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Adoption of rainwater harvesting and Its impact on farmers livelihood: A Case of pastoral area of Soro Woreda, Hadiya zone, Central region of Ethiopia

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Abstract: One of the main obstacles to development in many parts of the world is a lack of water, both in terms of sufficient quantity and quality. It has an impact on all facets of life, including health, food security, agricultural productivity, technological advancement, and state economies. The aim of this study was to assess the determinants of rainwater harvesting adoption in the pastoral area of Soro district. We obtained primary data through questionnaires, personal observation, focus group discussions, and key informant interviews, and collected secondary data from published and unpublished documents. We applied a multi-stage sampling technique to select 135 sample household heads (55 adopters and 80 non-adopters) from three purposively selected kebeles of the district. TWe analyzed the collected data using descriptive statistics like mean, standard deviation, and percentage.We also employed inferential statistics such as t-test, chi-square, and econometric (binary logit model) analysis. The results of the econometric model indicate that the educational status of household heads, family size, farm size, livestock holding, and frequency of contacts with extension agents all had a positive and significant influence on the adoption of rainwater harvesting, while the age of household heads and market distance had a negative and significant influence. The study's findings reveal that the impact of rainwater harvesting on livelihoods led to an average annual income of 7290.63 birr for adopters and 4009.31 birr for non-adopters, respectively. This indicates that adopters of rainwater harvesting have increased their income by 3281.32 birr per year from 2.04 hectares on average compared to non-adopters from 1.08 hectares on average. Rainwater harvesting technology significantly enhances the livelihoods of rural households. Therefore, the study calls for teamwork at different levels to enhance their adoption of rainwater harvesting, thereby improving the farmer's livelihood.

Keywords: Adoption, Adopter, Livelihood, Logit, Non-Adopter, Rainwater, Soro, Hadiya, Central Ethiopia

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INTRODUCTION

Background

A lack of water, both in terms of adequate quality and quantity, is a major constraint to development in many areas of the world. It affects every aspect of human life, including health, agricultural yield, food security, technical development, and a state's economy (WHO, 2017). In many regions worldwide, especially in developing countries, safe water for domestic and agricultural use is not always available. (Taddele *et al*., 2013). FAO (2005) also reported that in 2025, approximately 1.2 billion people will require 300 million tons of grain, especially in arid and semi-arid areas of sub-Saharan Africa, where the scarcity of water resources often limits the productivity of the agricultural sector.

Rainwater harvesting (RWH) has thus regained its importance as a valuable alternative or supplementary water resource, along with more conventional water supply technologies (Biazin, 2012). Water harvesting technologies (WHTs) increase yield and sustain income by reducing production risk. These technologies may become even more important in the future since drought spells are expected to become more frequent and severe in Ethiopia and other countries due to climate change (Deressa *et al*., 2009; Boelee *et al*., 2012). The benefits of rainwater harvesting technologies extend beyond supporting rain-fed farming to the whole ecological system (Aberra, 2014).

According to Aduna and Anuszkiewicz (2019), rainwater harvesting is one of the solutions to the problems of water shortage in the drier areas of Africa, but its implementation presents a number of challenges, of which storage is the main one. Many people in rural areas who would like to harvest rainwater lack the resources to do so. Conventional stone, brick, or fibrocement tanks are costly, and therefore there is a great need for cheaper alternatives.

In Sub-Saharan Africa (SSA), rain-fed agriculture is largely dominant; the food security and income of rural populations are vulnerable to rainfall variability. Sustainable intensification of agricultural techniques and water management practices results in higher agricultural production and improves resilience to drought (Aberra, 2014).

Agriculture in Ethiopia is mostly small-scale, rain-fed, traditional, and subsistence, with limited access to technology and institutional support services (Adugna, 2014). As a result, low crop productivity, population pressure, and a lack of technology contribute to the country's growing problem of low income and food insecurity (FAO, 2015). Ethiopia is the world's most susceptible to natural disasters and weather-related shocks because of its high dependence on rain-fed agriculture and other topography and low adaptive capacity (Tongul and Hobson, 2013).

