. If P_i is the probability of adopting a given rain-water-harvesting technology then $(1-P_i)$, the probability of not adopting, can be written as:

$$1-P_i=\frac{1}{1+e^{Z_i}} \quad (4)$$

Therefore, the odds ratio can be written as:

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

Now $\frac{P_i}{1-P_i}$ is simply the odds ratio in favor of adopting rain-water-harvesting ponds. It is the ratio of the probability that the farmer would adopt rain-water-harvesting for irrigation to the probability that he/she would not adopt it. Finally, taking the natural log of equation 5, the log of odds ratio can be written as:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \ln\left(e^{b_i + \sum_{i=1}^{n} b_i X_i}\right) = Z_i = b_0 + \sum_{i=1}^{n} b_i X_i \quad (6)$$

Where, Li is log of the odds ratio in favor of rain-water-harvesting adoptions, which is not only linear in Xi, but also linear in the parameters. Thus, if the stochastic disturbance term, (u_i), is introduced, the logit regression becomes:

$$Z_i = b_0 + b_1X_1 + b_2X_2 + \ldots + b_nX_n + u_i \quad (7)$$

3. Results and discussion

3.1 Households' demographic and socio-economic characteristics

As mentioned in the methodology parts the descriptive parts of the analysis is used to describe characteristics of the sample respondent. Table (1) shows descriptive statistics results of sample household based on participation in rain- water-harvesting using ponds. Family size is useful for formulating various development plans and for monitoring and evaluating their implementation. In the study area, the average family size was 5.5. The t-test shows that there is no significant difference in family size between the rain water harvesting adopter and non-adopter households (Table 1). The average cultivated land of all sample respondents was 1.3ha. On average adopters household have 1.5 ha while non-adopters have 1.2ha. There is a significant difference in their size land holding. The survey results showed that mean difference between rain water pond adopter and non-adopter was found to be significant at 1% significant level based on land holding of household.

Livestock is very important asset in farm household. In this study, the average livestock holding of household is 1.5 in TLU. On average participant household have 1.9 while that of non-participant in rain water harvesting is 1.2 in TLU. Participant households have larger livestock compared to non-participant households. The survey result revealed that, the mean difference between rain water harvesting –adopter and non- adopter household was significant at 1% level of significance based livestock holding in tropical livestock unit. Similarly, rain water harvesting adopters have more number of extension contact days compared to non-participants. The average number of days participants visited by extension workers in the year is 24.4time and that of non-participant is 23.2times in the year. The result showed that, the mean difference between numbers of times adopters visited by extension workers and non-adopters were also found to be significant at 10% significance level.

Descriptive statistics results of sample households presented in Table 2 based on measure of total farm income in Ethiopian Birr (ETB). The survey results show that on average rain water adopter households and non-adopter households had around 5043 and 2962 ETB respectively. This means, households that adopted rain-water-harvesting ponds were better off in total farm income compared to non-adopter households. There are statistical mean differences between both groups of households all outcome variables.

Table 1. Socio-economic characteristics of sample households and adopter to rain water ponds.

Variables	All sample HH(n=190)		Rain-water pond adopter HH(N=95)		Non-adopter HH(N=95)		Mean difference	t-value	sig
	Mean	Std	Mean	Std	Mean	Std			
Age of household head	35.5	7.4	37.3	8.7	33.8	5.2	-3.4	-3.3***	0.000
Market distance	10.5	3.1	10.4	3.1	10.6	3.1	0.2	0.4	0.630
Labor force	3.9	1.3	4.1	1.2	3.6	1.3	-0.5	-2.7***	0.000
Extension agent contact.	24.4	11.7	25.7	11.9	23.2	11.5	2.5	-1.5*	0.070
Extension distance	1.8	1.4	1.4	1.4	2.2	1.3	0.8	0.8	0.900

*** and * means significant at the 1%, and 10% probability levels, respectively

Table 2. Comparison of income variable between rain-water-harvesting adopter and non-adopter

	Rain water pond user		Non-user		Mean difference	t-value
	Mean	std	Mean	std		
Total farm income/yr	5042.6	2843	2962.2	2353.3	-2080.4	-5.5***

*** mean significant at 1% probability level.

Table 3. Logistic regression results for determinants of in rain-water- harvesting adopter

