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Farmers' Response and Willingness to Participate in Water Harvesting Practices: A Case Study in Ephrata Ena Gidem District/North Showa Zone,Amhara Regional State,Ethiopia

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ABSTRACT

Despite the significant contributions of agriculture in the overall economy of Ethiopia, its Productivity and yield per unit area is very low. Many factors contributed to bring up the Problem among which, moisture stress is to be cited. However, developing large scale irrigation is a costly alternative, which may require large quantity of capital resource. This is a difficult job to practice for the small scale resource poor Ethiopian farmers. The alternative, which may compromise the need for expanding irrigation and the capital shortage, may be promoting small scale irrigation schemes through practicing water harvesting. Therefore, the major concern of this study is to identify determinants of farmers' response and willingness to participate in water harvesting practices and the choice decision among alternative water storage structure technology groups. The study is aimed at proposing or indicating policy measures for promotion and adoption of water harvesting activities.

KEYWORDS : FARMERS' RESPONSE AND WILLINGNESS & WATER HARVESTING

Introduction

In Ethiopia, Agriculture provides livelihood to more than 85% of the population and more than 87% of the economically active labor force. Nearly, 90% of the export earnings and more than 50% of the country's GDP usually come from the agricultural sector, (CSA, 1997).The creation of conducive atmosphere for the better performance of the agricultural sector is not only an important and realistic option to increase food availability and food accessibility but, it is also a means to improve the standard of living of the quasi-totality of the population in the country (Degnet, 1999).

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 variation (Habtamu, 1999).

The frequency of drought phenomena has increased tremendously in recent decades and particularly since 1950's. The analysis of the rainfall data in this period indicated the occurrence of drought in every two years, which was once in seven years for earlier times (Berhanu1999).

As a result of the variable rainfall, increase in the frequency and severity of drought, Ethiopia has experienced repeated food shortages and famine which has caused a great deal of human suffering and migration as well as considerable losses in human and livestock lives during the worst famines like the ones that occurred in the years 1974-75 and 1984 (Ngigi 2003).

Out of potentially irrigable land, about 400,000 hectares are estimated to have potential for small-scale irrigation schemes. In addition, the rainfall that occurs over the extent of the country gives rise to an estimated 110 billion cubic meter of water as mean annual flow (FAO, 1993).Another factor favoring the adoption of irrigation was that it was seen as a window of opportunity during the mid-1980s (Catterson.1999).

Although, irrigation may be the most obvious response to drought, large-scale irrigation

Schemes have proved to be costly and can only benefit a fortunate few who could afford to invest (Critchley, 1991). Even though, the technology is politically accepted and recognized, it is not new to most development workers and government personnel, even though there are inadequate strategies, human resources and policies for its promotion (Ngigi, 2003).

This study was undertaken in Ephrat Ena Gidem district, Amhara National Regional State (ANRS). One alternative to improve agricultural production in the rain fed agriculture is to develop water-harvesting techniques and then use the limited water efficiently (CTA, 2002).

This led the concerned officials and experts to take the issue seriously and seek long lasting solutions. Among the means designed to cope with the problem, water harvesting got the top priority (RDPE, 2002). This is often because the technologies and designs were not suitable for either the environment or the cultural habits of the beneficiaries, or because operation and maintenance of the schemes turned out to be either too costly and/or too time consuming (Ngigi, 2003). For a water-harvesting project to be successful, the society must possess a high degree of individual commitment (FAO, 1994).

The factors affecting farmers' willingness to participate in rainwater harvesting at micro level are useful for policy makers and donors who are involved in the promotion of water harvesting activities. This study will be useful for agricultural and environmental researchers to develop and design a technology that can better fit farmers' socio-economic and agro-ecological conditions. This study is expected to indicate the weaknesses and strengths of the strategies, which are being practiced for water harvesting.

Objectives:

1. To analyze factors affecting farmers' willingness to participate in water harvesting Activities; and

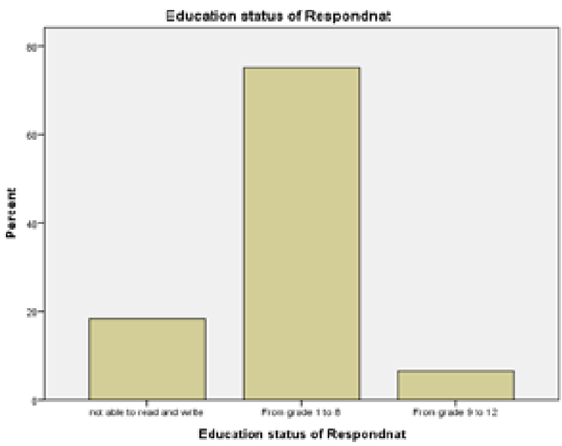
2. To identify factors affecting farmers' preferences among alternative water harvesting and Storage structure groups.

