INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, ECONOMICS & MANAGEMENT

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RESEARCH METHODOLOGY

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- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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DOMESTIC ROOF WATER HARVESTING PRACTICES: AN EMPIRICAL INVESTIGATION IN MEKELLE, ETHIOPIA

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ABSTRACT

The population size of Mekelle grows very fast while water supply remains inadequate to satisfy the demand. Despite the progress Mekelle Water Supply Service Office (MWSSO) made so far, there is still the challenge of providing adequate and persistent pure water supply in the town. The objective of this study is, therefore, designed to analyze the extent of the adoption of Domestic Roof Water Harvesting (DRWH) practices. The results of the study are based on data collected from a survey of 120 households which are selected using purposive and stratified sampling techniques to select enumeration areas and sampling unit (sample strata) respectively. And 30 sample respondents are selected using purposive sampling from each stratum. Different factors were significantly affecting the extent of adoption of DRWH practices these are age, income, perception towards quality & reliability of existing water supply, social responsibility and attitude towards importance of roof water harvesting, house ownership and affordability of the technology. Therefore, this study focuses on the extent of adopting DRWH as an alternative source of fresh water in the face of increasing water scarcity since it is remaining untapped resource.

KEYWORDS
Mekelle, potable water, roof water harvesting, technology adoption.

1. INTRODUCTION

Water is the major substance on the earth, covering more than 70% of its surface. Out of the total volume of water available on the surface of the earth, only 2 percent (over 28,000,000 km3) is fresh water. This fresh Water is a prerequisite for life and without it there will be no living thing. Fresh water is used for the purpose of human use, industries and agriculture (A. K. Dwivedi. et al. 2009). According to IFPRI (2010), access to safe drinking water can make an immense contribution to health, productivity, and social development. However, population growth; pollution and climate change are likely to produce a drastic decline in the amount of water in many parts of the developing world. As a result, millions of people throughout the world do not have access to clean water for domestic purposes. And this would have a consequence that 1.1 billion people lack access to improved water supply due to population growth and rapid urbanization WHO/UNICEF (2000), cited by A.K.Dwivedi. and Bhadauria, 2009. And this number will likely rise rapidly in the coming years unless serious measures are undertaken to stem the tide. Therefore, the problem of fresh water will be remained a serious issue in both urban and rural areas in developing as well as developed countries (Tripathi and Pandey, 2005; A.K. Dwivedi and Bhadauria, 2009).This led the international community to set goal in the United Nations Millennium Declaration to reduce by half the population with no access to safe water by 2015.

In many parts of the world, conventional piped water is either absent, unreliable or too expensive. Therefore, rainwater harvesting (RWH) has been identified as a valuable alternative or supplementary water resource, along with more conventional water supply technologies (Janette W. et. al, 2006).

RWH is primary source of fresh water and in many literatures; it is broadly defined as a collection and concentration of the rain for productive purposes like drinking, food making, cloth washing, back yard vegetables, permanent fruit production and livestock. But most of the rainwater from the roof top of the city goes back to rivers without being properly used. And, the rapid urbanization has further aggravated the urban runoff problem which causes erosion and land degradation (FAO, 2000).

People in some parts of the world where water shortage exists have a better understanding of the way to mix domestic roof water harvesting (DRWH) with other water supply options, in which it is usually used to provide full coverage in the wet season and partial coverage during the dry season as well as providing short-term security against the failure of other sources (Thomas and Martinson, 2007).

But, the application of RWH technique although potentially high is still traditional and low in Ethiopia Ngigi (2003), The reason that DRWH is rarely considered and becomes traditional is often simply due to lack of information on technical and financial feasibility, inadequate strategies, human resources and policies for its promotion.

Despite the progress registered for the last 10 years in Ethiopia, still it is one of the developing countries which facing several social and economic problems. As a result, its cities are confronted mainly with extensive poverty, which is characterized, among other things, by environmental problems and underdevelopment of physical infrastructure such as low access to health, education, water and low level of investment in social services. In line with the above facts of Ethiopia in general, the study area is highly characterized by inadequate availability and poor quality of ground and surface water supplies.

In general, DRWH has the potential to fill part of household's fresh water demand in Mekelle where other sources of fresh water have been limited. But so far, its adoption has been very limited for various reasons. However, there is a traditional (informal) practice of roof water harvesting in Mekelle as well as in other parts of Ethiopia.

Water resource availability or its lack is linked to economic and social progress, which suggests that development is strongly influenced by water resource availability and its management (Sullivan, 2002). This is because adequate and safe water supply is one of the basic urban services, which highly influence economic progress of towns and the health of their dwellers. Because,

'If there is water poverty, any measures to reduce income poverty are unlikely to be successful'. That is why the importance of adequate and safe water supplies for poverty reduction has attracted the attention of governments and different world organizations'.

