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OBJECTIVES

HYPOTHESIS (ES)

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RESULTS & DISCUSSION

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DETERMINANTS OF FARMERS WILLINGNESS TO PAY ON WATER HARVESTING TECHNOLOGIES: A CASE STUDY IN EAST GOJJAM ZONE, ETHIOPIA

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ABSTRACT

As agriculture has a vital role in the overall economy of the country, increasing its productivity is paramount important. But, its productivity affected by many factors among which moisture stress is to be cited. To cope up the moisture stress problem the government promotes some forms of small scale irrigation schemes through water harvesting technologies at a household level, but success to date is limited. Therefore, this study is conducted to analyze the socio-economic, physical and other related factors, which determines farmer's willingness to pay on water harvesting technology in East Gojjam Zone; Ethiopia. To address these objectives, both quantitative and qualitative data were collected from primary and secondary sources. The primary data were collected from 200 selected sample household. Binary Logit-model was used to analyze determinants of willingness to pay on Water Harvesting Technologies. The unit analysis was a house hold level analysis for binary logit. A total of 15 explanatory variables were included in the analysis. The result of the analysis indicated that among the hypothesized explanatory variables included in the model, seven variables namely, age of the household head, labour availability, distance of market from residence, distance of development center, Frequency of extension contact; Training on water harvesting matters and Perception of a house hold water harvesting technology were found to be significantly affecting the farmer's willingness to pay on water harvesting technologies. The findings of this study recommends that any effort in promotion of water harvesting technology should recognize the socio-economic, household and technological characteristics, strategies which focus on enhancing the willingness and /or ability farmers should be adopted, strengthen learning opportunities through established farmers training center to enhance their perception, knowledge and skill, strengthen extension contact frequencies, recognizing the distance of development and market center and the need to providing farmers with information on the benefit of water harvesting technology, particularly for aged.

KEYWORDS
East Gojjam Zone (Ethiopia), logit model, water harvesting technology, willingness to pay.

1. INTRODUCTION

Water harvesting (WH) has been defined and classified in a number of ways by various authors. According to Reij et al. (1993), water harvesting is usually employed as an umbrella term describing a whole range of methods of collecting and concentrating various forms of runoff (roof top runoff, overland flow, stream flow, etc.) from various sources (precipitation, dew, etc.) and for various purposes (agricultural, livestock, domestic and other purposes). Mekdaschi Studer, R. and Liniger, H., 2013 defined Water harvesting is the collection and management of floodwater or rainwater runoff to increase water availability for domestic and agricultural use as well as ecosystem sustenance. The aim of water harvesting is to collect runoff or groundwater from areas of surplus or where it is not used, store it and make it available, where and when there is water shortage. This results in an increase in water availability by either (a) impeding and trapping surface runoff, and (b) maximizing water runoff storage or (c) trapping and harvesting sub-surface water (groundwater harvesting, also see Box 6). Water harvesting makes more water available for domestic, livestock and agricultural use by buffering and bridging drought spells and dry seasons through storage. Rain water harvesting techniques can be applicable in all agro climatic zones. However, it is more suitable in arid and semiarid areas where the average annual rainfall is between 200 and 800 mm. In such condition, rain-fed crop production is challenging without using rainwater harvesting techniques. This implies that water harvesting and storage would be vital to ensure water availability especially during prolonged dry season and drought (Mugerwa 2007, and Enfors 2009).

The Ethiopian economy has largely remained dependent on agriculture, which accounts 40-50 percent of GDP, 85 percent of total labour employment and 90 percent of exports (NBE, 2006). Because of the economy being dominated by agriculture, the weak performance of this sector has an adverse effect on other sectors of the economy. Hence, increasing productivity of Ethiopian agriculture is paramount important. But increasing productivity is challenged by many factors of which moisture stress is to be cited. To cope up the moisture stress problem and hence to improve increasing productivity of Ethiopian agriculture practicing some forms of small scale irrigation schemes through practicing water harvesting technologies at a household level is promoting. Moreover, Ethiopia currently depends on rain fed agriculture. The inconsistency in the amount and seasonal pattern of rainfall and its inter annual variation constitute a major cause for frequent failures of crops and scarcity of livestock feed. Nowadays, as observed due to the effect of climate change The annual rainfall distribution in most parts of Ethiopia, including the highlands, is not only uneven but also highly unpredictable in its inter annual variations. Therefore, supporting this rain feed agriculture with water harvesting technology is unquestionable. Therefore, the government of Ethiopia has made an effort to promote water harvesting technologies in past years, success to date is limited.

Empirical studies give general information on physical, socio-economic and institutional factors determining the use water harvesting technologies. However, the factors, magnitude and direction of influence of each variable on farmers' decision on different studies at different place and time are different. This is due to variations in agro ecology, socio-economic and institutional factors among countries, regions, villages and farms. It implies that, the importance of area specific studies on factors determining the willingness to pay on water harvesting technologies.

