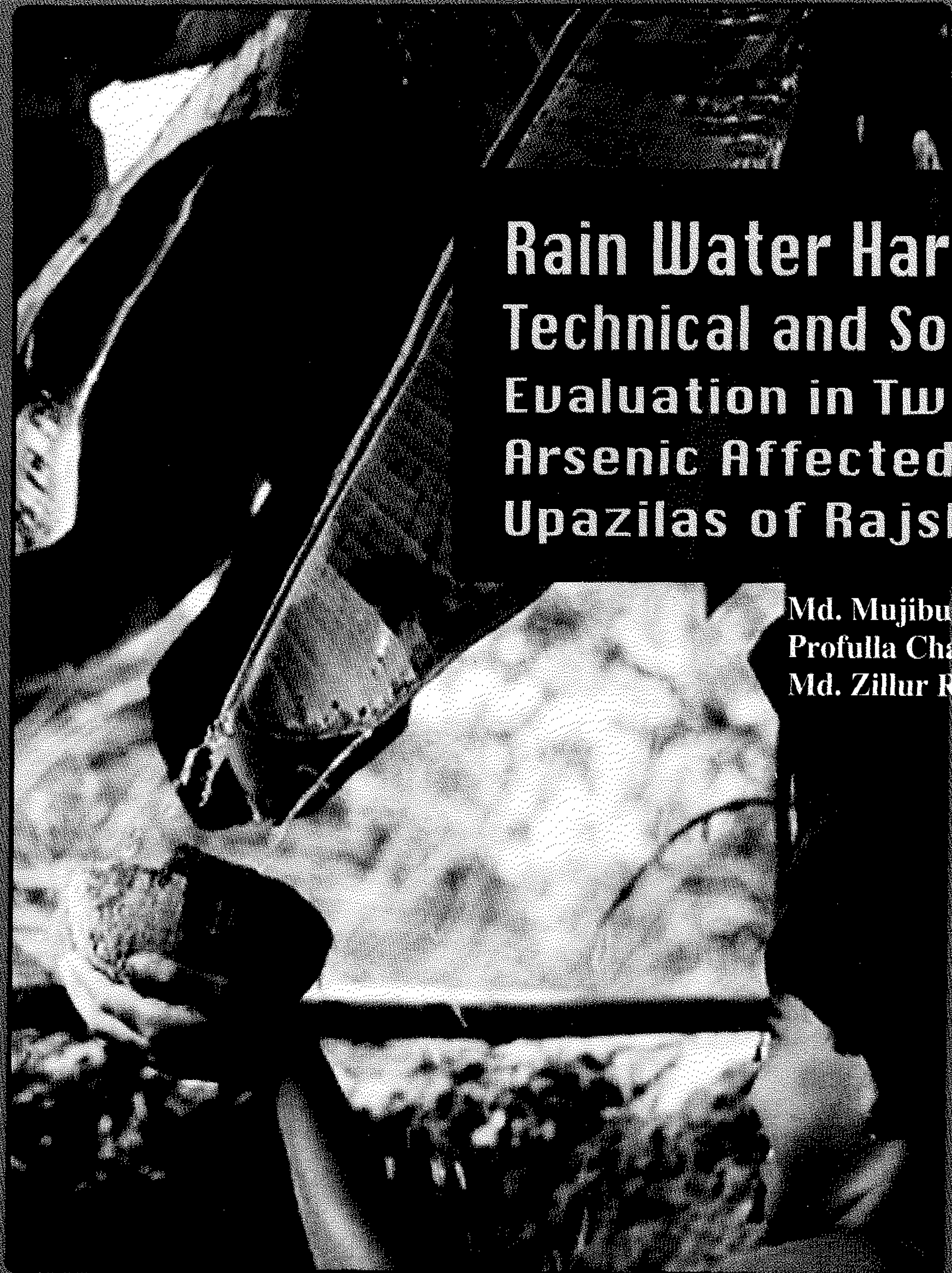
RAIN WATER HARVESTING IN BANGLADESH - AN ACTION RESEARCH PROJECT

(NGO FORUM AND WATSAN PARTNERSHIP PROJECT - SDC)



