Journal of Finance and Economics, 2022, Vol. 10, No. 1, 29-36
Available online at http://pubs.sciepub.com/jfe/10/1/5
Published by Science and Education Publishing
DOI:10.12691/jfe-10-1-5

The Effect of Rainwater Harvesting and Management in a Rain-fed Agricultural Production System of Sodo Zuria District, Southern Ethiopia

Mesay Gelaw Hoyiso*, Genemo Fitala Feyissa

Department of Economics College of Business and Economics, Madda Walabu University, Bale-Robe, Ethiopia
*Corresponding author: mesay678@gmail.com

Received April 11, 2022; Revised May 16, 2022; Accepted May 26, 2022

Abstract The research looked at the effect of rainwater harvesting and management in the Sodo Zuria District's rain-fed agricultural production system. To identify sample households, a multistage sampling procedure was used. The primary data were collected from 379 sample households, and secondary data sources were also collected from written documents and journal articles. Data analysis was employed using descriptive methods and econometric models. The study used a binary logit model to analyse the effect of rainwater harvesting and management in rain-fed agricultural production systems, while a logistic regression model was used to estimate the factors that affect adopters and nonadopters of rainwater harvesting technologies. Thirteen explanatory variables were considered to be included in the logit econometric model. Of those, six explanatory variables had a statistically significant influence on households' participation in adopting rainwater-harvesting technologies. These variables are the educational level of the household head, extension contacts, land size, farm experiences, tropical livestock units and family size of households. All significant variables have positively affected household participation in rainwater harvesting, and households that are users of rainwater harvesting affirm that their livelihood has been improved. Therefore, the promoters of rainwater harvesting should consider the educational level of the household head, extension contacts, land size, farm experiences, tropical livestock units and family size of households while initiating and implementing rainwater harvesting technologies.

Keywords: *rainwater harvesting technology, agricultural production, Binary Logit Model, Sodo Zuria District*

Cite This Article: Mesay Gelaw Hoyiso, and Genemo Fitala Feyissa, "The Effect of Rainwater Harvesting and Management in a Rain-fed Agricultural Production System of Sodo Zuria District, Southern Ethiopia." *Journal of Finance and Economics*, vol. 10, no. 1 (2022): 29-36. doi: 10.12691/jfe-10-1-5.

1. Introduction

1.1. Background of the Study

Rainfall is the primary source of agricultural water in most sub-Saharan African subsistence farming systems (SSAs). However, its distribution is inconsistent, especially in semiarid and dry subhumid areas, where crop production and animal raising have become risky businesses and people's lives have become highly precarious. National governments and international organizations have alternated between using one technique and another to assure the supply of water for agriculture [1].

Rain-fed agriculture is the dominant form of land use in Ethiopia. The economy of the country is highly sensitive to climate, and extreme variability in the intensity of rainfall and frequency of dry spells are the main causes of drought [2]. In this context, rainwater management and rainwater harvesting are critical tools for land and water development because they enable the management, storage, and use of scattered and intense precipitation for productive purposes, allowing overcoming dry spells and enhancing local ecosystems rather than generating violent runoff flows, erosion, and sediment loads in downstream areas [3].

Rainfall in Ethiopia varies geographically, temporally, and seasonally. Approximately 80% of rainfall occurs between June and September, with a 30% average year-overyear variance. As a result, expanding rainwater collection in particular, as well as enhancing water control and rainwater management practices in general, is critical for ensuring long-term rainfall utilization [4]. Rainwater collection also solves water scarcity in terms of space and time for domestic and agricultural use.

Rainwater harvesting (RWH) technology is used to collect rainwater and divert it to reservoirs to cope with rainfall variability and drought [5]. Novel agricultural technologies, such as RWH, can help improve the socioeconomic situation of rural livelihoods while also providing a climate change adaptation mechanism for long-term crop production. The overall purpose of Ethiopia's rainwater harvesting strategy is to promote and enhance Ethiopians' health and quality of life. The goal is to promote long-term social and economic growth by effectively managing and utilizing rainwater harvesting for natural, human-made, and cultural resources, as well as the environment. The farming system, social settings, economic activity, and vulnerability are all socioeconomic and institutional features and characteristics of RWHT. There has been no research in the study area/district on the effect of rainwater gathering and management in rain-fed agricultural production systems. To cover this information gap and in light of the foregoing problematic scenarios, the current study proposes to investigate the effect of RWH and management in a rain-fed agricultural production system in the SNNP regional state's Sodo Zuria area.