The factors that determine the willingness of farmers to pay on water harvesting technologies in the study area however not been fully evaluated and accordingly appropriate recommendations made. Given this state of facts, analysis of the issue of what specifically determines the willingness of farmers to pay on water harvesting technologies is very important and relevant to formulate policy options and support system that could be accelerate the use of water harvesting technologies. Therefore; this study was conducted in East Gojjam Zone, Amhara National Regional state, Ethiopia with the objective of) identify the determinants of willingness to pay on Water Harvesting Technologies in the study area.

2. EMPIRICAL STUDIES

Many researchers and experts in the field of natural resources conservation and water harvesting forwarded their reasons about different factors that affect the willingness of farmers to pay and efficiently use of technologies.

A study conducted by Job Kibiwot L., et.al, (2003) On Determinants of the Adoption of Water Harvesting Technologies in the Marginal Areas of Nakuru District, Kenya: The Case of Trench and Water Pan Technologies using probit model showed that farm income, farm size, labour requirement, and education of spouses significantly influenced adoption of water harvesting technologies.

A study conducted by Molla,T. (2005) on farmers' response and willingness to participate in water harvesting practices found out that education level of head of the household , labor availability, total tropical livestock unit owned , training and visit of the head of the household in different water harvesting matters , financial constraints of the household , general attitude towards the importance of water harvesting technology and Distance to extension center significantly affects the willingness of farmers to participate on water harvesting technologies.

A study conducted by Xue-Feng H. et.al (2005) on Econometric analysis of the determinants of adoption of rainwater harvesting and supplementary irrigation technology (RHSIT) in the semiarid Loess Plateau of China showed that Farmers' educational background, active labor force size, contact with extension, participation in the Grain-for-Green project, and positive attitudes towards RHSIT are some of the variables that have significantly positive effects on adoption of RHSIT, while farmer's age and distance from water storage tanks to farmers' dwellings have significantly negative correlation with adoption.

A study conducted by Abadi, T., (2006) on Analysis of Social Economic and Institutional Issues Affecting Utilization of Rainwater Harvesting Technology, Eastern Tigray, Ehiopia. Using binary logit model found out that Extension contacts, training, animal product income, market distance, location, cash availability, farmland size and input were found to be highly important variables influencing utilization of rain water harvesting technology.

Liniger et. al., (2011) also stated that in Sub-Saharan Africa, the most important adoption drivers of water harvesting were found to be yield increase and accessibility to information, followed by secure land tenure. Furthermore, it is important to ensure genuine participation of resource users alongside professionals during all stages of implementation to integrate all viewpoints and ensure commitment (Mekdaschi Studer, R. and Liniger, H., 2013). Often weak approaches and extension have led to poor adoption rates. Water harvesting technologies need to be adapted and fine-tuned to the local natural, socio-economic and cultural environment. Adaptation of standard designs to actual site conditions requires skill and experience, which often will determine the success of the water harvesting practices.

Mekdaschi Studer, R. and Liniger, H., 2013 also stated that Adoption rates of WH generally remain low. However, some practices such as rooftop WH or certain micro catchment technologies such as planting pits and contour bunds and macro catchment technologies such as earth dams have spread and continue to do so. Water harvesting technologies recommended for up scaling must be profitable for users and local communities, and technologies must be as simple and inexpensive as possible: and easily manageable also. Without security of land tenure, water rights and access to markets, land users remain reluctant to invest labour and finances in WH. Cost efficiency, including short and long-term benefits, is another key issue in the adoption of WH practices. Resource users are naturally more willing to adopt practices that provide rapid and sustained pay-back in terms of water, food or income.

3. HYPOTHESIS

Many researchers and experts in the field of water harvesting and adoption of technologies forwarded their reasons about different factors that affect the willingness of farmers to participate and efficiently use technologies. Based on literature reviewed and authors experience the expected sign, code, type and unit of measurements of independent variables included in the binary logit model were summarized in the following table 1.

