**Engineering Science**
2021; 6(1): 1-11
http://www.sciencepublishinggroup.com/j/es
doi: 10.11648/j.es.20210601.11
ISSN: 2578-9260 (Print); ISSN: 2578-9279 (Online)

# The Effectiveness of Rain Water Harvesting for Sustainable Practices in West Hararghe Zone, Oromia Regional State, Ethiopia

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**To cite this article:**
Dejene Teressa, Hailu Mosisa. The Effectiveness of Rain Water Harvesting for Sustainable Practices in West Hararghe Zone, Oromia Regional State, Ethiopia. *Engineering Science*. Vol. 6, No. 1, 2021, pp. 1-11. doi: 10.11648/j.es.20210601.11

**Received**: November 24, 2020; **Accepted**: December 14, 2020; **Published**: January 4, 2021

**Abstract:** This study was conducted in West Hararghe Zone, Oromia regional state to evaluate rain water harvesting Effectiveness for sustainable practices. The data were collected from a total 336 household selected randomly. The data's obtained were analyzed qualitatively. The study reviled that Rain water harvesting is one of the most important means to increase agricultural productivity and source of a domestic water supply for drought prone of Western Hararghe Zones. Specifically, in selected kebeles of Miesso district there is no access of perennial spring and river. Ground water also found at very deeper and can't be extracted by their current economic and educational status. In line with this about 83.6% of the farmers were implemented rain water harvesting practices on their farm land and communal land to minimize the risks associated with scarcity of rainfall. From these value 97.3% were in Miesso district. In agreement with this, 54.8% of the house holders have been using roof top water harvesting system in this study area. Specifically, about 25% of the respondents use roof top water harvesting system in Miesso district. Additionally, about 30.1% of the farmers were constructed family pond on their farm land for vegetable/horticultural crop production, cash crops (chat) and also for livestock. Contour ridges were implemented by 89.3% and 92.4% of the farmers in Miesso and Habro districts, respectively. Similarly, 73.8% of the respondents in the study area were implemented flood water diversion to their farm land. Accordingly, 30.8% and 20.5% of the respondents from Habro and Miesso district state preferred flooding WH system than others techniques.

**Keywords:** Water Harvesting, Performance, Serviceable, Challenges

## 1. Introduction

Agriculture is the most important sector and also central to the survival of millions of people in many sub-Saharan Africa (SSA). Most agriculture production in these developing countries is carried out on small land holdings, with approximately 80% of poor people continuing to depend on the agricultural sector for their livelihoods. The populations of these countries are the poorest and most vulnerable. They suffer from recurring and increased ranges of natural and human-made shocks that act as effective barriers to productive and sustainable livelihoods and demote a majority of the population to a state of chronic poverty [9]. The current scenarios predict that climate change will increase water scarcity in many places [8]. Therefore, the capacity to manage climate change is limited, due to the wide spread of recurring droughts, inequitable land distribution, and the dependence on rain-fed agriculture [11].

One of the hopeful technologies to combat the problem of food insecurity in arid and semi-arid lands is the use of rainwater harvesting systems. [10] indicates that rainwater harvesting is a promising technology for improving the livelihoods of many inhabitants of vast dry regions of the world. It provides opportunity to stabilize agricultural landscapes in Semi-Arid regions and to make them more productive and more resilient towards the climate changes

[11] water harvesting technology interventions promote economic growth and help alleviate poverty by reducing risk and making water available when and where it is needed [3].

Rain-water harvesting (RWH) is a technique used for collection and storage of rainwater from catchment areas. It is a technique used for collecting, storing and conserving rainfall and surface runoff in arid and semi-arid regions [2]. Broadly includes roof water harvesting, run-off harvesting, flood water harvesting and subsurface water harvesting. Rainwater harvesting systems can be applicable in all agro-climatic zones and can be more appropriate in arid, semi-arid and sub humid areas; where water demand of crops is higher than the supply because of low and uneven seasonal distribution of rainfall, and high evapotranspiration; in areas where other permanent water sources such as rivers, shallow wells and springs are not available or uneconomical to develop [7].

The main reasons for the importance of rainwater harvesting compared to other options are rainwater can easily be available in moisture stress areas compared to others sources of water.

### *1.2. Statements of the Problem*

In Ethiopia due to inaccessible water sources the farmers can't produce more than one harvest per year and farmers are challenged with frequent crop failure due to dry spells and drought [7]. In Ethiopia water scarcity has found to be a major factor for drought and frequent crop failure [6].

In the study area most of previously built concrete RWH tanks were found to be malfunctioned. The geo-membrane plastic sheet which was supposed to be used as a liner in excavated trapezoidal shape hole with the objective of trapping available RWH has been used as roof tops and walls by some farmers while some selling it. This indicates that, the attempt made for rainwater harvesting in various localities of the study area to attain increased food production in sustainable manner didn't yield the expected result. Even if large numbers of rainwater harvesting systems were constructed in the study area, their current performance, the benefit obtained and prospect to sustain this technology were not assessed properly. Due to this, the author was initiated to assess the performance of existing rainwater harvesting systems in the study area to determine their effectiveness, efficiency and sustainability. Besides, this research could be used as an information for policy makers and executive officials for better intervention that can facilitate the sustainability of RWH technology.