Rain Water Harvesting
Technical and Social Evaluation in Two Arsenic Affected Upazilas of Rajshahi

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Foreword

Since ancient times rainwater was in practice to varying degrees throughout Bangladesh. With the proliferation of tubewells the practice has waned. Yet in the coastal areas and Hill Tracts some people still practice rainwater harvesting and use large earthenware pots (Motkas) for storage. Water is a major and precious natural source. But around the world, the absence or scarcity of portable water continues to be a growing problem, especially in rural and remote areas of the developing countries. Recently Bangladesh is facing severe crisis in supply of safe drinking water due to increasing trend of arsenic contamination in the underground water, saline intrusion in the coastal areas, declining underground water table and rocky/stony layer into soil formation in the hilly area. To cope with the emerging problems in safe water supply, NGO Forum took bold initiative to introduce Rain Water Harvesting as an alternative water supply option since 1997.

RWH has many advantages than other technologies. Rainwater harvesting is a wholesome practice that has fallen on bad times due to no fault of the system. It is as relevant today as was hundreds of years ago. It provides water security at the household level as it puts control of water supply into the hands of the individual households. O&M and management of rainwater harvesting systems are less complex than most other technologies. It offers a convenience equal to piped supply during the rainy season, while it reduces time and energy spent on water collection for drinking and cooking even during a part of the dry period. Thus it potentially improves the position of women and girls as less time and energy is spent on water collection chores. Rainwater has also few disadvantages too. High initial investment cost is considered to be the major disadvantage. The installation cost of a RWHS is more than the other conventional technologies installed in the rural areas. To reduce the construction cost of RWHS for different group of consumer, NGO Forum has undertaken an Action Research Project in two arsenic affected upazila: Charghat and Bagha under Rajshahi district since 2000. The project was implemented with the financial support of Swiss Agency for Development and Cooperation (SDC) within the working framework of WATSAN Partnership Project (WPP).

The overall objective of the project was to "demonstrate that Rain Water Harvesting System can be suitable, safe, affordable, socially acceptable and sustainable source of water to meet the daily need of drinking and cooking for 8 – 10 months of the year". Different models of RWHSs have been designed and developed through rigorous field trial with the active participation of the community. Constructed 268 RWHSs of different capacity (500L, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3, 10.0 m^3) and used construction materials were concrete ring, brick, Plastic, Ferro cement, earthen Motka etc. Participatory monitoring mechanism was developed to create a regular information exchange between householders and the field staffs. The project field staffs along with the community performed a regular inspection of the system and advised the users on keeping the various parts of the system clean and checked the first flush device. The field staffs on a routine basis visited the site of the RWHSs, discussing with the caretakers and users to fill up the monitoring format and send it to the project office. The monitoring covered the quality of construction, O&M of RWHS, water quality and water use aspects.

The Action Research Project that placed the user community at the centre of planning and implementation. The project revealed an insight in many practical, technical, social, hydrological, arsenical and economical aspects that determined the installation of household rain water harvesting system and its successful use. This report is the outcome of the technical and social evaluation of the project.

I would like to express special thanks to the evaluation team for their remarkable effort in conducting the study. And also thanks to the project & regional staffs of NGO Forum, people of 268 Rain Water Harvesting user families of 15 villages in Charghat and Bagha Upazila of Rajshahi district who

provided necessary information at the time of interviewing, observation and case study. We would like to express our especial thanks to the Director of SWALLOWS, Sachetan and Samata Nari Kallyan Samity for providing necessary information on Rainwater Harvesting System as partner NGOs of NGO Forum. I also express special thanks to my colleagues for providing hard labour for publishing the Evaluation Report.

I hope that this evaluation report titled "Rain Water Harvesting Technical and Social Evaluation in two Arsenic Affected Upazilas of Rajshahi" will be found important information and interesting to the sectoral policy maker, scientists, engineers, researchers, local and international NGO workers working for arsenic mitigation in various parts of Bangladesh.