Ethiopia is mainly dependent on rain-fed agriculture, which is a major limiting factor for successful crop production (CSA, 2017). In many places, the amount of rainfall and duration of the rainy season are highly variable, frequently resulting in low production and low income (Parker *et al*., 2016). Because of the large difference between years coupled with a short rainy season, rain-fed agricultural use and livestock production are susceptible to water shortages. However, dry land areas like Somalia and the agro-pastoral communities of southern Tigray, Afar, and Borena often use ponds and sandwater for livestock (Jansen, 2009).

The Ethiopian economy still relies on agriculture for approximately 42% of the country's GDP, 85% of the labor force, and 90% of national export earnings (CSA, 2018). Hence, agriculture is the main user and consumer of water (Parker et al., 2016). The country's high rainfall zone accounts for about 24% of the land and 43% of the population. Despite the significant rainfall exceeding 800 mm/year in this zone, the rainfall is highly variable and occurs over a limited period of time. The moisture-deficient pastoral zone covers 76% of the country's land with less than 600 mm/year rainfall and a population of 57% (Bekele, 2010). The customary coping and adaptation strategies of agro-pastoralists and pastoralists in Ethiopia are unable to sustain local livelihoods during drought. As a result, irrigation development is the country's main strategy to maintain livelihoods in drought-prone areas (Asrat and Anteneh, 2019).

Rainwater harvesting for domestic water supply and agricultural purposes is increasingly becoming important in the face of growing the country's population, a shortage of resources, and food insecurity (Aduna & Januszkiewicz, 2019).

Recently, droughts have highlighted the risks to human beings and livestock that occur when rains fail. While irrigation may be the most obvious response to drought, it has proved costly and can only benefit a fortunate few. Nowadays, there is increasing interest in the country in the low-cost alternative generally referred to as 'water harvesting'. The latter refers to a practice of inducing, collecting, storing, and conserving local surface runoff for agricultural production (Nigigi, 2003).

However, in dry land areas like Somalia and in the agro-pastoral communities of southern Tigray, Afar, and Borena, livestock often use traditional ponds (birka) and sand-water. The government has implemented rainwater harvesting since 2002, especially in areas prone to drought. The adoption of pond technology for small-scale irrigation, however, is not uniform across the country. In a few areas, such as Tigray, the south-central region (Alaba Special Woreda), the east and west Hararghe zones of Oromia (especially Gursum District), and neighboring Somalia, farmers have widely adopted the technology (MoWR, 2010).

In Ethiopia, rainfall varies spatially, temporally, and inter-annually. About 80% of rainfall occurs between June and September, with a 20% average variation year over year. Thus, increasing rainwater harvesting in particular and improving water control and rainwater management techniques in general are essential to ensuring sustainable use of rainfall (Bekele, 2010). Moreover, rainwater harvesting addresses spatial and temporal water scarcity for home use and agriculture. Absence of awareness of the technology, high water loss through seepage, and labor-intensive pumping irrigation are the main difficulties in adopting water harvesting technologies (Alemu & Kidane, 2015).

Rainwater harvesting is vital in combating population pressure, food insecurity, soil and land degradation, high climate variability, and low agricultural productivity (Alemu

& Kidane, 2015). Water harvesting is considered the single most important means to increase agricultural productivity in drought-prone areas through cultivating crops all over the year (Hagos *et al*., 2006). Government intervention in rainwater harvesting contributed to improving agricultural productivity and changing cropping patterns towards market-oriented production, thereby enhancing farm households' incomes (Amha, 2006).

Crop production and animal husbandry are the mainstays of people's livelihoods in the Soro district. The area has high population density and erratic and unreliable rainfall, together with the recently declining length of the rainy period, unpredictable occurrence of dry spells, and lack of sufficient water resources, which have resulted in low agricultural productivity, crop failure, and consequently increased food insecurity (Soro Woreda Agricultural and Rural Development Office, 2020).