### *1.3. Objectives*

#### *1.3.1. General Objective*

The general objective of this study was to assess the performances of introduced rainwater harvesting techniques for sustainable utilization of rain water harvesting practices in West Hararghe Zone, specifically in Miesso and Habro districts.

#### *1.3.2. Specific Objectives*

1. To identify types of rainwater harvesting technologies practiced.
2. Identify the status/ current performance of rainwater harvesting technologies.

#### *1.3.3. Research Question*

1. What types of rain water harvesting techniques were practiced in the study area?
2. Did these implemented drain water harvesting techniques were in the effective manner?

## 2. Material and Methods

### *2.1. Description of the Study Area*

West Hararghe is one of the Zones in Oromia Regional state of eastern Ethiopia. The zone is found at 7°50' 00" to 9°30' 00" N latitude and 40°10' 00" to 41°45' 00" E longitude.

The capital town of the Zone is Chiro, which is located at a distance of 326 km East of Addis Ababa.

The area coverage of the Zone is 1,723,145ha (17,231km$^2$), comprising of 17 districts with a combined population of 1,871,706, of whom 912,845 are women. While 160,895 or 9.36% are urban inhabitants, a further 10,567 or 0.56% are pastoralists.

West Harerghe is subdivided in to three major climatic zones known to be temperate tropical highland locally known as dega (12.49%), Semi-temperate/Tropical rainy mid land or woinadega (38%), and Semi-arid/Tropical dry or kola (49.5%). The topography of the zone is characterized by steep slopes in the highlands and mid highlands and large plains in the lowland areas. The ecological zones are set based on the differences in altitude variation ranging between 500 up to 3500 meters above sea level kola (500 -1500 m a.s.l), woinadega (1500 - 2300 m a.s.l) and dega (2300 - 3500 m a.s.l). The mean monthly minimum temperature ranging from 16°C to 20°C, while the mean maximum is 24°C to 28°C. Annual rainfall averages range from below 700 mm for the lower kolla to nearly 1,200 mm for the higher elevations of woinadega and dega areas.

The study will be conducted specifically, in Mieso and Habro districts.

### *2.2. Methods*

#### *2.2.1. Data Collection Techniques*

Mieso and Habro district were selected purposefully based on agro-climatic condition and potential availability of rain-water-harvesting practice. Out of total kebeles, six kebeles were selected again decisively based on accessibility and potential availability of rain-water-harvesting practice from each district.

Factors like the homogeneity of population, cost of the survey, shortage of time, large number of factors analyzed and the precision level required were taken into consideration while deciding sample size. The samples size was determined by using the following formula at 95% confidence interval, 0.05 degree of variability and 95% level of precision. Accordingly, the total number of households who were fully participated in agricultural activity are 2100. So that based up on the following formula 336 respondents were selected randomly. [12]

$$n = \frac{N}{1 + N(e^2)}$$

Where n is the sample size, N is the total household heads size, and e is degree of variability

Six Focused group discussions (each comprising 5–7 participants from model, medium and low level farmers) was conducted based on checklists and semi-structured questionnaires, and in-depth interview was used for collection of data. During this session, respondents were expressed their views, feelings and perspectives about the rain water harvesting employment process and outcomes. The main objective of this method was to triangulate the survey method and investigated additional facts that are not addressed by the survey method. Moreover, key informants were interviewed (4 elders, 2 local administrators and 3 experts) from each woreda.

The main types of data collected were, socio-economic characteristics of the house holds', identification of RWH practices in the study area, current status of this RWH practices, major Challenges for sustainable utilization of rain water harvesting etc.

The main data collection tools used in this research were observation checklist, key informant guide, focus group discussion guide, Semi Structured Interview schedule (open ended, close ended and scale item questions were addressed) and a field practices performance evaluation check list. Household Questionnaire Survey was used to collect the primary data from sample households.

#### *2.2.2. Data Analysis Techniques*

the collected data were analyzed by using Both quantitative and qualitative techniques. Qualitative data obtained using semi-structured questionnaire; interview, observations, focal group discussion and document were analyzed qualitatively using appropriate words. For quantitative data, descriptive statistics such as percentages and frequency were employed to analyze the data gather.

## 3. Result and Discussion

### *3.1. Socio-economic Appearances of the Households*

#### *3.1.1. Sex and Age of the Respondents*

From the total of out of 336 respondents, males constituted 74.7% while female were only 25.3% (Table 1).