S. M. A. Rashid
Executive Director
NGO Forum for Drinking Water Supply and Sanitation

Preface

Naturally rainwater is clean, transparent, and free from bacteria and any other chemical constituent. It is the lightest water in nature. Water quality testing result revealed that rainwater collected from house roofs is usually much cleaner than water from other sources (apart from bore holes and springs). Rain Water Harvesting System (RWHS) is an option which has been adopted in many areas of the world where conventional water supply systems have failed to meet the needs of the people. It is a technique, which has been used since antiquity. Examples of RWH Systems can be found in all the great civilizations throughout history. The technology can be as simple or as complex as required.

Water is a major and precious natural source. But around the world, the absence or scarcity of portable water continues to be a growing problem, especially in rural and remote areas of the developing countries. Recently Bangladesh is facing severe crisis in supply of safe drinking water due to increasing trend of arsenic contamination in the underground water in different parts of the country. To cope with the emerging problems in safe water supply, NGO Forum took initiative to introduce Rain Water Harvesting as an alternative water supply option since 1997. RWH has many advantages than other technologies, though it has few disadvantages too. High initial investment cost is considered to be the major disadvantage. The installation cost of a RWHS is more than the other conventional technologies installed in the rural areas. To reduce the construction cost of RWHS and make it affordable for different groups of consumer, NGO Forum has undertaken an Action Research Project in two arsenic affected upazila: Charghat and Bagha under Rajshahi district since 2000 with the financial support of Swiss Agency for Development and Cooperation (SDC).

Upon completion of the project in December 2003, an evaluation of the action research project on domestic rainwater harvesting, particularly focusing on the technical and social aspects was undertaken. This report is the outcome of the technical and social evaluation of the project. The primary objective of the evaluation exercise was to assess the important technical and social aspects of the action research project. Such as design of RWHS components, construction methods and materials, operation and maintenance, water quality, socio-economic aspects related to RWHS, users' acceptability, cost and affordability, long term sustainability etc. Technical and social evaluation of the RWHS was done through analysis of design considerations, field observation, and case studies and through interviewing users and caretakers on various technical and social aspects of rainwater harvesting as implemented during the action research project in Charghat and Bagha Upazilas. The evaluation team randomly selected 14 RWHS for the evaluation purpose. These 14 RWHS included RWH units of different materials and different capacities and some do-it-yourself models installed by NGO Forum.

This evaluation report titled "Rain Water Harvesting Technical and Social Evaluation in two Arsenic Affected Upazilas of Rajshahi" is the product based on primary and secondary information and is supported by NGO Forum for Drinking Water Supply & Sanitation. We acknowledge the support provided by Mr. S.M.A. Rashid, Executive Director and other concerned senior staffs of NGO Forum for Drinking Water Supply & Sanitation for conducting this short evaluation work a successful one. We also express our sincere thanks to the NGO Forum Regional and Project staffs for their active cooperation throughout the period of data collection and writing of this evaluation report.

We would like to express our special thanks to the people of 268 Rain Water Harvesting user families of 15 villages in Charghat and Bagha Upazila of Rajshahi district who provided necessary information at the time of interviewing, observation and case study. We are indebted to the key informants for providing in-depth information especially on socio-cultural issues on rainwater harvesting system.

We hope that this evaluation report will find important information and interesting to latent readers and stakeholders.

Md. Mujibur Rahman
Profulla Chandra Sarker
Md. Zillur Rahman

Acknowledgment

This evaluation report entitled "Evaluation of Rain Water Harvesting Project" is the product based on primary and secondary information and is supported by NGO Forum for Drinking Water Supply & Sanitation. We acknowledge the support provided by Mr. S.M.A. Rashid, Executive Director, NGO Forum for Drinking Water Supply & Sanitation for conducting this short evaluation work. We also express our sincere thanks to Mr. Md. Abdus Salam, Field Coordinator, Mr. Md. Azahar Ali Paramanik, Manager, Field Operation, Mr. Md. Mizanur Rahman, Senior Regional Officer, Rajshahi, Mr. Md. Nurul Amin, Project Manager, Mr. Maruf Hasan Mazumder, Research Engineer, Mr. Dipok Chandra Roy, Field Engineer, Mr. Md. Mazidul Islam and Mr. Sabit Jahan, Field Supervisors for their active cooperation throughout the period of data collection and writing of this evaluation report.