Over the past decades, many studies have been conducted on factors determining the adoption of rainwater harvesting technology. While those studies do not describe the major problems faced by farmers' failure to adopt rainwater harvesting technology, there is little identification of the impact of the impact of rainwater harvesting on farms. Furthermore, the previous studies in the study area did very little identification in terms of determinants that hindered the adoption of rainwater harvesting technology and rainwater harvesting potential to improve rural household livelihood. Therefore, we designed this study to pinpoint the factors that influence the adoption of rainwater harvesting and its potential to enhance farmers' livelihoods.

2. MATERIALS AND METHOD

Description of the Study area

Soro Woreda, one of the 10 Woreda in Hadiya Zone, is situated between 7 023'00'' and 7 046'00'' North Latitudes and between 37018'00'' and 37023'00'' East Longitudes. The total population of the district was about 229,617, with 114,489 males and 115,128 females. The population density of the area is about 338 people per square kilometer (CSA, 2013). About 95.9% of the population of Soro district is involved in mixed-agriculture economic activity (crop production and animal rearing). Crop production was the most important farm activity in the study area. The dominant crops grown in the study area are cash crops, vegetables, cereals, pulses, and spices. Dominant crops cultivated include wheat, *teff* (*Eragrostis tef*), maize *(Zea mays),* sorghum, oats, barley, potatoes, beans and peas, vegetables, bananas, and inset (*Inset ventricosum). Smallholder farmers mostly cultivate Inset (Ensetventricosum) (Kibemo, 2011).* The mean annual temperature is about 19 oC, while the mean rainfall is about 1260 mm.

Research design and sampling techniques

The study employed a mixed-methods research design, specifically a triangulation approach. The mixed-methods research design enables the gathering, analysis, and mixing of both qualitative and quantitative data and methods in a single study (Creswell, 2003; Gay, Mills, and Airasian, 2009). We applied multiple-stage sampling techniques in this study to select sample household heads. We purposefully selected three kebeles, Buriye Lange, Ombe Lange, and 2nd oda, in the first stage due to their high moisture stress and widespread adoption of rainwater harvesting in the district. In the second stage, we use stratified sampling techniques to select household head sample respondents, categorizing them into two groups: household head rainwater harvesters (adopters) and non-harvesters (non-adopters). In the third stage, simple random sampling techniques selected a total of 135 respondents—55 adopters and 80 non-adopters—based on probability proportion to sample size. We used Yamane 1967 (cited in Yismashew Feyisa, 2014) as the formula to determine the sample size. N =

Data collection

The study utilized both primary and secondary data. We obtained primary data through questionnaires, personal observation, focus group discussions, and key informant interviews, and collected secondary data from published and unpublished documents.

Data analysis

In this study, we calculated descriptive statistics such as mean, standard deviation, and percentages to analyze and interpret the survey data. Additionally, we used research inferential statistics like t-tests and chi-square tests to compare and test the significance of statistical differences between rainwater harvesting adopters and non-adopters, considering various explanatory variables. We used a binary logit model to analyze the factors that influence farmers' decisions to adopt rainwater harvesting technology.

So, before running the logit model, use the variance inflation factor for continuous variables and the contingency coefficient for dummy variables to check if the variables are multi-collinear. This study analyzes the factors influencing the adoption of RWH technology in Soro District using a binary logistic regression model. We can use a variety of statistical models to establish a relationship between factors and the adoption of technologies. We used a binary logistic model to identify factors influencing the adoption of rainwater harvesting technology. Feder *et al*. (1985) pointed out that probit and logit models are well-established approaches in the literature on the adoption of technology. The cumulative probability functions of probit and logit models are quite similar. However, the logit model offers the advantage of more easily arriving at predicted probabilities compared to the probit model. According to Hosmer and Lemshew