***Table 1.*** *Sex of the respondents.*

| Variable | | | Sex | | Total |
|---|---|---|---|---|---|
| | | | Male | Female | |
| Woreda | Miesso | Frequency | 98 | 14 | 112 |
| | | Percentage | 87.5% | 12.5% | 100.0% |
| | Habro | Frequency | 153 | 71 | 224 |
| | | Percentage | 68.3% | 31.7% | 100.0% |
| Total | | Frequency | 251 | 85 | 336 |
| | | Percentage | 74.7% | 25.3% | 100.0% |

For analysis, the researcher categorized age of the respondents into four groups: very young (≤ 30), Young (31_45), middle (46_60), and old (≥61) (Table 3). Most of the respondents (42.6%)%) are in the age category of 31_45 years followed by 46_60 years (37.2%) (Table 2). Farmers under these age groups have capacity to contribution for labor force and also have good potential for good understanding of the problems of rainfall scarcity. This indicates the presence of a sufficiently large labor force in the community.

***Table 2.*** *Age of the respondents.*

| Variable | | | Age | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | < 30 | 31_45 | 46_60 | >61 | |
| Woreda | Miesso | Frequency | 23 | 57 | 27 | 5 | 112 |
| | | Percentage | 20.5% | 50.9% | 24.1% | 4.5% | 100.0% |
| | Habro | Frequency | 35 | 86 | 98 | 5 | 224 |
| | | Percentage | 15.6% | 38.4% | 43.8% | 2.2% | 100.0% |
| Total | | Frequency | 58 | 143 | 125 | 10 | 336 |
| | | Percentage | 17.3% | 42.6% | 37.2% | 3.0% | 100.0% |

#### *3.1.2. Educational Status*

The result presented in the table 4 below shows the educational status of the respondent categorized as illiterate", "Read and write", Attended elementary school education (grade 1-6)","and a grade 7 and above". Accordingly, 25.3%, of the respondents were attended formal education (14.8% grade 1-6 and 10.5% ≥ grade 7), 28.0% can read and write.

The rest 46.7%of the households are illiterate (Figure 1). This result indicated that most of the house in both the study area were not attended school for education. From these number of illiterate more than half (63.0%) were from Miesso district. This may due to accessibility of schools and life style of the pastoralists.

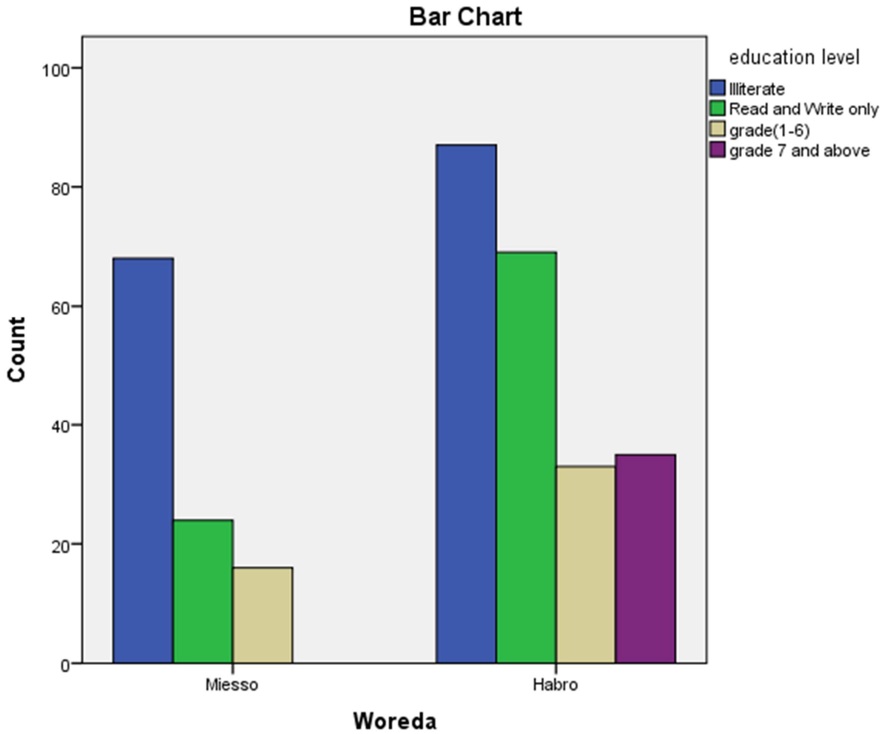


***Figure 1.*** *Showing educational status of the respondent.*

Therefore, good educational background is one of the crucial factors that affect farmers' response to introduced technologies and influencing adoption decision. Similar studies by [9] found positive relationship between educational background of the household and adoption of RWH technologies.

### *3.1.3. The Family Size of the Household*

This survey results showed that, the family size the households in the study area ranges from 2 to 10 persons with an average of 6 per household (Table 3).

