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Research Article

Assessment of Implementation of Rainwater Harvesting Structures in Drylands Areas and Their Challenges West Harareghe Zone, Chiro, Ethiopia

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Abstract

The main problem of this 21st century is lack of water and contamination of water. Even if Ethiopia has water tower country in the eastern Africa; she has known as scarcity of water both in quality and quantity. This study will be entitled with: assessment of implementation of rainwater harvesting structures in drylands areas and their challenges west Harareghe zone, Chiro Ethiopia. The objectives include: two phases: first phases include the following objectives-to identify the causes and factors that are adversely affects rainwater harvesting; to evaluate the challenges prevent rainwater harvesting and its utilization; to recognize the success and an exemplary model of rainwater harvesting areas; to investigate the consequence impacts of the failure of rainwater harvesting and to identify the socio-economic and environmental effects of rainwater harvesting. second phases include: implementation of model RWH structures for crop production on farm land, for forest tree production on forest land and for livestock consumption and fodder production on pasture land, for wild animals consumption and rehabilitation of their habitat through keeping of livestock and wild animals ecosystem balance; to be monitoring and evaluating the project and then transferring to other areas having similar agro-climatic conditions, topography and soil types. Of all identification of soil textures similarity to before losses of transfer of economy to other areas. Random sampling techniques will be considered by taking 10% of the PA population for interview through their stratification of random sampling techniques based on the criteria stated under the methodology.

Keywords

Water Harvesting, Rainwater Harvesting, Challenges, Socio-economic, Model, Impacts, Implementation, Monitoring and Evaluation

1. Introduction

1.1. Background and Justification

The evil anthropogenic activities that are doing on the land surface of the Erath adversely affect the watershed and their natural resources from the ancient up to the present day. As had reported that, the core anthropogenic activities caused by human being include degradation of forest resources for agricultural expansion to grow food crops and other uses [1]. This 21st century is mainly focused on the needs and demands of water at Global scale. The conflict or disagreement

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between populations at the World is on water uses while in contrast to this the conflicts between the societies solved and resolved by rainwater harvesting and uses solely. rainwater harvesting and utilization is the recent alternative source of water where ground water is uneconomical to extract and uses, where rainfall is scarce and soil moisture is deficit through the whole world it provide relief at all time [19]. This author had said based on their review of background of his paper; India is one of the world experienced country which was dramatically shifted from water development program to sustainable water development.

Most of fresh water on the earth surface it seems to be insufficient to meet the needs of present increasing of human population including domesticated and wild animals. The role of wetlands and forest resources are several as water suppliers should be considered in the whole watershed. *Forests influence the amount of water available from groundwater, surface watercourses and other water bodies. Forests can also protect water bodies and watercourses by trapping sediments and pollutants from other upslope land uses and activities.* Minimize erosion and impaired water quality due to sedimentation; improves soil infiltration rate and soil storage capacity. *Water may well be forests' most useful and important product* [14].

FAO had reported that *Ethiopia's drylands cover approximately 63% of the country's land area and are found mainly in the north, east and central areas of the rift valley, also south and south eastern parts of the country including a very wide and diversified range of agricultural environments* [17].

Rainwater harvesting has play a key role in controlling erosion, recharge to ground water and ground water table, and alleviation of problems of basic livelihoods [6]. Pollution of surface water has caused severe problems to environmental at present and harvesting rainwater and storage of underground is solving the scenarios of water issues [22]. Lowland areas of Oromia region Miesso and Somali region Shinille zone for instance in Ethiopia are the most stressed areas of water both for livestock and human consumption due to unseasonal and erratic rainfall patterns [23].

1.2. Statement of the Problem

The major issue of this 21st century is the water scarcity which is equivalent to food security. The common factors and causes are population pressures, and deforestation, improper land use planning and policy, socio-economic problems, land and natural resource tenure and overgrazing, improper structural constructions of SWC measures and rainwater harvesting structures and site mismatching respectively [20]. As those authors explained *watershed is one of the important analyses that are help to facilitate the determination of the size of catchment area of a hydrological feature*, which is influences the feature and the fact of rainwater harvesting. Water supply and available of surface and ground water resource are not meeting the future demands [5] whereas water conservation and development of alternative water sources are a basic to meet the demands of fresh water. *Rainwater harvesting is an alternative water supplying approach that captures, diverts, and stores rainwater for later use and is available to anyone*.

