Rainwater Harvesting (RWH) in Nepal

A case study on social acceptability and performance evaluation of RWH schemes implemented in Syangja and Tanahun districts

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EXECUTIVE SUMMARY

In Nepal the most accessible areas have already received improved water supply services while the number of unserved is still high among potential users of rainwater in remote and water scarce areas. Rainwater Harvesting (RWH) has gradually been gaining interest in both the urban and rural areas. Rainwater is a valuable resource, which should be exploited in the most efficient way to protect the people's health and livelihood. Rainwater harvesting is a suitable solution for households located higher up the hill sides where gravity flow systems are not feasible and motorized pumps are either too expensive or impractical due to lack of electricity.

In recent years collection of rainwater for domestic use has been promoted in Nepal by various agencies. The Department for Water Supply and Sewerage has produced some technical guidance on application and construction of rainwater systems, and several other sector agencies and NGO partners have followed suit (UNDP, RWSSP-Finnida, Helvetas, NEWAH, Rural Water Supply and Sanitation Fund Development Board, Biogas Support Program and the NGO Forum for Urban Water Supply and Sanitation). The main objectives of this study is to analyze key factors associated with the social acceptability of RWH schemes implemented in Tanahun and Syangja districts especially concerned with drinking purpose.

In total, three VDCs; two in Syangja (Chandibhanjyang and Aalamdevi) and one in Tanahun district (Sabung Bhagwatipur) with few years of community practice in managing RWH schemes were visited on the first week of October 2010. In each community, the interaction between rainwater harvesting group and the users was explored by conducting household surveys, participant observations and water quality testing. In total, **101 households** equally distributed among the selected communities were surveyed to explore consumer perceptions, social acceptability, water management practices, operation and maintenances practices and the physical condition of the systems. Water quality was tested using P/A vial only for Coliform in ten randomly selected households with extremely poor quality of water.

The level of user's satisfaction was not very impressive. About 70% users in Tanahun were not satisfied with size of jar. In Tanahun district, the capacity of the entire households jar is 2 m^3 which is inadequate for most of the households. However, in Syangja district size of jar ranges from 10 to 30 m^3. So, most of the users were relatively satisfied as they can store large quantity of rainwater for use in dry season. About 40% of users overall were not satisfied with the quality of harvested rainwater. In their opinion stored water is of poor quality. Some users expressed their dissatisfaction towards cleanliness of jar water. But more than 85% users were overall satisfied with the rainwater jars mainly because of decrease of water problem.

Most agencies adopt the same technology to promote rainwater harvesting. The typical rainwater harvesting system in the project districts consists of a ferrocement jar of 2-6 m^3, CGI sheet roof and a gutter made of HDPE pipe. Rainwater harvesting systems of the sample had been in operation between two and six years. Both ICCR and CCCR system of collection were found in use in the study areas. Physical condition of the system was also observed. Most of the catchment area was constructed maintaining the gradient. Almost all of the gutter and pipeline were well constructed. In 86% of the cases, catchment and materials were found in fair condition. In 84.85% of the cases, condition of the gutter was fair. 74.24% of the first flush systems were found in fair condition. However, only 44% of the total HH and institutional users have proper locking system in the faucet. In most cases the locking system of the faucet was either damaged or not in use. About 71 % of the individual and institutional system had properly covered jar.

Operation and maintenance practices adopted are one of the key factors for sustainability and better performance of RWH Schemes. Cleanliness of the RWH system is one among those factors that affect the quality of rainwater collected. Almost 80% of the individual HHs and institutions clean the RWH Jars. Most of the users clean the jar annually. About 48.48% of the individual HHs and institutions were found with leakage from some part of the RWH system. Major leakages were found from faucet and the jar. Only 7% of the individual HHs and institutional jars were found non functional mainly due to leakage.

Water use greatly varies from community to community depending on water availability. During the dry season rainwater cannot be utilized for all uses, so the most demanding uses need to be prioritized. According to our field survey, very few households are using rainwater for drinking and cooking purpose. 74% of the households used harvested rainwater for livestock, 68% preferred to use the rainwater for washing utensils whereas more than 52% used the harvested rainwater for washing clothes and flushing the latrine.

Initially, some communities are reluctant to accept the installation of rainwater harvesting systems mainly due to lack of knowledge and uncertainty about its usefulness. According to the interviewee, use of rainwater especially for drinking and cooking purpose is refused by users mainly due to poor water quality and habituated to previous sources. Only 22.77% of the households interviewed drink rainwater. Few interviewees mentioned that they do not use jar water for drinking and cooking purpose because of taste and religious beliefs. 65% of the tested samples were found to contain coli form mostly in systems presenting a poor sanitary condition.

The main reasons why these rainwater harvesting programs have not been accepted by the local community are lack of knowledge that rainwater is drinkable, habituated to previous water sources and poor water quality. The role of the NGO sector and international agencies to promote rainwater harvesting has been very important in Nepal, especially for the construction of household level systems in the rural areas. However, there has been no substantial effort from their side when it comes to regular maintenance and on-site inspection of the systems that are already implemented.

Local capacity to repair and maintain the systems was lacking in several communities. The challenge is not just to build capacity but also to retain it. The role of local government bodies (LGB) and the private sector are very critical. LGB are the main local institutions with capacity to create an enabling framework for the successful implementation of the systems. LGB should provide refresher trainings on a regular basis, guidelines on how to operate and maintain the systems.

The involvement of national authorities is critical to build awareness on the advantages of this local technology and ensure the correct utilization of the systems that are already in operation. Government should review its working policy with respect to rainwater harvesting and formulate suitable strategies and financial incentives to consolidate rainwater harvesting use not only in Syangja and Tanahun but also in the other hilly areas of Nepal.

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This small study report on RWH …………….reflects the views of the study team (group of students from IOE, WRC, Pokhara and University of Cologne, Germany). It does

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BSP	Biogas Support Program
CBWSSSP	Community Based Water Supply and Sanitation Sector Project
CDR	Central Development Region
CGI	Corrugated Galvanized Iron
CCCR	Community Catchment Community Reservoir
CCCD	Common Catchment Common Distribution
DDC	District Development Committee
DFID UK	Department for International Development
DOLIDAR	Department of Local Infrastructure Development and Agricultural Roads
DWSS	Department of Water Supply and Sewerage
EDR	Eastern Development Region
HHs	Households
IDE	International Development Enterprise
ICCD	Individual Catchment Common Distribution
ICIR	Individual Catchment Individual Reservoir
HDPE	High Density Polyethylene
lcd	litres per capita per day
LGB	Local Government Bodies
MPPW	Ministry of Physical Planning and Works
NA	Not Available
NEWAH	Nepal Water for Health
NMIP	National Management and Information Project (NMIP)
NWCF	Nepal Water Conservation Foundation
RCC	Reinforced Concrete Cement
RWH	Rain Water Harvesting
RWSSSP	Rural Water Supply and Sanitation Support Program
RWSS	Rural Water Supply and Sanitation Project
RWSSFDB	Rural Water Supply and Sanitation Fund Development Board
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
WHO	World Health Organisation

1 BACKGROUND

1.1 Water supply

1.1.1 Definition

In the context of Nepal, the five river basins, all important tributaries of the River Ganges, contribute 71% of the annual flow during the dry season and 40% in the monsoon. The average annual rainfall of Nepal is 1600mm (Maharatta, 2008). Despite the fact that Nepal is one of the Asian countries with highest level of water resources, water crisis is a major issue both in terms of quantity and quality in many urban and rural areas.

The policies of the Government of Nepal aim to provide an adequate basic supply of safe drinking water to all its citizens. The methodologies of ensuring such access have been laid down in various government documents which guide the water supply development activities of government and NGOs. In some instances coverage is not possible or sustainable using groundwater or surface water as households may be situated at an elevation that makes the supply of water within a reasonable distance from the household impossible, or because the quality of the water is contaminated by chemicals such as arsenic like in Terai regions. In such instances, project authorities may consider supporting a domestic or institutional rainwater harvesting system.

1. 1.2 Sources

The Himalayan country of Nepal most often faces problems of water stresses at various parts of the country though it is considered to be one of the richest countries in the world in terms of water resources. The steep high hill slopes of the country of which more than 76.9% of the total landmass is covered by mountains and hills that make up the home for more than 52% (about 12 million) of the total population face most severe water related stress due to scarcity where as the 23% of the Terai belt face problems of flooding (CBS, 2001). The hilly area of Nepal suffers from alternating cycles of excess and scarcity of water that are acute in the communities dwelling on the mountains and hill tops. The major population in these areas has to walk down for hours to have access to drinking water. The common sources of water in such areas are mainly kuwa, spring (also tap water) or streams and ponds.

1.1.3 Existing systems

Due to high altitude and scattered community it has been difficult and relatively expensive to apply Gravity fed water supply system or motorized system to such water-stressed areas. For such areas Rain Water Harvesting Schemes may prove themselves as the best alternative for water supply system.

1.2 Water supply situation

1.2.1 National Coverage

According to the Department of Water Supply and Sewerage (DWSS), the quantitative water supply coverage of Nepal is 80%, but the actual functional coverage is 53%.

1.2.2 District Coverage

The coverage and gaps of the two districts visited are given in table 1.

Table 1 : Drinking water supply coverage and gaps of Syangja and Tanahun districts

	Existing			Gap	
District	**Total HHs**	**Benefitted from well managed drinking water system**		**Drinking Water**	
		HHs	**Percentage**	HHs	**Percentage**
Tanahun	64,181	51,027	79.50%	13,154	21%
Syangja	63,524	49,871	78.51%	13,653	21%

(**Source**: NMIP & DWSS, 2009)

1.3. Introduction to the site

1.3.1 Site Selection

The sites were selected after consulting with advisors from RWSSP-WN and IOE, WRC. Syangja and Tanahun are suitable places close from Pokhara where rainwater systems are already implemented by the Government of Finland as well as various agencies. Moreover, the rainfall pattern of both the districts even makes it exciting to carry out this study. The other important factor is that both the districts have 21 % coverage gap of drinking water supply. Rural areas are the most affected ones.