Variables	Coef.	Odd ratio	Std. Err.	z	Significance
Age of household head	0.0374	1.03	0.018	2.11	0.017**
Gender of household head	0.3087	1.63	0.23	1.34	0.193
Education of household head	0.1552	1.32	0.038	4.12	0.00***
Family size	-0.0166	0.97	0.072	-0.23	0.806
Market distance	-0.0235	0.96	0.04	-0.59	0.571
Farm size	0.6976	3.37	0.229	3.05	0.00***
Livestock	0.6705	3.17	0.154	4.35	0.00***
Labor force	0.1607	1.33	0.093	1.73	0.08*
Extension contacts	0.0081	1.01	0.01	0.86	0.413
Extension Distance	-0.3819	0.51	0.091	-4.18	0.00***
Constant	-3.9394		0.991	-3.98	0.00

Number of obs=190, Prob>chi2=0.000, LR chi2(10)=97.42, log likelihood=-82.99, Pseudo R^2 =0.369
*** and ** means significant at the 1%, and 5% probability levels, respectively

3.2. Results of Econometric Model

The pseudo- R^2 indicates how well the regressors explain the participation probability. The logistic regression model was used to estimate factor affecting rain-water-harvesting adoption. The dependent variable in this model is a binary variable indicating whether the household was adopter of the rain-water-harvesting or non-adopter. It was represented in the model as rain-water-harvest adopter (RWH) =1 for a household that use pond to harvest rain water and non-adopter =0 for a household that do not use pond to harvest rain water. The model was estimated with STATA 11.2 computing software. The pseudo-R^2 value is 0.369.

It was found that rain-water-harvesting adoption is significantly influenced by six explanatory variables. Age of household head, level of formal education, , size of land holding, size of livestock in TLU, labor force in family member and distance from farmers extension center are significant variables which affect the participation of the household in rain-water-harvesting ponds and its utilization. Age of household head shows positive relation with participation in rain water harvesting practice. This implies that an increase in age of household head increases participation in rain water harvesting practice and the likelihood for household to become food secure. This is possible because older farmers have better experience in farming; try to learn more from past and use better planning than the younger ones. As the age of household head increase the probability of household adoption in rain-water-harvesting increase. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of rain water harvesting practice increase by a factor of 1.03 as age of household head increase by one year(Table 3).Access to higher formal year of schooling has positive relationship with household participation in rain-water-harvesting.

Similarly, size of land holding has positive effect on household participation in rain water harvesting adoption. As the size of land holding area increases the probability of being a participant in rain water harvesting increase. This is because of the fact that the size of landholding is a surrogate for a host of factors including wealth and capacity to bear risk due to larger farms. Larger farms are associated with greater wealth and availability of capital, which increases the probability of purchasing farm inputs and plastic material that is used to harvest rain-water. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of participating in rain water harvesting increases by factor of 3.37 as size of landholding increase by one unit (ha). Werku (2006) and Tafere (2005) too reached to similar conclusion with regard to size of land holding variable and participation in rain-water harvesting technology.

Similarly, households that have home nearer to farmers training center were more likely to be included in the rain-water-harvesting practice. This variable found to be positively related with the participation rain-water-harvesting and using for irrigation. This implies that household that have residence far from farmers training center have not updated information regarding with new agricultural technology and training. As the distance between farmers home and farmers training center increase the probability of household participation in rain-water-harvesting decrease. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of harvesting-rain-water and using for irrigation purpose decreases by a factor of 0.51 as distance between home and farmers training center increase by one kilometer (Table 3).

Households who have larger number of livestock in tropical livestock unit were more likely to be included in the rain-water-harvesting and utilization. This variable is found to influence participation of household in rain-water-harvesting positively and significantly. The implication of the result was that livestock are an important source of cash in rural areas to allow purchase of farm inputs that can be used when rain water is harvested used for irrigation purpose. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with the use of harvested rain water for agriculture. Given this potential contribution of livestock to sustainable household food supply and cash generation, they encourage adoption of new technology. The odds ratio of 3.17 implies that, other things kept constant, the odds ratio in favor of harvesting rain water and using for irrigation increases by a factor of 3.17 for each increase in TLU for livestock (Table 3). This implies that livestock holding has an influence on the adoption of new technologies in different areas. This finding is consistent with previous result of Abonesh et al (2006).