Methods:

Probability sampling with 201 respondents was conducted in Ephrataena Gidem district of north showa zone, Amahara regional state, Ethiopia

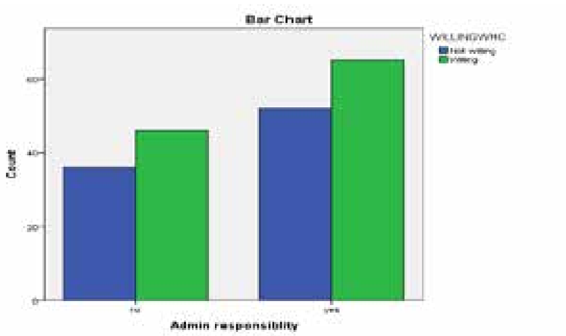
Data is analyzed by both descriptive statistics and econometric models to study the relationship between the dependent and explanatory variables. Using descriptive statistics the mean, range, minimum as well as maximum values of variables were indicated. The result obtained is used as an indicator of the relationship between explanatory variables and the dependent variable. In addition, econometric models were used to study the relationship between variables empirically. Thus, the binary logit model was used to analyze the willingness of farmers to participate in water harvesting activities. The multinomial logit on the other hand, was used to analyze the choice decision of households among alternative water harvesting storage structure groups.

Results and Discussion:
Figure-1:



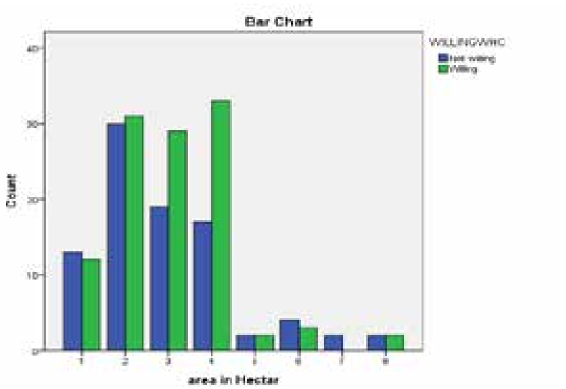
Source: results of descriptive statistics

Figure-2:



Source: results of descriptive statistics

Figure-3:



On average, the sample households kept about 1.8756 total tropical livestock unit: the minimum and maximum livestock kept being 1 and 5 tropical livestock units respectively with a standard deviation of 1.0721. Willing farmers own on average 2.22 livestock units and the non-willing have reported average 1.44 livestock units per household. The larger average tropical livestock unit owned in the willing farming household indicated that larger livestock ownership leads farmers to decide for participation in water harvesting activities.

The mean available labor in adult equivalent was 0.61 with the maximum and minimum being 0 and 1 respectively. Willing farmers have relatively lower labor units (59.8%) in adult equivalent when compared with non-willing sample a household (62.2%) which may indicate that labor availability is a key component to be considered for participation decision. This means that to undertake water harvesting works households need to have in sufficient labor availability.

Shortage of labor supply may lead a household to participate in water harvesting practices. Shortage of money may discourage farmers from participating in newly released agricultural technologies. Accordingly, 59.8% of the willing and 69.6% of the non-willing farmers faced money shortages during the past cropping season.

Table 1: Money shortages

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
Reported shortage of money	67	59.8	61	69.6	128	63.6
Reported non-shortage of money	45	22.3%	27	13.4%	72	35.8

Source: results of descriptive statistics

Farmers' institutional environment

Farmers' institutional environment has important bearing on the preferred status of the farmers with respect to willingness to participate in water harvesting technologies. The important institutional concerns, considered in this study, are credit facility, market accessibility, and agricultural extension (distance to the nearest development center).

The minimum and maximum time required to arrive at the nearest development center were 30 minute and 2 hours respectively. The average time required by sample households is about 1hr and 30 min with a standard deviation of 1hr and 3 minutes. On average 27.1%, willing farmers walk for less than 30 minutes while the figure was 46% for the non-willing farmers. This indicates that distance from development center may matter to make decision for participation.

Similarly, the maximum time required to arrive at the nearest marketing center is 3 hours while the minimum time was found to be only 30 minutes with a standard deviation of 1hr and 20 minutes. On average, 35.8% sample households were required to walk for less than 30 minutes to arrive at the nearest local market center. Similarly, willing and non-willing farmers walk for 65.9 and 52.5 minutes respectively.

In this study, access to credit was found to affect the probability of being willing to participate in water harvesting practices. The study found that about 37.8% of the respondents have faced problems in getting adequate loan facilities.42.8% of the non-willing and 31.4 % of the willing farmers suffered the same problem. This result indicated that shortage of money might discourage users from participating in water harvesting activities.