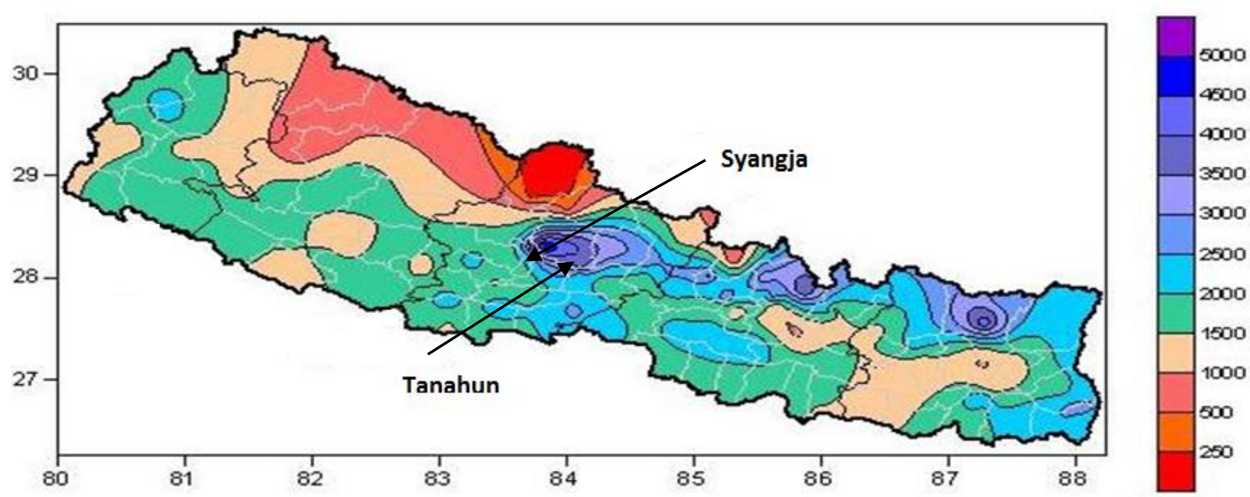


Figure 1: Average annual rainfall of Nepal and sites under our study (Source: Maharatta, 2008)

Rainfall data of Nepal (Maharatta, 2008)

- ❖ Maximum in Kaski district: 5000 mm
- ❖ Minimum Himalayan range: 250 mm
- ❖ Half of the country: 1,500 to 2,000 mm
- ❖ Average rainfall: 1600mm.
- ❖ Rainfall concentrated within one rainy season: 80% from June to September**.**

And the rainfall data of nearest stations were Ridi Bazar for sites in Syangja under our study. For Tanahun district, Khairenitar was chosen as the nearest station.

Table 2: Precipitation Record at the Nearest Rain Gauge Station at Ridi Bazar, Gulmi

Month 2003	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Average**
Rainfall(mm)	29	0	9	2	184	618	142	452	219	0	0	0	137.92

Source: Rain gauge station, Ridi Bazaar, Gulmi, 2003.

Similarly, the rainfall data collected in 2000 at Khairenitar station of Tanahun was annually 2439 mm maximum in 24 hours and monthly 118 mm in the month of June (CBS, 2000).

1.4 Objectives of the study

This study aims to evaluate the social acceptability of rainwater harvesting for human consumption and for livelihood improvement in rural areas of Tanahun and Syangja districts. The specific objectives of the study are summarized below:

- To analyze key factors or causes/issues associated with the social acceptability of Rain Water Harvesting schemes implemented in Tanahun and Syangja districts especially concerned with use of water for drinking purpose
- To assess the appropriateness of the technical design, construction quality and operation and maintenance of the RWH schemes and its impact on water quality, current water handling practices and functional status of the system
- To gain knowledge and skill on design process and implementation of RWH schemes practiced in Nepal

Use the findings to make recommendations to implementing agencies and policy makes about the use of rainwater harvesting in rural areas of Nepal.

1.5 Methodology

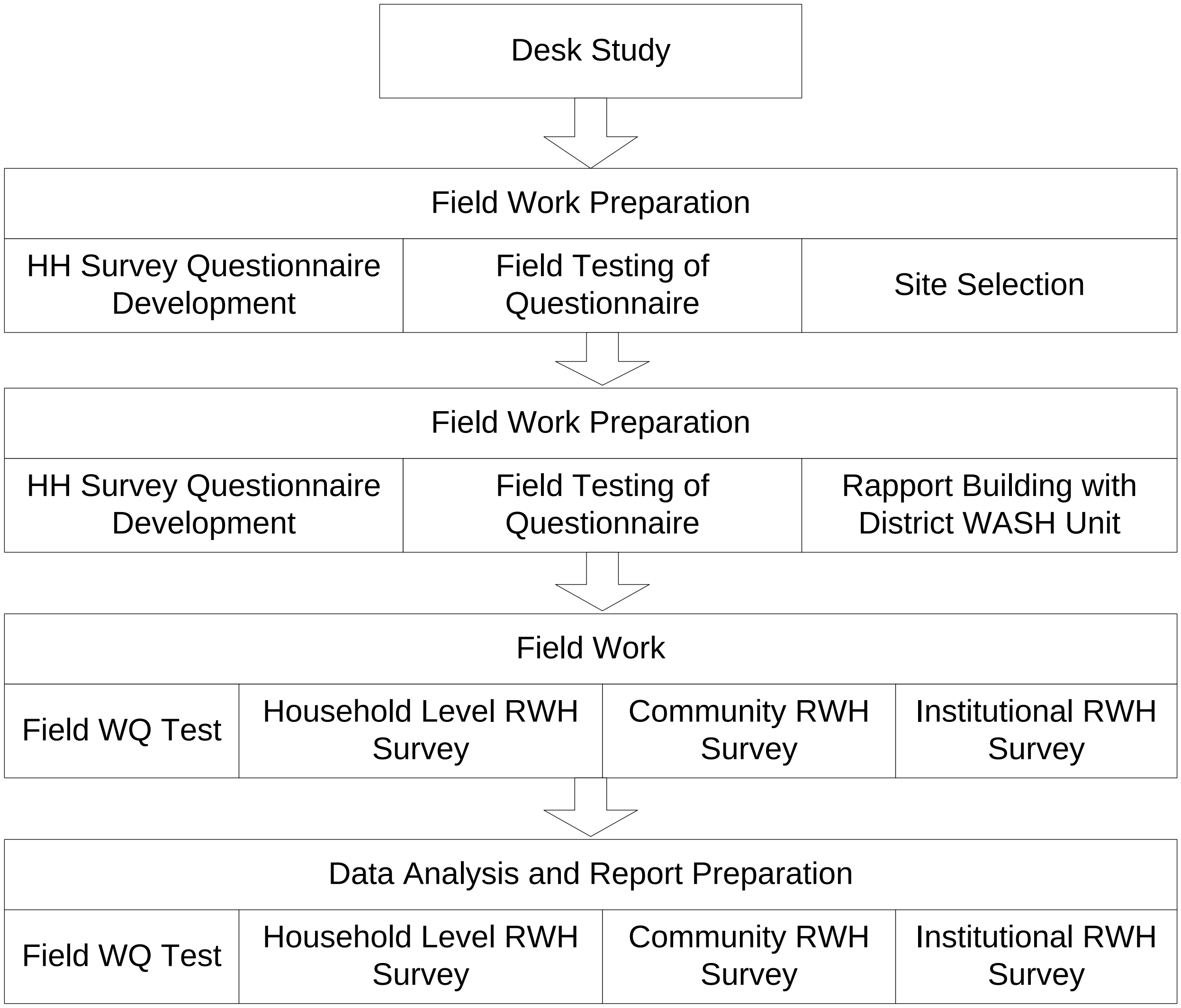


Figure 2 : Flowchart of overall project work

1.5.1 Research methodology

Both qualitative and quantitative research techniques were used to collect data on the use, and operation and maintenance of RWH systems. First, review of secondary data such as various reports, papers, guidelines and policies were done to review experiences from projects that has already been implemented by various agencies in project districts. Then a technical questionnaire was prepared to collect information about the main features of the RWH system, social views, water use and handling practices, water quality and operation and maintenance practices. After collecting the data from the interviewees, observations were made to cross-check and complement the information gathered. Under observation, water use and handling practices, operation and maintenance or cleanliness status around the jar and purpose of water being used were focused. Finally, water quality testing to monitor water quality of harvested rainwater. Water samples were tested only for one parameter coliform using P/A vial.

1.5.2 Field testing of the questionnaire

The prepared questionnaire was first tested on Deurali VDC Ward no. 7 in Kaski district for 10 houses. The field test provided an idea on how to conduct an actual questionnaire survey and abundance of the questions, whether they meet the objectives of our research study. Thus, the final questionnaire was modified and corrected based on the field test.

1.5.3 Sample Selection

Fifty households were selected from each district for the purpose of data collection. The selection of visiting households, institutions or community based RWH systems were made with the help of district WASH unit.

Table 3. Project sites for field visit and sample size

District	VDC	No. of tanks	Completion year	Organization involved
Syangja	Chandivanjyang	19 HHs 2 Ins. 20 Comm.	2050-2067	UNDP, BSP-Nepal, NEWAH
Syangja	Alamdevi	9 HHs 1 Comm.	2062-2067	UNDP, BSP-Nepal, NEWAH
Tanahun	Sabung Bhagwatipur	33 HHs 3 Ins. 14 Comm.	2060-2066	FINNIDA, DWASH
Total	3	101		

1.5.4 Water quality testing

20 samples were taken from houses, institutions or community based tanks which where water seemed microbiologically contaminated and tested for water quality. Only one parameter i.e. Coliform was tested. The sample was collected in a P/A vial that contained H_2S to feed coli form bacteria and inhibit the growth of the rest of bacteria. The stored water sample is kept in the bottle for 18 to 24 hours. After this period, colonies of coliform develop in black color.

1.5.5 Data analysis

Survey data was analyzed using SPSS 11.5. Basic statistical tools including frequency tables, percentages, cross tabulations and measures of dispersion were used to analyze survey data. When considered relevant, the different communities under study were compared for the main indicators.

2 DESK STUDY

2.1 Definition of RWH

‘Rainwater harvesting’ is a widely used term covering all those techniques whereby rain is intercepted and used ‘close’ to where it first reaches the earth. The term has been applied to arrangements to cause rainfall to percolate the ground rather than run off its surface, to forms of flood control, to the construction of small reservoirs to capture run-off water so that it can be used for cattle or micro-irrigation and to the collection of run-off from roofs and other impermeable surfaces. Thus, *roof*water harvesting is a subset of *rain*water harvesting, albeit an important one.

Rainwater harvesting (RWH) primarily consists of the collection, storage and subsequent use of captured rainwater as either the principal or as a supplementary source of water. Both potable and non-potable applications are possible (Fewkes, 2006). Examples exist of systems that provide water for domestic, commercial, institutional and industrial purposes as well as agriculture, livestock, groundwater recharge, flood control, process water and as an emergency supply for fire-fighting (Gould & Nissen-Peterson, 1999; Konig, 2001; Datar, 2006). The concept of RWH is both simple and ancient and systems can vary from small and basic, such as the attachment of a water butt to a rainwater downspout, to large and complex, such as those that collect water from many hectares and serve large numbers of people (Leggett *et al*, 2001a). Before the latter half of the twentieth century, RWH systems were used predominantly in areas lacking alternative forms of water supply, such as coral islands (Krishna, 1989) and remote, arid locations lacking suitable surface or groundwater resources (Perrens, 1975). The fundamental processes involved in rainwater harvesting are demonstrated in figure 3.