(1989), we can define the logistic distribution function for analyzing the adoption of RWH technology as follows:
According to Gujarati (1995) a logit model is specified as follows

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

Where Pi is a probability of adopting a given technology for the i^{th} farmer and ranges from 0 to 1, Z is a function of m explanatory variables (χi) which is expressed as:
Zi = β0 + β1 χ1 + β2 χ2 +…………+βm χm

(2)

Where β0 is the intercept and βi are the slope parameters in the model. If iP*i* is the probability
of adopting rain water harvesting pond, then 1-Pi indicates the probability of not adopting the technology is given by:

$$1\text{-}p = \frac{1}{1+ezi} \quad (3)$$

Dividing equation (1) by equation (3) and simplifying it will give us

$$\frac{pi}{1-p}=ezi \quad (4)$$

Equation (4) indicates the odds ratio in favor of adopting rainwater harvesting. It is the ratio of the probability that a farmer will adopt a given technology to the probability he will not adopt. Taking the natural logarithm of equation (4) the logit model is obtained as follows:

$$Li = Ln\frac{pi}{1-pi} = \beta 0 + \beta ixi \quad (5)$$

Where Pi= the probability that y=1(the event occurred or probability of adoption)
1-pi the probability that y=0 (the event does not occur or no adoption)
Li= the natural log of the odds ratio
β0 =the slope, measures the change in Li (logs of odds ratio) for a unit change in explanatory
Variable Xi
β0 = the intercept. It is the value of the log of odds ratio $\frac{pi}{1-pi}$ when all the explanatory variables are zero. Thus, if the disturbance term (Ui) taken into consideration the logit model becomes
Li = β0 + βi xi + Ui

No	Name of variables	Type	Definition and measurements	Expected sign
1	Age of household heads	Continuous	Year	-
2	Education of household	Dummy	1if Read and w rite,0 otherwise	+
3	Family size of household	Continuous	In adult equivalent	+
4	Sex of household heads	Dummy	1 if male,0 otherwise	+/-
5	Off-farm income	Dummy	1 if household engaged in off-farm incme,0 otherwise	+
6	Farm size of household	Continuous	Hectare	+
7	Livestock holding	Continuous	TLU	+
8	Non-farm income	Dummy	1 if yes,0 otherwise	+
9	Access to credit	Dummy	1 for user ,0 otherwise	+
10	Extension contact	Dummy	1 if there is contact,0 otherwise	+
11	Distance from market	Continuous	Km	-

3. Results and Discussion

3.1. Impact of Rain Water Harvesting on farmers' livelihood

3.3.1. Impact of adoption rainwater harvesting technology on crop production

As it is shown in the (Table 2) indicate that vegetable category such as, onion, tomato, potato, carrot and cabbage are the major crops grown in the study area by using the rainwater harvesting because of such crops need small quantity of water. (Ephrem ,2006). Vegetable represent the highest percentage (52.7%), the rest category, such spices, and cash crops have few crops grown in adopters of RWHT. Whereas non-adopter widely produces cereal crops 58.75% and adopters produces 29% of cereals crop per years.
Adopters of rain water harvesting farmer also shift in farm household crop choice decision towards highly priced and marketable agricultural products the number of harvesting per year could have a positive impact on the farm household heads income as well as livelihood (vegetables adopter 52.7% and 21.25% non-adopter and cash crops adopter 14.5% and 7.5%) than non-adopters. The result is consistent with reported by Ephrem (2006) in his study on impact assessment of rain water harvesting concluded that there was a shift in crop choice decision by rain water harvesting technology adopters towards highly price and marketable agricultural products.