This study will be proposed to examine these factors: challenges that are prevent RWH from implementation, implementation of model RWH structures for crop production, wild animals and livestock consumption in dryland areas where rainfall deficit is available, provision of awareness and training local farmers at agrosilviopasture areas [18] of eastern escarpment of Oromia regional national state of Ethiopia. Moreover this study will be seeing the success and failure of RWH in the stated areas where the poor people live with the objectives of identification of the causes and factors that are adversely affects rainwater harvesting; they will evaluate the challenges prevent rainwater harvesting and its utilization; recognition of the success and an exemplary model of rainwater harvesting in the study watershed and the investigation of the consequence impacts of the failure of rainwater harvesting. All of them are not till studied in Ethiopia except the success and failure of the RWH by considered as the major challenges. They will be also considered the adoption, perception, training, monitoring and evaluation of the project after and before implementation [7].

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study shall be observing the prohibited success, causes and factors of failure of RWH, consequences and challenges that are prohibiting rainwater harvesting and utilization of RWH in the eastern escarpment of Oromia National Regional State, Ethiopia. Moreover, they will investigate the exemplary model of RWH and then work on implementation of RWH structures.

1.3.2. Specifics Objectives

Consist two phases of specific objectives

i) First phase

1) To identify the causes and factors adversely affects rainwater harvesting
2) To evaluate the challenges prevent rainwater harvesting and its utilization
3) To investigate the consequence impacts of the rainwater harvesting
4) To identify socio-economic and environmental effects of rainwater harvesting
5) To recognize the culture, norms, and religious effects on rainwater harvesting

ii) Second phases

1) To recognize the success and an exemplary model of rainwater harvesting

2) To studying the identification of soil textures similarity before loss the transferring of money to other places.
3) To be implementation of the model RWH structures for crop production on farm land, for forest tree production on forest land and for livestock consumption and fodder production on pasture land including the wild animal water consumption and rehabilitation of their habitat through keeping of livestock and wild animals ecosystem balance.
4) To be monitoring and evaluating the project and then transferring to other places or areas having similar agro-climatic conditions, topography and soil types

1.4. Scope of the Study

The scope of this manuscript will be they will be covers: identification of causes, factors, and challenges prevent harvesting and uses of rainwater, failure of rainwater harvesting and their consequence effects, areas success with rainwater harvesting and an exemplary model RWH available in the areas, socio-economic and environmental impacts of rainwater harvesting, perception, and adoption of RWH by local people /farmers/, approaches and participation with different stakeholders. Moreover, they will be covers monitoring, evaluation, implementation, soil texture identification for implementation of RWH, norms, religious and culture that are affects RWH [11].

1.5. Hypotheses of the Study

Null hypothesis:

They are not observing variations between the success, cause and factors of failure, challenges, and socio-economic impacts of rainwater harvesting and other factors stated under the objectives.

H_o; $\mu_o = \mu$

Alternative hypothesis

They are observing variations between the success, causes and factors of failure, challenges, and socio-economic impacts of rainwater harvesting and other factors stated under the objectives.

H_a; $\mu_o \neq \mu$

Therefore, these two stated hypotheses will be testing at the significance level of 0.1 or 10% experiment standards errors. The statistical proofing will be either accepted or rejected null hypothesis or alternative hypothesis will be depend on the accuracy of field data collections and analyzing of the data.

1.6. Significance of the Study

1) The results should be helps the learners and the professionals who want to study in this field of specialization
2) The outcomes of the findings shall be helps the agricultural existents and experts who are working in the field of rainwater harvesting
3) Both governmental and none-governmental organization should be benefits from the outcomes
4) More and more benefits the female live in rural and urban areas through solving the challenges prevent from utilization and harvesting of RWH
5) Helps the elders to improve their income status particularly in areas where the rainfall is deficit

2. Materials and Methods

2.1. Description of the Study Area

The land lies of the west Harareghe zone is located between $40^{\circ}03'413''$ E longitude and $40^{\circ}09'00''$N latitude [2], but the land of the zone lied geographically between 40°03‟ 413” to 41°09’00’’ E longitude and 7°52’15” to 9°28'43”N latitude [8]. The nearby the west Harareghe zone at east east Harareghe zone, at north Somali region, at south and south east Aris and Bale zones respectively and at south Bale zone.