Table 2: Access to credit

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
I Can get adequate loan	61	68.5	64	60.7	125	62.1
I Cannot get adequate loan	28	31.4	48	42.8	76	37.8

Source: results of descriptive statistics

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Training, visiting and perception measures

Training users and visits to create awareness are preconditions for them to make decisions to participate in water harvesting sector. As indicated in Table 7 below, 67 sample household heads or 55.83% have participated in training and other water harvesting related matters. The figure is 64.2% and 60.6% for the willing and non-willing farming households, respectively.

The gap between the two groups is significant which implies that training and participating users in water harvesting related matters is an important factor to promote the technology quickly.

Table3:Participation and training

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
Partici-pation on water harvest matters	72	35.8	54	26.8	126	62.6
Non-par-ticipation on water harvest matters	40	19.9	35	17.4	75	37.3

Source: results of descriptive statistics

The attitude of users towards the importance of water harvesting practice is another factor, which was considered to explain the willingness of farmers to participate in water harvesting practices. Accordingly, 62.1% from the total respondents have responded that water harvesting technologies are not as such complex to implement. They reported water harvesting practice as economically important. As can be seen from Table 8, 90.4% of the willing and 57.7% of the non-willing farmers shared the same idea. This variable was seen as having very large difference between the willing and non-willing sample household groups. This indicates that those farmers who considered the available technology groups as simple as they can implement and maintain with their resources and ability are quick to adopt the technology.

Table 4: The importance of water harvesting technology

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
Water harvesting important	83	74.1	52	58.4	135	67.2
Water harvesting is not important	29	25.9	37	41.6	66	32.8%

Source: results of descriptive statistics

Significant numbers of farmers in the study area have practice small scale irrigation schemes. Of all the total respondents, 54.2% have reported that they have constructed small scale irrigation of their own. The figure is slightly smaller for the willing compared to the non-willing farm 53.3% and 55.1% for willing and non- willing respectively.

Households indicating that those farmers who have none before are more interested to have in the future.

Table 5: Irrigation use

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
Practice irrigation before	60	53.5	49	55.1	109	54.2
Not practice irrigation before	52	46.4	40	44.9	92	45.7

Source: results of descriptive statistics

Considering all sample households 29.8% responded that they have faced food shortages in the past 5 years. The figure is reported to be 33.9% for the willing and 24.7% for the non-willing farming households.

Table 6: Food availability status of sample households

	Willing		Non-willing		Total	
Attributes	Number	%	Number	%	Number	%
Yes	38	33.9	22	24.7	60	29.8
No	74	66	67	75.2	141	70

Source: results of descriptive statistics

Tests of the mean and frequency differences of variables

The mean values of the continuous variables in both willing and non-willing groups were

Compared using t-test; the test is used to indicate the mean difference between groups. That is why the test was used to identify the mean difference between willing and non-willing respondents. The t-values of 6 continuous variables were computed and all most all variables have significant mean variance on the two groups. as we see from the table below,

Accordingly, the mean difference of the variables Age, labor availability (LABORAVA), Total Tropical livestock unit (TTLU), distance from extension center (DISTEXTC), distance from nearest market center (DISTMARK) and total cultivated area owned (CULTAREA) are found to be significant at 5% probability level. Indeed, the two groups may not only differ in terms of quantitative variables, but also in terms of qualitative variables. In this respect, a chi-square test was used to examine the existence of statistically significant differences between the two groups. Accordingly, 7 discrete variables were considered and the two groups were found to be different in all terms.

More specifically, the chi-square test reveals that 4 discrete variables showed statistically significant differences between the two groups at 1% probability level. The sensitivity of the model (Correctly predicted willing) and specificity (correctly predicted) non-willing is 55.7% and 44.2% respectively.

The significant variables are IRRIGUSE (Irrigation use), FOODSHOR, ADQOLO and attitude towards water harvesting technology (ATITECHN) level.

Household's willingness to participate (WTP)

112 farmers or 55.7 percent of the sample households were willing to have some water harvesting structures. The third question inquires the farmer to respond whether he is willing or not to have some water harvesting structures irrespective of the issue of costs. The content of the question in here leads the respondent to show his willingness to construct any type of water harvesting structure in his plot, though the costs were to be covered by government or other NGOs. Accordingly, 181 respondents 90 percent of the sample farmers showed their desire to have some type of structure.

Therefore, in the context of this study a respondent is said to be willing if he/she falls in Category one and Category two. They are considered as real demanders of the technology. This three stage questioning was believed to reveal the willingness to pay for the technology. Those who are willing to participate are also willing to pay for the technology.

Here the number of farmers who fall under groups one and two yield 112(55.7%) the total number of willing respondents. Hence, 112 farmers or 55.7% of the total respondents were considered to be the willing farmers. On the other hand, 89 farmers or 44.33 % of the respondents were considered to be non-willing farmers. Those farmers who desire but not willing to pay were asked, as to why they are not willing to contribute at least half of the costs of the technology, which they desire. Most responded that they are unable to afford at least half of the costs of the technology. According to this group of respondents, the costs of the technologies, which are being practiced, were beyond their ability to pay. They also pointed out that they have critical shortages of labor to contribute. Still there are other respondents within this group who demands only governments or other NGOs contributions for the total costs of the structures.