Though, DRWH technology will have the capacity and should be designed with the aim of raising the urban water supply coverage to satisfy the full demand along with other sources under use widely, the Ethiopian water resources management policy didn't point out anything about rainwater harvesting. In fact, recently there are some attempts mainly in rural areas and the national safe water supply target established in the national water sector development program indicates coverage will be 96 percent by the end of 2016. So, it would be a challenging to the ministry to achieve its plan without considering 'rainwater' the ultimate source of fresh water which is simple and affordable technological option.

In relation to the population growth, the population projection made by regional bureau of plan and finance, stated that the city's population is 272, 539 in 2012 with annual growth rate of 4.7%. Thus the daily water requirement of the city is 43,992 m^3 per day while the existing supply is 20,500 m^3 per day and average per capita water requirement is 161 liters per capita domestic consumption while the existing condition reveals 40 liters per capita domestic consumption (MWSSO, 2012). Therefore, this persistent shortage of water brings an increasing interest to low cost alternatives generally referred to as 'water harvesting' especially for DRWH which can be used for different purposes.

The immediate output of this study is assessing different socio-economic and other factors affecting the extent of adoption of RWH by providing adequate information towards increasing its exploitation. Because sustainable availability of safe water supply in the required quality and quantity promotes the socio-economic development of the city in particular and the region in general. And investment is attracted and the city's socio-economic development brings structural change from traditional economic activity to modern scale business ventures.

However, there are many researchers who conducted research on RWH for agricultural purposes in Ethiopia but as to my knowledge; no published study is available which assesses the extent of adoption of RWH as an alternative source of potable water supply in urban areas.

2. CONCEPTS OF ROOF WATER HARVESTING

A. K. Dwivedi. (2009) stated that the human civilization, entirely depend upon rivers, lakes and ground water to fulfill their water demands. However rain is the ultimate source that feeds all these sources. The implication of rainwater harvesting is to make optimum use of rainwater at the place where it falls i.e. to conserve it without allowing it to drain away. Rainwater harvesting is an ancient technique enjoying a revival in popularity due to the inherent quality of rainwater. Rainwater is valued for its purity and softness. It has a nearly neutral pH[1], and is free from impurities such as salts, minerals, and other natural and man-made contaminants.

According to Befekadu k., (2008), about 70 Percent of the precipitation that reach on the land area is evaporated or transpired directly back to the atmosphere; 10 Percent socks in and becomes ground water, and 20 Percent runs off in to lakes, streams and rivers.

Thus using DRWH system we can use the rainwater before any of the losses mentioned in the above paragraph and avoid the difficult to regain it back by investing huge amount of money for pumping, construction of Dams or reservoirs, construction of purifications or treatment plants and convey the stored water from head works to each house through various pipe size and length etc (Thomas. T, Martinson, D.B, 2003)

Indiscriminate exploitation of ground water and the decline in ground water level shave rendered many bore wells dry either seasonally or throughout the year. To overcome such a situation, bore wells and tube wells are now being drilled to greater depths, often tapping ground water from deep aquifers till then considered 'static'. (www.arpnjournals.com, 2006)

Butler et al (2011) suggested that rooftop rainwater harvesting for household purpose only represent a small part of the total water balances. In areas with significant variations in the annual rainfall pattern, the matching of water supply and water demand may be difficult. However, in terms of economic and human welfare it has a crucial role to play. Rainwater in many cases is the easiest to access, most reliable, and least polluted source. It can be collected and controlled by the individual household or community as it is not open to abuse by other users.

3. EMPIRICAL STUDIES ON TECHNOLOGY ADOPTION

The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used. According to Hall and Khan (2002), decisions to begin using the new technology are often the result of a comparison of the uncertain benefits. That means the decision of whether or not to adopt a new technology hinges upon a careful evaluation of a large number of technical, economical and social factors.

Yapa and Mayfield (1978) also suggested that the adoption of an entrepreneurial innovate by an individual requires at least four conditions. These are (a) the availability of sufficient information (b) the existence of a favorable attitude towards the innovation (c) the possession of the economic means to acquire the innovation (d) the physical availability of the innovation.

4. DECISION BEHAVIOR OF HOUSEHOLDS ABOUT RAIN WATER HARVESTING

Degnet (1999) had summarized different empirical studies on the association between adoption decision and the factors which influence adoption particularly in less developed countries into the following groups.1) household characteristics such as age, education, gender, family size, experience and social status of the head of the family, 2) economic characteristics such as house ownership, availability of cash, 3) supply and institutional factors such as households access to credit, awareness creation and sensitization service, access to and availability of skilled labor and raw materials.