***Table 3.*** *Farmers' Household Size.*

| | | | Family Size | | | Total |
|---|---|---|---|---|---|---|
| | | | 1-3 | 4-6 | 7-10 | |
| Woreda | Miesso | Frequency | 12 | 56 | 44 | 112 |
| | | Percentage | 10.7% | 50.0% | 39.3% | 100.0% |
| | Gelemso | Frequency | 17 | 119 | 88 | 224 |
| | | Percentage | 7.6% | 53.1% | 39.3% | 100.0% |
| Total | | Frequency | 29 | 175 | 132 | 336 |
| | | Percentage | 8.6% | 52.1% | 39.3% | 100.0% |

### *3.1.4. Source and Status of Their Income*

The result presented in the table 5 below showed that 89.9% of the respondents depend on mixed farming system (both animal husbandry and crop cultivation) for their livelihood. Specifically, in Miesso district all of the respondents depend on mixed farming while 84.8% of the farmers in Habro district depends missed farming. The rest 15.2% depends on crop cultivation alone.

***Table 4.*** *Source of Income.*

| Variable | | | Source of income | | Total |
|---|---|---|---|---|---|
| | | | Crop cultivation | Mixed farming | |
| Woreda | Miesso | Frequency | 0 | 112 | 112 |
| | | Percentage | 0.0% | 100.0% | 100.0% |
| | Habro | Frequency | 34 | 190 | 224 |
| | | Percentage | 15.2% | 84.8% | 100.0% |
| Total | | Frequency | 34 | 302 | 336 |
| | | Percentage | 10.1% | 89.9% | 100.0% |

However, 54.8% of the farmers of the study areas replied that their annual agricultural income can't satisfy their annual consumption. More than two third of these respondents were from Miesso district. More than half of these respondents (57.1%) stated that their annual agricultural income is sufficient only for 4-11 months. For the rest months, respondent stated that they need to be supplemented by food aid (table 5).

***Table 5.*** *For how many months their income is sufficient.*

| Woreda * If your answer is no, for how many months is it sufficient Cross tabulation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | If your answer is no, for how many months is it sufficient | | | | | | | | Total |
| | | | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Woreda | Miesso | Frequency | 4 | 12 | 4 | 28 | 4 | 32 | 4 | 24 | 112 |
| | | Percentage | 3.6% | 10.7% | 3.6% | 25.0% | 3.6% | 28.6% | 3.6% | 21.4% | 100.0% |
| | Habro | Frequency | 0 | 0 | 0 | 34 | 16 | 54 | 0 | 120 | 224 |
| | | Percentage | 0.0% | 0.0% | 0.0% | 15.2% | 7.1% | 24.1% | 0.0% | 53.6% | 100.0% |
| Total | | Frequency | 4 | 12 | 4 | 62 | 20 | 86 | 4 | 144 | 336 |
| | | Percentage | 1.2% | 3.6% | 1.2% | 18.5% | 6.0% | 25.6% | 1.2% | 42.9% | 100.0% |

### *3.2. Source of Water*

Accessibility of water for home consumption and agricultural activity is one the challenging problems most low lands of Western Hararghe zone. To survive in various condition of water stress area they were adopted different mechanism against shortage of water. As a result most of the farmers in the study area use ground water and rain water for sustaining their livelihood. This survey result also confirmed that 78.6% of the respondents in Miesso district use both tap water and rain water home consumption. There is no access of perennial spring and river nearby their village. Ground water also found at very deeper and can't be extracted by their current economic and educational status. Therefore, the only option they have is to use rain water harvesting and community However, more than half (62.5%) of the respondents in Habro district uses spring water. Generally, most of the farmers (41.7%) in the study area use spring water for home consumption which is followed by tap water (27.1%) (Table 6).

***Table 6.*** *Source of water for home consumption.*

| Woreda * What is the source of water for house consumption Cross tabulation | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variable | | | What is the source of water for house consumption | | | | Total |
| | | | spring, | Tap water, | Both Tap and Rain water | Ground Water | |
| Woreda | Miesso | Frequency | 0 | 24 | 88 | 0 | 112 |
| | | Percentage | 0.0% | 21.4% | 78.6% | 0.0% | 100.0% |
| | Habro | Frequency | 140 | 67 | 0 | 17 | 224 |
| | | Percentage | 62.5% | 29.9% | 0.0% | 7.6% | 100.0% |
| Total | | Frequency | 140 | 91 | 88 | 17 | 336 |
| | | Percentage | 41.7% | 27.1% | 26.2% | 5.1% | 100.0% |

For livestock and irrigation purpose 50% of the farmers in Miesso district uses rain water but in Habro districts 46.4% of them uses spring water which is followed by ground water (37.5%). Generally, 31% and 26.8% of the respondents in the study area uses spring water and ground water for their livestock and irrigation purpose respectively (Table 7).