TABLE 1: DEFINITIONS AND UNITS OF MEASUREMENT OF VARIABLES INCLUDED IN THE LOGIT MODEL

Variable	Variable code	Type of variable	Unit of measurement	expe. sign
Willingness to participate	WTP	Dummy	1 if a household willing to participate/pay, 0 Otherwise	
Age of the household head	**AGE**	Continuous	Measured in years	-
Responsibility	**RESP**	Dummy	1 if the household head has social position in the PA, 0 other wise	+
Education level	**EDUC**	Dummy	1, if the house hold head is literate (read and write) and 0, other wise	+
Total tropical livestock unit	**TLU**	Continuous	Measured in tropical livestock unit (TLU)	+
Total size of cultivated land	**AREACUL**	Continuous	Measured in hectare	+
Labour availability	**LABORAV**	Continuous	Measured in adult man equivalent	+
Shortage of food	**FDSHOR**	Dummy	1 if a household has faced food shortage in 5 years time ; 0 , otherwise	+
Distance to nearest development center	**DISTEXTC**	Continuous	Measured in minutes	-
Distance to market	**DISTMARK**	Continuous	Measured in minutes	-
Access to credit	**ACCR**	Dummy	1 if the farmer responded as he has access to credit and 0 otherwise	+
Training and visiting	**TRAIN**	Dummy	1, if a household had got Training and visit in different water harvesting practices (workshops, seminars, etc) w and 0 ; other wise	+
Irrigation	**IRRUSE**	Dummy	1; If a household has owned irrigated plot and practice and 0; otherwise	
Perception of a house hold water harvesting technology	**PERCEPT**	Dummy	1; if a household considered WHT important and 0 = otherwise	+
Extension contact of a household head	**EXTNCON**	continuous	Measured in number	+
Annual off farm income of a household head	**OFFFAIN**	Dummy	1; if a house hold participate on off farm activities; and 0 otherwise	-/+

4. METHODOLOGY

4.1.1. THE STUDY AREA

East Gojjam zone is one of the eleven zones of the Amhara regional state which is located in the northern part of Ethiopia. The administration zone is bounded by west Gojjam to the west; by Oromia region (wellega) to the south; wello zone to the east and South Gonder zone to the north.The area has a total area of 14705.36 sq. km, with an altitude ranging from 800 to 4070 m.a.s.l. Its topography is estimated to be 48% mountainous, 12% rugged and 40% gentle slope. It has also four agro climatic zones namely kola, Woinadega, Dega and Wirch covering 16%, 37%, 45% and 2% of the total area, respectively. It receives a mean annual rain fall of 900 to 1800 mm and annual temperature of 8 to 27co The Zone is divided in to 16 districts and 2 urban administrative with a total of 382 kebeles of which 36 are urban kebeles. The estimated land use pattern of the zone shows that 33.67% is used for cultiviation,11.7% for grazing, 20.6% for forest bushes and shrubs and The rest 34.03% is used for other purposes & including unused land (ZODA,2012)

Agriculture, like in the other parts of Ethiopia is the main source of income for the community in the study area. The zone is characterized by mixed farming where the rural population of the zone is dependent on both crop and livestock production for their livelihood. Due to the increasing population pressure, the amount of land a household uses decreases from time to time. Due to this reason many farmers are forced to make deforestation and use of grazing land in search of additional arable land. This has led to plough undulating areas and ended up with sever soil erosion.

The agriculture extension service in the zone mainly focuses on providing basic agricultural trainings, teaching and demonstration about the use of agricultural inputs, forest development, soil conservation and livestock production aspects. The major source of agricultural credit to the farmer is the regional government that receives loan from commercial banks by providing its annual development budget as collateral. The actual credit provision is undertaken through cooperatives and Amhara Credit and Saving Institution (ACSI). Yet, availability of fertilizer, improved seeds and credit at the required time and place particularly for remote and inaccessible areas are the major problems encountered to boost agricultural production and productivity. In addition; nowadays uneven distribution of rain fall/erratic rain affects the production system of farmers.

According to the discussion with soil and water conservation experts, water harvesting technologies are introduced and implemented by farmers in the study area. However, the management and utilization of the technology by the used famers needs very much follow up to make it effective. The supply of type technologies with the interest of users would also needs consideration.

4.1.2. SAMPLING DESIGN AND DATA COLLECTION

Both primary and secondary data were collected. The primary data were collected from 200 sample household heads through conducting formal survey based on structured questionnaire that was prepared. Personal observation and group discussions were also made. Secondary data were collected from the different records, strategic plans, seasonal and annual reports, and previous studies. Three stage sampling technique was used to draw the sample respondents of the study. In the first stage, 3 districts which have good experience in implementing water harvesting technologies were purposely selected. This has been done based on the discussion with the zone agricultural and rural development department. Secondly, from each district 2 Kebeles and a total of 6 Kebeles were selected using simple random sampling technique. Finally, Probability proportional to size random sampling technique was used to draw individual sample households from each kebeles.

4.1.3. ANALYTICAL METHODS

Both descriptive statistics and econometric models were employed to study the relationship between the dependent and explanatory variables. Descriptive statistics such as mean, standard deviation and percentage were used. The result obtained was used as an indicator of the difference between the two groups (willing and non-willing). Besides, binary logit model was used to identify the determinants farmers' willingness to pay on water harvesting technologies.