2.1.1. Climate of the Study Area

According to, WFP, had reported of west Harareghe agro-climatic classification based on the watershed topographic map or altitude belt of classification are classified into three categories: 501-1500 m a. s. l. is Kolla or Gamojji climate, 1501-2500 m a. s. l. is WeynaDega or BethaDar’e climate and 2501-4500 m a. s.l. is Dega or Bethada climate [24].

Climate change affects all the Ethiopian economy particularly the rural poor. Both in frequency and intensity of increases due to long drought, which in return human and livestock diseases and riverine and floods are increased the impacts [16]. Food and water security in rural livelihoods such as pastoral, agro-pastoral and farming systems are still largely dependent on climate systems and their maintenance.

West Harareghe zone rainfall pattern is bimodal type and out of the six rainfall patterns of the Ethiopian Awash basin rainfall pattern is covers the zone. The spring seasons are very short rainy seasons and mostly uses for land preparation and “Belge” crops growing whereas the second seasons of rainy seasons is very long duration and the most important for the zone’s rain-fed agricultural practices. The annual average rainfall of the zone is range from 500 to 1300 mm [2], west Harareghe zone generally receives greater than 500 mm rainfall per year. The annual average temperature is ranges from $25°C$ *to* $30°C$ [8]. [17] while the annual average temperature

$15°C$ *to* $30°C$ *and sometimes* $25°C$ *to* $30°C$ Sumer and winter respectively [8]. *Most of western Harareghe Districts were lies in the semi-arid to the most highland agro climatic conditions* [4]. Miesso district average annual temperature the minimum 25 ℃ and the maximum 37 ℃ and the annual rainfall ranges from 500 to 700 mm and t*he agro ecology of the district is about 99% covered by lowland* [4].

2.1.3. Soil Types of the Study Area

As defined in the World Soil Charter, sustainable soil management comprises activities that are maintain or enhances the supporting, provisioning, regulating and cultural services provided by soils without significantly impairing either the soil functions that are enable those services or biodiversity [15]. Global assessment of soil degradation project had been undertaken the late 1980s and evaluated 13 types of soil degradation through inventory of soil degradation. These are: water erosion (topsoil loss and mass movement, including rill and gully formation), wind erosion (topsoil loss, terrain deformation-primarily dune activities), and overblowing of (surface burial from Aeolian deposition), loss of nutrients and/or organic matter, salinization, acidification, pollution, compaction and physical degradation, waterlogging, and subsidence of organic soils. Globally, five specific threats are identified under Article 6 of the draft of Soil Framework Directive proposed in the strategy: these are: erosion by wind and water; organic matter decline; compaction; salinization; and landslides of soil and rock material. In addition to these, soil sealing (the permanent covering of the soil with an impermeable surface and soil contamination (the intentional or unintentional introduction of dangerous substances on or in the soil are also identified as threats.

The assessments of threat to soil functions are leads to the needs to be the soil is provide a function performs. The European Union recognizes seven soils functions that are vulnerable to soil threats: biomass production, including agriculture and forestry, storing, filtering and transforming nutrients, substances and water, biodiversity pool, such as habitats, species and gene, physical and cultural environment for humans and human activities, source of raw materials, acting as a carbon pool and archive of geological and archaeological heritage. The three core services provided by the soils of the soil determined by soil properties: texture, organic matters and mineralogy. These are altogether the natural capital of soils [15],

2.1.4. Vegetation Covers of the Study Area

Vegetation covers of the west Harareghe zones are heavily degraded in the highland, middle land and low land areas. The lowland areas where this study will be carry out they will covers with degraded acacia woody species and others lowland. Indigenous spp are *Acacia abyssinica, Carpruna urea, Acacia albida, Acacia nilotica* and exotic spp are *Lantana camarea Aceacia tortoise, Acicia senegal,* and *Propsi julifera.*

2.1.5. Farming Systems

Mixed farming system is the indigenous knowledge and skill of the farmers in the zone. Animal rearing and crop growing in admixture is a common daily practices. Animal fatting and *Catha edulis* and a few areas coffee production for income generation is the west Harareghe zone economy. Root and tuber crops as a source of income are common production. With support to these facts [17], *had reported that Crops grown in the drylands include: sorghum, finger millet, field peas, chickpea, cowpea, perennial cotton, safflower, castor bean, sesame and other crops*. *Pastoral/mixed farming is the major farming system of the Miesso area* [4].