The same as cereals crops such as, maize, teff and sorghum are leading and dominant crops in the non-adopters of RWH in the study area

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Table 2: sample household heads by types of crops grown

Type of crops	Adopter	percent	Nonadopter	percent	Total sample	percent	N=55
(%)	N=80	(%)	`N=135	(%)			
Vegetables	29	52.7	17	21.25	46	34.2	
Cash crops	8	14.5	6	7.5	14	10.37	
Cereals	16	29	47	58.75	63	46.63	
Spices	2	3.8	10	12.5	12	8.8	
Total	55	100	80	100	135	100	
Source: survey, 2020							

3.3.2. Impact of adoption of rainwater harvesting technology on household income

Household income from vegetable production: The survey results indicate that adopters of rainwater could diversify and generate relatively better income from the sale of different vegetables as compared to the non-adopters of RWHT. Table 3 reveals that the sample adopters of rainwater harvesting generated a total mean income from vegetables of 10,091, while the non-adopters earned 6007.28 birr annually. The mean difference between the two groups is statistically significant (P = 0.01) at the 5% probability level.

Household income from livestock holdings: livestock is the most productive asset of a farm household. Livestock rearing, in conjunction with crop production, is the primary source of livelihood for the population in the study area. We calculate each household's total livestock unit (TLU) to represent their livestock holdings. The livestock holdings can generate cash through the sale of products, allowing farmers to purchase various agricultural and rainwater harvesting inputs. The survey result indicated (Table 3) that the total mean income earned from livestock sales was 8738.10 birr per year for adopters, while that of non-adopters was 4083.81 birr per year because harvesters provide water for livestock consumption and availability. The mean difference between the two groups is statistically significant (p = 0.000) at the 5% probability level. This indicated that adopters of rainwater harvesting have generated relatively better income from livestock production as compared to non-adopters of the technology.

Household income from non-farm activity: non-farming activities include dairy, transporting, agro-processing, and others**.** Income earned from outside agricultural activities increases the farmer's financial capacity and increases the probability of investing on new technologies (Habtemariam, 2004). Non-farm households are better endowed with additional income to purchase inputs. As indicated in Table 3), the total sampled adopter households mean annual income from non-agricultural activities was 3042.81 birr per year, whereas the total mean annual income for the non-adopters was 1936.86 birr per year. The mean difference between the two groups is statistically significant (p = 0.000) at the 5% probability level, indicating that adopters of rainwater harvesting technology could generate better income from non-farm income generating activities.

Table 3: Average net yearly income sources of sample households

Net yearly income of HHs	Adopter n=55		Non adopter n=80		t-value
	Mean(birr)	Standard deviation	Mean(birr)	Standard deviation	
Livestock income	8738.10	1578.9	4083.81	756.36	-14.2**
Vegetable income	10,091	2,293.7	6007.28	1,090.74	-3.26**
Non-farm income	3042.81	281.47	1936.86	365.61	-18.7**

Source: own survey, 2020 ** Significant at 5% probability level

3.2. Result of econometric model

3.2.1. Determinants of rainwater harvesting adoption

As shown in Table 4, the values of the VIF for five continuous variables by using linear regression in SPSS . were found to be small (i.e. VIF value less than 10) indicating that data have no serious problem of multicollinearity. As a result, all continuous explanatory variables were retained and entered in to the binary logistics analysis

Table 4: Variance Inflation Factor (VIF) for Continuous Explanatory Variables

variables	Tolerance variables	Variance inflation factors
Age	0.445	2.24
Family size	0.297	3.36
Market distance	0.299	3.34
Farm size	0.318	3.14
Livestock holding	0.915	1.152

To check the degree of association among categorical variables or the existence of a multi-collinearity problem, we computed the contingency coefficient, which measures the association between various discrete variables based on the chi-square. The decision rule for the contingency coefficient states that when its value approaches 1, there is a problem of association between the discrete variables, i.e., the value of contingency coefficients ranges between 0 and 1, with zero indicating no association between the variables and values close to 1, indicating a high degree of association.

The correlation results reveal that there was no problem of association among the dummy explanatory variables. We conducted the model analysis after checking for linear association problems. This study employed the logit model to estimate the effects of the hypothesized independent variables on the adoption of water harvest technology.