Rain-water-harvesting require large number of labor force in rural area. Households that have larger number of working group members were more likely to be included rain-water-harvesting. As it is reveled from estimation of the logit regression analysis indicate that, participation in rain-water-harvesting technology has a positive and statistically significant association with use of higher labor, most likely due to the higher level of labor requirement during construction of rain water harvesting pond and watering activities involved. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of participating in rain water harvesting increases by factor of 1.3 as number working family member increase by one person.

4. **Some practice of farmers in moisture stress area of eastern Hararghe low land against drought and water shortage**

According to (Sianesi, 2004) there is no enough water for most farmers, in Ethiopia, to produce more than one crop per year due to lack of water storage and large spatial and temporal variations in rainfall. Furthermore; there are frequent crop failures due to dry spells and droughts which have resulted in a chronic food shortage facing the country. Ethiopian agriculture is mostly rain fed, whereas inter-annual and seasonal rainfall variability is high and droughts are frequent in many parts of the country. Rainfall variability has historically been a major cause of food insecurity and famines in the country. During research data collection the following farmers practice against moisture stress and lack of water for both domestic use and irrigation water was observed by researcher and arranged in the following parts of the paper.

Farmers in their specific area may face water shortage for both domestic use and irrigation purpose. Through straggling for survive in various condition of water stress area they may adapt different mechanism against shortage of water. In fact, without water, life on Earth would have never begun. Acting as a medium in which organic compounds could mix with one another, water facilitated the formation of the planet's first life forms, possibly even protecting them from the sun's radiation. Our bodies also use water to flush out toxins, regulate body temperature and aid our metabolism. No wonder, then, that water makes up nearly 60 percent of our bodies or that we can't go for more than a few days without it. In low land area where spring or other source of water for domestic use is far from their residence they have to go that distance to fetch water for their livestock and drinking purpose. In most area of such harsh condition women and children were the main parts of the community that mostly participated in fetching water in the farm household.

Fig 1. Women and children participated in fetching water

A drought can be defined as a prolonged period of unusually dry weather in an area where some rain might normally be expected. Droughts involve water shortages, crop damage, steam flow reduction and depletion of groundwater and soil moisture. In the area where ground water table is far from surface, farmers are trying to dig very long well to obtain drinking water. In such area of water stress place of Eastern Hararghe, farmers are finding water in around 36-40m deep well. Sometimes, they may face the absence of water after such efforts, loss of time and costs. This shows that how farmers are making strive against shortage of water to survive in water stress area. The following figure 2 shows when farmers in eastern Hararghe low land is struggling for search of water for domestic use.

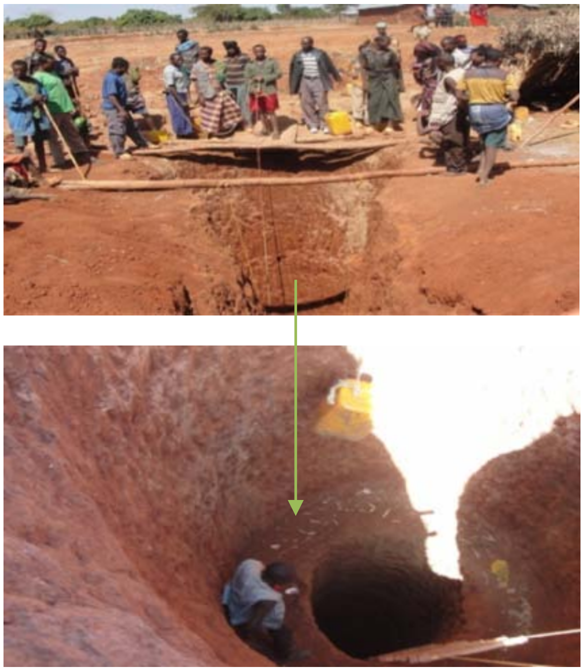

Fig 2. Farmers' effort for searching groundwater in low land area

The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. In different area farmers have accumulated different experience in water harvesting.