2. Methodology

2.1. Description of the Study Area

The Soddo zuria district is one of the rural Woreda administrations in the Wolaita zone (Southern Nations Nationalities Peoples' Region). The district is located at a distance of 390 km (to the south) from Addis Ababa. There are 24 rural Kebele administrative districts in the district. The district's total land coverage was 40805 hectares, with 12269 hectares (35.75 percent) set aside for crop production, 9067 hectares (19 percent) set aside for fallow land, 12019 hectares (30.61 percent) set aside for grazing area, and 7450 hectares (15.02 percent) set aside for forestland. The district's agroecology is characterized by midland, which comprises approximately 87 percent of the total area, and highland, which has harsh mountains and slopes.

2.2. Description of the Study Area

The household head was the study population, and a representative sample was drawn from the kebele office's list of households organized by housing number.

2.3. Data Type and Source

To acquire both qualitative and quantitative data for this study, both primary and secondary data sources were used. The primary data were gathered through a well-structured, timed questionnaire and interview.

Furthermore, direct personal observation was employed. Indeed, secondary data were gathered from published and unpublished papers of the Wereda/administrative district's office and agricultural Bureau, as well as the SNNP Regional state, to supplement the main data.

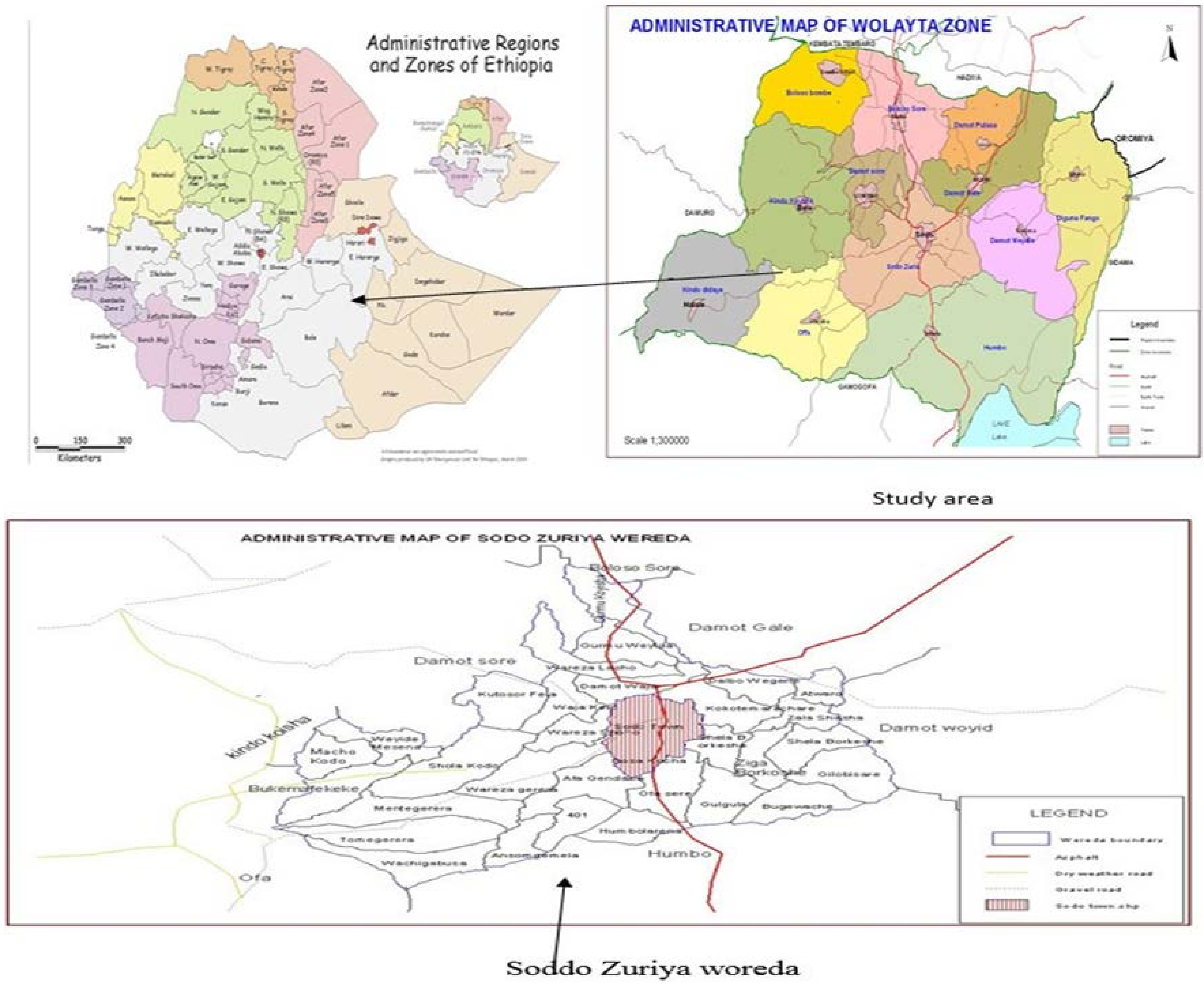

Figure 1. Map of the Study area

2.4. Sampling Size Determination and Sampling Technique

2.4.1. Sample Size

According to the district's administrative bureau in 2009 (2016/17) in *Sodo Zuria* district, there were 27,037 households. Based on the following formula, 379 household heads were sampled from the selected study areas based on [6] sample size determination formula as shown below

$$n = \frac{z^2(pqN)}{E^2(N-1)+z^2pq}$$

$$= \frac{(1.96)^2(0.5)(0.5)(27,037)}{(0.05)^2(27,037-1)+(1.96)^2(0.5)(0.5)}$$

$$= 379$$

Where n= sample size
Z= confidence interval of 95% = 1.96
P= proportion al of sample size which has
q= 1-p: 1-0.5= 0.5 p=0.5
E= Allowable error, which is 5%
N= number of household which is now 27,037.

2.4.2. Sampling Techniques

The sample of households was done using a multistage sampling technique. First, the Sodo zuria district was chosen specifically because of the widespread usage of rainwater harvesting. Four representative kebeles were chosen at random from twenty-four project target kebeles/localities in the second stage. The houses were then divided into rainwater harvesting users and nonusers. Users (adopters) of rainwater harvesting are those who used any rainwater harvesting equipment during the production year. Non–user (non–adopter) households are defined as farmers who have not engaged in any rainwater harvesting efforts during the same time that they have been in the same location.

2.5. Methods of Data Collection