In participation decision studies, responses to a question such as whether farmers are willing to participate in a given technology could be 'yes' or 'no', a typical case of dichotomous variable. A variety of statistical models can be used to establish a relationship between the household characteristics and the willingness for participation. Conventionally, linear regression analysis is widely used in most economic and social investigations. This is, because, it has some desirable properties for specific type of enquiry and data and is widely available in computer packages (Green, 1991). Moreover, it is easy to interpret and it is a reasonable procedure even if some of the assumptions underlying it are not met in the data (ibid). However, the same source further stated that while estimates derived from linear regression analysis may be robust in the face of errors in some assumptions, other assumptions are critical and their failure will lead to quite unreasonable estimates. To mention some weakness, the linear probability Model (LPM) may generate predicted values outside the 0-1 intervals, which violates the basic tenets of probability. The other problem with LPM is that the variance of the disturbance term is heteroscedastic. Furthermore, the assumption of normality in the disturbance term is no longer tenable.

The inadequacy of the linear probability model suggests that a non-linear specification may be more appropriate and the candidate for this will be an S-shaped curve bounded in the interval of 0 and 1 (Amemiya, 1981; Maddala, 1983). These authors suggested the S-shaped curves satisfying the probability model as those represented by the cumulative logistic function (logit) and cumulative normal distribution function (probit).

The choice between these two models revolves around practical concerns such as the availability and flexibility of computer program, personal preference, experience and other facilities. In fact it represents a close approximation to the cumulative normal distribution. Hosmer and Lemshew (1989), pointed out that a logistic regression has got advantage over others in the analysis of dichotomous outcome variables. There are two primary reasons for choosing the logistic distribution. These are 1) from a mechanical point of view, it is an extremely flexible and easily used function, and 2) it lends itself to a meaningful interpretation. The logit model is simpler in estimation than the probit model. Therefore, a binary logistic regression model will be used to study the decision behavior of sampled households (Pindyck and Rubinfeld, 1981).

Following Hosmer and Lemshew (1989), the logistic distribution function for identification of the willing and non-willing farmers can be defined as:

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

Where:

P_i is the probability of being willing to choose or decide for the i^{th} farmer and Z_i is a function of n explanatory variables (X_i), and expressed as:

$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \text{-----} + \beta_m X_m$ 2

Where β_o is the intercept and β_i are the slope parameters in the model. The slope tells how the log-odds in favor of being willing to participate in water harvesting practices change as independent variables change.

Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean Pi, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds, (Gujarati, 1995). The odds to be used can be defined as the ratio of the probability that a farmer will practice (P_i) to the probability that he/she will not ($1-P_i$).

But

$1-P_i = \frac{1}{1+e^{z_i}}$ 3

Therefore,

$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i}$...4

And

$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{\beta_0+(\sum_{i=1}^{n}\beta_i X_i)}$ 5

Taking the natural logarithm of the odds ratio of equation (5) will result in what is known as the logit model as indicated below:

$\ln\left[\frac{P_i}{1-P_i}\right] = \ln\left[e^{\beta_0+(\sum_{i=1}^{n}\beta_i X_i)}\right] = Z_i$ 6

If the disturbance term U_i is taken into account, the logit model becomes

$Z_i = \beta_o + \sum_{i=1}^{n}\beta_i X_i + U_i$ 7

Hence, the above econometric model will be used in this part of the study to identify variables that affect the farmers' willingness to pay on water harvesting technologies.

5. RESULT AND DISCUSSION

5.1.1 DESCRIPTIVE ANALYSIS

In this study the meaning of willingness to participate considers commitment. Hence, the questionnaire was prepared in three different types. The first type of question focuses on the costs of the technology totally covered by the respondent. It means that no financial supports are to be expected from the government or other donor agencies and the farmer himself should cover all types of costs. As a result, 16.5 % (33) of the respondents were reported that they are willing to have some structures. The second type of question stresses that the respondents to cover half of the costs to construct and run the water harvesting structures. Based on this, 78 farmers or 39 percent of the total sample respondents were willing to have some water harvesting structures. The third question focused how they are willing to participate, if the total costs were to be covered by government or other NGOs. Accordingly, 109 in number or 54.5 percent of the sample farmers showed their desire to have some type of structure.

Therefore, in this study, a respondent is said to be willing if a respondent falls in categories one or two, because he/she is considered as real demanders of the technology as he/she was committed to pay for the technology. Adding the number of farmers who fall under these two groups excluding redundancy was give up the total number of willing respondents. Hence, 78 farmers or 39% of the total respondents were considered to be the willing farmers. On the other hand, 122 farmers or 61 % of the respondents were considered to be non-willing farmers.

In order to investigate the presence of group mean difference with respect to the hypothesized social, economic, institutional and physical factors uni-variate tests were used. Student's t-test and Chi-square statistics were used to identify the potential continuous and dummy variables differentiating willing from nonwilling respectively. Willing and nonwilling households significantly different in four of the seven hypothesized continuous variables (Table 2).