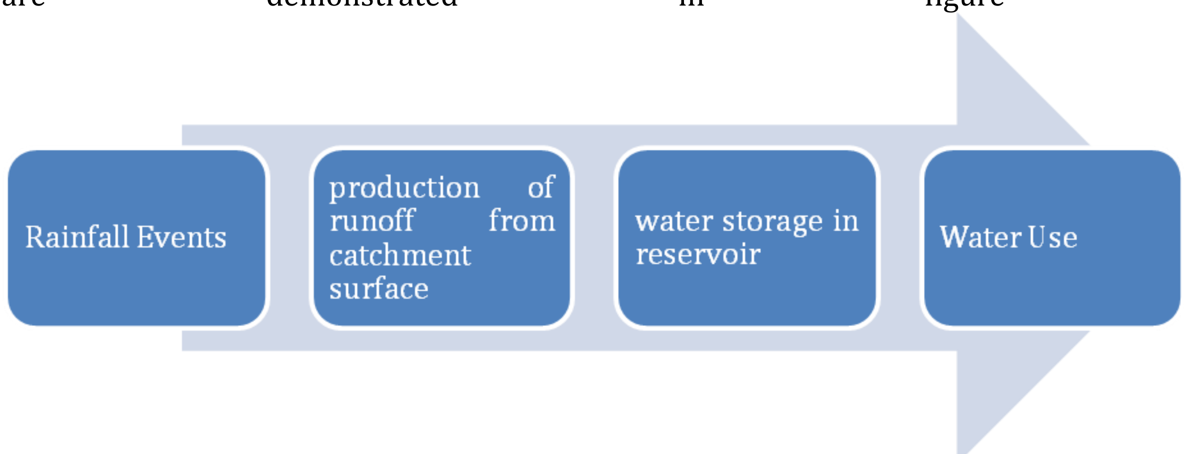


Figure 3 Fundamental rainwater harvesting processes

All rainwater harvesting systems share a number of common components (Gould & Nissen-Peterson, 1999):

1. A catchment surface from which runoff is collected, e.g. a roof surface.
2. A system for transporting water from the catchment surface to a storage reservoir.
3. A reservoir where water is stored until needed (usually known as Jar)
4. A device for extracting water from the reservoir.

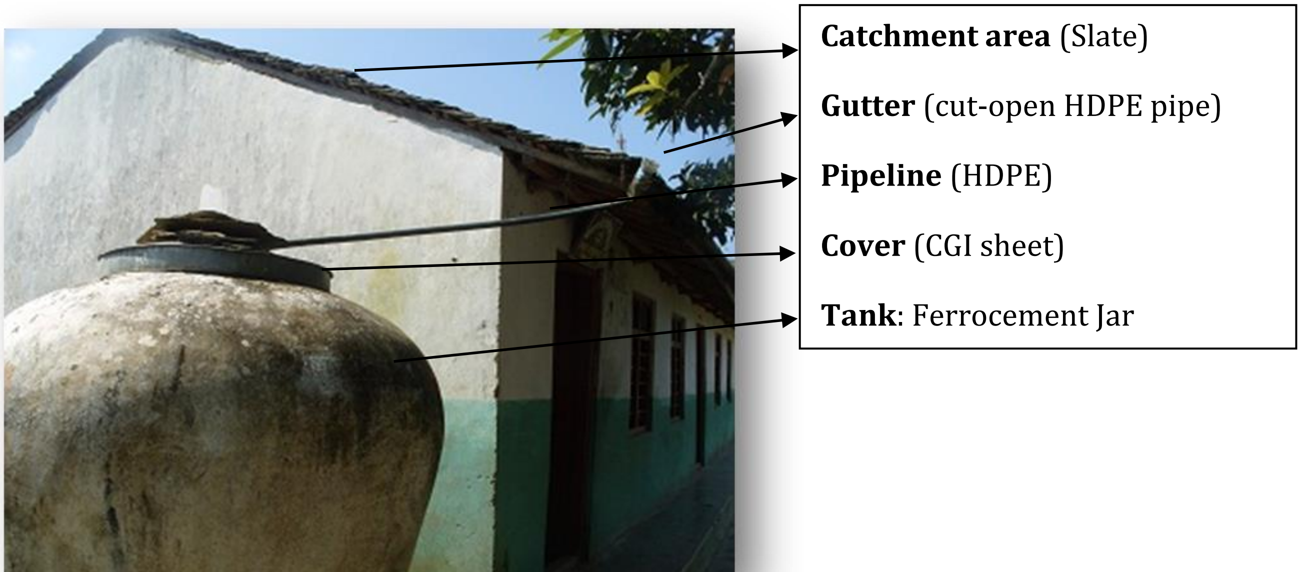


Figure 4 : Picture of a simple domestic RWH system

Rooftop rainwater harvesting consists of collecting rainwater runoff generated from rooftops and storing it for later use. The essential elements of a roof water harvesting system, as shown in Figure 1.1, are a suitable roof, a water store and a means of leading run-off flow from the first to the second. In addition, some RWH systems have other components to make them easier to manage or to improve the quality of the water.

Rainwater harvesting is one of the suitable solutions for households located higher up the hill sides where gravity flow systems are not feasible and motorized pumps are either too expensive or impractical due to lack of electricity. It is estimated that more than 160 communities use rainwater to meet their daily drinking needs in rural Nepal (Pretus, 2009). Rainwater harvesting practice is age-old in Nepal. The collection of rainwater in ponds and the collection of rainwater in improvised containers have traditionally been practiced during the rainy season. In recent years, groundwater recharge and rooftop rainwater collection are also gaining popularity in both rural and urban areas. Systematic rooftop rainwater harvesting was firstly promoted in the early 1960s in a hospital of Pokhara (Pretus, 2009). Other similar initiatives from DWSS and the Peace Corps date back to 1980s (Dixit, 2002). In 1996 a large program supported by the Government of Finland (earlier FINNIDA) built a large number of household level rainwater harvesting systems in Daugha VDC initially and soon after, in other villages mostly in the Lumbini zone.

In recent years collection of rainwater for domestic use has been promoted in Nepal by various agencies. The Department for Water Supply and Sewerage has produced some technical guidance on application and construction of rainwater systems, and several other sector agencies and NGO partners have followed suit (RWSSP earlier Finnida, Helvetas, NEWAH, Rural Water Supply and Sanitation Fund Development Board, Biogas Support Programme and the NGO Forum for Urban Water Supply and Sanitation). In the process, experience has been gained in suitable technical, social and financial aspects of rainwater harvesting. The Department of Urban Development and Construction (DUDBC) has been working since early 2006 on promotion of rainwater harvesting in the urban areas. This effort is supported by UN-Habitat, NGO Forum for Urban Water Supply and Sanitation, ENPHO, Lumanti, etc. DUDBC has just produced a final draft of the RWH Guidelines which are to be used to guide municipal authorities and those engaged in the building trade. The focus of the guidelines is on collecting safe water for domestic purposes, conservation of water in the urban setting and management of drainage and flooding.

Three different types of rooftop rainwater harvesting are found in the country: community systems that serve the whole community and are managed by a users committee, institutional systems that serve a limited group of beneficiaries and are usually managed by an assigned person from that institution under institutional management system, and household level systems that serve one family and are privately managed.

Even if most of the rain is concentrated in four months during the monsoon season and few additional showers throughout the year, rainwater can improve substantially the water security of rural and urban communities of Nepal. Different local conditions determine the need for rainwater harvesting use and storage (*see* tab 2):

Figure 5 : Main reasons to build rainwater harvesting systems in Nepal

- ***No other source of water in the vicinity***
- ***Seasonal scarcity***
- ***Unreliable water supply***
- ***Very scattered or isolated household***
- ***Pollution of existing water sources (e.g. arsenic and iron)***
- ***Conservation of depleting ground water resources***
- ***Reduction of urban run-off***
- ***Pollution control***

2.2 Types and technologies of domestic RWH system

There are two types of rainwater harvesting system: Centralized system where the rainwater collection and storage is centralized and then arranged to distribute through piped system. It needs a large catchments area, storage tank and some treatment system depending on the nature of catchments area. The other type is individual system where rainwater is collected and stored for every household separately and used. The individual rainwater harvesting is more popular, cost effective and reliable in the rural water supply system (RWSSFDB, 2006). Currently it is estimated that over 11000 systems are in use in the hill districts of Nepal (Pretus, 2009). There are mainly two types of domestic water supply system:

a) Individual Catchment Individual Reservoir (ICIR)
b) Common Catchment Common Reservoir (CCCR)

In ICIR system, rainwater is collected and stored for every household separately and used. The individual rainwater harvesting is more popular, cost effective and reliable in the rural water supply system.

In CCCR system, the rainwater collection and storage is centralized and then arranged to distribute. It needs a large catchments area, storage tank and some treatment system depending on the nature of catchments area. The catchment may be of only one (ICCD) or many catchments (CCCD), from where the rain water is collected in one reservoir and distributed to users.

2.3 Implementation Status of RWH in Rural Areas of Nepal and in Project Districts

Nepal Interim Plan (2007/08-2009/10) has also recognized RWH as a key strategy for the development and expansion of water supply and sanitation in the areas where there is little source of surface / underground water.

The Finnish Government supported Rural Water Supply and Sanitation Support Program (RWSSSP) was implemented in three phases from 1990 to 2005, expanding its activities from six to eight districts in the Western Development Region. RWSSSP imported the rainwater harvesting (RWH) idea in its Phase II following a study visit to Thailand, and pilots were constructed. In the Phase III the RWH systems were introduced mainly to the hill top areas in Gulmi, Palpa, Tanahun, Parbat and Arghakhanchi Districts. In this phase the demand for the RWH systems increased rapidly. Eventually there were 108 RWH schemes within which the total number of 9,714 RWH systems was constructed. In total 42,332 people, mostly living in marginalized poor communities in the hill tops, benefited from RWH systems (Malla et. al, 2009). UNDP, BSP-Nepal, RWSSP-WN, DWASH are the major organizations involved in the construction of the implemented RWH system in the project districts.

2.3.1 Implementing Agencies, Completed Projects and Ongoing Projects

In rural Nepal rainwater harvesting systems are mostly found in the hilly areas. In the last 10 years, more than 11,000 rainwater harvesting tanks have been installed by various sector agencies in these areas (*see* tab. 4). The main organizations promoting this technology include Government of Finland, Helvetas and more recently BSP. Interest is also growing among other agencies such as NEWAH, PLAN and Rural Water Supply and Sanitation Fund Development Board. Rainwater harvesting programs are found in more than 160 communities and at least in 20 districts of the country. The largest number of tanks is found in the Western Development Region, particularly in Palpa, Arghankhanchi and Gulmi. More recently, RWH schemes are also being built in Dailekh, Doti and Makwanpur (Pretus, 2009).