The investigation was conducted using both primary and secondary data sources. The primary data come from cross-sectional data obtained from a sample that is meant to reflect the entire population. The questionnaire was created first. Respondents from similar communities were used to retest the questionnaire. This is done on purpose to improve readability and flow and reduce repetition. Minor changes were made as a result, and a survey was conducted. For data gathering, the researcher used interviewers (the researcher and a hired interviewer). The recruited interviewer was chosen from the research area.

Two factors were used to choose the interviewer: education and experience. The enumerator received three days of training from the lead researcher on how to administer the questionnaire and collect data. The purpose of the questionnaire was to collect statistical data on household demographics, consumption, and other vital socioeconomic data. The question was distributed to the head of the family in this survey, and the replies represent an individual's assessment of the entire household's rainwater harvesting. The survey was carried out for thirty days in a row. The questionnaire items were read aloud to individuals who did not read or write, and their responses were immediately recorded by the enumerators. When the head of the family is not present, he or she can provide specific information about the household's socioeconomic situation, as well as other members of the household. In addition, home research is a key component of public policy and local economic and social development studies.

2.6. Methods of Data Analysis and Interpretation

Both descriptive statistics and econometric models were used to describe the data acquired through questionnaires. Mean, standard deviation, and percentage are some of the methods used in descriptive analysis. In addition, t tests and chi square statistics were used to compare rainwater harvesting technology participants (users) and nonparticipants (nonusers) in terms of some explanatory variables. Statistical Package for Social Sciences (SPSS version 22) and STATA 13.0 version software were used for all quantitative approaches.

To distinguish adopters from nonadopters, the binary logit model is preferred over alternatives. In this section, STATA 13 software was used to calculate the coefficients of the determinants odds and odds ratio, as well as to evaluate the statistical significance of the determinants and the dependent variable of rainwater harvesting participation.

2.7. Econometrics Model Specification

To observe the independent influence of each independent variable on the result variable, a binary logistic regression model was used. The implementation of the logit probability regression model is advised when the dependent variable is binary and assumes a value of 0 or 1. In some cases, the regression and/or dependent variable can be qualitative or dummy, especially when the dependent variables are of the yes or no kind.

Depending on the AIC (Alkaike Information Criterion) and BIC (Bayesian Information Criterion) values, as well as the distribution of the latent variable (i.e., if it is distributed normal probit model will be used while if it is distributed logistically a logit model was used) [7]. The dependent variable in estimating the logit model was RWH participation, or RWH users, which takes the value of 1 and 0 otherwise.