Thus, Martison et al (2001), suggested the success or failure of any rainwater harvesting technology will ultimately depend on the degree of acceptance by the households. It is essential that the needs and aspirations of the households are clearly understood and fully provided in the planning, designing and implementation process. It should give sense in terms of productivity of resources used.

As mentioned in CTA (2000) also, widespread adoption of rainwater harvesting techniques by the local population depends on cost and simplicity of the technology for implementation and maintenance. Another consideration would be whether success in rainwater harvesting promotion and adoption is facilitated by integrating different forms of rainwater harvesting systems. And many other researchers and experts in the field of natural resources conservation and rain water harvesting also forwarded their reasons about different factors that affect the decision of household's to participate and efficiently use rainwater-harvesting works.

Adoption of rainwater harvesting technologies despite their technical benefits will depend on knowledge of socio-economic and cultural dynamics, on the part of the technology developer, and on the household/ community perceptions. A comparison of promotion approaches of the same technology in different environments, either by the same or different actors, reveals the importance of participatory, household friendly approaches, and due consideration of socio-economic and cultural backgrounds (Ngiggi,2003).

Abdulkarim (2002) enumerated conditions that should be considered during rain water harvesting system planning and design for the technology to be more acceptable by the users. These are a) Socio-economic aspects which may include community acceptance and participation, Understanding of needs and aspirations, prioritization of needs, appropriate technology, proper planning and analysis, pilot scheme approach, technical services, cost and benefit consideration of investment and operation, application,.

Hence, it is essential to mention and summarize focusing on very influential factors that affects the extent of rain water harvesting practices. And, the following points were commonly cited in many literatures, as determinants of household behavior towards rain water harvesting practices.

Awareness and sensitization: surprising deposited the fact that rainwater harvesting have been around for hundreds of years. It has never been sufficient attention as viable solutions to our food and environmental problems. If it had been given sufficient attention, like other technologies, with the accompanying services, equipment and personnel, the situation would have been radically different (Critchley, 1991; FAO, 1994).

Legal, policy and institutional issues: despite the centrality and potential of rainwater harvesting in alleviating water scarcities, it is surprising to find no comprehensive policy guiding it in the Greater Horn of Africa countries (Ngiggi, 2003).

Environmental issues: in general rainwater harvesting systems are environmental friendly, rainwater harvesting technologies have been reported to reduce soil erosion by capturing roof water and hence reduce run offs and land degradation (Hatibu and Mahoo, 2000).

Awareness creation by Water sector service; Making use of the available service within government departments and equipping them with the necessary skills and material support would enhance adoption and replication. Households' exposure visits and stakeholders' collaboration and networking would suffice in disseminating the technologies (Ngiggi 2003).

Public perception and acceptability: One of the key factors in the success or otherwise of any water reuse scheme is the perception of the users and the acceptability to them of the existing or proposed technology. It is important that the social and cultural aspects of water use are considered when planning and designing such systems because past failure to adequately take into account and address public concerns has led to the cancellation of a number of potentially beneficial reuse schemes. (Jeffrey & Gearey, 2006).

Satisfaction with present water sources: If households have no problem in terms of accessibility and convenience of water supply, cost and quality of water. There may be a tendency to overlook the need to adopt DRWH practices.

Limited previous exposure to permanent DRWH systems: lack of familiarity with DRWH systems within the community hinders the adoption and effective use of the technology.

Shortage of skilled masons to construct water retaining structures: specialist training is usually required to develop the community's skills base in the new technology.

Lack of responsibility for self help: in some countries, there is the widespread expectation that water provision is the government's responsibility. Consequently many communities are unwilling or not motivated to address their water supply problems alone, particularly if it may compromise their subsequent involvement in piped water supply projects (for example, Uganda and Sri Lanka).

[1] PH indicates the acidic nature of rain water as compared to surface and sub surface water sources. As a result, it is valued for its purity and softness.

Socio economic factor: These factors include households' income, size, level of education, occupation and other demographic characteristics. Therefore, those factors are used to assess the extent of adoption and use of DRWH. Hence, a consideration of socio-economic factors is very important. Household surveys often gather a large amount of information on household socioeconomic and demographic characteristics such as size and composition (by sex and age) of the household, education level and occupation of each member, and earnings, as well as data on household living conditions such as number of both rooms, toilet rooms, availability of laundry machine, car etc.).

Household water consumption is also partly influenced by the level of education of household members (mainly household heads). It is believed that education is directly related to household per capita water consumption. The reason is that as the level of education of household heads increases; there would be more awareness of the health benefits of water and frequent bathing and washing in the household.