However, there are farmers (38) or 18.9% of the total respondents who neither desire nor are willing to participate. Most of them have no information about the uses of water harvesting structures.

Econometric results for the binary logistic regression model

In the preceding parts of this thesis the descriptive analysis of important explanatory variables that were expected to have impact on the decision of a given farmer to participate in water harvesting works were presented. In this section, the selected explanatory variables were used to estimate the binary logistic regression model to analyze the determinants of household's willingness to participate. A binary logistic regression model was fitted to estimate the effect of hypothesized explanatory variables on the probabilities of being willing or not. STATA 12 for windows was used for the econometric analysis.

Prior to the estimation of the model parameters, it is crucial to look into the problem of Multicolinearity(that check association among the potential candidates of continuous variables) in the model. To this end, the Variance inflation factor (VIF) was used to test the degree of multicollinearity among the continuous variables.

The values of the VIF for continuous variables were found to be small (i.e VIF values less than 10). To avoid serious problems of multicollinearity, it is quite essential to omit the variable with value 10 and more from the logit analysis. The data have no serious problem of multicollinearity. As a result, all the 6 continuous explanatory variables were retained and entered into the binary logistics analysis.

Similarly, the contingency coefficients, which measure the association between various Discrete variables based on the Chi-square, were computed in order to check the degree of association among the discrete variables. The values of Contingency coefficients ranges between 0 and 1, zero indicating no association between the variables and the values close to 1 indicating a high degree of association within the variables. Accordingly, the results of the computation reveal that there was no serious problem of association among the discrete explanatory variables

Eventually, a set of 14 explanatory variables (6 continuous and 8 discrete) were included in the model and used in the logistic analysis. These variables were selected based on theoretical explanations and the results of various empirical studies. To determine the best subset of explanatory variables that are good predictors of the dependent variable, the logistic regression was estimated using enter method of Maximum Likelihood Estimation, which is available in statistical software program (in this case STATA version 12). In this method, all the above mentioned variables were entered in a single step. For estimation of the logistic regression model, some of the explanatory variables that are expected to improve the model fitness were selected and included in the model analysis.

Table7: Parameter Estimates for binary logit

Variable	B	Odds ratio	Wald	Sig
AGE	0.0036843	.0151922	0.761	0.388
EDUC	-.0.0401096	-.1653911	0.174	0.674
TTLU	0.253646	1.045905	24.195	0.000*
TRAINING	0.0187601	.0772365	0.037	0.848
FINANCON	-0.1636928	-.4336562	1.140	0.286
IRRIGUSE	0.580593	.2392544	0.428	0.514
CULTAREA	0.00664	.0027379	0.000	0.983
DISTEXTC	-0.2729665	-1.125573	11.455	0.001*
ADEQOLON	0.1116574	.4672017	1.482	0.223
ATITECHN	0.2427288	.9984159	6.343	0.012**
LABORAVA	-0.095794	-.3994388	1.034	0.310
DISTMARK	0.2116446	.8727128	12.549	0.000*
RESPONSI	0.07266392	.2986714	0.601	0.437
FOODSHOR	0.1053472	.4435771	1.146	0.285
CONSTANT		-2.96982	4.725	0.030

-2 log Likelihood Ratio 103.96
Pearsons Chi-Square (X2) 68
A Correctly predicted (count R2) 201
B Sensitivity 112
C Specificity 89
*** and ** shows significance at 1% and 5% probability levels, respectively**
A Based on a 50-50 probability classification scheme
B Correctly predicted willing groups based on a 50-50 probability classification scheme
C Correctly predicted willing groups based on a 50-50 probability classification scheme
Source: results of binary logit analysis

Table 8: Sensitivity analysis

Description	Probability	Change in probability	Percentage change in probability
Typical farmer	0.58652		
Typical farmer with near distance to market	.8727128	.2116446	21.1
Typical farmer do have good attitude about water harvest	.9984159	.2427288	24.2
A 10% increase in TTLU	1.045905	.253646	25.3
A 10% increase in distance from development center	-1.125573	-.2729665	-27.3

Mean and frequency comparisons for multinomial logit analysis

Table 9; multiple comparison

Dependent Variable	Structure U	(J) Structure	Mean Dif-fe-rence (I-J)	Std. Error	Sig
PLOAREA	1	3	2.32	0.358084	0.500
	1	2	2.32	0.273916	0.500
	2	3	2.32	0.358084	0.500
DISTPLU	1	2	1.74	0.07159	0.292
	1	3	1.74	0.502472	0.181
	2	3	1.74	0.945886	0.721
TTLU	1	2	0.75	0.3599	0.618
	1	3	0.75	0.46763	0.503
	2	3	0.75	0.32595	0.618

Source: results of mean comparison with independent samples t-test.