2.7.1. Binary Logit Model

The logit model was chosen because typical least squares models presuppose a continuous dependent variable, whereas the response to household rainwater harvesting is a binomial process with a value of 1 for RWH adopters and 0 for nonadopters. The parameters of this model were determined using maximum likelihood estimation rather than the OLS regression technique's movement estimation. The logit approach produces asymptotically efficient and consistent parameter estimates. The logit method is well known for producing statistically valid findings [7]. The value of the cumulative distribution function, which is defined as a function of the explanatory factors, is used to calculate the probability of RWH.

The following is the mathematical formulation of the logit model:

$$pi = \frac{e^{zi}}{1+e^{-zi}} \quad (1)$$

where pi is the probability of participation in RWH.

$$z_i = a_0 + \Sigma_i{}^n = 1^{ai\ xi+ui}$$

Where α_0=intercept, α_i=regression results
ui= disturbance term xi = preintervention character.

The probability that a household belongs to nonparticipant is:

$$1 - pi = \frac{1}{1+e^{-zi}} \quad (2)$$

The odds ratio is $= \frac{pi}{1+pi} = e^{zi}$ taking natural logarithm, then

$$z_i = a_0 + \Sigma_i{}^n = 1^{ai\ xi+ui} \quad (3)$$

3. Results and Discussion

3.1. Descriptive Analysis

The raw data obtained from 379 sample households via a structured questionnaire distribution and data collected from various sources are examined using descriptive and econometric data analysis methods. The results of descriptive and econometric analyses are given and discussed in this section. Mean, standard deviation, and percentage are some of the methods used in descriptive analysis. In addition, t tests and chi square statistics were used to compare rainwater harvesting technology users and nonparticipants in terms of some explanatory variables.

3.1.1. Descriptive Statistics Results (Dummy and Categorical Variables)

Household heads' gender: There were 179 RWH users and 200 RWH nonuser households in the sample. The survey found that male-headed homes made up 88.89% and female-headed households made up 11.11% of the total 379 sampled households. Male-headed and female-headed households accounted for 93.30 percent and 6.70 percent of RWHT user households, respectively, and 84% and 16% of RWHT nonuser households, respectively. The chi-square test revealed that there was a statistically significant difference between adopter and nonadopter household heads in terms of the sex of the household head (Table 1).

Education Level of household head: In a modernizing or rapidly changing environment, education aids farmers in acquiring and understanding information about agricultural inputs and newly found seeds, as well as calculating suitable input levels. Improved attitudes, beliefs, and behaviors may lead to a higher readiness to take risks, adopt new ideas, save for the future, and adopt more productive activities in general. The education level of household heads was divided into two groups, as indicated in Table 1: illiterate and literate (read and write, elementary, high school and preparatory and above). According to the results, 18.5% of the respondents were illiterate, whereas 81.5% were literate.

According to the study, 6.15% and 83.85% of user households were illiterate and literate, respectively, while 29.5% and 70.5% of nonuser control families were illiterate and literate (read and write, elementary, high school, and preparatory and above). The chi-square test revealed a statistically significant difference in household head education between adopter and nonadopter household heads at the 1% level (Table 1).

Table 1. Descriptive statistics of sample households (for dummy and categorical variables)

Variables	Types	RWH User		RWH non user		Total		Chi^2
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	
Sex	Male	167	93.30	168	84	335	88.89	12.99***
	Female	12	6.70	32	16	44	11.11	
	Total	179	100	200	100	379	100	
Education	Illiterate	11	6.15	59	29.5	70	18.5	23.44***
	Literate	168	93.85	141	70.5	309	81.5	
	Total	179	100	200	100	379	100	
Access to credit	Yes	44	24.58	102	51	146	38.52	34.55***
	No	135	75.42	98	49	233	61.48	
	Total	179	100	200	100	379	100	
Marital status	Unmarried	13	7.23	31	15.5	44	11.61	1.222
	Married	166	92.73	169	84.5	335	88.39	
	Total	179	100	200	100	379	100	
Participation in training	Yes	144	80.45	108	54	262	69.13	43.55***
	No	25	19.55	92	46	117	30.87	
	Total	179	100	200	100	379	100	

Note: ***, **, *, represent a level of significance at 1%, 5% and 10%, respectively
Source: Own survey result, 2021.