Table 4 : Completed RWH systems in the rural areas of Nepal in 2008

Agency (Program)	Year	Number of Communities	Number of Tanks	Type of Tank	Geographical Area
GON/DWSS/DWSSDOs	1984-2003	NA	58	Community tanks (Ferro, 5-25 m^3 ; Stone Masonry 40-115 m^3 ; RCC 500 m^3	Lamjung, Kavre, Gorkha, Tanahun, Arghakhachi, Gulmi, Lalitpur, Parbat, Syangja, Baglung, Dhankuta, Ilam, Palpa, Pyuthan, Dang
Government of Finland (RWSSP)	1996-2008	109	9741	Ferro cement jar - 6.5 m^3 (initially 2m^3)	Lumbini zone (Gulmi, Palpa, Arghakhanchi, etc)
Helvestas (WARM-P and RAIN Foundation-pilot)	2003-2008	18	719	Ferro cement jar - 6.5 m^3	Doti, Dailekh, Kaski, Syangja, Tanahun
NEWAH (DFID supported)	2002-2003	2	53	2 m3 / 10 m3 school	Dhankuta and Tanahun
NEWAH (WAN, DFID, RAIN Foundation supported)	2002-2004	10 schools	10	Masonry - 16-25 m^3 , etc	Kaski, Syangja, Tanahun, Dhankuta
NEWAH (SIMAVI supported)	2007	4	156	Ferro cement jar 2-4-6 m^3	EDR
NEWAH (Oxfarm supported)	2008	4	55	Ferro cement jar - 6.5 m^3	FWDR
BSP (RAIN Foundation-pilot)	2006	6	6	Stone Masonry 20-60 m^3	Kaski (3), Syangja (2), Tanahun (1)
BSP (Ashen Award-Biogas plant attached)	2006-2008	NA	300	Stone Masonry 7.5 m^3	15 districts (EDR, WDR, and CDR)
PLAN	2003-2007	8	283	Ferro cement jar - 6.5 m^3 (initially 2m^3)	Makawanpur
DOLIDAR	2007-2008	NA	10	NA	Lamgunj (5), etc.
TOTAL		164	11,391		

(Source: Pretus, 2009)

The number of RWH systems is likely to increase substantially in the near future. In Nepal the most accessible areas have already received improved water supply services while the number of unserved is still high among potential users of rainwater in remote and water scarce areas. Agencies of the sector plan to build rainwater harvesting systems in more than 40 rural communities of Nepal (*see* tab. 5) to provide safe drinking water and enhance the livelihood conditions of the beneficiaries (Pretus, 2009).

Table 5 : Ongoing RWH projects in rural areas of Nepal in 2008

Agency	Programmme	Number of Communities	Number of Tanks	Type of Tank	Geographical Area
Gvernment of Finland	Rural Village Water Resources Managemennt	2	235	Ferrocement jar (6.5 m^3)	Dailekh and Doti
Helvestas	Water Resources Management Program(WARM-P)	NA	NA	Ferrocement jar (6.5 m^3)	Dailekh and Doti
FB	RWSSFD6P-II/World Bank	4	400	Ferrocement jar (2.4-6 m^3)	Gulmi (2), Palpa (1), Arghakhachi (1)
BSP	HIER2	6	NA		Bajahng, Kaski, Parbat and Tanahun
BSP	PLAN 50	5	65		
BSP	Ashen Award- Bio gas attached	NA	100	Stone masonry (7.5 m^3)	
PLAN	HIER2	12	400	Ferrocement jar (6.5 m^3)	Makawanpur
NEWAH	SIMAVI supported	8	218		Baglung, Parbat and Gulmi
ADB-DWSS	CBWSSP	5	NA		Dadeldhura, Dailekh, Gulmi
TOTAL		42	1,435		

(Source: Pretus, 2009)

2.3.2 Main factors determining the feasibility of RWH systems in rural Nepal

To ensure good utilization and conservation of water resources, the Government of Nepal has prepared a policy on rainwater harvesting in 2009 to promote suitable developments in rainwater harvesting for human consumption and domestic use, and facilitate guidance and capacity building.

The policy aims to:

• Foster optimum utilization of rainwater to cater for the needs of rural and urban households that face shortages of water for daily uses

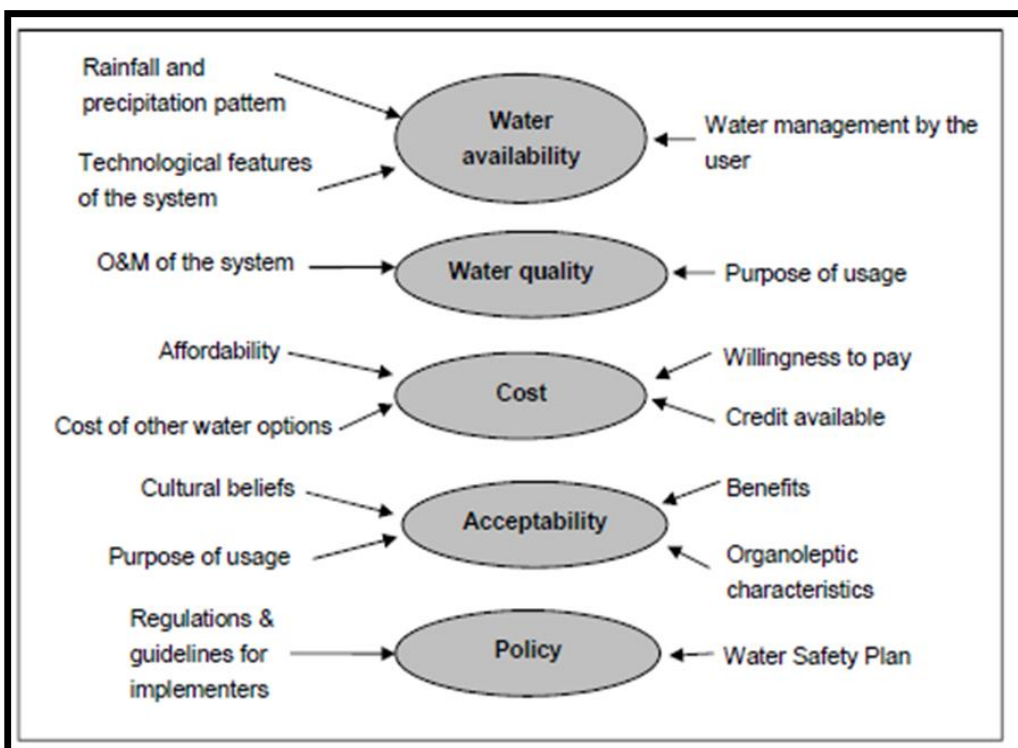
• Stimulate development of technical and financial solutions to effective rainwater harvesting in domestic and institutional settings;

• Provide an enabling framework for local government and NGOs to encourage and facilitate application of rainwater harvesting in all suitable situations.

Thus, the MPPW, with its departments; and in collaboration with the MLG, will promote the application of rainwater harvesting through support for research, piloting and evaluation of all relevant aspects of the rainwater harvesting chain. To that end the Ministry will encourage its departments, NGOs, universities and the private sector to develop and test suitable technologies and approaches.

A series of interlinked factors like availability of water, social acceptability, installation cost of the system, water quality and government policies, etc. determine if RWH is viable in rural areas (*see* Fig. 6).

Figure 6 : Main factors determining the feasibility of RWH (Source: Pretus, 2009)



3 ANALYSIS AND FINDINGS PRESENTATION

In total, three sets of questionnaires were developed for community reservoir users, institutional users and household users. So the findings from all three sets of questionnaires are presented in combined form below.

3.1 General

Out of 96 individual households under our study, the benefitted population was 680. The literacy rate was found to be 85.5% which is very high compared to the national literacy rate. The major castes in the community under our survey were Brahmin, Chhetri, Magar, Newar and Dalits. The major occupations of the household owners are presented in table below.

Table 6 : Occupation of household owners

Occupation	**No of HHs**	**Percentage**
Agriculture	49	51.04%
Business	5	5.21%
Ex-army/Pensioner	14	14.58%
Teaching	3	3.13%
Service	17	17.71%
Household Works	7	7.29%
Student	1	1.04%
TOTAL	**96**	**100.00**

3.2 Water Use

3.2.1 Water Use before implementation of RWH Jar construction

The major source of water in Syangja and Tanahun districts are spring/Kuwa. Few households in Syangja also used stream as the source of water. The quality of water from the above sources was generally fair. The average no of trips before RWH Jar construction was found to be 6.11 GAGRIS of average capacity 20 liter. From our study we found that 3.96% of the households required less than 15 minutes, 36.63% households required 15 to 45 minutes and 59.41% households required more than 45 minutes to fetch one round trip of water. More than 80% of the interviewees said that the main difficulties to fetch water from the above sources were long queue and disputes. Few interviewees also mentioned that forest crossing, landslides and steep hills were amongst other difficulties.

Table 7 : Time required for each HHs to fetch water one round trip

Time Required	No of HHs	% of HHs
<15 minute	4	3.96
15-45 minute	37	36.63
>45 minute	60	59.41

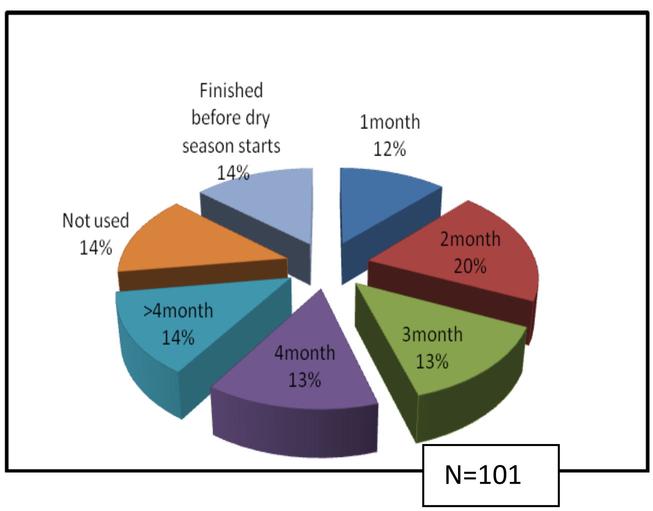
Most of the sources were reliable for the whole year, some sources were reliable for 6 to 9 months and very few sources for less than 6 months but due to less quantity of water during the dry season there was long queue and disputes. The fetched water was used for various purposes like drinking, cooking etc. but not for bathing and washing clothes.

3.2.2 Water Use after implementation of RWH Jar construction

Even after the implementation of RWH system, almost all the households are still fetching water from the previous sources. The average no of trips from previous sources decreased to 3.39 GAGRIS of average capacity 20 liter after RWH Jar construction. In Syangja district, water fetched from other sources was used mostly for drinking and cooking purpose by most of the households, few households were using for other purposes also. In Tanahun district, the fetched water and jar water was used randomly for various purposes.