**** Significant at 5% probability level**

The results of the Chi-square test indicate that only Cost of water harvest structure, Water harvest structure area and fertility of soil is significant mean difference among groups. The rest of the variables have insignificant mean difference at probability $P<0.05$.

Preference among water storage technology groups

Willing respondents were asked to reveal their preferences among water storage technology groups. Of the entire total willing farmers, 7 respondents or 3.5 % preferred aboveground structure groups. 96 farmers or 47.8 percent of the total willing respondents wanted to have underground structures. Still 9 farmers or 4.5 % of the willing respondents preferred to have surface pond structure groups. Sample farmers were also asked the reasons for preferring a specific group. Most farmers who preferred underground type of structures forwarded their reasons as, the underground structures are convenient to manage. Those who prefer the underground structure group reasoned their preferences as underground structures prevent evapo-

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ration. Some farmers within this group also added other reasons that underground groups are easy to construct.

On the other hand those who prefer above ground structure group put their reasons, as their plot is sloppy and cannot be dug deep into the ground to construct underground type of structures. Some farmers within this group have also a fear that if they build underground type of structures, at some day their children or their animals may fall into the water harvesting structures.

Surface pond structure demanders on the other hand, have their own reasons for their preferences. Most surface pond preferring farmers said that this structure group is the most suiting structure type for their plot because as their plot has black soil, it will be costly if they want to build underground structures. In addition, surface pond structures can vary in size as the ability to pay off a given farmer. They can hold large or small quantity of water as per requirement and ability.

Econometric results of the multinomial logit model

As done in the binary logistics part, various tests of multicollinearity were conducted and Hence variables were found free from the problem of multicollinearity. See appendix table 7 for variance inflation factor and appendix table 8 for contingency coefficient. The various goodness of fit measure was checked and validate that the model fits the data. The likelihood ratio test statistics exceeds the Chi-square critical value at less than 1% probability level. This implies that the hypothesis, which says all coefficients except the intercept is zero, was rejected. The value of Pearson Chi-square test shows the overall goodness of fit of the model at less than 1% probability level.

All the 10 explanatory variables considered as determinants for the choice decision of sample households among different water storage structure groups, become insignificant at P<0.05 and P<0.1 for all structure groups as one can see from the table below.

Table 10: Parameter Estimates of the Multinomial Logistic Regression

Structure		B	Odds ratio	Wald	sig
	Intercept	-24.8			
	EDURESPO	0.0195745	-1.128839	0.02	0.991
	PLOAREA	0.0028914	4.472486	0.014	0.029
	DISTPLO	0.019335	-1.173699	0.05	0.568
	SLOP	0.0041659	0.3588601	0.23	0.827
Under-ground	OWNPLO	-0.0114752	1.767929	0.02	0.328
	FERTILIT	-.0.0114262	-6.503998	0.33	0.039
	FINANCON	-0.0660115	-2.720616	0.028	0.428
	LABOURAVA	0.006645	-0.0072663	0.027	0.992
	TTLU	0.0009591	-4.107065	0.012	0.036
	SOILTYPE	0.263001	-3.152985	0.00	0.147
	COSWHS	0.110877	-4.469759	0.00	0.073
	WHSAREA	-0.0236833	5.623369	0.00	0.092
	Intercept	-14.5			
	EDURESPO	5.56e-07	2.15004	0.005	0.983
	PLOAREA	-2.16e-06	-4.322937	0.069	0.036
	DISTPLO	5.77e-07	2.1322977	0.075	0.352
	SLOP	-1.71e-07	-0.1069862	0.040	0.955
Above Ground	OWNPLO	-1.79e-06	-2.468429	0.024	0.247
	FERTILIT	3.14e-06	5.968153	0.275	0.061
	FINANCON	5.33e-07	-12.10472	0.891	0.993
	LABOURAVA	4.56e-09	0.1108146	0.678	0.899
	TTLU	1.98e-06	4.148057	0.277	0.037
	SOILTYPE	1.54e-06	4.462933	0.022	0.057
	COSWHS	2.17e-06	5.092077	0.000	0.048
	WHSAREA	-2.73e-06	-7.0085529	0.003	0.041
	Intercept	10.2			
	EDURESPO	-0.0195751	-2.15004	0.003	0.983
	PLOAREA	-0.0028893	4.322937	0.045	0.036
	DISTPLO	-0.0193356	-2.139154	0.006	0.352
	SLOP	-0.0041657	0.106986	0.044	0.955
Surface pond	OWNPLO	0.0114769	2.468429	0.618	0.247
	FERTILIT	0.0114231	-5.968153	2.37	0.061
	FINANCON	0.066011	12.10472	0.108	0.993
	LABOURAVA	-0.0016645	-0.1108146	0.005	0.899
	TTLU	-0.000961	-4.148057	0.155	0.037
	SOILTYPE	-0.0263016	-4.462933	0.367	0.059
	COSWHS	-0.0110899	-5.092077	0.00	0.048
	WHSAREA	0.023686	7.008529	0.00	0.041