Access to credit: In Table 1, the study found that 24.58% of households used credit services, while 75.42% did not. The majority of the households surveyed did not have access to credit. According to the survey, 42.58% and 51% of nonusers have access to credit services. According to the chi square test, there was a statistically significant relationship between RW participation and credit services.

Marital status of the household head*:* According to the results in Table 1, married and other (single, divorced, and widowed) household heads accounted for 88.39% and 11.61% of the total 379 sampled households, respectively. The results also revealed that married household heads and others (single, divorced, and widowed household heads) made up 92.73% and 7.27% of RWH user households, respectively, and 84.5% and 15.5% of RWH nonuser households. There was no statistically significant difference in the marital status of the household head between adopter and nonadopter household heads, according to the chi-square test.

Participation in Training: Training is a method of passing on knowledge and improving farmers' ability to adapt to new methods. It is a requirement to prevent the complexity of new technology while it is being implemented. When new technology is brought to the farming community, training is a crucial component in ensuring that the new technology is adopted. The purpose of this study was to determine the respondents' level of training involvement. The majority of users (144, 80.13%) had taken agricultural training in crop, livestock and natural resource management; however, only 108 (54%) of the nonuser group participated, which was statistically significant (P=0.000).

3.1.2. Description of Continues Variables

Age of the household head: Whether the household benefits from accumulated farming experiences is influenced by the age of the household head. In the study area, the average age of the sample household heads was 46 to 49, with standard deviations of 10.34 and 14.34 for RWH users and nonusers, respectively. The sample household heads were 48 years old on average, with a standard deviation of 13.11. There was no significant difference in the mean age of the household heads between the user and nonuser groups, according to Table 2.

Family size: In terms of adult equivalents, the sample households had a mean family size of 5.45 people per household, with a standard deviation of 2.33. The mean family size in adult equivalent for nonuser and user sampled family groups was 5.83 and 4.74 people per household head, respectively, with standard deviations of 2.31 and 2.26. The difference in family size between RWH users and nonusers was statistically significant at the 5% probability level (Table 2).

Livestock holding: Livestock are also the household's most valuable producing assets. Livestock are major sources of draft power for plowing, transportation, and riding in the research region. They serve as a source of status and play a part in religious and cultural ceremonies. It is also regarded as a preserved asset that may be utilized during times of food scarcity. Cattle, sheep, goats, donkeys, and chickens were the most common livestock species held by the sample houses in the study area. RWH user households have a higher average number of (3.39 in TLU) than nonuser households, with an average livestock holding of 2.0 in TLU and a standard deviation of 1.23. (1.25 in TLU). Table 2 shows that the mean comparison of the two groups in terms of livestock holdings is statistically significant at the 1% probability level, according to the t test results.

Distance from the nearest market: The economic viability of RWH development has clearly been determined by markets. The average distance from the nearest market for the sample household was 3.23 km, with a standard deviation of 0.054. The mean distances from the nearest market for users and nonusers were 3.03 km and 3.34 km, respectively, with standard deviations of 0.47 and 0.55, which were statistically significant between groups at the 5% probability level.

Off/nonfarm income: Petty trade, selling charcoal and wood, weaving, selling local drinks, and other nonfarm activities are descriptions of off-farm activities in the study area. According to the t test results in Table 2, the average annual off/nonfarm income for the sample households was 5666.4 birr. RWH user households earned 6036.12 birr per year, while non-RWH user households earned 5467.38 birr per year. At the probability level, the mean difference in nonfarm income between RWH users and nonusers was not significant.

Land size: In agrarian societies such as Ethiopia, land is the most valuable productive asset. The most important scarce factor of production is cultivable land. The average land holding size of the sample households in the study area was 0.53 ha, with a standard deviation of 0.32. The average land holding size of non-RWH households and user households was 0.51 ha and 0.54 ha, respectively, with standard deviations of 0.29 and 0.33. The mean difference in land holding size between RWH users and nonusers was not significant at any probability level (Table 2).

Farm experiences: The household head's farm experiences influence whether the household benefits from rainwater harvesting. The average farm experiences of the study area's sample household heads in terms of RWH ranged between 3.37 and 1.16, with standard deviations of 1.49 and 0.32 for RWH users and nonusers, respectively. The sample household heads' average farm experience was 1.93 years, with a standard deviation of 1.39. Table 2 shows that there was a significant difference in the farm experiences of the household heads between the RWH user and nonuser groups.