3.2.3 Use of harvested Rainwater

Water use greatly varies from community to community depending on water availability. During the dry season rainwater cannot be employed for all uses, so the most demanding uses need to be prioritized. The principle fit for purpose water use is usually kept in mind while managing rainwater in the dry season. Drinking and cooking uses demand high quality water but at the same time they demand low volume of water compared to other uses. Thus, the volume of stored rainwater should be sufficient to meet those uses requiring high quality.



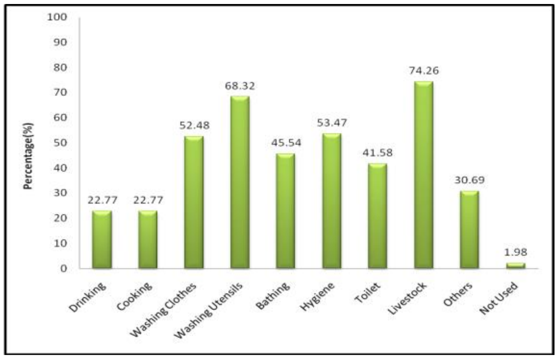


Figure 7. Different uses of harvested rainwater

According to our field survey, very few households (about 22.77%) are using rainwater for drinking and cooking purpose. More households are using harvested rainwater for other different purposes like livestock, washing utensils, bathing, washing clothes and flushing of the latrine. Moreover none of the household in Syangja district is using rainwater for drinking and cooking purpose. Among the community users none of the users of Syangja use collected rainwater for drinking purpose while all the community users of Tanahun district do. Two schools of Syangja and two of Tanahun district uses rainwater for drinking purpose and a school in Tanahun use it only for flushing toilets.

N=101

Generally the dry period lasts for about 5 months. According to the users, only 14% of the households use rainwater for more than 4 months, another 14% do not use the rainwater and remaining 72% households have insufficient jar water (see Figure 8). 14% of the users have no water remain to be used in dry season mainly because of lack of proper water handling practice. Most of users in Tanahun district continuously use the collected rainwater from the time it is available until it is finished.

In case of community reservoir under our study, the two communities' harvested rainwater can be used for only two months in both districts and one community's harvested rainwater can be used for only 12 days in Aalamdevi VDC of Syangja district.

Figure 8 : Period of harvested rainwater use

3.3 Technical

In our study area, a very similar type of technology is used for the collection of rainwater for various purposes. The systems normally consist of a catchment area, a reservoir, gutters and pipeline and a first flush device that needs to be operated manually. The rainwater falling in the catchment (commonly GI sheet) is collected with the help of gutter and diverted to the reservoir through a systematic pipeline. Both ICIR and CCCR system of collection were found in use in the areas. One community harvesting in Syangja and one in Tanahun district collects water from roof of 3 catchment areas (CCCD system) and remaining community harvesting from a single catchment (ICCD system).

3.3.1 Catchment, Gutters and Pipelines

In rural Nepal people are increasingly using Corrugated Galvanized Iron (CGI) sheets to build the roof of their house. One of the advantages of this material is its high run off coefficient. Furthermore, the smooth surface of CGI sheet and the high temperatures reached in this type of surface help to sterilize bacteria and produce very good water. Hence, most agencies are supporting the use of CGI sheet roof to those households having thatched roof (Pretus, 2009). In most privately owned rainwater harvesting systems the roof of the house is used as the catchments area. However, many households requiring a new catchment build a separate shed to fix the gutter. Slate roofs are also used as the catchment area of the RWH system by few households. Most of the individual HHs and all institutions (more than 80%) use GI sheet roof as the catchment area, some HHs in Tanahun district (about 16%) also use slate roof and a house in Syangja district use RCC roof as the catchment area.

N= 66

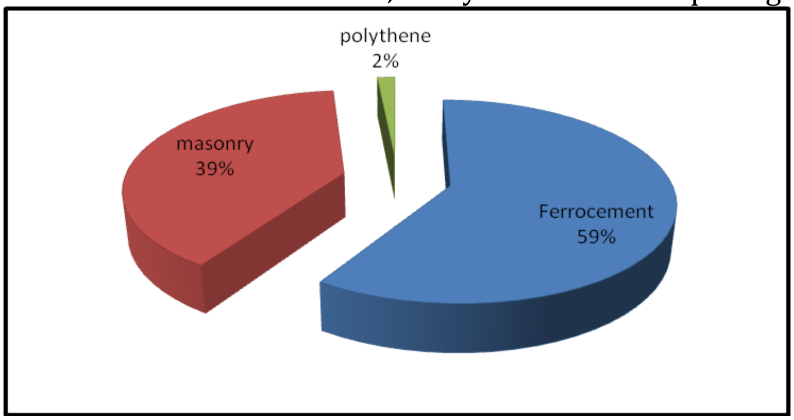


Figure 9 : Catchment material for individual HHs and institutions

The size and slope of the gutter and pipe delivering water into the tank influences significantly the amount of water totally collected. Increasing the slope towards the storage tanks from 1:100 to 3:100 increases the potential water flow by 10-20% (Worm & Hattum, 2006). The gutters and pipeline in the study area is made of HDPE pipe which diverts water into the reservoir.

3.3.2 Jars

For the collection of rain water, almost all individual users of Tanahun district use ferrocement jars of capacity 2 m^3 and two schools ferrocement jars of 6 m^3. The community harvesting jars are also ferrocement jars of capacity 10 m^3 and 20 m^3. In Syangja districts most of the individual HHs use masonry jars and some use ferrocement and polythene jars. The school use ferrocement jars and the community harvesting jars are masonry of capacity 125 m^3, 25 m^3 and 20 m^3. The HHs jars are of wide variety of capacity.

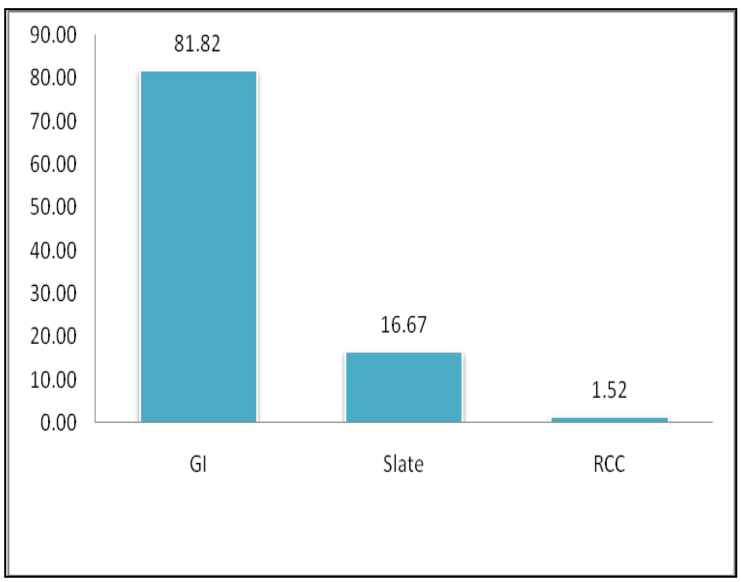


Figure 10: Material composition of Jar for individual HH and institutions

3.3.3 First Flush diversion and Filter system

From the field survey it is found that 77.27 % of the total HHs and institutions are practicing the 1st flushing system and remaining 22.73 % do not use it. According to the interviewee most of the HHs flushes the rain water for about 15-30 minutes and some

N=101

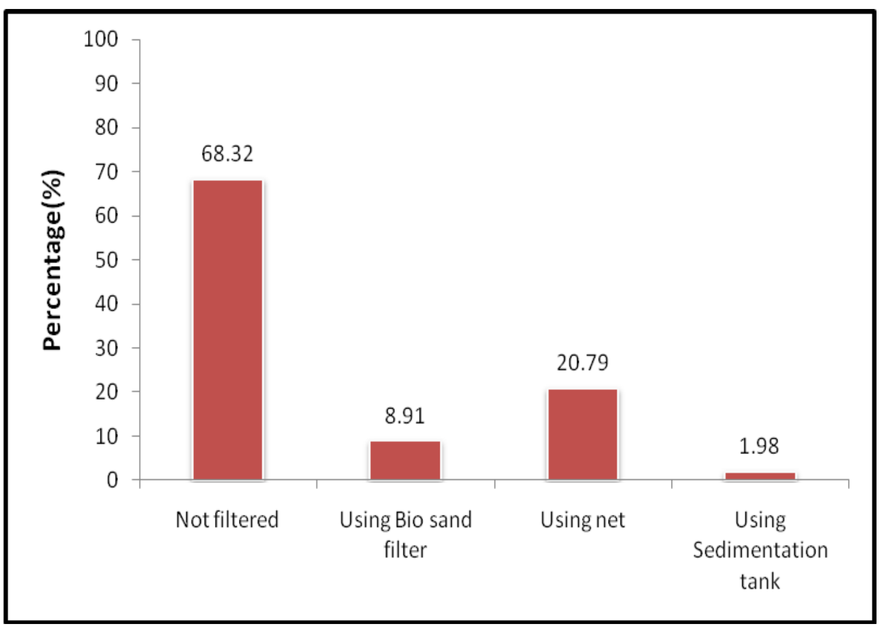
the water becomes clear.

One of the most promising difficulties with the manually operated 1st flush system is that during the rain there would be no one in the house to flush the first rain. Thus the effectiveness of first flush system is decreased. The community users of Syangja do not practice 1st flushing system while the community users of Tanahun use it. Rainwater is generally collected in the jar directly (1st flushed) in the collection jars. Some of the users use net to prevent entrance of foreign particles like leaves. Most of the net provided during construction of jar in Tanahun district has been damaged and very few have replaced it. Some users in Syangja district also use bio-sand filter and sedimentation tank for filtration of water before collecting it (see Figure 10).

Figure 11: Filtration procedure before entering the tank

3.4 Water Quality

Rainwater has been promoted as safe drinking water. In theory rainwater from a well-maintained RWH system should be able to meet the highest water quality standards. Due to the low mineral content of the water, it has a long storage life in the RWH jar. Water can also improve in quality if allowed to stay for some time inside the jar before use. In practice the water is not always free from bacterial contamination. Fecal coli form bacteria may enter the RWH jar from the roof, gutters, open jars, and by people being in contact with the structures without considering the hygienic aspects of the interaction. Rainwater can become contaminated by anything that it comes in contact with, whether before it enters the RWH jar, while in the RWH jar, or later on, when taken out from the RWH jar (Rautanen, 2003).