The rain-water harvesting techniques most commonly practiced in Ethiopia today are run-off irrigation (run-off Farming), flood spreading (spate irrigation), in-situ water harvesting (ridges, micro basins, etc.) and roof water harvesting. Macro-catchment water harvesting, also called harvesting from external catchments is the case where runoff from hill-slope catchments is conveyed to the cropping area located at hill foot on flat terrain. Run-off irrigation during rainy season is widely used in Hararghe for the production of major crops in the area; sorghum and chat (Chat edulis). The technique is based on the use of runoff produced from the adjacent upland farms and made to be diverted for use back in the farm at a lower elevation. This technique is well adapted for crop production in the lowland area of Easter Hararghe. Flood water harvesting can be defined as the collection and storage of creek flow for irrigation use. Flood water harvesting, also known as 'large catchment water harvesting.

Crop productivity has been significantly increasing and production is getting stabilized even at bad seasons. Every bit of runoff from the farm is harvested and it is used for irrigation, and it is now becoming a common practice in Haramaya, Fadis and Gursum District. During the early part of the season, one or two run-off irrigation improves the establishment of the crop stand and the last season runoff (again three or four irrigation) will bring the crop to full maturity.

In some area of Eastern Hararghe zone, farmers use run-off sandy catchment as source of water for both domestic and irrigation purpose. The system is that, at summer time when the flood is created from rain in large catchment around, it move to the lower and plain due to gravity. The run-off water can infiltrate in huge sandy and flat catchment. Then after, in dry season farmers dig in the soil near to huge sandy and harvest large amount of water for irrigation. This kind of run-off water harvesting is possibly created in very flat and large catchment area where farmers dig sandy and harvest water for irrigation and other domestic purpose. As numbers dry months increase the depth of the water in sandy soil increase. Flood water infiltration and ground water recharge of a shallow alluvial aquifer is very important technique and practice in moisture stressed area of Eastern Hararghe.

The following figure 3 shows large and flat sandy where rain flood during rainy season infiltrate in and then farmers use the sandy as source or storage of flood for off season. The sandy absorb large amount of flood during summer rain. Later in off season farmers dig out the nearby soil of the sand and use the water for both domestic use and irrigation purpose. Infiltration depends on there being sufficient porosity in the surface soil for rainfall to infiltrate, and in the subsoil and parent material (if shallow) for rainwater to percolate. When the porosity of the surface soil is too low to accept rainfall, or subsoil porosity is too low to allow rainwater percolation (i.e. permeability is too slow), then infiltration will be restricted and rainfall will be lost as runoff. However, in the following figure infiltration is very high because of sand accumulation.

sag

Fig 3. Catchment sandy as source of water for irrigation and domestic use.

The unstable distribution pattern of rainfall and moisture stress problem from year to year results in uncertain and often uneconomic condition for agricultural production in arid and semi-arid parts of Ethiopia. Each year, drought adversely affects agricultural production somewhere in the country. Therefore, the major concern in the drought prone and moisture deficit areas of the country is addressing the issues of food security as a major strategy where the primary solution has to be found within agriculture. Moisture conservation and water harvesting are the major activities for enhancing agricultural development in such zone. Rain water harvesting helps to overcome water scarcity in the moisture stress area. Farmers have different experiences in practicing water harvesting depending on the real condition in that environment. To solve the problem of irrigation water some farmers uses hand dung well to harvest water, the other uses ground water while the other farmers rainwater harvesting in PVC plastic.

As witnessed in several parts of the world, complications due to the amount and distribution of rainfall could be averted through the expansion of RWH practices. According to UN officials, Ethiopia is among the nine countries of Africa which posses great potential for RWH. It is estimated that the country could meet the needs of six to seven times its current population, i.e., equivalent to 520 million people (Kassahun, 2007). The application of water harvesting technique however, although potentially high, is still low in Ethiopia. Similarly, in this area farmers are using plastic structure to harvest rain water for irrigation and domestic use. The following pictures are show how farmers in some parts of Eastern Hararghe zone especially in Gursum are harvesting rain water for irrigation purpose to increase their income and minimizing their problem of food security. Not rain water harvesting only the solution but also how to manage the harvested rain water and efficient utilization should be the main issue in water harvesting system. Rainwater Harvesting is when the precipitation is collected from a small/large surface area (catchment) and directed through channels to a storage facility or to a nearby field or retained at the site itself. This study was undertaken in area where rain water harvesting technology, trapezoidal pond and cylindrical structures are being practiced.