Extension contacts: The average number of extension visits by DAs to total sample households was 4.58 times per year, with a standard deviation of 2.96. The average number of extension visits per year for RWH households was 5.59, with a standard deviation of 2.23. Non-RWH households, on the other hand, received 3.69 extension visits per year, with a standard deviation of 2.36. The difference in the number of extensions visits by DAs between RWH user and nonuser households was found to be statistically significant at the 1 percent probability level (t= -6.58).

Table 2. Description of continuous variables sample households

NO	Variables	RWH user HH		Non-RWH user HH		Combined		t value	Sign
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation		
1	Age	46.05	10.34	49.06	14.34	48.01	13.11	1.094	
2	Family size	4.74	2.31	5.83	2.26	5.45	2.33	2.27	**
3	TLU	3.39	1.06	1.25	0.375	2.00	1.23	-14.65	***
4	Distance from market	3.03	0.47	3.34	0.55	3.23	0.54	2.89	**
5	Off/farm income	6036.12	5036.8	5467.38	4754.3	5666.4	4837.3	-0.55	
6	Land size	0.54	0.33	0.51	0.29	0.53	0.32	0.36	
7	Farm experiences	3.37	1.49	1.16	0.32	1.93	1.39	-11.48	***
8	Extension contact	5.59	2.23	3.69	2.36	4.58	2.98	-6.58	***

Note: *** significant at 1%, ** significant at 5% and * significant at 10% significance. **Source:** Own survey result, 2021.

3.2. Econometric Analysis

A binary logit model, as described in the model specification section, was used to analyse the determinants of rainwater harvesting. The model's suitability for econometric analysis is highly dependent on how much it predicts from the actual observation or what percentage of the actual observation is truly predicted by the model. As a result, the researcher used various tests to determine whether the model fits the data. To determine whether to use the logit or probit model, the researcher compared both logit and probit regression models using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). Accordingly, (AIC) for logit=39.87, which is < (AIC) for probit=40.91. In addition, (BIC) for logit=68.23 which is < (BIC) for probit=79.24. The model with less (AIC) and (BIC) is preferable.

Table 3. Results of Model Goodness of fit test

Model	Obs	AIC	BIC
Probit model regression	379	40.912	79.238
Logit model regression	379	39.871	68.228

In estimating the logistic regression model, the dependent variable used in the model was a binary variable indicating 1 for RWHT users and 0 otherwise. Before proceeding to influence estimation, correlation was applied to check for the presence of serious multicollinearity problems among the explanatory variables. The model results for the correlation test of the variables showed that there were no serious problems of collinearity among explanatory variables, which is why there was no correlation greater than 0.8. Therefore, no explanatory variable dropped from the model since there was no serious problem of collinearity among explanatory variables. The logistic regression model was used to estimate the factors of each technology user and nonuser household as a function of observed household characteristics.

To identify the major determinants of household saving, the dependent variable was regressed against various independent variables. The regression table revealed that the binary logistic model managed to predict 86% of the responses correctly. Apart from percent correct predictions, the Chi-square model has "n" degrees of freedom. Accordingly, p values associated with the value of chi-square 0.0000 degrees of freedom. The indicates that the model as a whole is statistically significant, which shows that the model fits the data well.

The estimated logistic regression model indicated that six of the thirteen explanatory variables used in the estimation model significantly influenced RW participation. This includes educational level of the household head, extension contacts, Land size, Farm experiences TLU and family size of households. All significant variables positively affected household participation in RWHT. The explanations for significant variables are as follows.

The literacy/education level of the household head determines whether the household uses RWH. At the 5% level of significance, the variable's marginal effect was found to have a positive sign and statistical significance. According to the marginal effect, being literate increases the likelihood of using rainwater harvesting by 4.9 percent, all else being equal. This is because literate household heads can obtain basic information about the value of rainwater harvesting. This result is consistent with finding [8].

Land size is another factor that influences whether a household uses RWH. At the 10% level of significance, the variable's marginal effect was found to have a positive sign and statistical significance. According to the marginal effect, increasing the size of a household's land by one hectare increases participation in RWH by 70%, all else being equal. This is because the size of the land allows households to easily farm it for various agricultural products, which encourages households to participate in rainwater harvesting. This result is consistent with [9].

The number of livestock in the household also influences whether the household uses RWH. The variable has a statistically significant (at the 1% significance level) and positive marginal effect coefficient. The magnitude and sign of the marginal effect show that increasing the number of tropical livestock units in a household by one unit (in TTLU) increases the household's RWH participation by 5.3% while holding other variables constant. This result is line with finding [10].