2.1.6. Topography of the Study Areas

It refers to landscape features based the slope of the land surface either measured or expressed in degree or percent. Classification is depending on the slope classes. Accordingly Ethiopia have five classes of landscape features: 0-10% which held lowlands (703000 km^2) area of the country (less than 15000 m a. s. l.) including the flat plain, highland plateau and the valley bottoms. The rest classes are found in Ethiopian highlands 11-25%, 26-35%, 36-50% and >50, which occupy the large areas.

2.1.7. Land Uses and Land Covers of the Study Areas

Ethiopia massive land has 1221480 km^2 (122148000 ha) area of total; and the major land use and land covers are 1115000 km^2 (111500000 ha): 14.7% cultivation land, 56.9% grazing and browsing land, 11.7% forestland and 18.7% wasteland [13, 21].

Landsat satellite images of 1972-1979 in Ethiopia and their land covers are encompasses 12 types: namely cultivated lands, urban and build-up, afro and sub-afro alpine vegetation, forestland, woodland, riparian land, bush land, shrub land, grassland, wetland, bare land and wasteland [21].Total land area of the Miesso District is about 257344 ha [4].

2.1.8. Population Demography

The study [10] is the main source of population data on their demography, social, economic and housing characteristics of the areas which are the core one for researchers to solve any problems and to implement the project for the problems.

The study will be consists thre districts of the west Harareghe zone of dryland areas where, rainfall, surface and ground water are deficit. Namely these districts are Miesso, Anchar and Boke districts of the flat topography.

Oromia has the most densely populated region among the 11th Ethiopian region and occupied the 1st position and the total population was 27, 158, 471 or 36.7% and the average annual growth rate was estimated about 2.9%. Population by sex in Oromia region male 13,676,159 or 50.4% and female 13, 482, 312 or 49.6% [10] but currently even if there is no conduction of the Ethiopian population inventory due to the political instability of the country there will be more than this figurative. Population of the districts by total, sex and housing should be presented as below based on [10].

Table 1. Total number of housing and average HH of the Oromia region.

TH			Average HH size		
Urban-rural	**Urban**	**Rural**	**Urban-Rural**	**Urban**	**Rural**
5,590,530	866,294	4,784,236	4.8	3.8	5.0

Table 2. Total population of west Harareghe zone by sexes.

Total population	Sex	
Urban-rural both sexes	**Male**	**Female**
1,879,391	96,211	916,580
Urban		
161, 988	85,435	76,553
Rural		
1,717,403	877,375	840,027

Table 3. Total population of the study districts by sexes.

Districts	Total population	Sex		Total household
	Urban-rural both sexes	**Male**	**Female**	
Messio District	130,709	66,891	63,818	27,404
	Urban			
	25,388	12,878	12,510	6,021
	Rural			
	105,321	54,013	53,308	21,388

Table 1. Total population of the study districts by sexes.

Districts	Total population	Sex		Total household
	Urban-rural both sexes	**Male**	**Female**	
Anchar District	84, 443	43, 424	41,019	
	Urban			
	6,489	3,403	3,086	
	Rural			
	77,954	40,021	37,933	

Districts	Total population	Sex		Total household
	Urban-rural both sexes	Male	Female	
Boke District	1,55,211	79, 463	76, 348	32219
	Urban			
	6, 685	3, 536	3,149	
	Rural			
	149, 126	75, 927	73,199	

2.2. Methodology

2.2.1. Sampling Design and Sampling Techniques

First of all conducted field surveying and collected the basic and essential information; they will be design and decided sampling size. Basic information it helps to select and decided the watersheds having the proposed problems and objectives.

2.2.2. Criteria Requires to Collect Data

The solving of the proposed problems will be depend on these criteria: gender, wealth status, distance from the market, marriage status, education, institution, Scio-economic, culture, ecological and environmental, religious, cooperative, age, kebele leader, landholding size, landless, employment, DA, supervisors, office managers, and eders, adoption and non-adoption, precipitation and non-precipitation, dependent and independent of rainwater harvesting considering [11].

2.2.3. Source of Variables

Variables to be studying under this paper will be continues normal distortion variables ND (μ, σ^2). it will consists dependent and independent variables: rainwater/water harvesting, failure of RWH, success of RWH, implementation and operation of RWH, creativity, innovation of technologies to harvest RW, and training of RWH, and perception, adoption, socioeconomic constraints, age and education, culture, religious, professionals, local institutions, policy and benefits of RWH, respectively.