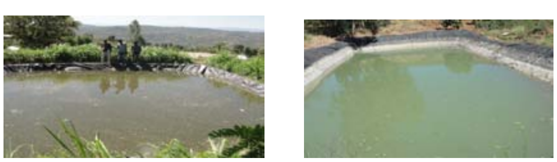

Figure 4. Trapezoidal pond covered with pvc plastic in study area

Figure 5. Sample of cylindrical rain-water-harvesting ponds (pvc) plastic

The problem of soil water losses through surface runoff and evaporation is one of the major limiting factors in agricultural production today. Especially in arid ad semi-arid lands, short intense storms coupled with prolonged dry spells make crop production difficult, if not impossible. In arid and semi-arid area of low land, farmer's uses different mechanism to reduce amount of moisture evaporated from perennial crop. In this study area of eastern Hararghe, farmer was using harvested rain water for irrigating their main cash crop in dry season. They are using pvc plastic to harvest rain water during rainy season. The amount of rain harvested is limited to capacity of plastic used to store water. To utilize this limited water efficiently and effectively they are using different mechanism that minimizes water lose. The main cash crop in the study area is chat crop which require 2-3times more water in single crop season. However, farmers are reducing frequency and amount of water required for this crop by reducing their old leaves. This dropped leaves also used as mulch to reduce evaporation from the surface soil. After this leaves are removed from the chat tree (Chat edulis), it requires little amount of water to be harvested for the market.

Fig.6 Removing perennial crops' leaves to reduce evapo-transpiration

The problem of water shortage for crop production can be alleviated through proper management and utilization of available rain water or rainfall harvested. Farmers in different area practice various methods in solving their own problem. This method can be the best technique for farmers in other area. Efficient use of water by irrigation is becoming increasingly important and agronomic measures such as mulching and anti-transpirants can reduce the demand for limited irrigation water obtained from rain water harvesting and improve irrigation water use efficiency.

Generally, Farmers should share information on best practice. Information documentation and sharing experiences among the stakeholders would be an effective strategy. There is need to facilitate farmer to farmer learning through exposure and exchange visits, information sharing, establish farmers shows and facilitate farmers to document their experiences. It is important to boost on farm and applied research in participatory technology development for various technologies. Therefore, awareness on rain water harvesting management and technologies for farmers, DA's, Experts and other stakeholders will be the first step on improving water harvesting system and efficient utilization of water

5. Conclusion and recommendations

Rain-water-harvesting for irrigation is important development effort to ensure households food security and farm income if properly implemented. Based on the empirical findings reported in this study, the following recommendations are forwarded:

Education of household head and participation in rain-water-harvesting ponds showed positive and significant relationship. The more household head educated, the higher will be the probability of educating family member and familiar with modern technology adoption and participation in rain-water-harvesting.

Formal education is one of the factors that affect income of household and food security. Strengthening educational capacity of household heads and whole community leads to acceptance of important new technology and increase household income and food security. Therefore, a way of access to adult education should be designed.

Similarly, a rain-water-harvesting activity is labor intensive and requires more participation of family member and community in pond construction. This variable has positive and significant relationship with participation in rain-water-harvesting activities. So, encouraging farm community work share or cooperative work in rain-water-harvesting pond preparation is very important in the study area.

Based on primary data collected from household survey, Logistic regression estimation revealed that age of household head, education level, number of livestock in TLU, size of land holding, distance between home and farmers training center and labor force the member are significantly affected the rain water harvesting adoption decision of household in study area. Participant households obtained on average rain water harvesting adopter households and non-adopter households had around 5043 and 2962 ETB respectively. It is concluded that strengthening participation in rain-water-harvesting pond preparation and utilization is very important for households income generation. This can be attained through training farmers and building their capacity for pond construction. Therefore, government and other development institution should increasing household participation in rain-water-harvesting for irrigation through developing water-harvesting technology, improving capacity of existing rain-ponds and asset building like rain-harvesting PVC plastic and motor pump facility.