TABLE 2: CONTINUOUS VARIABLES DIFFERENTIATING WILLING FROM NON WILLING HOUSEHOLDS TO PAY FOR WATER HARVESTING TECHNOLOGIES AMONG 200 SAMPLE HOUSEHOLDS

Variable	willing	non-willing	total	t-value
AGE	44.38	46.14	45.09	1.009
LABORAV	3.57	3.3	3.4	1.406
AREACUL	1.61	1.45	1.51	1.192
TLU	5.85	5.08	5.38	1.716*
EXTECON	1.728	1.295	1.464	2.35**
DISTEXTC	24.44	31.11	28.51	-2.453**
DISTMARK	37.15	48.2	43.89	-3.519***

*,**,*** indicates Significant at 10%,5% and 1% probability level respectively

Source: Survey result

The average age of the sample household heads was found to be 45.69 years ranging from 22 to 82 years with standard deviation of 12.10. Of the total sample household heads 47 percent of them have an age of greater than 45 years. The mean age of willing and non willing respondents of water harvesting technologies are 44.38 and 46.14 years with standard deviation of 11.21 and 12.49, respectively. The mean age of willing was found to be less than that of non willing. The result of t-test showed that the mean difference of two groups was insignificance.

The survey result indicated that among the total sample household heads, 94% were male and 6% of them were female. Likewise, 93.6% of willing and 94.3% of non-willing were male. About 95% of willing and 93% of non-willing were married. The chi-square test for sex and marital status distribution between the two groups was found to be insignificant.

The size of labour force in the household is assumed to bring about differences in decision of farmers to pay on water harvesting technologies. Farmers with large household members will be able to supply the additional labour that might be required for construction water harvesting structure. However, the result of t-test showed that there was no significance difference in the mean size of labour force between willing and non-willing. The available family labour was calculated in terms of man equivalent following Storck *et al.* (1991). The average available labour was estimated to be 3.4 man-days for total sample households, 3.57 man-days for willing and 3.3 man-days for non-willing respondents, with a standard deviation of 1.35, 1.4, and 1.33, respectively. About 67% of total respondents reported that they face labour shortage during peak agricultural production periods and used hired casual (temporary) labour to solve the problem of labour shortage.

The area of cultivated land was assumed to influence the participation on water harvesting technologies. The survey results showed that landholding size of total sample households ranges from 0.25 to 4 ha with a mean of 1.51 and standard deviation of 0.93 ha. The average landholding size of willing and non-willing was 1.61 and 1.45 ha with a standard deviation of 0.75 and 1.03, respectively. Farm size of most farmers (82%) falls between 0.25 and 2 ha. It was found that only about 18% of the sample households have a farmland of above two hectares. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size difference between the two groups was insignificance.

The average size of livestock in TLU was found to be 5.38, 5.85 and 5.08 for total sample households, willing and non-willing with a standard deviation of 3.08, 3.26 and 2.94 respectively. The difference between mean livestock holdings of willing and non-willing households was statistically significant. About 51% of total sample household heads has more than 5 TLU sizes of livestock.

Access to extension service is very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and water harvesting technologies in particular. Development agents were assigned in all sample PAs. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and training. However, about 7.7% of users, 9% of non user's have reported that they did not get extension services (visits) in the study year. About 69% of sample households had been visited by development agents from one to three times per month.. The average monthly frequency of extension services/visits/ was found to be 1.728 and 1.295 for willing and non- willing with a standard deviation of 0.80 and 0.83, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance.

The average walking time required to reach a development center in minutes was found to be 28.51, 24.44, and 31.11 for total sample households, willing and non-willing with a standard deviation of 18.96, 17.71 and 19.35 respectively. The difference between mean average walking time for willing and non-willing households was statistically significant.

The average walking time required to reach in nearby market center in minutes was found to be 43.89, 37.15 and 48.2 for total sample households, willing and non-willing with a standard deviation of 22.27, 17.65 and 23.86 respectively. The difference between mean average walking time for willing and non-willing households was statistically significant.

Different empirical studies also showed that willing and non-willing households not only differ in quantitative variables but also in terms of qualitative variables. It was, therefore, desirable to use a method of testing the differences between willing and non-willing with respect to qualitative variables. Hence, the chi-square test was used to test the presence and absence of difference between the two categories of households (Table 3).

The education level of household heads is expected to increase the ability to obtain, process and use of information relevant to the use of improved agricultural technologies in general and Water harvesting technologies in particular. Concerning the educational level of sample household heads, the survey results indicated that about 31% of the total respondents are illiterates, while the rest 69% of the respondents had various educational levels ranging from the ability to read and write up to 12th grade. As shown in Table 9, about 23% of willing and 30% non-willing were illiterate farmers. The result of $\chi 2$-test showed significant difference for distribution of illiterate and literate household heads of the two groups.