3.4.1Physial and Chemical parameters

During our study in Syangja and Tanahun districts, different observations were made to study physical parameters like taste and odor and chemical parameters like temperature and turbidity of harvested water. According to the users, about 79.21% stated that the jar water is clean. It is found that due to lack of proper cleanliness, improper cover etc. harvested water may be contaminated. In one community of Syangja different types of dead animals (rats, small insects) were also found. About 5.94% users stated that the harvested water has taste. Among them 2 households have slate roof, so the jar water tasted like smoke while the others stated it as *khallo*. About 93.07% of the users found it as odorless whereas the remaining 6.93% described its odor as smoky & offensive. One of the user said that the jar water smells like cement and concrete. In some household (about 8.91%), the jar water contains algae and microbiologically contaminated, as the jar were not properly covered. But in most of the houses, where the jar were frequently cleaned & properly covered algae was absent. Rainwater collected from rooftops usually contains small fraction of suspended solids which makes rainwater slightly turbid. In 95.05% of houses the jar water was not turbid.

Table 8: Water Quality summary of RWH (N=101)

Parameters	Yes	No
Taste	5.94	94.06
Odor	6.93	93.07
Turbidity	4.95	95.05
Hotness	2.97	97.03
Microbial and algae	8.91	91.09

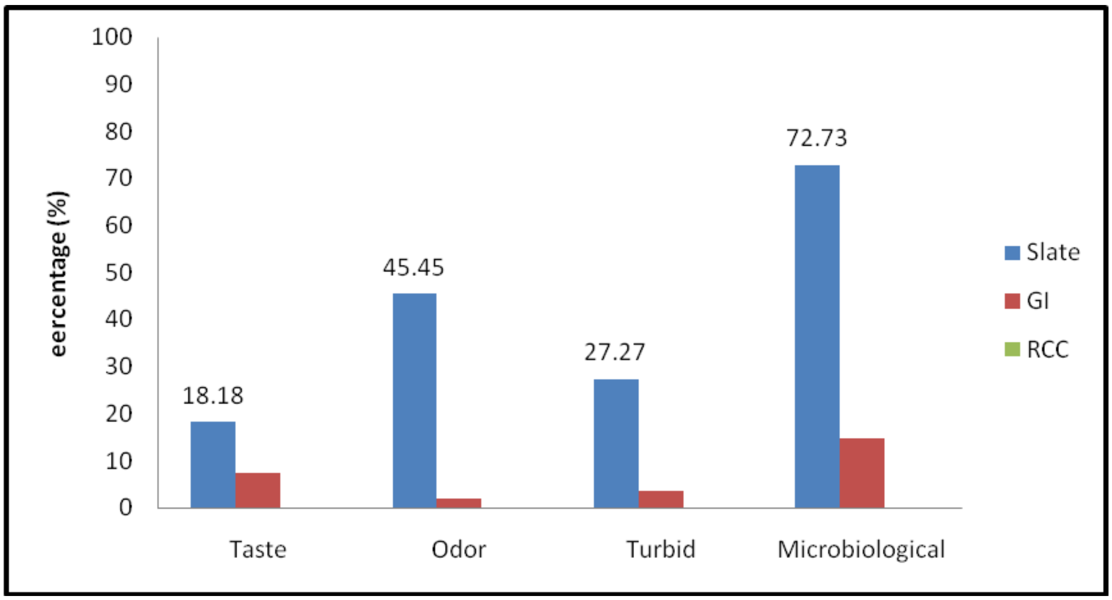


Figure 12 : Water quality according to catchment material for HHs and Institutions

3.4.2 Microbiological parameters

Main vectors of microbiological contamination include birds, mice, cats and lizards which may frequent the catchment area and the branches overhanging the system. Presence of coliform, were tested by P/A vial. Among the 101 households, 20 samples were taken randomly, 10 from Syangja district & 10 from Tanahun. According to the manual guideline, the vial was filled with water sample upto the arrow mark as indicated in the vial. After 48 hours, the color of the vial was observed. Detection of black color indicates the presence of fecal pollution. The presence of coli form were tested in different VDCs. 65% of result were positive i.e. 13 samples out of 20 samples (5 of Syangja and 8 of Tanahun) contains coliform. In one of the school of Sabung Bhagwatipur, where the rain water is used for drinking purpose coliform was found whereas in one of the house of Chandibhanjyang where the jar was installed in 2050 the coli form was absent.

Table 9 : Result of P/A vial test

District	No of Samples Taken	Coliform Present	Coliform Absent
Syangja	10	5	5
Tanahun	10	8	2

3.4.3 Home treatment practice

Rainwater is usually of very high quality. The chances of contamination increase when rainwater lands on the catchment area due to presence of leaves, dust particles or microbes or due to rusting of catchment materials. Quality of rainwater should be safe for human consumption. Purification needs to be done properly to ensure good quality water. It is necessary to follow a series of good practices to minimize the chances of water contamination. There are different methods of purification such as chlorination, filtration, boiling, SODIS etc.

In Syangja district, only schools use the harvested rainwater for drinking but they didn't use any treatment procedure before drinking the rainwater.

In Tanahun, all the community reservoir users use the harvested rainwater for drinking. 27.27% of the households and a school also use rainwater for drinking purpose and they too didn't use any treatment procedure However, only 3.7% of the HHs under our study said they boiled rainwater before drinking.

3.5 Operation and Maintenance

Operation and maintenance practices adopted are one of the key factors for sustainability and better performance of RWH Schemes. In the areas under our study, there are no maintenance workers for the purpose of maintenance of the RWH system. All the users themselves maintain the system. There is no operation and maintenance fund collected in the community of both districts.

3.5.1 Physical condition of the RWH system

In Tanahun district, operation and maintenance practice is rarely observed. Most of the jars are kept as it is after construction. Only few of the users have well maintained the jars and painted it. Some jars presented external cracks and leakage due to lack of maintenance. Some users tried to repair the leakage from the jar but were unsuccessful due to lack of expertise. Few jars were covered with broken lids. Few of the HHs jars in Chyachul, Tallothar (in Dalit community) are in critical condition and even have no cover. According to the interviewee, the community jar is cleaned and maintained by few of the users. In Syangja district, most of the jars are well maintained by the users themselves.

Table 10 : Physical condition of RWH system (N=66)

Observation	fair	moderate	poor	structural damage	corroded
Present condition of roof and roofing material	86.36	0.00	0.00	3.03	10.61
Present condition of gutter	84.85	1.52	7.58	6.06	NA
Present condition of pipeline	81.82	0.00	4.55	13.64	NA
Present condition of first flush	74.24	0.00	4.55	21.21	NA

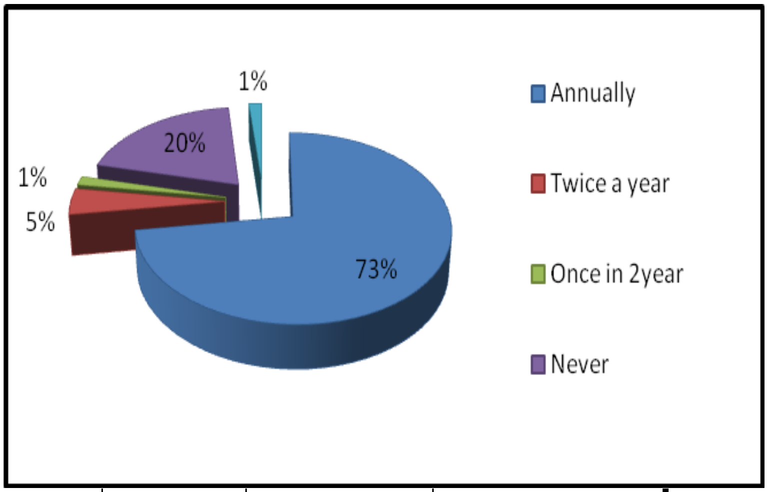


Figure 13: Cleaning of RWH jars for Individual HHs and Institutions

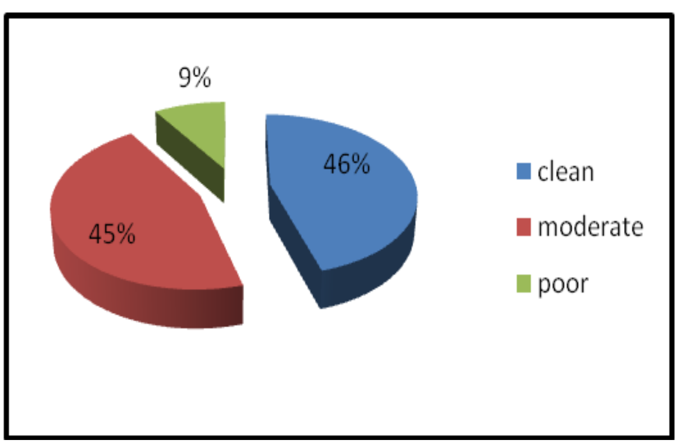
3.5.2 Purification practices of the jar and other O&M practices

Cleanliness of the RWH system is one of the major factors that affect the quality of rainwater collected. Almost 80% of the individual HHs and institutions clean the RWH Jars. Most of the users clean the jar annually after the jar is emptied and before collection of rainwater (fig 13). The method of cleaning is almost the same. One of the members of the family enters the jar and cleans it by scrubbing with either brush or clothes or jute bags. The jar is then flushed with water from outlet valve. Some of the users clean the jar twice a year and some once in two years. About 20% of the users haven't cleaned the jar after its construction. Lack of proper cleanliness also has become a main reason of not using rainwater for drinking purpose.

Along with the jars, cleanliness of the catchment area should also be insured. Clean catchment area provides relatively clean water. Only about 45% of the individual and institutional users clean the catchment area. The roof is cleaned either by sweeping the leaves or flushing with water. According to the interviewee the main difficulty in cleaning the roof is its inaccessibility. The GI sheet roof constructed separately over the shed or nearby is relatively easier to clean. The surrounding and the outer part of the jar also need to be clean to prevent the rainwater from contamination. In the area under our study, the outside of the jar are found to be generally clean. Some jars in Tanahun are partially covered with algae. Some of the jars in Chyachul, Tallothar (in Dalit community) lack cleanliness both inside and surrounding. It is advisable to brush and paint the tank once a year to reduce the development of cracks.

Figure 15 : Cleanliness inside the jar

Figure 14: Cleanliness outside the jar



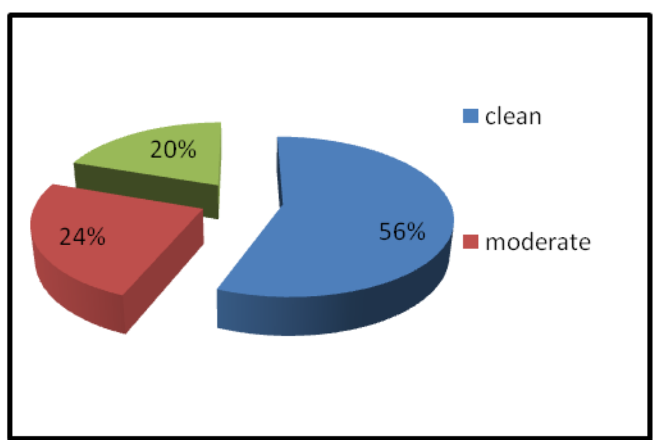


Figure 16 : Presence of cracks and algae on the jar due to lack of maintenance

3.6 Social Acceptability

Initially, some communities are reluctant to accept the installation of rainwater harvesting systems mainly due to lack of knowledge and uncertainty about its usefulness. The mobilization phase is a key component of any rainwater harvesting program, particularly in areas where villagers are not familiar with the technology (Laia, 2009).