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Finally thanks are also due to Mr. Md. Refatul Islam and Mr. Md. Abdul Mannan who took utmost care in computing part of this evaluation report.

Authors

Executive Summary

Introduction

In an effort to provide safe drinking water to the people of arsenic affected Bagha and Chargat Upazilas under Rajshahi district an action research project on rain water harvesting potential was conducted by NGO Forum for drinking water supply and sanitation with financial support of SDC. As per original plan, the project was supposed to be completed by December 2001. An evaluation was conducted in August 2001 that identified some important pending issues, which were not possible to be completed within the planned project period, as the overall length of the project was considered short to assess the full potential of the rainwater harvesting system. The team recommended that the research period be extended for another two seasonal cycles beyond December 2001, i.e., the project should be continued till December 2003. As per recommendation of the evaluation in 2001, the project was extended up to December 2003.

Upon completion in December 2003, an evaluation of the action research project on domestic rainwater harvesting, particularly focusing on the technical and social aspects was undertaken. This report is the outcome of the technical and social evaluation of the project.

Objectives of the Technical and Social Evaluation

The primary objective of the evaluation exercise was to assess the important technical and social aspects of the action research project on rainwater harvesting system in Charghat and Bagha Upazilas of Rajshahi district conducted by NGO Forum. The evaluation team randomly selected 14 RWHSs for the evaluation purpose. These 14 RWHSs included RWH units of different materials and different capacities and some do-it-yourself models. Following specific aspects were evaluated during the evaluation study :

- Design of RWHS components
- Construction methods and materials
- Operation and maintenance
- Water quality
- Socio-economic aspects related to RWHS
- Users Acceptability
- Cost and affordability
- Long term sustainability

Methodology of the Evaluation Study

Technical and social evaluation of the RWHS was done through analysis of design considerations, field observation, and case studies and through interviewing users and caretakers on various technical and social aspects of rainwater harvesting as implemented during the action research.

Apart from interviewing the users and the caretakers, literature including manuals, progress reports, monitoring reports, mid-term evaluation reports were consulted. A few randomly selected water samples were also tested in the laboratory for ascertaining quality of the stored rainwater. A presentation was also made in a seminar arranged by NGO Forum in order to interact with concerned professionals in the sector.

Project Approach

The research carried out under the purview of WatSan Partnership Project (WPP) is a demand-based project that operated its activities through partner NGOs directly working with Village Development Committees (VDC) in the project area. The project started with promotional activities of disseminating information on arsenic and its harmful effects on public health, and safe water options (Rain Water Harvesting, its cost and implications). Actual construction and participatory monitoring activities started later. Project emphasis was given on the construction of systems that use locally available materials such as motkas for storage and polythene sheet for collection.

Design Considerations of RWHS

The primary design consideration of rainwater harvesting system in the project area is based on the concept of "combined water supply system". Rainwater harvesting as the sole source of water supply is costly particularly because of the large storage required for reliable supply throughout the year. In this research project, household rainwater harvesting is designed in combination with other suitable community water sources to make the system cost effective, affordable for low income groups, and to provide water security round the year.

People can construct storage reservoirs of less capacity so that they can use rainwater during the entire rainy season and about 2 – 4 months of the dry period. For the rest 2 – 4 dry months the users can collect water from any communal system such as nearby or distant arsenic free tubewells, filtered pond water, dugwell or even from a large community rainwater storage reservoir, e.g., at schools or colleges where large roof catchment areas are available.

The research reveals that average rainwater supply is abundant in terms of rainfall provided sufficient roof area is available. In the project area, in most cases, only a part the total roof catchment is being used for rainwater harvesting purpose. This means that if larger roof catchment area could be used for rainwater supply throughout the year if larger storage facilities could be provided.