Source: results Multinomial analysis

-2 Log Likelihood = 35.2

Interpretation of empirical results:

Soil type of the plot (SOILTYP): This variable is insignificant at (P< 0.05) to affect the choice decision for all structure groups. The negative sign of the coefficient in surface pond structure case is related to the hypothesis of this study but the positive and negative coefficients in the underground and aboveground structure groups is found to contradict with the idea in the hypothesis. This means that the respondent farmers are less considerate about the soil type when they choose water harvest structure. This idea has no scientific base and it contradict in half terms with the idea of Brady and Well that stated red soils are more preferable to construct underground structure groups but surface ponds are usually constructed in black soils (Brady and Well, 2002).

The odds ratio -3.152985 in underground structure groups indicate that as farm plot soil type changes the house hold is less likely to prefer underground water harvest structure. Similarly the odds ratio of 4.462933 in above ground water harvest structure indicates as the soil type of the farm plot changes the household have more probability to prefer above ground water harvest structure. And that of -4.462933 odds ratio of surface pond indicates the households are less likely to prefer surface pond structure when soil type changes.

Slope of the plot (SLOP): It affects the choice decision for all choice structure groups insignificantly at (P< 0.05). The coefficients of this variable capture positive sign in underground and surface pond structure groups and negative sign for aboveground structure group. This result is inconsistent with the idea in the hypothesis and the general theoretical framework when we see the case of underground and surface pond structure group coefficients, which is mentioned in (FAO, 1994). Users usually prefer to construct underground and surface pond structure groups in plots having flat topography mainly to avoid or to minimize the large earth works required to construct them.

The odds ratio of 0.3588601 in the underground structure group case indicate that as farmer plot changes its type from less sloppy to sloppy the farmer is more likely to prefers underground water harvest structure . And the same works for surface pond water harvest structure with odds ratio of 0.834.On the other hand the odds ratio of -0.106 in above ground water harvest structure indicates as farm plot changes from less sloppy to sloppy the farmer less likely to prefer above ground water harvest structure.

Distance of the plot from homestead (DISTPLO): This variable is insignificant at probability (P< 0.05) to affect the choice decision for all water harvest structure groups. The parameter in one group also took the expected sign, which is negative in the underground but the rest positive in aboveground and negative surface pond structure groups is not in line with the hypothesis. The result for the two groups disagreed with the idea in the hypothesis. The negative sign of the coefficients in the underground was as anticipated indicating that as the distance of a plot from homestead is large, users are not interested to construct underground structure groups as the water is used for drinking purpose. Theoretically, it was true for that case.

The odds ratios -1.17 for the underground indicates that as distance from home to plot increases the farmers are less likely to prefers underground water harvest structure then the rest of the two groups. The same works for surface pond structure with the odds ratio of

-2.13.The odds ratio of 2.13 for above ground structure indicates that as farm to home distance increases the farmer's probability to choose above ground structure increases.

Area of the plot (PLOAREA): The variable affects the choice decision for all structure groups significantly at (P< 0.05). The coefficients of this variable for surface pond water harvest structure group found consistent with the hypothesis but inconsistent for other groups because this structure group require large area as compared to others. The odds ratio 4.47 for underground structure indicates that as farm area increases by one unit the farmer is more likely prefer underground water harvest structure group. On the same fashion the odds ratio of 4.32 on surface pond structure indicate that the farmer is more likely to prefer this group as plot area increases by one unit. On the other hand the odds ratio of -4.32 above ground indicates that as farmer plot area increases by one unit the probability of the farmer to prefer this groups will decrease or less likely to prefer this group.

Labor availability (LABORAVA): The variable is insignificant at (P<0.05) to affect the choice decision for all structure group. The coefficients in all structure group case inconsistent with the hypothesis of this study. This disagrees with the theory that surface pond structure groups in general demand large labor units than the aboveground ones (Martinson et al., 2001).

The odds ratio -0.0072 and -0.1108 for the choice of underground and surface pond structure groups respectively indicates that with one additional unit of labor for the farm the farmer is less likely prefers underground and surface pond structure group. On the other hand the odds ratio 0.110 for aboveground water harvest structure indicates that with one additional unit of labor the farmer is more likely to select aboveground water harvest structure. Whereas the theory on the ground explains this group require more finance than labor.

Total livestock unit (TTLU) this variable is significant with P<0.05 for all structure groups. The coefficient in this variable captures the sign of the hypothesis in this study that is negative, positive and negative for underground, aboveground and surface pond structures respectively. This is in line with the theoretical frame work those farmer with large livestock unit will require above ground structure group for livestock drinking and the asset on live animal give them more financial freedom. The odds ratio of -4.10 and -4.14 in underground and surface pond structure refers that the farmer is less likely to prefer underground and above ground structure groups when the live stock unit increases by one.