Household's Perception on Quality of Water Service: Because water quality and reliability may vary from one source to another, such variables should be included in household behavior to adopt other alternative sources choice. These include quality opinion variables about the taste, smell, and color of the water and hours of water availability and potential pressure problems (Gould and Nissen-Peterson, 1999). Also, quality perceptions may be correlated with income and education, implying collinearity issues. To avoid such biases, one could develop an average of opinion (on water quality) for households living in the same neighborhood, or relying on the same water source, if the average could be computed without considering the opinion of the individual household under consideration.

Rainwater quality and health: Some other literature states rainwater is often used for drinking and cooking and so it is vital that the highest possible standards are met. Rainwater, unfortunately, often does not meet the World Health Organization (WHO) water quality guidelines. This does not mean that the water is unsafe to drink. Gould and Nissen-Peterson (1999), in their recent book, point out that the Australian government have given the all clear for the consumption of rainwater 'provided the rainwater is clear, has little taste or smell, and is from a well-maintained system'. It has been found that a favorable user perception of rainwater quality (not necessarily perfect water quality) makes an enormous difference to the acceptance of RWH as a water supply option. There are several simple methods of treatment[2] for water before drinking.

5. MATERIALS AND METHODS

5.1 DEMOGRAPHIC DETAILS OF THE STUDY AREA

Mekelle town is one of the ancient towns of Ethiopia. Today, mekelle is one of the fast growing town having total area of 19,200km^2 and it is located in the north part of Ethiopia some 783km far from Addis Ababa. The city is the center of many federal, regional and international organizations. According to the regional bureau plan and finance population projection, the projected population estimate based on the population census of 2007, is a total population of 272,519. (BoFED, 2011). Thus, the population of Mekelle city has been growing considerably in the last 10 years. The city water supply service has attempted to cover the growing water demand. However, so far it has only achieved limited results. Reasons for water shortage of the city includes expansion of construction and industrial activities, increase in city's population due to both natural growth and immigration from surrounding areas in search of better living conditions. (MWSSO, 2012).

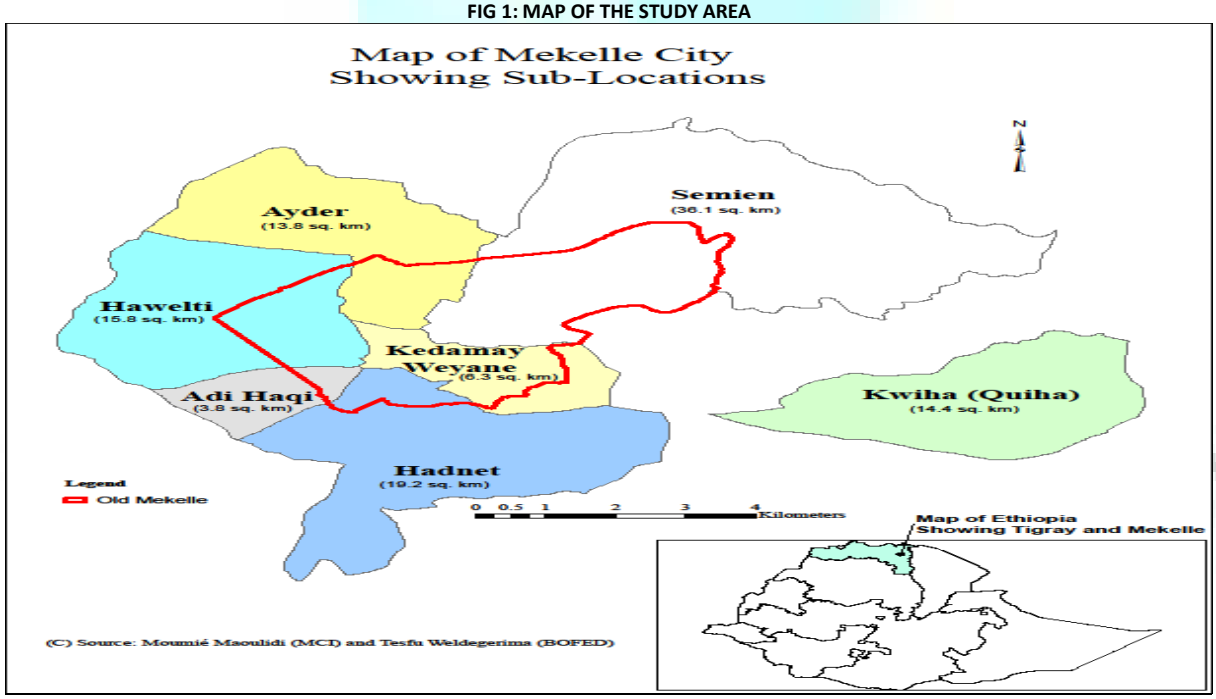
In order to distribute the available scarce water equitably among the population of the city, the enterprise has introduced a shifting system since four years ago. However, the current water supply situation of the city continues to be inadequate.