TABLE 3: DUMMY VARIABLES DIFFERENTIATING WILLING AND NON-WILLING HOUSEHOLDS TO PAY ON WATER HARVESTING TECHNOLOGIES

variable	score	willing	non-willing	total	χ2
EDUC	0	25	37	62	28.8***
	1	53	85	138	
PERCEPT	0	0	29	29	95.22***
	1	78	93	171	
TRAIN	0	34	101	135	24.5***
	1	44	21	65	
ACCR	0	8	6	14	0.780
	1	70	116	186	
IRRUSE	0	15	88	103	0.18
	1	63	34	97	
FDSHOR	0	69	95	164	81.92***
	1	9	27	36	
OFFFAIN	0	55	76	131	19.22***
	1	23	46	69	
RESP	0	33	68	101	0.02
	1	45	54	99	

Source: Survey result

Farmer's perception about the importance of use of water harvesting technologies as well as its consequences might make farmers to use water harvesting technologies. The majority of the sample household heads (85.5%) have perceived the importance of water harvesting technologies. From this, only 39% households were willing to use water harvesting technologies. This shows that perceiving the importance is not always a guarantee to the use of the technologies. The difference between the two groups with respect to perceiving the importance was statistically significant between the two groups.

Training is expected to be an important variable to create awareness about the technologies for households and helps them to decide to use technologies based on knowledge. The results of the study showed that 65 sample household heads or 32.5% of respondents have participated in training of water harvesting related matters. Likewise, 56.4% and 17.21% of willing and non-willing farming households respectively had taken training. The difference between the two groups is too large which implies that training is an important factor in the decision of households to use water harvesting technologies. The result of χ2-test also showed that significant difference between household heads of the two groups.

Shortage of money may discourage farmers from participating in newly released agricultural technologies. Therefore, the presence of credit institution and availability of adequate loan is an important factor for the use of water harvesting technologies, as the technologies are money demanding. Regarding to availability of adequate credit; the study found out that about 7% of the respondents have faced problems in getting adequate loan facilities. Of which 10.3% of the willing and 4.92% of the non-willing farmers suffered the same problem. The result of χ2-test also showed that insignificant difference between household heads of the two groups.

Of the total respondents, 48.5% have reported that they have of their irrigation plots and had also practiced small scale irrigation; of which 80.8% and 27.86% willing and non willing farmers respectively. The figure is larger for the willing compared to the non-willing farm households indicating that those farmers who have an experience in use of irrigation are more willing in use of water harvesting technologies. Concerning food shortage 18% of total respondents reported that they had faced food shortages in the past 5 years; of which 11.5% and 51.9% were for the willing and non-willing farming households respectively. The result of χ2-test also showed that significant difference between household heads of the two groups.

Participation on off farm activities of sample household heads, the survey results indicated that about 34.5% of the total respondents were participated on off farm activities, while the rest 65.5% of the respondents were not. About 70.5% of willing and 62.3% non-willing households were not participated in off farm activities. The result of χ2-test showed significant difference for distribution of participated and non participated household heads of the two groups.

Of the total sample household heads, 49.5% were reported that they responsibility at their village or peasant association level. The figure was 57.7% and 44.3% for the willing and non-willing farmers respectively. The higher figure for the willing respondents when compared with the non- willing may indicate that as the head of the household has a responsibility, the chance of getting information and hence understanding about the technology increases. This contributes to decide to construct some form of water harvesting technologies.

5.2 ECONOMETRICS ANALYSIS

5.2.1 DETERMINANTS OF FARMERS WILLINGNESS TO PAY ON WATER HARVESTING TECHNOLOGIES

Under this section the important socio-economic, physical and institutional factors, which were hypothesized to influence farmers' decision to pay on water harvesting technology were analyzed. Logit-model was used to analyze determinants of farmers' willingness to pay on Water Harvesting Technologies. The unit analysis was a house hold level analysis. Before estimating the model using hypothesized variables, it is crucial to check the problem of multicollinearity or association among potential explanatory variables. Towards this, multicollinearity problem for continuous explanatory variables was assessed using a technique of variance inflation factor (VIF) and the degree of association between each dummy/discrete variable was also assessed using contingency coefficient. Finally, the variables were considered for further analysis after verifying that multicollinearity is not a problem.

Generally, fifteen (15) explanatory variables were included in the model to identify the determinants farmers' willingness to pay on Water Harvesting Technologies. The various goodness of fit of measures was checked and validate that the model fits the data. The chi-square value of a likelihood ratio is significant at less than one percent level of significance. This confirms the joint significance of the explanatory variables included in the model and shows existence of useful information in the estimated model. The maximum likelihood econometric estimation method was used to estimate the coefficients of the explanatory variables in the Binary logit model. The results of Binary logit model regression analysis are presented in Table 4.