The storage volume required for a nuclear family is around 6.5 m^3. As mentioned earlier, rainwater supply is sufficient to justify the design of 6.5 m^3 storage tank. However, the high cost of storage reservoirs and space constraints in most cases were the limiting factors and the tank storage capacity used was well below 6.5 m^3. The affordability of people was considered as the controlling factor in determining the tank size, instead of considering the demand and supply analysis. In most cases, the capacity of the storage tank was determined considering use of stored water for at least 2 – 3 months, assuming longest average dry period of 5 months. This implies that people will have to rely on other sources like collecting water from distant arsenic free shallow or deep tubewells, dugwells, filtered pond water or large community rainwater reserve e.g., at schools and colleges.

Rainwater Quality

Rainwater quality was evaluated considering relevant water quality parameters that include pH, Turbidity, Total Coliform, Fecal Coliform, Iron, Zinc, Calcium, Magnesium, Fluoride and Lead. However, pH and Fecal Coliform (FC) are considered to be of special interest because of exposure of rainwater to atmospheric contamination and settled particles and bird droppings on the roof catchment.

pH values on the higher side ranging between 7.5 and 9.5, and initially a few samples showed even higher values up to about 11.0, which could be attributed to the use of cement containing lime. Later tests from the same storage tanks showed lower pH values but still remaining high in the region of 8.0 of the pH scale. Fecal Coliform was absent in most samples tested, and Pb and Zn are within acceptable limit. Iron and Fluoride concentration are below detectable range of measurement, i.e., < 0.05 mg/L.

A major change in water quality between rainwater and previously used groundwater is that of iron, manganese and hardness concentration. The problems associated with high iron and hardness in groundwater are not present in rainwater, which increases the acceptability of rainwater among users. A common concern about absence of fluoride in rainwater and consequent dental health problem is often raised. However, it can be noted that fluoride is also less than acceptable value of 1.0 mg/L in tubewell waters in most parts of the country. Test results for water quality parameters such as Fe, Ca, Mg, Pb, Zn, Turbidity, Fluoride etc. are within the drinking water guideline value and acceptable. The quality of rainwater has brought some positive impacts on the quality of food cooked using rainwater, as claimed by the users.

Operation and Maintenance

Evaluation team put special emphasis on the maintenance issue of the RWHS. It was evaluated through field observation and interviewing the caretakers and users about maintenance of different components of RWHS. It may be mentioned here that the team visited the project area during the dry period, which began two months back. Through field observation following facts about maintenance of the system were revealed.

- User groups of RWHS were found well aware about maintenance of catchment surface.
- Gutters and tanks are to be cleaned frequently to prevent over flow during heavy rains.
- First flash for more than 5 minutes divert the first 10 to 20 liters of rain water and prevent contamination of the water in the tank.
- Regular inspection and repair of system.
- Appropriate tank cover and filter nets on inlet and outlet holes to protect water quality.
- Down pipes, fly-guard-net etc. were in good condition.
- Water collection tap, first flashing system, over flow pipe etc. were properly positioned and were working properly.

It was also found that the cost of O&M of the rainwater harvesting system is negligible. Some users reported that they had to spent only about 60 taka in the last three years for replacing the tap that costs about Taka 10 each, buying a few fly guard nets costing Taka 2 to 3 each and buying some bleaching powder for cleaning the storage tank. No maintenance requirement of the storage tank was reported during the project period of over three years.

Important Achievements of RWHS Project

Safe and Affordable Water Supply Option :

The rainwater harvesting system in combination with a suitable community water source for a period of 2 – 4 month during the dry period of the year appears to be a viable, safe water supply option particularly for arsenic affected areas of Bangladesh. Size of the storage tank can be compromised and hence cost reduced with the period of use of the community water source. This provides a great flexibility for people to have safe water option.

Do It Yourself (DIY) Model :

Some "Do It Yourself" models were introduced in the project area in order to provide rain water supply for the very poor. Motka (burnt clay) storage jars, double chari (two cement concrete made large bowl joined with or without RCC rings in the middle) are found to be much cheaper than other options on offer. Such storage jars are produced locally in the project area and their total domestic storage capacity can be increased in stages. No problems with water quality or with other components of DIY models could be found during the evaluation of the system.