TABLE 1: POPULATION PROJECTION OF THE STUDY AREA

Year	2004	2007	2010	2015	2020	2025
Population	207,308	237,456	272,223	337,686	413,420	505,422
Annual G. rate	4.63	4.66	4.45	4.4	4.13	3.95

Source: Appraisal report of MWSSO expansion project, 2008

FIG 1: MAP OF THE STUDY AREA



Source: Adopted from BoFED Mekelle city profile, 2011

5.2 EXISTING WATER SUPPLY SOURCE AND PRODUCTION CAPACITY OF MEKELLE

As to the information obtained from Mekelle Water Supply Service Office, the introduction of a modern water supply system in Mekelle town began by 1950 ec and in the last 50 years only small changes has been made on the water service production and distribution system. The main water source for mekelle water

[2] • Boiling water will kill any harmful bacteria which may be present
• Adding chlorine in the right quantity (35ml of sodium hypochlorite per 1000 litres of water) will disinfect the water
• Slow sand filtration will remove any harmful organisms when carried out properly
• A recently developed technique called SODIS (Solar Disinfection) utilizes plastic bottles which are filled with water and placed in the sun for one full day.

supply is from 22 boreholes with depth ranging from 65 m to 250 m. Water production is effected by submersible pumps. The water that is produced from these boreholes is located in to the town's reservoirs, and then after disinfection process the water is delivered to the distribution networks.

The supply capacity of the existing water sources is deteriorating from time to time and some boreholes are abandoned due to the increase in demand and consequent shortage of water and over depletion. The production and distribution capacity of Mekelle water supply in 2012 is 20,500 M^3/day including about 20% of non revenue water (system leakage) while daily average demand for water of the city is estimated to be 43,992m^3. This supply covered only around 50% with 40 liters per capita domestic consumption. Water services are provided to about 272, 539 people in the city through 23,000 connections and about 32 public stand posts. This service is provided to residential and non residential uses out of the total service connections, about 87% are residential, using about 52.7% of water supplied; 13% are governmental, commercial and business, which uses 47.3% of the remaining water supplied. (MWSSO, 2012).

5.3 METHOD OF DATA COLLECTION AND ANALYSIS

5.3.1DATA SOURCES AND DATA COLLECTION PROCEDURE

5.3.1.1 DATA SOURCES

Both primary and secondary data sources are used for this study. The primary data is collected using structured questionnaire. The data on socio-economic aspects of the households such as age of a household head, education level, residential plot size, family size, and other economic, institutional and technological factors which explain household's decision behavior regarding domestic roof water harvesting participation.

The secondary data is collected from relevant sources such as the water supply service office of Mekelle, city Municipality and other related offices and officials. The data are collected from reports, statistical document as well as published and unpublished documents.

5.3.1.2 SAMPLING PROCEDURE AND SAMPLE SIZE

According to Mekelle town administration classification, the town is classified in to seven administration units (kefele ketmas); the sample for the study is draw from two sub towns, and the selection of the two sub towns is using purposive sampling method aiming to ensure representativeness of adopters and non adopters of DRWH as well as all residence types. Thus, based on the categories of settlement that consist all types of residence and the presence of both adopters and non adopters of DRWH practices, Hadenet and Adihaki having total population of 49,994 and 28,049 respectively are selected as Enumeration areas (EA). After selecting the area, the total community living in those kefele[3] ketma (sub towns) was stratified using stratified sampling method in to four groups (strata) based on their house ownership type. As a result, the main stratification unit was their house ownership registration. Then, the types of house were classified as follow. Group 1 includes residences having Nebar Tehzeto registration type (old settlements), group 2 includes residences having condominium registration type , group 3 includes residences having Lease registration type and group 4 includes residences having Mahber (association) registration type. In view of this 30 sample households were selected using purposive sampling technique from each stratum or survey domain, This was done by considering the financial constraints, time shortages, lack of transportation and the presence of similar socio economic characteristics of the population groups (presence of homogenous characteristics) in the study area. Thus, a total of two Enumeration areas (EA) and four enumeration categories (EC) out of which a total of 120 households were included in the study as sample respondents.

Prior to the final administration of the questionnaires several steps were passed through. First, enumerators had given training and briefings on the objective and contents of the questionnaire and have been also acquainted with the basic techniques of socio-economic data gathering and interviewing techniques. Secondly, the questionnaires were tested at the household level on 15 purposively selected households. Thirdly, some amendments on the questionnaire were made following the results of the pretest.

5.3.2 METHODS OF DATA ANALYSIS

Descriptive statistics is employed to study the extent of roof water harvesting practices. Using descriptive statistics the mean, standard deviation, minimum as well as maximum values of variables were indicated. The result obtained is used as an indicator of the household behavior towards roof water harvesting practices.