The other independent variable influencing household RWH participation is the extension contract. The variable has a statistically significant (at the 5% significance level) and positive marginal effect coefficient. The marginal effect indicates that participating in an extension visit by a development/agricultural agent increases RWH participation by 9.6% when all other variables are held constant. This finding is consistent with [11] finding that the intensity of extension services increases the likelihood of using rainwater harvesting technology.

Farm RWH experiences: one of the determinants of whether a household uses RWH or not. At the 1% level of significance, the variable's marginal effect was found to have a positive sign and statistical significance. The marginal effect indicates that a one-year increase in farm experience increases participation in rainwater harvesting by 5.2%, all else being equal. This is because when new technology is introduced to the farming community, experience becomes an important factor in increasing the adoption of new technology (rainwater harvesting). This result is in agreement with [12].

The other independent variable that influences household participation in RWH is family size. The variable is statistically significant and has a positive effect (at the 1 percent level of significance). Holding other variables constant, the marginal effect shows that a one-number increase in household family size increases RWH participation by 3%. This finding was similar to the findings of [13], who discovered that the likelihood of using rainwater-harvesting technology increases due to a larger labor force in larger family households.

Table 4. Logistic estimation results for the likelihood of households' RW participation

	Logistic regression			
Variables	**(dy/dx)**	**Standard Error.**	**p value**	**Sig**
Sex	-14.80	39.11	0.705	
Age	.004	.082	0.959	
Marital status	-6.04	19.47	0.756	
Education	0.0499	0.0018	.0421	**
Land size	0.705	0.420	0.096	*
Tropical Livestock	0.0532	0.0178	0.003	***
Off-farm income	0.0025	0.0020	0.219	
Extension visit	0.0964	1.931	0.05	**
Participation on training	0.174	.479	0.716	
Distant to nearest market	5.353	2.419	0.27	
Farm experiences	0.0521	0.89	0.002	***
Access to Credit	0.25	0.98	0.521	
Family Size	0.03	0.31	0.01	***
Constant	36.707	79.047	.642	
Mean dependent variable	0.350	SD dependent var	0.479	
Pseudo r-squared	0.862	Number of obs	100	
Chi-square	111.613	Prob> chi2	0.000	
Akaike crit. (AIC)	39.876	Bayesian crit. (BIC)	68.533	

*** p<.01, ** p<.05, * p<.1.

Source: Own survey result, 2021 *** significant at 1%, ** significant at 5% and * significant at 10% significance.

4. Conclusions and Recommendations

4.1. Conclusions

The effect of RWH and management in a rain-fed agricultural system in Sodo Zuria district, Wolaita zone of Southern Nation Nationalities and Peoples Regional State was evaluated in this study using cross-sectional data collected from four rural kebeles in the district. Furthermore, the study identified the factors influencing household participation in RWH. The primary data for this study were collected from 379 households (179 RWHT users and 200 non-RWHT users) in four rural kebeles of the district using a preplanned questionnaire and interview. The primary data collected from the sampled households were thoroughly analysed using descriptive and econometric techniques.

Descriptive statistics revealed a statistically significant mean difference between RWH user and nonuser households in terms of educational level of the household head, extension contact, participation in training, credit received, sex of household, TLU and distance from near market, farm experiences, and family size. In terms of land size, off-farm income, marital status, and age of household head, the two groups showed a statistically insignificant mean difference.

The binary logit model result also revealed that a combination of factors such as the educational level of the household head, extension contacts, family size, land size, TLU, and farm experiences significantly influenced household RWHT participation. According to the effect estimation, the RWH had a statistically significant and positive effect on program beneficiary households' income in the study area.

Finally, participation in rainwater harvesting had a significant effect on the agricultural system, resulting in an improvement in the district's living standards.

4.2. Recommendations

The following recommendations are made in light of the empirical findings presented in this study. According to the findings, the education level of the household head was also positively related to the participation of households in RWHT. As a result, education opportunities for households in the study area should be provided through either formal education or adult education in rural areas.

The analysis found that livestock ownership had a significant and positive impact on rainwater harvesting participation. This finding highlights the need for stakeholders in governmental and nongovernmental organizations to strengthen the mixed crop-livestock farming system through research and development efforts to enhance their complementary benefit by increasing demand capacity for disseminating promising technology based on farmers' endogenous knowledge and practice.