Ownership of the plot (OWNPLO): This variable is also insignificantly at (P< 0.05) and (P< 0.1) for all water harvest structure groups. The sign of the coefficients in all the groups capture as hypothesized in this study. Many literatures repeatedly underscore the land tenure as the determinant factor for the adoption of water harvesting practices. The odds ratio 1.76 and 2.46 indicates that the farmer is more likely to prefer construction of underground and surface pond structure groups respectively when ownership of land changed even On the other hand odds ratio of -2.46 for aboveground structure indicates the farmer is less likely to prefer construction of the aboveground structure on rented or hired plot of land due to high cost requirement of the structure.

Fertility of the plot (FERTILIT): It refers to the fertility status of the plot on which water harvesting structure is to be constructed. This was significant at (P< 0.05) for underground structure group only with sig value of 0.039. The coefficients of the variable in the two structure groups that of underground and aboveground agree with the hypothesis of this study, which is negative and positive respectively. This result is consistent with the hypothesis, which argues those aboveground structure groups are built for the purpose of crop production but the underground one for drinking water supply. But for surface pond structure group the coefficient is inconsistent with the hypothesis.

The odds ratio -6.5 and -5.9 shows that as the plot becomes fertile, the farmer is less likely to prefer underground and surface pond water harvest structure group. On the same manner the odds ratio of 5.9 indicates that as soil become more fertile the farmer is more likely to prefer above ground structure group because it is highly advisable for crop production and the farmer can compensate the cost with income increment after harvest.

Education level of head of the household (EDUC): Education level is insignificant to affect the decision for all structure groups at (P< 0.05). The coefficients in the two structure groups were found to be negative for that of underground and surface pond structure group. And it is positive for that of the above ground structure group. The result shows that with increase in the level of education of the head of the household the farmer is more likely to prefer above ground water harvest structure than the rest of the two groups.

Financial constraints of the household (FINANCON):
Financial constraint is insignificant at (P< 0.05) to affect the choice decision for all structure groups. The coefficients signs are inconsistent with the hypothesized signs for the underground structure groups. But for the above ground and surface pond structure group it is in line with the hypothesis. The result in all the two groups is consistent with the idea in the hypothesis and with the theoretical framework, which says aboveground structure groups generally require large amount of money when compared with the other two groups (Rees, 2001). The odds ratio -2.72 indicate that as farmer face more financial shortage; it is less likely to prefer underground water harvest group. On the same fashion the odds ratio of -12.1 in above ground refers the farmer is less likely to prefer above ground structure group with one unit increment in financial constraint. Whereas the odds ratio of 12.1 in surface pond structure refers the farmer is more likely to prefer surface pond structure with one unit increment in financial constraint. This coefficient is totally in line with the theoretical frame work that surface pond structures are the least cost structure compared to the other groups.

Cost of water harvesting structure (COSWHS) this variable is significant at P<0.05 for both aboveground and surface pond structure group. This variable has capture signs that are in line with the hypothesis that is positive for the above ground group and negative for surface pond structure group. And justifies the theoretical frame work that says the above ground water harvest group requires more financial resource than the rest of the structure groups and the surface pond structure require least financial resource. The odds ratio of -4.46 and -5.09 in the underground and surface pond structure indicates that as cost of water harvest structure increases by one unit the farmer is less likely to prefer underground and surface pond structure group. On the other hand the odds ratio of 5.09 in above ground structure refers the farmer is more likely to prefer above ground structure group as cost of water harvest structure increases by one unit.

Water harvesting area (WHSAREA); this variable is significant at P<0.05 for both aboveground and surface pond structure group. The coefficients of this variable capture sign in line with the hypothesis for two of the structure group that is for the above and surface pond structure group that is negative and positive respectively. And this justifies the theoretical frame that says surface pond structure require more area as compared to the rest of the two groups. The odds ratio of 5.62 and 7.00 in the underground and surface pond structure indicates that as water harvesting area increases by one meter the farmer is more likely to prefer underground and surface pond structures. On the other hand the odds ratio of -7.00 on the above ground structure refers the farmer is less likely to prefer aboveground structure group as water harvest structure area increases by one unit.

CONCLUSIONS AND RECOMMENDATION
Conclusion
This study has tried to look into the socio-economic, physical and other related factors, which can affect the willingness of farming households to participate in water harvesting works and preferences among water storage technology groups. For this, data were collected from 201 farm households drown randomly from Ephrata Gedim district. The primary data were collected using structured questionnaire. Secondary data were collected to supplement the data obtained from the survey.

Fourteen variables hypothesized to explain farmers' willingness to participate in water harvesting activities were used to study the participation decision of farm households in water harvesting activities. Similarly, 12 hypothesized explanatory variables were used to identify the preferences of farm households among water storage technology groups. Evidences from the descriptive analysis indicate that willing farmers have better education standards, own more livestock units, have relatively large adult equivalent labor force and have better access to credit.