6. RESULTS AND DISCUSSIONS

This part is mainly concerned with the description and interpretation of the findings. Thus, some of the socio-economic, attitudinal and technological characteristics are discussed below. And the analysis was made to identify the most important factors that affect the extent of adoption of DRWH.

6.1 RESULTS OF DESCRIPTIVE STATISTICS

6.1.1 HOUSEHOLD CHARACTERISTICS

TABLE 2: DEMOGRAPHIC CHARACTERISTICS OF SAMPLE RESPONDENTS BY HOUSEHOLD GROUP

Category	Adopters		Non adopters		Total	Chi-square	
	Freq	%	Freq	%	Freq	%	
Sex of respondents							
Male	23	74.20	79	88.76	102	85.00	3.83*
Female	8	25.80	10	11.34	18	15.00	
Marital status							
Married	24	77.42	72	80.90	96	80.00	8.68**
Single	1	3.22	13	14.61	14	11.67	
Divorced	6	19.35	4	4.49	10	8.33	
Educational status							
Illiterate	2	6.45	18	20.22	20	16.67	3.81
Primary School	9	29.03	19	21.35	28	23.33	
Secondary School	6	19.35	20	22.47	26	21.67	
Diploma & above	14	45.16	32	35.96	46	38.33	

Source: survey result

The minimum and maximum ages registered were 31 and 67 years respectively, with a standard deviation of 7.73 years. The average age of the sample households was 50.5 years and the average age figure is 48.5 and 51.2 for adopters and non adopters respectively. This shows young people have more probability to adopt new technology (Table 3).

- [3] Kefle ketma, Hadent, Adi Haki, are to mean specific administration units
- Nebar tehzto, Mahber, lease and condominium are to mean types of house ownership registration of individual respondents.
- Ketena= specific local administration unit

TABLE 3: HOUSEHOLD CHARACTERISTICS OF SAMPLE RESPONDENTS BY HOUSEHOLD GROUP

Attributes		Obs	Mean	Std. Dev.	Min	Max	t-test
Age	Adopters	31	48.48387	6.587215	37	60	1.699*
	Non adopters	89	51.20225	8.010192	31	67	
Family size	Adopters	31	5.225806	1.627066	3	9	-3.089***
	Non adopters	89	4.202247	1.575233	1	9	

Source: survey result

*, **, *** Significant at 10%, 5%, 1% level of significant respectively.

6.1.2 ECONOMIC CHARACTERISTICS

With respect to monthly income of the sample household, it was calculated by comparing the monthly income reported by the respondent with that of the monthly expenditure plus a 5 percent estimated saving of that respondent. In this regard, the monthly income of the respondents ranges from 2000 birr to 9,500 birr. The average income is 4,543.333 birr with a standard deviation of 1,741.087 birr. The survey result indicates that adopters have average income of 6,367.742 birr. The corresponding figure for non adopters was 4,676.404 birr. About 39.17 percent of the sample respondents have other source of income other than the income of the household head from employed family member or house rent. The figure will be 22.50 and 16.67 percent for adopters and non adopters respectively. (Table 4)

TABLE 4: ECONOMIC CHARACTERISTICS OF HOUSEHOLD BY HOUSEHOLD GROUP

Attributes		Obs	Mean	Std. Dev.	Min	Max	t-test
Monthly Income	adopters	31	6367.742	1473.632	4000	9500	-5.84***
	Non adopters	89	4676.404	1358.31	2000	8000	
Plot size	adopters	31	302.5806	99.34679	175	500	4.49***
	Non adopters	89	188.1798	129.0353	41	500	
Monthly expenditure	adopters	31	5851.613	1484.334	3200	9000	5.07***
	Non adopters	89	4391.573	1345.41	1800	7600	

Source: survey result

Accordingly, the survey result indicates the respondents residential plot size ranges from 41 sqm to 500 sqm. The average residential plot of adopters is 302.58 sqm with a standard deviation of 99.3468 sqm. The corresponding figure for the non adopters is 188.18 sqm with standard deviation of 129.0353 sqm. This result indicates that large plot size encourages household's decision to adopt DRWH practices. (Table 4)

Of the total sample household heads 15.8 percent have some responsibility at their kebelle (ketena). The figure was 29 percent and 11.2 percent for the adopters and non adopters respectively. The higher figure for the adopters when compared with the non adopters may indicate that as the household head assume some responsibility, the chance of getting information and hence understanding about the advantages of DRWH increase. Thus contributes to decide to construct some form of rain water harvesting tank.