***Table 7.*** *Water source for livestock & irrigation*

| Woreda * Water source for livestock & irrigation Cross tabulation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | | | Water source for livestock & irrigation | | | | | Total |
| | | | River | Rain water | Ground Water | Both ground and Rain water | spring | |
| Woreda | Miesso | Frequency | 0 | 56 | 12 | 44 | 0 | 112 |
| | | Percentage | 0.0% | 50.0% | 10.7% | 39.3% | 0.0% | 100.0% |
| | Habro | Frequency | 36 | 0 | 84 | 0 | 104 | 224 |
| | | Percentage | 16.1% | 0.0% | 37.5% | 0.0% | 46.4% | 100.0% |
| Total | | Frequency | 36 | 56 | 96 | 44 | 104 | 336 |
| | | Percentage | 10.7% | 16.7% | 28.6% | 13.1% | 31.0% | 100.0% |

### *3.3. Farmer's Perception on Scarcity of Rainfall*

All of the respondents (100%) in Miesso and 77.7% in Habro districts indicated that scarcity of rainfall is common problem of agricultural activity in the study areas (Table 8). As a result all of the respondents faced many problems. As mentioned by the respondents and key informants, the major problems are reduced in crop production, lack of water for livestock, lack of animal feed, the spreading out of animal diseases, expand food in secured area (hunger) due to shortage and unpredictable rainfall, shortage of portable water supply etc. Accordingly, 82.1% of the respondents in Miesso district confirmed that they encountered all the problems mentioned above. While 31.9% were challenged by decreased in crop production, lack of fodder and water. Generally, 48.2% of the respondents in the study area specified that they were encountered all the problems mentioned above throughout their live in this areas due to scarcity of rain fall.

***Table 8.*** *The scarcity of rainfall.*

| Woreda * Is the scarcity of rainfall is common problem of agriculture in your area? Yes/No Cross tabulation | | | | | |
|---|---|---|---|---|---|
| Variable | | | Is the scarcity of rainfall is common problem of agriculture in your area? Yes/No | | Total |
| | | | Yes | No | |
| Woreda | Miesso | Frequency | 112 | 0 | 112 |
| | | Percentage | 100.0% | 0.0% | 100.0% |
| | Habro | Frequency | 174 | 50 | 224 |
| | | Percentage | 77.7% | 22.3% | 100.0% |
| Total | | Frequency | 286 | 50 | 336 |
| | | Percentage | 85.1% | 14.9% | 100.0% |

The respondents were enquired to check their perception on whether they believe that rain water harvesting can solve problems they encountered as a result of shortage and irregular rain fall. Consequently, 89.3% of the respondents in Miesso district were accepted the above-mentioned problems. However, 63.2% of the respondents in Habro district were agree with statement. This dissimilarity in perception towards rain water harvesting between these two districts may be due to severity the problems, accessibility of other option (ground water) and lack of good awareness on RWH. Generally, 56.3% of the respondent in the study area confirmed, rain water harvesting can reduce the severity problems caused by the scarcity and erratic rain fall (table 9).

***Table 9.*** *Problems faced by the respondents as a result of shortage rain fall.*

| Woreda *If yes what problem did you faced Cross tabulation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | | | If yes what problem did you faced | | | | | | | Total |
| | | | *1 | *2 | 3* | *4 | *5 | *6 | *7 | |
| Woreda | Miesso | Frequency | 8 | 0 | 4 | 4 | 4 | 92 | 0 | 112 |
| | | Percentage | 7.1% | 0.0% | 3.6% | 3.6% | 3.6% | 82.1% | 0.0% | 100.0% |
| | Habro | Frequency | 44 | 1 | 23 | 4 | 4 | 54 | 61 | 191 |
| | | Percentage | 23.0% | 0.5% | 12.0% | 2.1% | 2.1% | 28.3% | 31.9% | 100.0% |
| Total | | Frequency | 52 | 1 | 27 | 8 | 8 | 146 | 61 | 303 |
| | | Percentage | 17.2% | 0.3% | 8.9% | 2.6% | 2.6% | 48.2% | 20.1% | 100.0% |

*1=Decrease in crop production, *2=Loss of livestock, *3=Lack of fodder and water, *4=Migration of livestock to other area where water and grass available, * reduced in body weight and marketing value of livestock, *6=All, *7=Decrease in crop production, Lack of fodder and water.