Productive Time Saving :

Prior to the introduction of RWHS in the project households, especially women had to spent hours to fetch water often from remote sources of safe water supply, mostly from arsenic free tubewells. The introduction of RWHS has now resulted a significant time saving as households can easily get safe water supply from RWHS just beside or inside their kitchens. The time thus saved can be used for other productive purposes.

Increased Water Use Efficiency :

Because of the combined household and community source system, people are now more careful in using the stored water. It was revealed from interviewing users during field visits that as the dry season approaches people become more cautious about water use. Leakage or wastage by any other means are strictly prevented by the householders themselves, so that a greater part of the dry period can be covered by the stored rainwater.

Conclusions

The action research project clearly identifies rainwater harvesting as a potentially safe, reliable and affordable alternative source of water supply for drinking and cooking for at least 8 – 10 months of the year. The project carried out by NGO Forum in two arsenic affected Upazilas reveals that the cost of rainwater harvesting can be brought down to affordable limits of people when used in combination with another safe communal water source for about 2 – 4 months during the dry spell of the year.

The research project conducted in selected Upazilas further demonstrates that with the active participation of the users and the backup support by the local NGOs and VDCs can bring the desired changes in the water supply scenario of the arsenic affected areas. Other important conclusions drawn from evaluation of the action research project are as follows.

- The supply of rainwater, given the CI roof catchment area available, is much higher than the household demand for drinking and cooking.

- The rainwater can be stored in tanks, jars or pots of different sizes and materials of varying costs to match individual household's need and affordability.

- The household rainwater harvesting system in combination with a suitable communal safe water source can save a tremendous amount of productive time of people for a large part of the year (8 – 10 months).

- The "do it yourself" (DIY) model using burnt clay pot locally known as "motka" of smaller sizes (300 to 600 Litres each) is gaining popularity among the poor as a cheaper means of rainwater storage.

- Operation and maintenance of rainwater harvesting is very simple and can easily by done by the caretaker or even by any member of the family, and costs could be as little as Tk. 20/- per year for a household unit.

- Simple cleaning of roof catchment before rain events, flushing out of the first 5 – 15 minutes rainwater (depending on the rainfall intensity, and using the simple first flush outlet device) before each rain event, and occasional bleach washing of the storage reservoir, may provide bacteria free, safe drinking water to people.

- The project has also been successful in promoting private entrepreneurship development. A number of trained masons and skilled workers are now engaged in producing rainwater storage tank components, motkas and covers of varying sizes and costs in their own yards. A little guidance in product marketing could further influence promotion of rainwater harvesting option in the region.

Recommendations

This action research project has clearly demonstrated that proper collection and storage of rainwater can solve the acute problem of safe drinking water in arsenic affected areas, and that motivation and training has a key role in the success of the project. It can not be expected however, that the outcome of this single research project will be equally applicable to other arsenic affected areas throughout the country. It is therefore, important that similar action research projects be undertaken in other parts of the country to examine its effectiveness in different socio-economic and hydro-geological conditions.

Even in the current research project area at Charghat and Bagha, further support is needed particularly in operation and maintenance of the installed units. Continued efforts in capacity building of the local entrepreneurs and of the users will bring total confidence in people that RWHS in combination with an appropriate community water source is a sustainable safe water supply option.

Based on the discussions with the users, local NGOs, VDC members, private entrepreneurs during this short evaluation, several important recommendations pertaining to policies, planning and strategies for the development of rainwater harvesting system as a potential safe water option are made as follows:

- The poorer section of the people are not in a position to bear the costs of installation of RWHS and therefore needs initial investment support along with active participation of VDCs and local NGOs.

- Community safe water source must be ensured through development of appropriate technological options. Proper management of khash ponds, regenerating inactive wells, or installing large community rainwater reservoirs appears to be the probable methods for community water supply for the dry period.
- The success story of rainwater harvesting should be replicated not only in arsenic affected areas, but also in other areas where there is a crisis of safe water for drinking and cooking.
- Rainwater management training focussing women, who use water from dawn to dusk for different purpose, should be promoted.
- A flow of client to client motivation i.e., rainwater users to not users motivation program should be encouraged for wider acceptance of rainwater harvesting system.
- Finally, motivation, monitoring, evaluation and follow up should be a continuous process in order to achieve long term sustainability of rainwater harvesting system.