According to the interviewee, use of rainwater especially for drinking and cooking purpose is refused by users mainly due to poor water quality and habituated to use previous sources. Some users in Syangja district want confirmation about quality of rainwater whether it complies with the drinking water standards. Many users demanded to check water quality twice a year and technique to make the jar water drinkable from the respective authorities.

3.6.1 Social constructions, traditional beliefs and water quality

Most of the community under our study in the Syangja and Tanahun districts were composed of Bhramin, Newar, Magar, Chhetri and Dalit. Using rainwater for drinking purposes might not be accepted by some households because of social customs and beliefs. Nepalese traditional beliefs assert that still water or stored water is *basi* (impure). Nepalese prefer drinking free flowing water because this is considered *chokho* (ritually pure) (Dixit, 2002). Few interviewees mentioned that they do not use jar water for drinking and cooking purpose because they believe that stored water is stale water which cannot be used for worshiping the god.

Only 22.77% of the households interviewed use rainwater for drinking. The level of acceptability of rainwater for drinking purposes does not only depend on individual perceptions but is also influenced by the social constructions and cultural beliefs of the whole community or group of individuals. Rainwater was not used as drinking water except in two schools in Syangja district because they are habituated to drinking from previous sources like *kuwa* and stream.

Whereas in Tanahun, all the community reservoir users were found using harvested rainwater for drinking. About 27.27% of the households and 2 institution use rainwater for drinking purpose. The main reasons expressed by the households for not using rainwater for drinking are described using chart below.

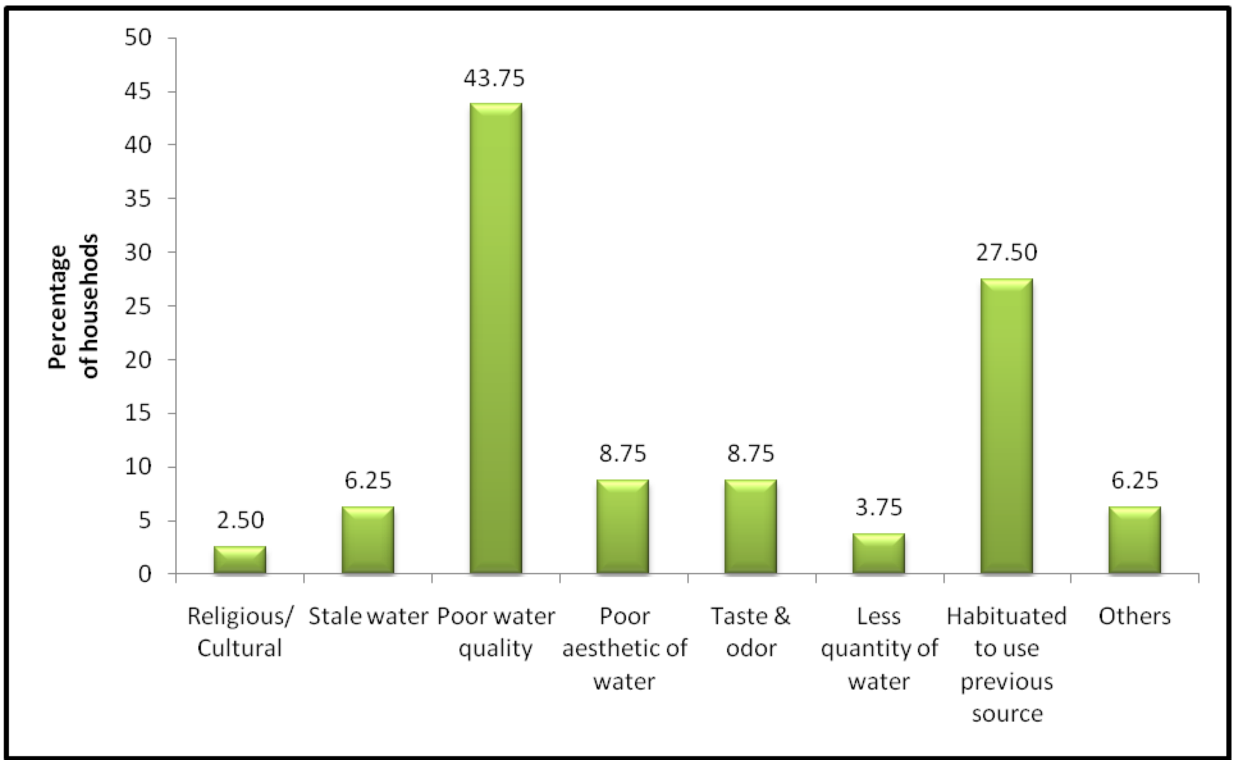


Figure 17: Reason behind not using rainwater for drinking purpose

From Figure 17, we can say that the most common reason for not drinking rainwater is due to poor rainwater quality. During our observation, we found that the jar water in community reservoir in Syangja district is of very low quality. We observe dead rats, leaves and dust particle in one community reservoir. The rainwater from this reservoir is used only for livestock and in toilet flushing. The local reservoir users in the community didn't trust the quality of rainwater for drinking purpose. Water quality of individual reservoir is generally fair but users do not use for drinking.

Unlike this the community reservoir in Tanahun district is recently constructed (in 2066 B.S) and water quality of community reservoir is fair so, almost all community users are using rainwater of community reservoir for drinking purpose but only few households are using rainwater for drinking from their individual reservoir.

Some users are habituated to use water from previous sources due to lack of knowledge that rainwater can be used for drinking. Some users dislike the taste of rainwater as they termed it as *khallo* which is different from previous sources. Due to its low mineral content, rainwater may have a particular taste or lack of taste compared to mineral-rich water (WHO, 2007). Some users in Tanahun district mentioned that water collected from slate roof has objectionable taste and odor. In Tanahun district, the size of individual households jar is 2 m^3, which is insufficient to meet daily water demand for whole dry season. So most of the households start to use the harvested rainwater before the dry season starts. This has decreased their interest towards rainwater harvesting .

Few users were unable to clean the jar so the RWH system is not working properly and some users said that collected rainwater is aesthetically poor so they do not use it as drinking water.

3.6.2 Benefits of harvested rainwater

The benefits rainwater harvesting offers to its users is likely to influence the level of acceptance towards this alternative water source. It is well documented that improved water supply brings about positive changes on health. However, its impact on other productive activities is often underestimated (Moriarty *et al*, 2004). Field evidences show that rainwater harvesting does not only improve the health condition of the beneficiaries but also has a positive impact on livelihood enhancement.

Main benefits of rainwater are water available near the house. They need not to go *kuwa* and stream whole day to fetch water. The average no of trips to fetch water decreased from 6.11 GARGRIS per household to 3.39 GAGRIS after the installation of the RWH system.

- As already mentioned, decrease in average no of trips saves time which is utilized in various reproductive activities
- More than 90% respondents used the saved time for agriculture, animal husbandry.
- Small children can go to school on time because they need not to carry water from other sources. It was mentioned that before RWH implementation small children should fetch the water
- Few respondents are able to rest longer with the time saved. It was also frequently mentioned that before having the rainwater harvesting system women had to get up at midnight to fetch water and therefore, they could only get few hours sleep. This

also had positive impact on women's health, gender empowerment and livelihood enhancement of the family members.

- The water wasted from jar is used in kitchen gardening by all the household users of both the districts. So rainwater can be used to grow vegetables in dry season which improves their problem of food security.
- 3 of the households stated that they saved time to start their small business.
- In the past, higher castes didn't include disadvantaged households of lower castes in public sources. After the installation of the rainwater system, most of the arguments or disputes due to water issues have decreased. So, rainwater system has increased community unity and social harmony.

3.6.3 Level of Users Satisfaction

About 70% users are not satisfied with size of jar. In Tanahun district, the capacity of the entire households jar is 2 m^3 which is inadequate for most of the households. However, in Syangja district size of jar ranges from 10 to 30 m^3. So, most of the users were relatively satisfied as they can store large quantity of rainwater for use in dry season. About 40% of users are not satisfied with the quality of harvested rainwater. In their opinion stored water is of poor quality. Some users expressed their dissatisfaction towards cleanliness of jar water.

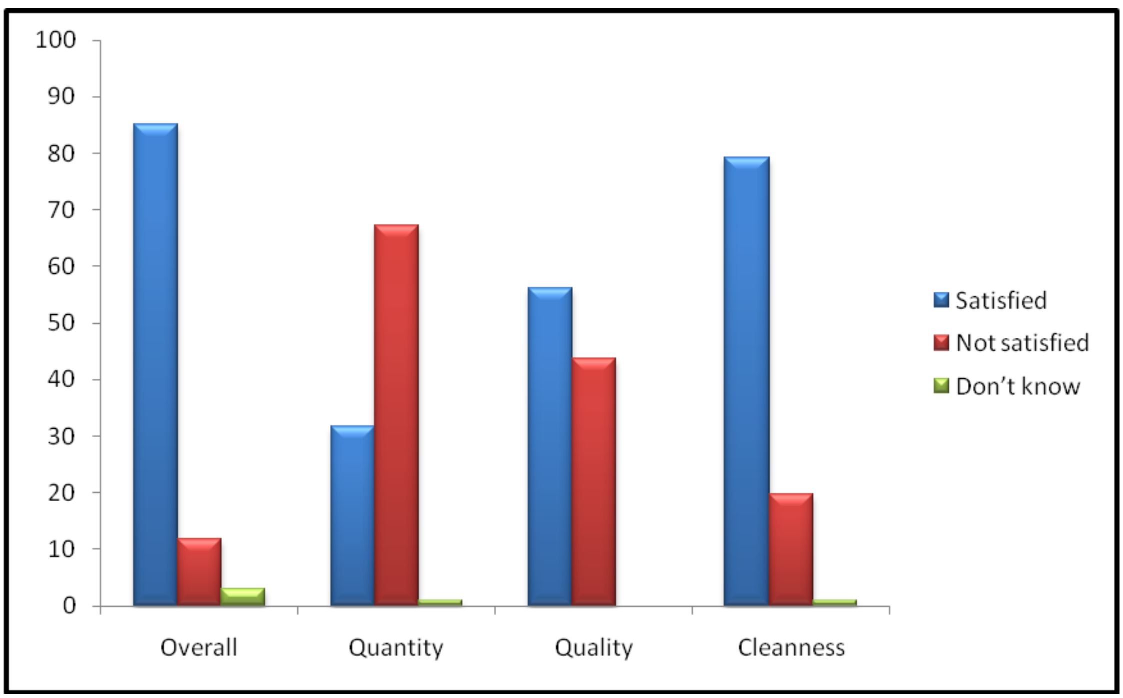


Figure 18 : Level of Users satisfaction towards RWH system

But more than 85% users are overall satisfied; they got some amount of water from the jar. Reason behind overall satisfaction is summarized below:

- 64.29% agreed that water problem decreased due to rainwater jar construction
- 19.05% of the households agreed that time is saved due to jar construction
- 19.05% users mention that dispute for water is decreased
- 10.71% of the households got water easily

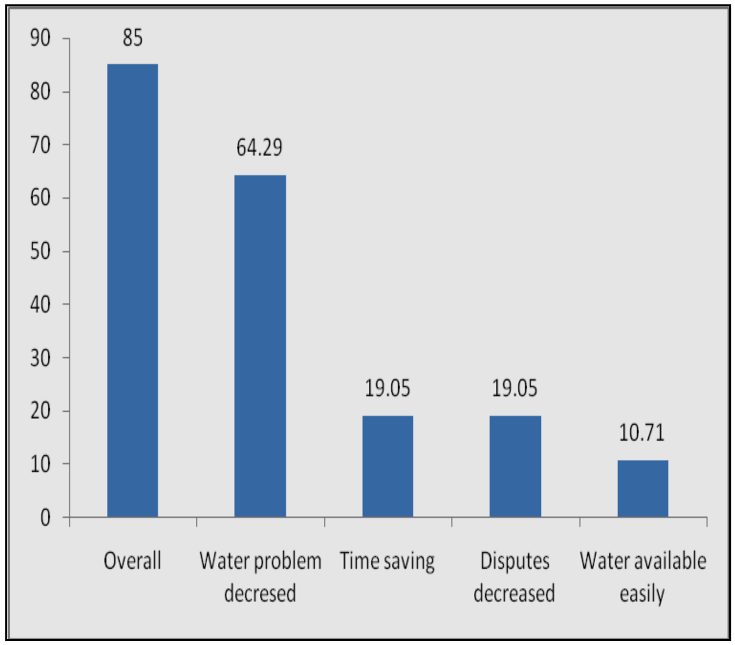


Figure 19 : Reason behind overall satisfaction

Before jar construction, there was long queue to carry water in the *kuwa* and stream. In order to fetch water from these sources, social disputes were frequent. One person in a household had to spend whole day to fetch the water from these sources. Some users should face many difficulties to fetch water. After construction, the disputes are decreased. People can save their time and they can utilize the saved time for agriculture and animal husbandry, some users started their small business also.

3.7 Major findings on Observation

3.7.1 Catchment area, gutter and pipeline

Most of the catchment area were the roof of the houses constructed maintaining the gradient. Roof of some houses were also found to have very less gradient. Almost all of the gutter and pipeline were well constructed. Only two HH were found with improper gutter and pipeline. And two HH in Tanahun district were found without catchment area and the gutters and pipeline were removed and kept separately. The roof of one HH constructed separately was blown away by wind and not constructed then after. And another house removed the roof after severe leakage from RWH jar. Only 44% of the total HH and institutional users have proper

Figure 20 : Damaged locking system and leakage of tap water

locking system in the faucet. In most cases the locking system of the faucet was either damaged or not in use.

3.7.2 Covering of jar

The RWH jars needs a tight and proper cover to prevent collected water from contamination. All the jars in Tanahun were covered by tin cover and those in Syangja either with tin or concrete cover. About 71 % of the individual and institutional system was properly covered. Some jars in Tanahun were found without cover and some tin covers were found broken. On the other hand some of the users were connecting the inlet pipe from one side keeping the cover open.

Figure 21 : Improper sealing of the Jar cover

3.7.3 Leakage from RWH System

Leakage from any part of the RWH system has adverse effect on the performance of the whole system. About 48.48% of the individual HHs and institutions were found with leakage from some part of the RWH system. Most prominent leakage was found form faucet and jar. About 21% of total household were found with leaked faucet and 14% of total jars were leaked. Some jars were found with leakage from the base and some from the side of the jars. Some of the household were found with leakage from the pipeline esp. from joint of gutter and pipeline. Some of the joints were found broken and some pipeline were found wrapped with plastic to control leakage. One house in Tanahun complained of roof leakage. Among 32 HHs found with leakage, 41% leakage were found from faucet, 26% from jar and 23% from pipeline (see Figure 21).

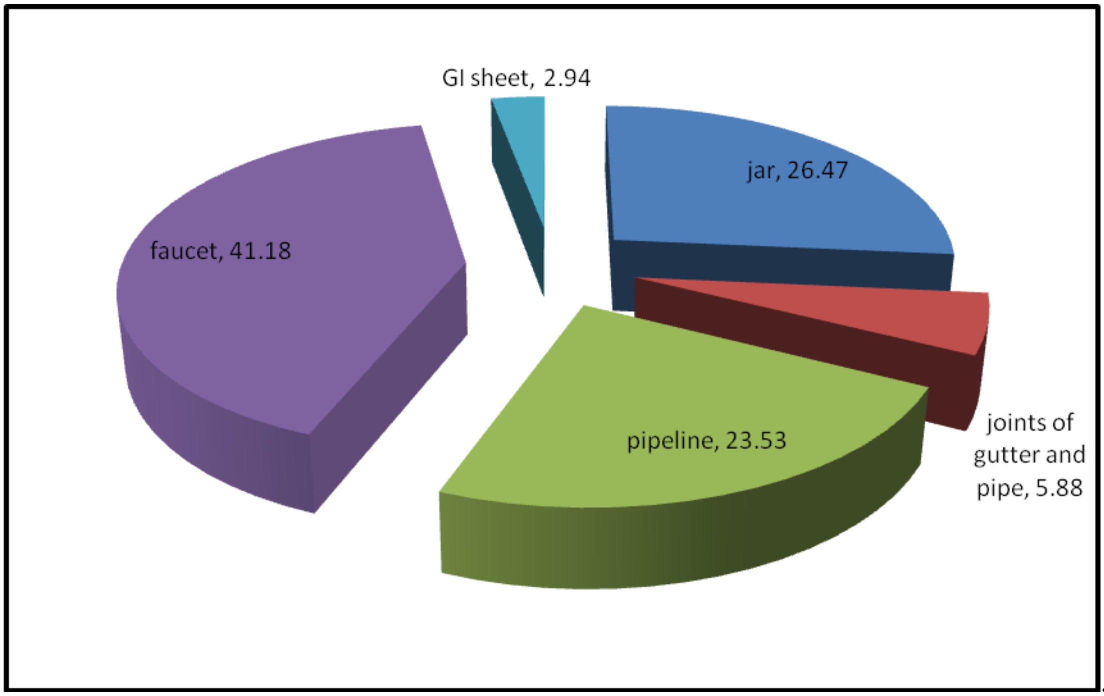


Figure 22 : Leakage from RWH system

Figure 23 : Leaking Pipeline

3.7.4 Waste water management

Water wasted from the RWH jars needs an effective management and can be used for kitchen gardening with advantage. Under our study area, more than 65% of the individual HHs and institutions have well managed drainage system for the waste water. The waste water were properly drained and disposed off either in the kitchen garden or away from the house. About 55% of the users use the waste water in kitchen gardening.

3.7.5 Functionality of jar

In our study area, 7% of the individual HHs and institutional jars were found non functional mainly due to leakage. Two individual jars were found abandoned in Tanahun district and all other were in use. Some other jars were also found abandoned due to migration of the HH owner.

Table 11 : Functionality of the jar

Functionality of jar	No of HH	Percentage(%)
Well functional	43	65.15
Partial functional	18	27.27
Not functional	5	7.58

Figure 24 : A jar not in function

4 LIMITATIONS OF THE STUDY

- For water quality testing, we could not perform any other phisio-chemical and biological tests rather than P/A vial test for coliform testing due to unavailability of ENPHO kit. Due to this shortcomings we cannot say whether the rainwater contain E-coli or not. Other parameters like turbidity, temperature etc. were analysed on the basis of answers given by the interviewees.
- We cannot access the economic impact of the schemes on the community due shortage of time.
- The hygiene aspect of the harvested rainwater was limited on the toilet flushing, washing utensils, washing hands, bathing and washing clothes only.
- The design parameters and cost estimation of the RWH system were not carried out.

5 CONCLUSIONS AND RECOMMENDATIONS

The role of the NGOs and INGOs has been very important to promote rainwater harvesting in Nepal, especially for the construction of household level systems in the rural areas of the country. However, there has been no substantial effort from their side when it comes to regular maintenance and on-site inspection of the systems that are already been implemented. From our field visit we have observed that the situation of RWH system implemented in Tanahun district is in critical condition (esp. in Dalit community) compared to those implemented schemes in Syangja district.

The main reasons why these rainwater harvesting programs have not been accepted by the local community esp. for using in drinking purpose are

1. The users lack in knowledge that rainwater is drinkable
2. The users are habituated to drink water from previous water sources
3. The quality of water collected and stored in jar is relatively poor.

The water quality of the jars is found poor mainly due to the following reasons

1. Lack of cleanliness around the jar
2. Ineffective first flushing system
3. Lack of proper Operation and Maintenance practices in the area
4. Improper covering of jar

The role of international agencies has been prominent in implementing RWH schemes in Nepal. The involvement of national authorities should also progressively grow to build awareness on the advantages of this local technology and ensure the correct utilization of the systems that are already in operation. The main recommendations from our findings are listed below.

- Technical design is very essential for durability and good water quality. A poor technical design has direct effect on the sustainability and water quality. It can be improved by providing more emphasis on construction materials and its quality, size and other technical issues. They are given below.
    1. Providing good filter systems like bio sand filter at the entrance of the Jar.
    2. By providing automatic first flushing system
    3. Providing adequate size of jar according to the demand of the household.

- The agencies implementing the schemes should provide the demonstration system and technical knowledge on how to operate and maintain the system effectively. Campaigns and awareness programs should be conducted regularly on water use and handling practices, home treatment procedures, O&M practices of the system.

- They should test the quality of rainwater and confirm it with the national water quality standards. They should inform individual HHs and community reservoir users about the various mitigation measures through community and focus group discussion.

- Few people from the community should be trained for O&M practice in the community. These people should provide orientation to the users on various practices like brushing and painting the jars once a year as well as provide repair and maintenance support as required.

- The private sector particularly in rural areas should help the expansion of rainwater harvesting systems on self initiation. Successful initiatives like the public private partnership found in the Biogas Supported Program could help to scale up rainwater harvesting in Nepal.

- The working policy on rainwater harvesting becomes critical to guarantee the successful implementation of rainwater harvesting programs. Guidelines should be put in place to define, among others, project selection criteria, financial modality, technical design and recommendations for operation and maintenance practices.

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