The situation in the perception of water supply reliability and quality shows, 74.2 and 25.8 percent of the non adopters reported that there is unreliable and reliable water supply respectively in the study area. The corresponding figure for the adopters is 67.7 and 32.3 percent respectively. With respect to the quality of pipe water supply, the adopters reported that 19.35 and 80.65 percent were satisfactory and poor quality respectively. The corresponding figure for the non adopters is 65.17 and 34.83 percent were reported satisfactory and poor quality respectively. Thus, the existing water supply reliability and quality contributes to decide to adopt DRWH practices.

TABLE 5: THE IMPORTANCE OF ADOPTING DRWH

Attributes	adopters		Non adopters		Total	Chi-square	
	Freq	%	Freq	%	Freq	%	
Important	27	87	30	33.71	57	47.5	26.28***
Less Important	4	13	59	66.29	63	52.5	
Not important	0	0	0	0	0	0	

Source: survey result

From the existing water supply problem point of view the number of adopters are few in number. Out of the total 120 sample respondents, a total of 31 households were reported as adopters. With regard to the importance of adopting DRWH, 87 and 13 percent of the adopters reported that important and less important respectively. The corresponding figure for the non adopters is 34 and 66 percent respectively. But no household is reported that DRWH is not important. This figure indicates that those non adopters now are more interested to have in the future.(Table 5).

TABLE 6: SHORTAGE OF MONEY

Attributes	adopters		Non adopters		Total	Chi-square	
	Freq	%	Freq	%	Freq	%	
No	18	58.06	25	28.09	43	35.83	8.98***
Yes	13	41.94	64	71.91	77	64.17	

Source: survey result

The study found that about 85.8 % of the sample respondents have their own private house. The figure was 87.1 and 85.39 percent of the adopters and non adopters of DRWH technology have their own private house respectively .This result indicates that respondents having their own private house are encouraged to adopt DRWH practices (table 7).

TABLE 7: HOUSE OWNERSHIP TYPE OF SAMPLE RESPONDENTS

Category	adopters		Non adopters		Total	Chi-square	
	Freq	%	Freq	%	Freq	%	
Private	27	87.1	76	85.39	103	85.83	11.1***
Rent	4	12.9	13	14.61	17	14.17	
Relative's house	0	0	0	0	0	0	

Source: survey result

TABLE 8: GOVERNMENT FOCUS TO WATER SUPPLY

Attribute	adopters		Non adopters		Total	Chi-square	
	Freq	%	Freq	%	Freq	%	
Some attention	0	0	47	52.81	47	39.17	6.46**
Less attention	31	100	42	47.19	73	60.83	

Source: survey result

Water is the most important element of life and base of every economic development. Hence, without availability of adequate and safe water supply there will be no development and life at all. In this regard, the respondent's perception towards government role and level of attention to this crucial element in the study area was assessed. The result of the survey revealed that of the total sample respondents 31 (100 %) of the adopters responded that government gives less attention to water supply issue especially for alternative sources of water. While 53 and 47 percent of the non adopters responded that government gives some attention and less attention to water supply problem.

The total sample households (adopters and non adopters) reported that they did not get awareness about the formal way of practicing DRWH as an alternative source of water supply by government bodies. This shows that government policy has traditionally focused on increasing water supply by investing in large scale and centralized projects. But the importance of securing water supply necessitates that all options has to be explored was not taken in to account. Thus the result of the survey study indicates that lack of awareness on DRWH technology affects household decision to adopt DRWH practices highly.

A fast growth rate of population together with large investment in construction and manufacturing sectors causes shortage of water supply in the study area. The survey result indicated that as ground water is the only source of water supply in the study area there is shortage of water supply at source due to over depletion of ground water, quality problem of pipe water, less government focus for water supply problem and technical problems of the municipal in maintenance and mapping of distribution systems of the existing water supply unable to meet the ever increasing demand for water and those are the main driving causes for some households to practice DRWH

6.2 TESTS OF THE MEAN AND FREQUENCY DIFFERENCE OF HOUSEHOLD RELATED VARIABLES

The mean values of the above continuous variables in both adopters and non adopter groups were compared using t-test is used to indicate the mean difference between groups. That is why the test was used to identify the mean difference between adopters and non adopters. The t- values of 3 continuous variables were computed and in all of these variables the two groups were found to differ significantly.

Indeed, the two groups may not only differ in terms of quantitative variables, but also in terms of qualitative variables. In this respect, a chi square test was used to examine the existence of statistically significances between the two groups. Accordingly, 8 discrete variables were considered and the two groups were found to be different in terms of 6 variables. More specifically, the chi- square test reveals that 6 discrete variables showed statistically significant differences between the two groups at 5 % probability level.