The results indicated that, among the 15 hypothesized explanatory variables included in the model, seven variables were found to be significantly affecting the farmers' willingness to pay on water harvesting technologies in the study area. These are age of the household head (AGE), labour availability (LABORAV), distance of market from residence (DISTMAR), distance of development center (DISTEXTC), Frequency of extension contact (EXTCON); Training on water harvesting matters (TRAIN) and Perception of a house hold on water harvesting technology (PERCEPT). The coefficients of other eight variables were not statistically significant at the conventional probability levels implying that they were less important in effecting the farmer's willingness to pay on water harvesting technologies.

Among the statistically significant explanatory variables age of the household head (AGE), distance of market from residence (DISTMAR), and distance of development center (DISTEXTC) were found to affect the farmer's willingness to pay on water harvesting technologies negatively. other variables such as labour availability (LABORAV), Frequency of extension contact (EXTCON); Training on water harvesting matters (TRAIN) and Perception of a house hold water harvesting technology (PERCEPT) were also affect the farmer's willingness to pay on water harvesting technology positively. The effects of the significant variables on the farmer's willingness to pay on water harvesting technologies are discussed below.

Age of the household head is significant at 10% probability level and related negatively with the farmer's willingness to pay on water harvesting technology. Bekele and Holden (1998) also reported similar negative relationship between age and adoption of land conservation practices in the Ethiopian highlands. The odds ratio (0.968) indicates that under constant assumption means keeping the influences of other factors constant the farmer's willingness to pay on water harvesting technology decrease by a factor of (0.968) as the age of house hold head increase by one year.

TABLE 4: MAXIMUM LIKELIHOOD ESTIMATES OF A BINARY LOGIT MODEL

variables	B	S.E.	Wald	Sig.	Exp(B)/odds ratio
AGE	-0.033	0.017	3.701	0.054*	0.968
RESP	0.148	0.419	0.125	0.724	1.160
EDCU	0.596	0.439	1.836	0.175	0.551
LABORAV	0.265	0.159	2.787	0.095*	1.304
DISTMKT	-0.017	0.010	2.914	0.088*	1.017
DISTEXTC	-0.020	0.011	3.337	0.068*	0.981
ACCR	0.798	0.726	1.209	0.272	0.450
EXTNCON	2.053	0.348	34.789	.000***	7.791
TRAIN	1.592	0.407	15.278	.000***	0.203
AREACUL	-0.170	0.188	0.818	0.366	1.185
IRRUSE	-0.369	0.390	0.895	0.344	0.691
FDSHRO	0.732	0.508	2.073	0.150	2.079
TLU	-0.043	0.074	0.337	0.562	0.958
PERCEPT	2.109	0.857	6.050	.014**	0.121
OFFAIN	0.491	0.384	1.642	0.200	1.635
Constant	4.729	1.924	6.044	0.014	113.206
Chi-square ………. 66.956* -2 log likelihood…….. 200.543 Count R^2 ……………..78.4 Sensitivity…………. 61.5 Specificity…………. 80.3 Number of cases…… 200					

Source: Survey result

***'**&* Significant at 1%, 5%, and 10% probability level respectively.

Labour availability is significant at 10% probability level and related positively with the farmer's willingness to pay on water harvesting technology. FAO (1994) and Ngiggi (2003) have reported availability of labour as first criterion to participate in water harvesting works. The odds ratio (1.304) indicates that under constant assumption means keeping the influences of other factors constant the willingness to pay on water harvesting technology increase by a factor of (1.304) as the labour availability increased by one unit.

Distance of market from residence variable is significant at 10% probability level and related negatively with the farmer's willingness to pay on water harvesting technology. Lapar and Pandey (1999) came up with a negative relationship between adoption decision of farmers and distance to market center. The odds ratio (1.017) indicates that under constant assumption means keeping the influences of other factors constant the willingness to pay for water harvesting technology decrease by a factor of (1.017) as the distance of market from the residence far away by one additional minute.

Distance of development center from residence variable is significant at 10% probability level and related negatively with the farmer's willingness to pay on water harvesting technology. Chilot (1994) has found significant negative relationships between distance to an extension office from homestead and adoption of wheat technologies. The odds ratio (0.981) indicates that under constant assumption means keeping the influences of other factors constant the willingness to pay on water harvesting technology decrease by a factor of (0.981) as the distance of development center from the residence far away by one additional minute.

Frequency of extension contact is significant at 1% probability level and related positively with the farmer's willingness to pay on water harvesting technology. Many studies have shown the positive relationship between extension contacts and use technologies (Baidu-Forson, 1999; Semgalawe, 1998; Wagayehu, 2003). Therefore, it is found that a household head that has greater contact with a development agent is more likely to pay on water harvesting technologies. The odds ratio (7.791) indicates that under constant assumption means keeping the influences of other factors constant the willingness to pay on water harvesting technology increase by a factor of (7.791) as the monthly frequency of extension contact increased by one unit.