Table 5: Contingency coefficient (CC) for dummy Explanatory Variables

Variable	SEXHH	EDHH	OFFFRMIN	ACSTCRD	EXTENCON	NONFRMINC
SEXHH	1					
EDHH	0.567	1				
OFFFRM	0.576	0.683	1			
ACSTCR	0.593	0.682	0.970	1		
EXTENCN	0.621	0.698	0.926	0.954	1	
NONFRM	0.414	0.750	0.719	0.698	0.666	1

Table 6: Parameter estimates for binary logit madel

Explanatory Variable	Coeff	S.E	Z.	P.	Odd ratio
AGE	0.012	0.132	3.89	0.000***	0.644
SEX	0.152	0.046	0.33	0.742	2.079
EDUC	0.020	0.047	0.07	0.010**	2.06
FAMILYSI	0.075	0.008	8.98	0.001***	1.442
NONFRINC	0.012	0.441	0.31	0.775	1.000
OFFRINC	0.111	0.112	0.30	0.303	5.87
FARMSIZ	0.272	0.044	6.08	0.000***	2.382
EXQEXT	-0.21	0.951	-2.24	0.02**	1.31
MARKDIS	-0.04	0.007	-6.08	0.000***	4.216
CRDUTI	0.009	0.135	0.07	0.705	0.72
LIVEST	1.98	0.598	3.16	0.001***	3.50
Constant	0.058	0.151	-3.89	0.036	0.001

Number of cases- 135
Log likelihood = 104.96
LR chi2 = 89.7%
Pseudo R^2 = 0.23
Prob > chi2 = 0.000

Source: Model output ** and *** represent significance at 5% and 1% probability levels, respectively.

Significant explanatory variable in logit model:

Age of the household head: This is a variable considered to provide a chance for rural households to participate in the adoption of rainwater harvesting technology as defined in the hypothesis. This study found that age significantly influences households' decisions to adopt RWHT at a probability level of 1%. The possible explanation is that relatively older farmers do not have the interest to participate in an activity that requires much time and is labor-intensive. The odds ratio age implies that, keeping other factors constant, as the age increases by 1 year, the probability of adoption of rainwater harvesting technology decreases by a factor of 0.644. This finding is in line with Fasil (2011) and Kimani et al. (2015), who revealed that the age of the household head negatively influences the adoption of rainwater harvesting technology.

Education of household head: As hypothesized, the educational level of household heads has a positive and significant effect on the adoption of rainwater harvesting at a 5% probability level. The significant positive effect of education was that it improved household heads' readiness to adopt or accept new ideas, innovations, and technologies, and increased their ability to obtain, process, and use information. The odd ratio of education status suggests that, when controlling for other factors, having a literate household head increases the decision to use rainwater harvesting technology by a factor of 2.07. The findings of Siraji and Beyene (2017) revealed that education increased farmers' ability to acquire important agricultural and technological information, resulting in increased adoption of rainwater harvesting technology.

Extension contacts: At the 5% probability level, this variable confirms our positive and significant expectation of extension contacts with the adoption of RWH. Through extension contacts, farmers receive training on the advantages, practices, and characteristics of all aspects of modern agricultural technologies. Holding other factors constant, the result of the odd ratio for extension services shows that a farmer who uses extension services one day increases the probability of adoption of RWH technology by a factor of 1.31. The result is consistent with Adam and Bedru's (2005) research on the use of improved haricot bean varieties in Ethiopia's central Rift Valley.

Livestock holding: As expected, the extent of livestock ownership significantly and positively affected the adoption of RWHT at the 1% probability level. One possible explanation for the result could be that wealthy farmers with better livestock, due to their better risk-bearing behavior, are more likely to adopt new technology. If all other factors stay the same, the odd ratio for livestock units shows that a one-unit increase in tropical livestock units raises the chance of using rainwater collection technology by a factor of 3.50. Tesfaye et al. (2001) and Haji (2003) reported the same results. This finding implies that livestock holding has a positive influence on the adoption of rainwater harvesting technology and annual farm income.