From the total sample households, 59, 17 and 9 percents of the respondents were use rain water only during rainy season, full rainy season and partial dry seasons, full rainy and dry seasons respectively. The figure was 25.8 % and 59.2 % for the adopters and non adopters respectively. Full rainy & full dry season, full rainy & partial dry season and only rainy season consumption of rain water was mainly indicated by the adopters of the technology and non adopters having traditional practices respectively. While some 15% of the respondents mainly living in condominiums responded that they did not use rain water because the design of the house did not allow them to use (Table 9).

TABLE 9: DURATION OF RAIN WATER USE BY SAMPLE HOUSEHOLDS

Category	adopters		Non adopters		Total	
	Freq	%	Freq	%	Freq	%
Rainy season only	0	0	71	79.77	71	59.17
Full rainy & partial dry season	20	64.52	0	0	20	16.67
Full rainy & full dry seasons	11	35.48	0	0	11	9.17
Rain water non users	0	0	18	20.22	18	15.00

Source: Survey result

The study found that 14, 10 and 3 percents of the respondents were adopting the practice of DRWH because of the presence of shortage of water supply, quality problem of pipe water and to save water tariff respectively. Saving pipe water tariff is not only from the income approach but mainly from the water resource management perspective (i.e freely available rain water has to be utilized). The figure was 100% for the adopter group. With respect to the non adopters the main reasons not to adopt the practice of DRWH are 26, 45 and 29 percent for Shortage of income, lack of awareness about DRWH technology and lack of space in the residential compound for reservoir construction or installation respectively (table 10).

TABLE 10: REASONS TO ADOPT AND PRACTICE DRWH

Main reasons	Freq	Percent
Shortage of pipe water supply	17	14.17
Quality problem of pipe water supply	12	10.00
To save pipe water tariff	4	3.3

Source: Survey results

6.3 HOUSEHOLD'S DECISION TO ADOPT DRWH

As it has been mentioned one of the gauges of a community's acceptance of a new idea is availability of information about the technology up to decision to practice and invest on it. It was encouraging to note that in all the situations where the idea of cost of adopting rain water harvesting technologies was introduced and readily accepted provided the cost is within their reach (Ngiggi, 2003).

Thus, the meaning of adoption in this study carries investment in rain water collecting tank. Therefore, in the context of this study, a respondent is said to be adopter if he/she is formally harvesting rain water for domestic uses by investing in above or underground tank. In this regard, 25 % of the respondents were adopters. On the other hand, 75 % of the sample respondents are non adopters. Those non adopters were asked as to why they are not adopting DRWH are most responded that lack of awareness about practicing DRWH in its formal way than its traditional practices consciously. Some of the respondents also reported that they are unable to afford its cost according to this group of respondents, the cost of the technologies were beyond their ability to pay. They also pointed out that there is problem of space within their compound and fear of leakage from septic tank to the water tank. Still there are other respondents believed that, the issue of water supply is not the concern of private households but that of government only.

7. CONCLUSION

In spite of being water is the basic element of life and urbanization, investment and industrialization in particular and economic development in general depends highly on availability of adequate water supply, however, water supply in the study area still remains in adequate. The supply of safe and adequate water is below the ever increasing demand for water and still is characterized by insufficient supply. Many people attribute the problem to the growth of population at a rate faster than water supply would guarantee, over depletion of ground water, environmental degradation, poor water resource management and inefficient water use, Insufficient capital for surface water harvesting and ill- thought- out policy . This shortage water supply coupled with rapid population growth and urbanization, has an impact on household water security and profound effect on productivity and the economy in general.

Hence, promoting domestic roof water harvesting practices at individual household levels plays important role. However, there is no study as such which can indicate the status of promotion and adoption of roof water harvesting works across potential users' in urban areas.

Therefore, this study has tried to look in to the socio-economic and other factors, which can influence the household decision behavior to participate in domestic roof water harvesting. Indeed it will give a brief understanding about perception of existing water supply quality and reliability, perception on the importance of adopting DRWH, the extent of DRWH adoption, and duration of use. Therefore the study took 120 households to conduct the survey in which the household respondents were purposively selected from two kefel ketma within the study area and the result of the study understands the following findings:

Evidences from the descriptive analysis indicates that adopters of DRWH have better education standards, enough residential space, have relatively higher income and good understanding about importance of DRWH and quality perception of water supply and most of them did not face financial constraints. Non

adopters on the other hand have relatively low level of education in proportion to adopters, have no adequate awareness about importance of DRWH, as compared to adopters they also have financial constraints and no adequate residential plot size. This means non adopters having relatively better education and good understanding about DRWH have financial and space problem to adopt the technology, while some other non adopters have adequate income and space but they have lack of awareness about the technology and even their perception towards water supply is not their issue but the responsibility of government only. On top of this; they have lack of access to credit.

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