2.2.4. Sampling Techniques

Purposefully it will be use random sampling method giving an equal chance of probability distribution and then it will be use systematic stratification of random sampling techniques.

2.2.5. Sampling Size Determination Model

Collecting data from the whole population is very difficult both finically and time restriction. Due to these two factors researchers will be use the representative sample size that will represents the whole population to obtain the genuine data. So that there are two systems of deciding sample size 1) decision of the researcher and 2) statistical formula. so that for this paper the second method will be use. Sample size estimation is important for the analysis of data when the variable is measured repeatedly for each independent respondents and experimental unit [7]. the author also describe that using univariate analysis by reduction the multivariate to avoid the correlations among repeated measurements from a subject of variable from a multiple to a single measurements.

According to the watershed method; first the selected community watershed will be divided into five sub-watersheds: upper watershed, middle watershed, bottom watershed, eastern escarpment watershed and western escarpment watershed. Thus, the total representative sample size for the whole population is determined by this simple formula:

$$S = \frac{CWP \times e}{n}$$

Where, S is representative sample size, CWP is community watershed or "Kebele" total population, e is significant level and n is the total number of sub-watersheds.

Boke District: $S = \frac{155811 \times 0.1}{5} = 3116$

These S will be again divided for the number of "GARES" available within the sub-watershed. In similar to Woreda community watershed population after observed the field and gathered the secondary basic information using the above formula the representative sample size of the community watershed will be determined.

The second method is the [3] method: based on this simple and easy statistical Model; representative sample size will be determined.

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

Boke District $n = \frac{155811}{1+155811 \times 0.1^2} = 99.93 \sim 100$

Where, Z is the whole population size; e is the significant level and in this case it is 10% which mean 90% of the confidence interval and n is representative size for the whole population size of community watersheds.

The third method is [3]; the mathematical formula is as below:

$$n = \frac{NZ^2PQ}{d^2(N-1)+Z^2PQ}$$

Where, n= sample size of housing units (household head); P= Housing unit variable (residential houses); Q= Non-residential houses (different sectorial offices, schools, etc. in terms of percentage) = 1-P; N= Total number of housing units; Z= Standardized normal variable and its value that corresponds to 90 % confidence interval d = Allowable error (0.1) and after calculated n is Sample size.

First of all the community watershed or Kebele watershed that is fulfilling the requesting criteria should be selected from the three Districts proposed. At most two Kebele will be select from each District and overall six kebeles will be selects from land low areas of each District.

2.3. Statistical Research Model

As explained [9], had revealed that, the probit, and logistic regression model is most applicable to overcome the problems associated with linear statistics to estimate the accurate non-adopted, implemented and maintained and non-adopted, non-implemented and non-maintained stone bunds their farmlands. People use the probit and logistic model for dichotomous analysis and they are the most popular model. The equation model is written as follow:

$$P_i = F(\alpha + \beta X_i) = \frac{1}{1+e^{-(\alpha+\beta X_i)}}$$

Where, i indicate the $-i^{th}$ observation in the sample, P_i is the probability that an individual will make a certain choice given Xi, e is the base of natural logarithms and approximately equal to 2.718, X_i is a vector of exogenous variables, α and β are parameters of the model ($\beta_1, \beta_2 - - - - - \beta_k$are the coefficients associated with each explanatory variables X_1, X_2, …, X_n and).

$$I_i = \ln(1 - P_i) = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} \pm - - - + \beta_n + X_{ji} + e$$

Individual Explanatory variables on its log of odd $\{\ln[\frac{P}{1-P}]\}$

2.4. RWH Technologies and Their Design and Layout

The selected and proposed rainwater harvesting for dryland areas and both are used for harvesting storm water and SWC measures to control runoff and soil losses.

Semicircular structure

Table 5. *Design and layout of semicircular structure for rainwater harvesting dimension.*

Parameters		**Description**
Catchment: cultivation ratio	3:1	For range land improvement and fodder production are the general recommendation for water harvesting
Suitability	1% slope or less	Consists of a series of small semi-circular bunds with radii of 6 meters Arranged in staggered alignment called a-design
Cross-section of over the whole length for each bund	19 m	
Height	25 cm	With side slope 1:1 ratio
Top width	25 cm	
Bottom width	75 cm	
Distance between adjacent bund in the same row	3 m	Constructed on the counter line
Distance between two rows	3 m	

Source: A Manual for the Design and Construction of Water Harvesting Schemes for Plant Production. Water Harvesting (Agl/Misc/17/9) [12]

2.5. Source of Data

The study will be considered two sources to collect data. The first source of data is secondary source of data. The data was collected and documented by natural resource management office. Other secondary source of data includes theses, journal, books, internet, and magazine. The second source of data is primary data which will be collects from the field by interviewing local people and observing the field.