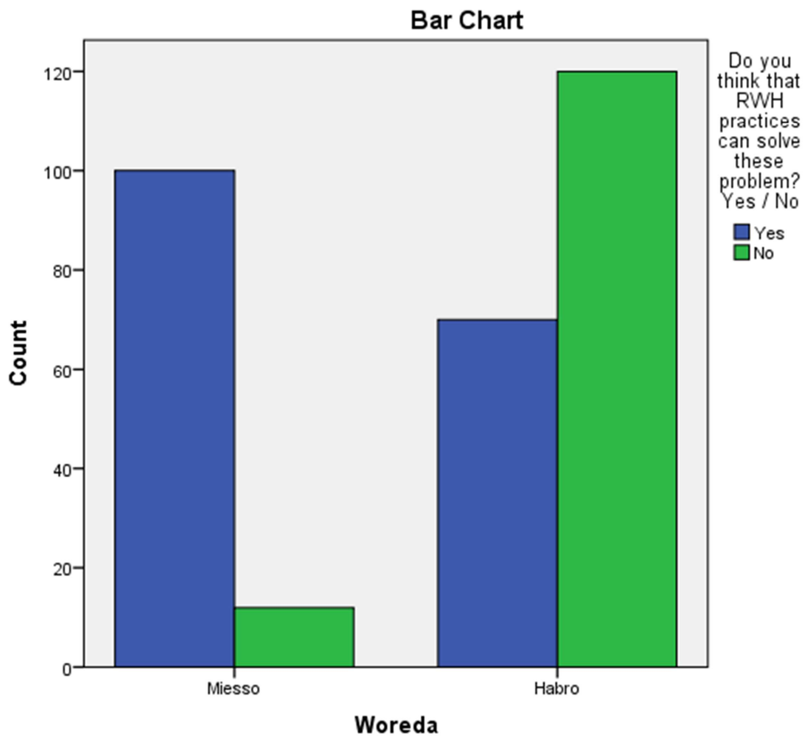


***Figure 2.*** *Showing farmer's perception on ability of RWH practices to solve their problems.*

### *3.4. Implementation of Rain Water Harvesting Practices*

Rain water harvesting is a single most important way of water accessibility for drought prone area [13]. In line with this about 83.6% of the farmers were implemented rain water harvesting practices on their farm land and communal land to minimize the risks associated with scarcity of rainfall. Specially, in Miesso district 97.3% of the households were engaged in RWH (table 10). This may be related to vulnerability of the district to scarcity of rain fall and also possession of larger number of livestock that forced them to participate in rain-water-harvesting and utilization.

Therefore, vulnerability is one of the factors that influence participation of household in rain-water-harvesting positively and significantly [14]. In Ethiopia, to produce more than one crop per year due to lack of water storage and large spatial and temporal variations in rainfall. Furthermore; there are frequent crop failures due to dry spells and droughts which have resulted in a chronic food shortage facing the country. Ethiopian agriculture is mostly rain fed, whereas inter-annual and seasonal rainfall variability is high and droughts are frequent in many parts of the country. Rainfall variability has historically been a major cause of food insecurity and famines in the country.

***Table 10.*** *Farmers implemented rain water harvesting on your farm land.*

| **Woreda * Did you implemented rain water harvesting on your farm land/home? Yes / No Cross tabulation** | | | | | |
|---|---|---|---|---|---|
| **Variable** | | | **Did you implement rain water harvesting on your farm land/home? Yes / No** | | **Total** |
| | | | **Yes** | **No** | |
| Woreda | Miesso | Frequency | 109 | 3 | 112 |
| | | Percentage | 97.3% | 2.7% | 100.0% |
| | Gelemso | Frequency | 172 | 52 | 224 |
| | | Percentage | 76.8% | 23.2% | 100.0% |
| Total | | Frequency | 281 | 55 | 336 |
| | | Percentage | 83.6% | 16.4% | 100.0% |

Based on this survey data result, key informants and also personal observation, the major rain water harvesting system implemented by farmers in the study area are categorized under four classes namely, roof top water harvesting, insitu moisture harvesting (contour bund& tie ridging), community and family earthen excavated ponds with and without geo membrane plastic sheet, and floodwater diversion to the farm (flooding).

*1. Roof top water harvesting*

Roof water harvesting is a system of collecting rain water from roof of building and store it in same storage facility for future use when there is shortage of water [15]. Its quality also reported as good compared to other water sources in the rural areas.

The emergence of this technique these days is due to the increasing shortage of water from the conventional sources, shallow wells, perennial springs, rivers/streams. In earlier times, roof water harvesting practices were confined to urban areas only. However, its use in the rural areas are increasingly becoming important these days as more people in the rural areas are having corrugated roof houses.

In agreement with this, 54.8% of the respondents in the study area were confirmed that they have been using roof top water harvesting system. But in Miesso district only 25% of the respondents uses roof top water harvesting system (table 14). This low value is related to lack of corrugated iron sheet roof house. Most of the farmers in this study area made their house from local material such as grass (figure 3).

***Table 11.*** *Roof top rain water harvesting implemented in the study area.*

| **Woreda * did you implemented roof top rain water harvesting? Cross tabulation** | | | | | |
|---|---|---|---|---|---|
| **Variable** | | | **Did you implement roof top rain water harvesting?** | | **Total** |
| | | | **Yes** | **No** | |
| Woreda | Miesso | Frequency | 28 | 84 | 112 |
| | | Percentage | 25.0% | 75.0% | 100.0% |
| | Habro | Frequency | 156 | 68 | 224 |
| | | Percentage | 69.6% | 30.4% | 100.0% |
| Total | | Frequency | 184 | 152 | 336 |
| | | Percentage | 54.8% | 45.2% | 100.0% |

***Figure 3.*** *Showing roof top rain water harvesting practice in the study area.*

Even though, some of the respondents were fail to use roof water harvesting technique due to lack of corrugated iron roof house, the researcher observed some respondents have corrugated iron sheet roof house but not using the roof effectively for rain water collection (Figure 4). Some respondent relate this low utilization with lack of water storage materials (tanker). Failure to give full attention for roof water harvesting is additional weakness observed in the study area.