Farm size: At the 1% significance level, there was a positive correlation between farm size and the adoption of RWH. A farmer with a large farm is more likely to adopt RWHT than someone with a smaller farm. The odds ratio results for family size indicate that, other than being constant, the farm size increases by one unit, and the probability of adopting rainwater harvesting technology increases by a factor of 2.38. This finding is consistent with Beyene et al. (2017).

Distance to the market center: The logit model results reveal a negative and significant relationship between the framer's residence's distance from the nearest market and the adoption of rainwater harvesting. This implies that for households with farmland far from the nearest market, the transaction cost for acquiring input and output increases, whereas the nearest market location has the advantage of selling their farm product at a good price. The odd ratio result indicates that as the distance from the nearest market increases by 1 km, the probability of adopting RWHT decreases by a factor of 4.216. Kidane (2001) and Haji (2003) reported similar results. The finding implies that distance to the nearest market has a negative and significant impact on the adoption of rainwater harvesting technology.

Family size: At the 1% probability level, the model result revealed a positive and significant association between the availability of an active labor force and the adoption of rainwater harvesting. The fact that households with a large number of healthy family members participate in water harvesting confirms this. The odd ratio result shows that a one-unit increase in family size in adult equivalent households increases the probability of adopting rainwater harvesting technology by a factor of 1.442. This must be because the application of RWH is labor-intensive and requires more household labor to adopt. This finding was in agreement with the evidence from Zingiro (2012), who found that the probability of using rainwater harvesting technology increases due to the large working force in larger family households.

CONCLUSION AND RECOMMENDATION

Descriptive and econometric model Descriptive and econometric model analyses indicate that the adoption of rainwater harvesting is significantly and positively influenced by the educational status of household heads, family size, farm size, livestock holding, and the frequency of contacts with extension agents. Additionally, the age of household heads and market distance have a neConversely, sex, off-farm income, credit service, and non-farm income did not provide strong evidence for predicting the probability that household heads adopted rainwater harvesting. livestock hoholding,nd frequency of contacts with extension ageagents,d nas well astively and significantly influenced by age of housethe aged heads and market distance. Conversely, sex off-farm incsex,, creThe results also showed that the average annual farm income for adopters is 7290.63 birrr, compared to 4009.31 birrr for non-adopters.This indicates that adopters of rainwater harvesting technology have significantly increased the household's income by 3281.32 birr per year, from an average of 2.04 hectares to 1.08 hectares. The study found that household heads' educational level had a positive and significant influence on the adoption of RWH. irr birr 4009.31birr peradoptersThis 4009.31 indicates thf rainwaterThe distance from the nearest market had a significant and negative impact on farmers' adoption of rainwater harvesting. Therefore, we should conduct a market linkage analysis, given that farmers in the region have shifted their production to sell valuable agricultural products such as vegetables and perennial crops, turning them into price takers instead of producers. Therefore, it is necessary to conduct additional research in the value chain domain. The study's results also showed that farmers with larger livestock holdings in TLU adopted RWH more effectively than those with smaller livestock holdings. Therefore, we must make efforts to promote livestock husbandry and boost annual farm income. Farmers who had better extension contacts were more likely to adopt RWHT. Therefore, we must strengthen the provision of extension services to enhance farmers' access to information and advice.armers with a smaller number of livestock holdings. Therefore, efforts have to be made to promote livestock husbandry and annual farm income. Farmers with better extension contact adopted RWHT than others. Therefore, the provision of extension services has to be strengthened so as to improve farmers's accessibility to information and extension advice.

Finally, given the weather uncertainties faced by farmers in rain deficiency areas, rainwater harvesting technology would have the potential to improve rural livelihoods. However, the government focuses on its upscaling.

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