Moreover, willing farmers perceive water harvesting as the main means of alleviating moisture stress and believed that the available water harvesting technologies, even if not all can be implemented and sustained at individual farm household levels. Most willing farmers have exposures to training, field visits, and other water harvesting related matters, which made them aware of the means and uses of water harvesting. Non-willing farmers on the other hand, are located relatively at a farther distance from extension centers. This means they do have lesser development agent contact for being informed about new agricultural inputs and technologies.

In relative terms the non-willing farmers own irrigated plots as compared to the willing farmers. Majority of them faced financial and labor shortages. The result of the binary logit analysis indicated that four variables at (P< 0.05) were found to be significant to affect the willingness of users to participate in water harvesting activities. Age was found to have a negative and significant impact on farmers' willingness to participate in water harvesting practices at (P< 0.05) level of significance implying that as farmers' age increases by one year the farmer willingness to participate on water harvest decreases. This has natural and expected result as person's age increases the willingness to have some change in life matters decreases and the person depends on his experience and knowledge on the area.

Attitude towards the importance of water harvesting activities is another highly significant and positively related variable to affect the willingness of sample Households to participate in water harvesting works. This means that favorable attitude towards the importance of water harvesting technologies is an important input to decide for participation. Financial constraint is positively and significantly correlated to the willingness of users to participate in water harvesting practices. The result revealed the truth in such a way that a farmer faced with financial constraints has strong will to participate on water harvesting practice even though they cannot purchase local and industrial materials needed for constructing water storage structures with the current income stream. Total livestock unit of the farmer is the last important variable which is significant at P<0.05 and positively correlated with willingness of farmer to participate on water harvesting practice. This justifies the reality in ground that as farmer livestock unit increases the household daily demand for liters of water increase so that he needs to participate on water storages system to satisfy the demand in dry seasons.

The result of the multinomial logit analysis revealed that Plot area of farmer affects the farmer choice decision on all structure groups significantly at P<0.05 and correlate positively with underground and negatively for the rest of the structure groups. Fertility of the soil have significant influence on choice decision of the farmer in underground structure case at P< 0.05 as soil become more fertile the farmer probability of selecting the ground structure group will reduce because the structure is more important for drinking and guarding water storage than large farm production purpose.

The other significant variable at P<0.05 is total livestock unit available at farm household which relate positively with above ground structure unit and negatively with surface pond structure group. This is due to the fact that surface pond structure is less important for storage of drinking water for both human and animal due to easy pollution and contamination of the water under this structure as result of the openness of the structure. Cost of water harvest structure group and water harvest structure area are other variables that are significant at P<0.05 for both above and surface pond structure groups. Cost of water harvest structure relates positively and negatively with above and surface pond structure groups respectively. This is due to the real fact that the above and surface ponds require high and low cost respectively. Whereas water harvesting area has correlates negatively and positively with above and surface pond structure groups. This is due to the fact that above and surface pond structure require small and large area respectively.

Policy Implication

Based on the main findings of the study, the following recommendations are made.

1. Attitudinal change of farmers with participating users in training, farmer's field day, field visits, visits to other villages and other water harvesting related issues is an essential element to promote water harvesting in small holder, resource poor farm household level. To accomplish this responsibility, the government and other development agents has to first equip the pertinent experts who are working specially at PA, district, and regional levels with the necessary knowledge about the uses and means of implementing water harvesting technologies is found very valuable per the finding of this study.

2. The farmers' willingness to participate in water harvesting works was also found to be highly correlated with the age of the farmer. In this case the development agents and extension workers need to be very selective on recruitment of model farmer at early stage of the new technology to be very effective and record high adoption rate. Investing time with younger farmers will result high acceptance and success.

3. Financial status of the farming households is another key factor explaining the decision behavior of farmers for participation in water harvesting works. Those households facing financial constraints were willing to participate in water harvesting activities. Even though this farmers have financial constraint in their daily life. Working to alleviate the financial constraints of users is, therefore, essential for policy makers and other NGOs to promote water-harvesting practices in the long run and to have high adoption rate. This can be carried out using various means, one of which is provision of adequate loan with possible minimum interest rates. The other means may be creating favorable marketing policy and organizing users to find their potential markets and improving market infrastructure.

4. Finally, it would be necessary to indicate the preference decision behavior of farm Households among alternative water harvesting technology groups based on the characteristics of a plot. As plots vary in various biophysical factors, the preference decision of users among water harvesting technology groups also vary following the variation in characteristics of plots. Basically Plot area, cost of water harvest structure and water harvest structure area are the main variable that need attention before consulting farmer for adoption of water harvest structure. Therefore, experts and policy makers should consider developing and promoting water storage structure groups focusing on the characteristics of a particular area and locality.

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