***Figure 4.*** *Showing roof top rain water harvesting practice in the study area.*

However, roof water harvesting in Ethiopia has the advantage of being low cost, relatively simple in design (household technology), less laborious and it saves time [16]. It provides adequate water during the rainy season, a period when the rural people are busy with the farm activities and when there is shortage of labor. They are more appropriate in areas where there are no rivers, ground water sources around, and where rainwater is the only feasible means of providing a water supply.

1) Earth excavated rainwater-harvesting pond (Kure)

Kure (traditional RWH) is simple earth excavated pond construct constructed for flood water harvesting [17]. It is simple and can be managed by the community. This was due to its less cost i.e. only labor involvement is required. The size of this structure is different among different farmers based on their interest.

***Figure 5.*** *Traditional RWH technology (Kure) at Hamaressa kebele farmer's farm land.*

The result presented in the table15 indicated that about 30.1% of the farmers were constructed family pond on their farm land for vegetable/horticultural crop production, cash crops (chat) and also for livestock. From these value more than half (60.7%) of the implementers are from Miesso district. However, during this data collection we researchers witnessed that most of the ponds have no water due to seepage problem and high evaporation rate. Mr. Adem Mohammed and Abdi Beker is one of the farmers a Hamaressa kebele of Miesso district who stated that most of farmers in his village including him uses the collected water only for a few days due to high seepage loss and siltation problems (Figure 5). To alleviate these challenges they repeatedly requested the government to support them by delivering geo membrane plastic sheet for many times but still they couldn't get a solution. As a result many of the reservoirs constructed most of the respondents were failed to be maintained.

***Table 12.*** *Local Earth Pond implemented in the study area.*

| **Woreda * Local Earth Pond Cross tabulation** | | | | | |
|---|---|---|---|---|---|
| **Variable** | | | **Local Earth Pond** | | **Total** |
| | | | **Yes** | **No** | |
| Woreda | Miesso | Frequency | 68 | 44 | 112 |
| | | Percentage | 60.7% | 39.3% | 100.0% |
| | Habro | Frequency | 33 | 191 | 224 |
| | | Percentage | 14.7% | 85.3% | 100.0% |
| Total | | Frequency | 101 | 235 | 336 |
| | | Percentage | 30.1% | 69.9% | 100.0% |

This traditional pond have been used in Ethiopia for millennium, some estimates it as early as 560 BC. They are used to harvest rainwater for both human and livestock watering in most rural areas, particularly in the arid and semi- arid areas where annual rainfall is less than 600 mm.

Even though traditional ponds are major sources of water in the rift valley where ground water is deep and other sources of water are not feasible, the use and promotion of ponds even for livestock watering is increasingly becoming difficult and challenging by the spread of deadly child-hood malaria, and for this reason most NGOs are unable to promote and support pond construction due to environmental constraints [7].

2) Geo-membrane RWH structure

The use of geo-membrane RWH structure is another introduced RWH technology in the study area. It is a plastic sheet lined in excavated trapezoidal shape hole with the objective of controlling available RW from seepage loss. This plastic sheet was distributed for few farmers free of charge by the government and non-government organization for promoting the technology in order to initiate farmer's adoption strategy RWH practices. Since 2008/9 GC, the technology has become more familiar with the farmers [18] Currently farmers in the study area have been reflecting good interest to have this plastic sheet. The data collected key informant also showed that geo-membrane RWH technology is well perceived (received) among farmers in their respective woreda. As an evidence they have mentioned some farmers have good experience and benefitted from geo membrane RWH structure by producing vegetables like cabbage, onion, and tomato also other farmers have were requested them for material support repeatedly. Even if most the respondents showed good interest to use geo membrane plastic sheet, they couldn't afford to buy by themselves. Due to this reason only 21.4% of the respondents were lucky to get geo membrane plastic sheet from the government and nongovernment organization and practiced on their farm land (table 13).

***Table 13.*** *Trapezoidal RWH tank with geo membrane plastic sheet.*

| **Woreda * Trapezoidal RWH tank with geo membrane plastic sheet Cross tabulation** | | | | | |
|---|---|---|---|---|---|
| | | | **Trapezoidal RWH tank with geo membrane plastic sheet** | | **Total** |
| | | | **Yes** | **No** | |
| Woreda | Miesso | Frequency | 32 | 80 | 112 |
| | | Percentage | 28.6% | 71.4% | 100.0% |
| | Habro | Frequency | 40 | 184 | 224 |
| | | Percentage | 17.9% | 82.1% | 100.0% |
| Total | | Frequency | 72 | 264 | 336 |
| | | Percentage | 21.4% | 78.6% | 100.0% |

The GM plastic sheets were distributed for the purpose of rain water harvesting.

*2. Insitu moisture harvesting*

Insitu moisture harvesting is a technique used to increase amount of water stored in the soil profile [10]. The most common insitu moisture harvesting structures are: -Contour ridges, Broad bed and furrow system, tied ridging, Negarim micro catchment, Semi-circular& Trapezoidal Bunds bunds, Eye brow basins and trenches. Among these practices contour ridges, broad bed and furrow system and tie ridging are commonly practiced in the study area. Accordingly, 89.3% and 92.4% of the farmers in Miesso and Habro districts were implemented contour ridges, respectively. Whereas 7.4% and 1.2% were implemented furrow system and tie ridging in addition to contour ridges in Miesso and Habro district were implemented contour ridges, respectively (Table 14).