The problem of water shortage for crop production can be alleviated through proper management and utilization of available rain water or rainfall harvested. Farmers in different area practice various method in solving their own problem. This method can be the best technique for farmers in other area. Efficient use of water by irrigation is becoming increasingly important and agronomic measures such as mulching and anti-transpirants can reduce the demand for limited irrigation water obtained from rain water harvesting and improve irrigation water use efficiency. Infiltration depends on there being sufficient porosity in the surface soil for rainfall to infiltrate, and in the subsoil and parent material (if shallow) for rainwater to percolate. When the porosity of the surface soil is too low to accept rainfall, or subsoil porosity is too low to allow rainwater percolation (i.e. permeability is too slow), then infiltration will be restricted and rainwater will be lost as runoff.

References:

1) Abonesh, T., Ayalneh, B and Namara, R. E. (2006). The impact of small scale irrigation on household food security and assessment of its management system: the case of Filtino and Godino irrigation schemes in Ada Liben District, East Shoa, Ethiopia. Publisher: International Water Management Institute (IWMI). Available on the: http://publications.iwmi.org/pdf/H044135.pdf

2) Aldrich, J. H. and Nelson, F. D. (1984). Liner Probability, Logit and Probit Model: Quantitative Applications in the Social Science. Sera Miller Mc Cun, Sage Pub. Inc, University of Minnesota and Iola, London.

3) CSA (Central Statistics Agency). (2007). Summery and statistical report of 2007 population and housing census of Ethiopia. Available from: http://www.csa.gov.et.

4) Gujarati, D. N. (2003). Basic Econometrics. Second Edition. McGraw Hill, Inc., New York.

5) Kassahun, D. (2007). Rain Water Harvesting in Ethiopia. Capturing the realities and exploring

opportunities. FSS research report No. 1. Forum for Social Studies. Addis Ababa, Ethiopia.

6) Kun, Z., Linus, Z., William, H., Mancang, L and Hui, C. (2004). Quality issues in harvested rainwater in arid and semi-arid Loess Plateau of northern China, Journal of Arid Environment, 57(4): 487-505.

7) Liao, T. (1994). Interpreting probability models: Logit, probit, and other generalized linear models, Sage University Paper Series on Quantitative Applications in the Social Sciences, Series No. 07–101.

8) MoARD (Ministry of Agriculture and Rural Development). (2010). Household Asset Building Programme. Programme Implementation Manual. Addis Ababa, Ethiopia

9) Mwanakatwe, P. (2010). Ethiopia’s Economic Growth Performance: Current Situation and Challenges. The African Development Bank Group. Economic Brief: 1(5): 1-5

10) Ngigi, S. N. (2003). Rainwater harvesting for improved food security: Promising technologies in the Greater Horn of Africa. Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association (KRA), Nairobi, Kenya. 266.". In: Proceedings of 3rd Int. Conference on bearing capacity of roads and airfields PP: 743-756, Trondeihm, Norway Longhorn; 2003.

11) Nissen, P. E. (1982). Rain Catchment and Water Supply in Rural Africa: A Manual. Hodder and Stoughton, WBC print Ltd., London

12) Pacey, A and Cullis, A. (1989). Rainwater Harvesting: The Collection of Rainfall and Runoff in Rural Areas, WBC Print Ltd., London, 5-12pp

13) Rami, H. (2003).Ponds filled with challenges. Water harvesting-experiences in Amhara and Tigray. UN OCHA-Ethiopia, 1-6 pp

14) Sianesi, B. (2004). An evaluation of the active labor market programs in Sweden. The Review of Economics and Statistics, 186(1):133-155.

15) Tafere, M. (2005). Farmers’ Response and Willingness to Participate in Water Harvesting Practices: a case study in Dejen district East Gojam zone M.Sc Thesis. Alemaya University, Ethiopia.

16) Theib, O and Ahmed, H. (2006). Water harvesting and supplemental irrigation for improved water productivity of dry farming systems in West Asia and North Africa, Agric. Water Manage., 80(1-3) 57-73.

17) Werku, T. (2006). Analyzing Factors AffectingtAdoption of Rainwater Harvesting Technology in Dugdat Bora Wereda, Ethiopia. MSc Thesis, Alemaya University, Ethiopia

18) World Bank. (2010). Project performance assessment report. World Development Indicators 2010. Washington, D.C.