According to the findings, extension contracts had a positive and significant effect on farmers' participation in rainwater harvesting. As a result, it is necessary to increase the number of extension visits made by development agents to all rural households.

The findings revealed that farm experiences positively influenced household RWHT participation. It is necessary to avoid the complexity of new technology during implementation. When new technology is introduced to the farming community, farm experience becomes an important component in increasing the adoption of new technology. As a result, it is necessary for experienced farmers to participate in the government's technology increase for all rural households.

Participation in rainwater harvesting technology was found to be directly related to family size. The main reason for this is that as family sizes grow, there is no way to access more land for cultivation to meet the demand for large family sizes. Furthermore, the majority of the families in the study areas were young, indicating a high fertility rate in the area. With this scenario, having a larger household size exacerbates the problem of meeting food demands, let alone education, health, and other nonfood household demands that will bring future returns. As a result, affirmative action-based awareness creation on the effects of technological growth at the family and community levels should be strongly advocated as a means of moving the agricultural system forward.

According to the findings of the study, total land holding has a significant impact on the adoption of rainwater harvesting. The findings indicate that farmers with large land holdings are more likely to adopt RWH technology. This implies that research, extension, and planning agencies should be sensitive to the needs of smallholder farmers by developing and disseminating relevant technologies and strategies. DAs should encourage farmers with small land holdings to participate in improved RWH technology.

Conflict of Interest

This work is our original work, therefore; there is no conflict of interest as far as this research is concerned.

References

[1] Aziz Shikur and Tesfaye Beshah. (2013). Analysis of influencing factors in adoption of rain Water harvesting technology to combat the ever-changing climate variability in Lanfuro Woreda, Southern region, Ethiopia. Wud pecker Journal of Agricultural Research. Vol. 2(1), pp. 015-027.

[2] Dile, Y. T., Karlberg, L., Temesgen, M., Rockström, J., (2013), The role of water harvesting to achieve sustainable agricultural intensification and resilience against water related shocks in sub-Saharan Africa, Agriculture, Ecosystems and Environment, 181(2013), 69-79.

[3] Dile, Y.T., Rockström, J. &Karlberg, L., (2016b), Suitability of Water Harvesting in the Upper Blue Nile Basin, Ethiopia: A First Step towards a Mesoscale Hydrological Modeling Framework, Advances in Meteorology, 1-12.

[4] Bekele, S. (2010). Irrigation potential in Ethiopia: Constraints and opportunities for enhancing the system. International water management institute. Colombo, Sri Lanka.

[5] Kattel, RR (2015), 'Rain water harvesting and rural livelihoods in Nepal', South Asian Network for Developmentand Environmental Economics (SANDEE) Working paper no. 102-25, Available from: <http://www.sandeeonline.org/>, [October 2015].

[6] Kothari C.R. (2004). Research Methodology Methods and Techniques, Second Revised Edition. University of Rajahstan, Jaipur (India) New Age International (P) Ltd., Publishers.

[7] Gujarati, P. (2009). *Basic Econometrics (Fifth Edition ed.). New York, America: McGraw-Hill*/Irwin.

[8] Merkineh M. (2011). Tarmers' views of soil erosion hazards and decision on conservation intervention practices. The case of Mt. Damota subwatershed, Wolaita Zone, SNNPRS, Ethiopia. MSc. Thesis presented to the school of Graduate studies of Hawassa Universities. Pp.85.

[9] Ermias Mekonnen (2017). A review of factors influencing adoption of rainwater harvesting technology in Ethiopia. Department of hydraulic and water resources engineering, college of engineering, Wolaita sodo university; p.o.box: 138; Wolaita sodo, Ethiopia.

[10] Getou. S. (2009). Factors affecting adoption of rainwater harvesting: the case of Damot woide woreda, Southern Nations, Nationalities and People's Regional state, Ethiopia.

[11] Tesfaye Worku, (2005). Analysing factors affecting adoption of rainwater harvesting in DugdaBora Woreda, East Shewa, Ethiopia. An MSc. Thesis presented to the school of graduatestudies of Haramaya University.

[12] Jemal Ahmed, (2014). Utilization of rain water harvesting technology of small holder farmers: The of case plastic ponds in batiworeda, Amhara national regional state, Oromia special zone, Ethiopia.

[13] Nasir Siraj, Fekadu Beyene. (2017). Determinants of Adoption of Rainwater Harvesting Technology: The Case of Gursum District, East Hararghe Zone, Ethiopia. Social Sciences. Vol. 6, No. 6, 2017, pp. 174-181.