The model result indicates that Training on water harvesting matters affects the farmer's willingness to pay on water harvesting technology positively and significantly at ($P<0.01$). Sambrook and Akhter (2001) have found similar result that a strong positive relationship between training in different water harvesting matters and willingness to participate in water harvesting activities. Tesfaye et al. (2001) has also arrived at similar results in wheat adoption study in Amhara region. The odds ratio of the willingness to pay on water harvesting technology by a farmer increases by a factor of 0.203 as a household is trained in the given water harvesting technology.

Perception of a house holds water harvesting technology (PERCEPT) affects the farmer's willingness to pay on water harvesting technology positively and significantly at ($P<0.05$). FAO (1994) considered technological appropriateness as a key determinant factor for the adoption and promotion of water harvesting practices across potential willing. Bekele and Holden (1998) also found positive relationship between attitude towards new land conservation technologies and adoption. The odds ratio of the willingness to pay on water harvesting technology by a farmer increases by a factor of 0.1.21 as a household perceived water harvesting technology is important.

6. CONCLUSION AND RECOMMENDATIONS

Ethiopia is highly depending on rain fed agriculture with limited use of irrigation and small size of land per house hold. The inconsistency in the amount and seasonal pattern of rainfall and it's inter annual variation constitute a major cause for frequent failures of crops and scarcity of livestock feed. Due to the effect of climate change the annual rainfall distribution in most parts of Ethiopia, including the highlands, is not only uneven but also highly unpredictable in it's inter annual variations. Hence, the effect of agriculture in the overall economy of the country is high; increasing productivity of Ethiopian agriculture is paramount important. To do this; among other factors, this requires overcoming the moisture stress problem is believed to play a pivotal role in the agricultural development of the country.

Currently, the government of Ethiopia has tried to adopt the household level water harvesting ponds, shallow and deep well development as one strategy of the country's irrigation development in order to alleviate the problem of food security and enhance the overall growth of the rural economy. This is clearly stated in the policy document of Agricultural Development Led Industrialization (ADLI). Therefore, the government of Ethiopia has made an effort to promote water harvesting technologies in past years, success to date is limited. The factors that determine the farmers' willingness to pay on water harvesting technologies in the study area however not been fully evaluated and accordingly appropriate recommendations made. The finding of this study, therefore, would provide first hand information on the factors determining the farmers' willingness to pay on water harvesting technologies for different governmental, nongovernmental organizations, extension agents working in the study area and other similar areas. Researchers would also have used as a stand point for further detail investigation. The results of logit model analysis based on a sample of 200 farmers selected from three districts namely, Motta, Enebsiesarmider and Enarjenawuga districts of East Gojjam zone; Amhara region; Ethiopia in 2013 showed that among the 15 hypothesized explanatory variables included in the model, seven variables were found to be significantly affecting the willingness to pay on water harvesting technologies in the study area. These are age of the household head (AGE), labour availability (LABORAV), distance of market from residence (DISTMAR), distance of development center (DISTEXTC), Frequency of extension contact (EXTCON); Training on water harvesting matters (TRAIN) and Perception of a house hold water harvesting technology (PERCEPT). The coefficients of other eight variables were not statistically significant at the conventional probability levels implying that they were less important in effecting the willingness to pay on water harvesting technologies.

Based on the findings of this study the following points need to be considered as possible policy recommendations in order to enhance the willingness of farmers to pay on water harvesting technologies.

The result of this study showed that the majority of the sample household heads (85.5%) have perceived the importance of water harvesting technologies. From this, only 39% households were willing to use water harvesting technologies. This shows that perceiving the importance is not always a guarantee to the use of the technologies. Besides, as observed in the field observation most of the constructed water harvesting structures were not used to for crop production, rather they largely used for drinking of animal's water. Therefore, to encourage the willingness of farmers to pay on water harvesting technologies in general and use of harvested water for crop production in particular, agricultural extension and projects which, promote water harvesting technologies should have to be strengthen and strategies which focuses on enhancing the willingness and /or ability of farm house hold heads should be designed.

The result also showed that the probability of farmers' willingness to pay on water harvesting technologies increases with an increase in labour availability, frequency of extension contact, participation on training and perception on importance of water harvesting technologies. This implying that expansion of credit system for alleviating labour shortage vital to increase farmer's willingness, as the technology is labour demanding in both construction and utilization. The positive effect of extension contact on farmers' willingness to pay emphasizes the need to improve extension system. Therefore, to sustain the positive contribution of the extension contact to farmers' willingness to pay on water harvesting technologies the concerned bodies should strengthen the extension contact between the farmers and development agents by strengthen and expanding agricultural technology outreaches services and strengthen capacity of development agents. In addition, enhancing the knowledge and skill of farmers about the technology in general and aged farmers in particular should also need emphasis. Distance of development center and distance of market from residence negatively and significantly affects the willingness of farmers to pay this implies that the need to consider establishment of extension service out reaches and nearby markets.

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