***Table 14.*** *Insitu moisture harvesting practices in the study area.*

| **Woreda * Insitu moisture harvesting Cross tabulation** | | | | | | |
|---|---|---|---|---|---|---|
| | | | **Micro-catchment** | | | **Total** |
| | | | **1** | **2** | **1&3** | |
| Woreda | Miesso | Frequency | 100 | 8 | 4 | 112 |
| | | Percentage | 89.3% | 7.1% | 3.6% | 100.0% |
| | Gelemso | Frequency | 207 | 17 | 0 | 224 |
| | | Percentage | 92.4% | 7.6% | 0.0% | 100.0% |
| Total | | Frequency | 307 | 25 | 4 | 336 |
| | | Percentage | 91.4% | 7.4% | 1.2% | 100.0% |

1: Contour ridges, 2: Broad bed and furrow system, 3: tie ridging

*Flood water harvesting (FWH)*

The result presented in table 15 below indicated that 73.8% of the respondents in the study area have been practicing flood water diversion to their farm land. Some farmers preferred this WH system than others techniques. Accordingly, 30.8% and 20.5% of the respondents from Habro and Miesso district state that flooding is more effective due to its less labour requirement and also easy to irrigate the field up field capacity based on the amount and duration of the rain fall.

***Table 15.*** *Floodwater diversion to the farm land (flooding).*

| Woreda * Floodwater diversion to the farm land (flooding) Cross tabulation | | | | | |
|---|---|---|---|---|---|
| | | | **Floodwater diversion to the farm (flooding)** | | **Total** |
| | | | **Yes** | **No** | |
| Woreda | Miesso | Frequency | 76 | 36 | 112 |
| | | Percentage | 67.9% | 32.1% | 100.0% |
| | Gelemso | Frequency | 172 | 52 | 224 |
| | | Percentage | 76.8% | 23.2% | 100.0% |
| Total | | Frequency | 248 | 88 | 336 |
| | | Percentage | 73.8% | 26.2% | 100.0% |

### *3.5. Current Status of Rain Water Harvesting Practices in the Study Area*

As it was mentioned earlier under implementation of rain water harvesting, 83.6% of the farmers were implemented rain water harvesting practices on their farm land and communal land to minimize the risks associated with scarcity of rainfall.

However, we were observed the well fenced and protected earth excavated community ponds in Oda Bela kebele which have been serving the local community for domestic use and livestock watering. As it was observed from the figure 6 below, this pond (Haro hoji qoda) was protected by vegetative silt trap.

***Figure 6.*** *Showing well protected community pond at Oda Bela kebele in Miesso district.*

***Table 16.*** *Reason for the failure of rain water harvesting structure.*

| Woreda * If not functional why? Cross tabulation | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **If not functional why?** | | | | **Total** |
| | | | ***a*** | ***b*** | ***c*** | ***d*** | |
| Woreda | Miesso | Frequency | 32 | 4 | 44 | 32 | 112 |
| | | Percentage | 28.6% | 3.6% | 39.3% | 28.6% | 100.0% |
| | Habro | Frequency | 17 | 32 | 17 | 141 | 207 |
| | | Percentage | 8.2% | 15.5% | 8.2% | 68.1% | 100.0% |
| Total | | Frequency | 49 | 36 | 61 | 173 | 319 |
| | | Percentage | 15.4% | 11.3% | 19.1% | 54.2% | 100.0% |

*a*=siltation, *b*=Lack of maintenance and geo_membrane plastic sheet, *c* Seepage loss, *d*=both seepage and siltation.

# 4. Conclusion and Recommendation

### *4.1. Conclusion*

Freshwater collecting at the domestic or communal level empowers rain fed farms to access a source of supplementary irrigation, the financial security also recovered. It can be good option for the rural areas which are suffering from water scarcity.

Understanding this, government invested a huge amount money, time & effort for introducing and promoting RWH technology at many farmers' villages. Most of total budget assigned for food aid (FFW) was used by regional states for the construction of rainwater harvesting. The result of this research also showed that about 83.6% of the farmers were implemented rain water harvesting practices on their farm land and communal land to minimize the risks associated with scarcity of rainfall. Specially, in Miesso district 97.3% of the households were engaged in RWH.

### *4.2. Recommendation*

1. Awareness creation should be encouraged
2. Technical skill gap should be fulfilled for both farmers and experts
3. Follow up, monitoring and evaluation should be encouraged
4. Sustainable solution (permanent water harvesting

tankers) which is suitable and early controlled by farmers

5. Develop modern model center for teaching, visiting, to encourage farmer's skill, interests etc.
6. Giving full attention for the change not for surviving (running here and there when the community faced critical problem only.

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