2.6. Data Collection Method

This study will be qualitative and focus on the collection of qualitative data rather than quantitative data. Questionnaires will be developing both in open, closed and semi loused forms; then interview the representative respondents to collect the required data to solve the study problems. Carry out the transect walks observe with key informant, rise questions, discuss and collect and required the data. Therefore, the necessary data will be record with checklists.

2.7. Data Analysis

The collected data will be arranged by types and provide codes/ then, after that they will be subjected to SAS or SPSS computer based processes software and analyzed. Statistically analyzed data shall be testifying using different statistical methods. The data will be analyses by using GLM multivariate of ANOVA, multiple linear regression and which will be testing by use F-test, t-test, or chi-square testing. Because of they will be helps the researcher to provide the better alternative solutions for the studying problems.

The personal correlation between subjects will be observing. Therefore, the results will be present using descriptive statistics, variance and standard deviation, and mean. It display with chart, table, bar graph.

Table 6. *Activity Schedule.*

Activities	Jan	Feb	Ma	Ap	M	Ju	Jul	Au	Sept	Ocb	Nov	Dec
FIRST PHASE												
Preparation research proposal									√	√	√	
Preliminary surveying	√											√
Contact to agricultural and rural development of Districts office	√		√	√								
Interview for causes and factors affect rainwear harvesting		√										
Interview for challenges prevent from rainwater harvesting and its utilization			√									
Interview of the success of rainwater harvesting model project				√								
Observation and asking the local people about consequence impacts of the failure of rainwater harvesting					√							
Asking about core socio-economic and environmental effects of rainwater harvesting						√						
Secondary data collection							√					
Organizing data								√				
Write up the draft									√			
Write up the final										√		
Submission											√	
Defend or presentation	√											
Correction based on comments		√										
Final submission (2017 E.C.)			√									
Second Phase (2018 E.C.)												
Implementation of the selected model RWH	√	√										√

Activities	Jan	Feb	Ma	Ap	M	Ju	Jul	Au	Sept	Ocb	Nov	Dec
structures for crops, and forest trees production and animal fodder												
Implementation of structures for RWH on rehabilitated lands for wild animal habitat manipulation	√	√										√
Purchase of seeds							√	√				
Trees and fruit trees raising in nursery										√	√	√
Distribution (free charge or low costs)			√	√								
Identification of soil textures similarity before loss the transferring of money to other places using field testing methods												
Monitoring and evaluating the project and then transferring to other places of the same climatic conditions, topography and soil types	√	√	√	√	√					√	√	√

3. Budgetary Requirements

Table 7*. Fixed materials costs.*

Items	Unit	Quantity	Price per item	Total price	Description
Water level	No	3	3,000	9000	Sweden made
Ranging pole	No	6	600	3600	4 m or 5 m length
String	Roll	1	400	400	5 m or 10 m length
Compass	No	2	20,000	40,000	Sweden made and function compass only
Clinometer	No	2	15,000	30, 000	
Total				53,000	

Table 8*. Seeds costs and others related.*

Items	Unit	Quantity	Price/ item	Total price	Description
Forest seeds	Kg	6	1000	6000	Different seeds each 1 kg
Fruit seeds	Kg	6	1000	6000	Different seeds each 1 kg
Fruits cutting or rhizome	Bundle	5	800	4000	Different cutting materials
Fodder seeds	Kg	5	200	1000	Each 1 kg different seed varieties
Polythene bag	Roll	4	2000	8000	10 cm, 8 cm, 15 cm and 30 cm diameter
Total				25, 000	

Table 9. Variable materials costs.

Items	Unit	Quantity	Price per item	Total price	Description
Drawing paper	No	2	260	520	
Paper	Packet	3	300	900	
Pen	Packet	3	240	720	
Pencil	Packet	2	120	240	
Marker –lead	Packet	1	720	720	
Total				3,100	

Table 10. Activities costs.

Activities	Unit	Quantity	Required days or months	Cost per day	Total costs
Preliminary survey	PD	1	30	363	10890
Feedback of basic information	PD	1	30	363	10890
Draft proposal writing	PD	1	30	363	10890
Final proposal writing	PD	1	45	363	16335
Secondary data collection	PD	4	30	363	43560
Field data collection	PD	4	90	363	130680
Implementation of RWH on cultivated and pasture lands (Agripasture)	PD	4	120	363	174240
Implementation of RWH on cultivated and pasture lands (Silivopasture)	PD	4	120	363	174240
Total					571,725

Table 11. Miscellaneous costs.

Description	Unit	Quantity	Single price	Total price
Transport costs some times	ETB			20,000
Required supplies	-			30,000
Drivers	PD			15,000
Assistants	PD			20,000
Entertainments	-			20,000
Trainees	PD			25,000
Trainers	PD			20,000
Additional costs accordingly project run	-			10,000
Total				160,000

Table 12. Summary costs.

Summary	
Fixed materials costs	53, 000
Variables materials cost	3,100
Seeds and others related	25, 000
Activities costs	571, 725
Miscellaneous costs	160, 000
Sub-total	812, 825
Safety factor costs 20%	162, 525
Grand total	975, 390

Abbreviations

1st	First
Cm	Centimeter
DA	Developmental Agent
Etal	Extra
FAO	Food and Agricultural Organization
Kg	Kilogram
Km^2	Square Kilometer
Ha	Hectare
HH	Household
M	Meter
Mm	Millimeter
PD	Persons per Day
°	Degree
℃	Degree Centigrade
M	Meter
%	Percent
n. d.	No Date
No	Number
ND	Normal Distribution
μ	Meau
α	Standard Deviation
α^2	Variance
RWH	Rainwater Harvesting

Author Contributions

Mussa Abdula Ibro is the sole author of this manuscript. I was develop the conceptualization and resources of the research aims and goals. Identify the issues and create the idea of this project research. I was read, reviewed, revised and improved this manuscript by himself of the conceptualization. The responsibility of ethics to conduct the study and clarity of this manuscript they are taken by the author himself.

Conflicts of Interest

The author has declare that, no conflict of interest about all of this manuscript.

Appendix

Personal information check lists and questionnaires

I Personal information

Kebele name_______________

Gare name________________

Gote Name____________

Full name of interviewer_____________________ Sex_ ____________Age______

Family size ____________Female_______ Male____________

Marital status Divorse____________married_____________Single___________Diead_____________

Education status: Grade 1-6_____________Grade 1-8, Grade 1-10_____________ and Grade 1-12 and above____________

Land owner and uses

Own_____________ contractor ____________ equal uses____________ and cooperation

Land obtain from

Family______________ Frenzies_______________ and Government______________

Land holding size per ha__________________

II Check lists and questionnaires

1) Uses of rainwater harvesting

Uses of RWH	Rank using PRA matrixes
Crops production	
Livestock	
Households consumption/human	
Wild animas	
Supplementary irrigation for surface water	
Complementary irrigation	
Other uses	

2) Surface water resources

Types of surface water	Quantity in number	Uses
Spring		
Streams		
Rivers		

3) Ground water

Types of ground water	Quantity in number	Uses
Water wells		
Water pits		
Water ponds		

4) Types of RWH

Types of RWH	Micro catchment	Macro catchment	Uses
Rooftop			
Courtyard			
Flood			
Spte water or wadi water			

5) Which rainwater harvesting are available in your area? use the sign of "√"

Traditional RWH _________

Modern RWH____________

Both _____________

6) Problems of the area

Problems	Rank
Water scarcity	
Rainfall deficit	
Lack of water	

Problems	Rank
Erosion and sedimentation	
Crops failure at the end of rainy seasons	
Crops decline in yield year after year	
Livestock production decline year after year	
Forest fire	
Deforestation	
Crops pest and disease due to moisture stress	
Animal fodder	
Wild anima migration	
Wild animal habitat destruction for agricultural uses	
Surface water dry	
Ground water depletion	
Lack of Watershed conservation	
Lack of Participatory watershed development	
Lack of gender equity on development of RWH at watershed level	
Complexity of technology innovation for RWH	
Perception	
Adoption	
Economy	
Social	

7) what are the major and minor challenges for failure of RWH in your area
8) are they a model RWH in your area which are successful and profitable the societies
9) which types of RWH technologies are uses in common in your area
10) what are the benefits obtained from RWH technologies
11) for what purposes they are using RWH in your area

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