Table of Contents

Chapter 1

Introduction

Background / Project Location / Objectives of Technical and Social Evaluation / Scope of Evaluation Study / Methodology of the Evaluation Study

1.1 Background

Since the detection of excessive arsenic in shallow groundwater aquifers in early nineties, efforts are being made by different organizations to develop and promote alternative safe water supply options for people in the affected areas. Options like rainwater harvesting, shallow dugwells, filtering pond and river waters are being tried with partial success because none of the options could offer a complete solution an affordable cost.

As a result of accelerated installation of shallow handpump tubewells over the past decades, as means of cheaper and convenient "safe" water supply, most people of the country has become heavily dependent on groundwater. Replacing these handpump tubewells, despite severe arsenic contamination, with other options of similar benefits and convenience has become a challenging task for all concerned. The immediate challenge therefore, is to assess various technological options in terms of their technical feasibility, economic viability, social acceptability and environmental sustainability. Rainwater harvesting system, which has been widely used in many parts of the world, possesses a great potential in addressing today's real challenge of acute arsenic poisoning in different parts of the country.

NGO Forum for Drinking Water Supply and Sanitation as a leading organization in WatSan sector is continuously striving to provide safe water to people with different alternative, appropriate and sustainable technological options to suit different hydro-geological and socio-economic conditions of the country. During the period from May 2000 to December 2003, NGO Forum conducted an action research project of rainwater harvesting system from in Bagha and Charghat Upazilas under Rajshahi district with the financial support of SDC. As per original plan, the project was supposed to be completed by December 2001.

An evaluation was conducted in August 2001 by a team comprising of one external consultant from SKAT, one representative from NGO Forum and one from SDC WatSan Partnership Project. The assessment mission identified some important pending issues, which were not possible to be completed within the planned project period, as the overall length of the project was considered short to assess the full potential of the rainwater harvesting system. The team recommended that the research period be extended for another two seasonal cycles beyond December 2001, i.e., the project should be continued till December 2003. As per recommendation of the evaluation in 2001, the project was extended up to December 2003. Upon completion in December 2003, an evaluation of the action research project on domestic rainwater harvesting, particularly focusing on the technical and social aspects was undertaken. This report is the outcome of the technical and social evaluation of the project.

1.2 Project Location

The study area is located in the arsenic affected villages at Bagha and Charghat Upazilas in Rajshahi district in the western part of the country. Figure 1.1 shows the location of the project area in Bangladesh map.

The average annual rainfall of the project area is around 1400 mm and the highest rainfall occurs in the month of July, which is around 3000 mm. Different villages of these Upazilas were selected for carrying out the research project. Rainwater harvesting units of different capacities were constructed in these villages. A summary of RWHS units of varying capacity, installed by NGO Forum is presented in Table 1.1.

Table1.1 Total number of RWHS units installed during the project period

sl. no.	Type	Capacity (Liter)	Size of Catchment (Sft.)	No. of System	Cost (Tk.)
1	FC tiles tank	3200	100-120	4	6000
2	FC tiles tank	2500	90-100	22	4500
3	FC Jar	2500	90-100	29	4400
4	FC Jar	2000	80-90	8	3800
5	FC Jar	1000	70-80	7	2800
6	RCC ring	2500	90-100	11	4400
7	RCC ring	2000	80-90	1	3800
8	RCC ring	1000	70-80	6	2700
9	Brick tank	2500	90-100	34	5000
10	Brick tank(SS)	2500	90-100	2	5500
11	Brick tank	1000	70-80	5	3500
12	Brick tank	500	60-70	8	1300
13	Chari tank	950	70-80	1	1800
14	Chari tank	650	60-70	1	1200
15	Earthen motka	500	60-70	127	550
16	Plastic tank	500	60-70	2	3300
			Total	**268**	

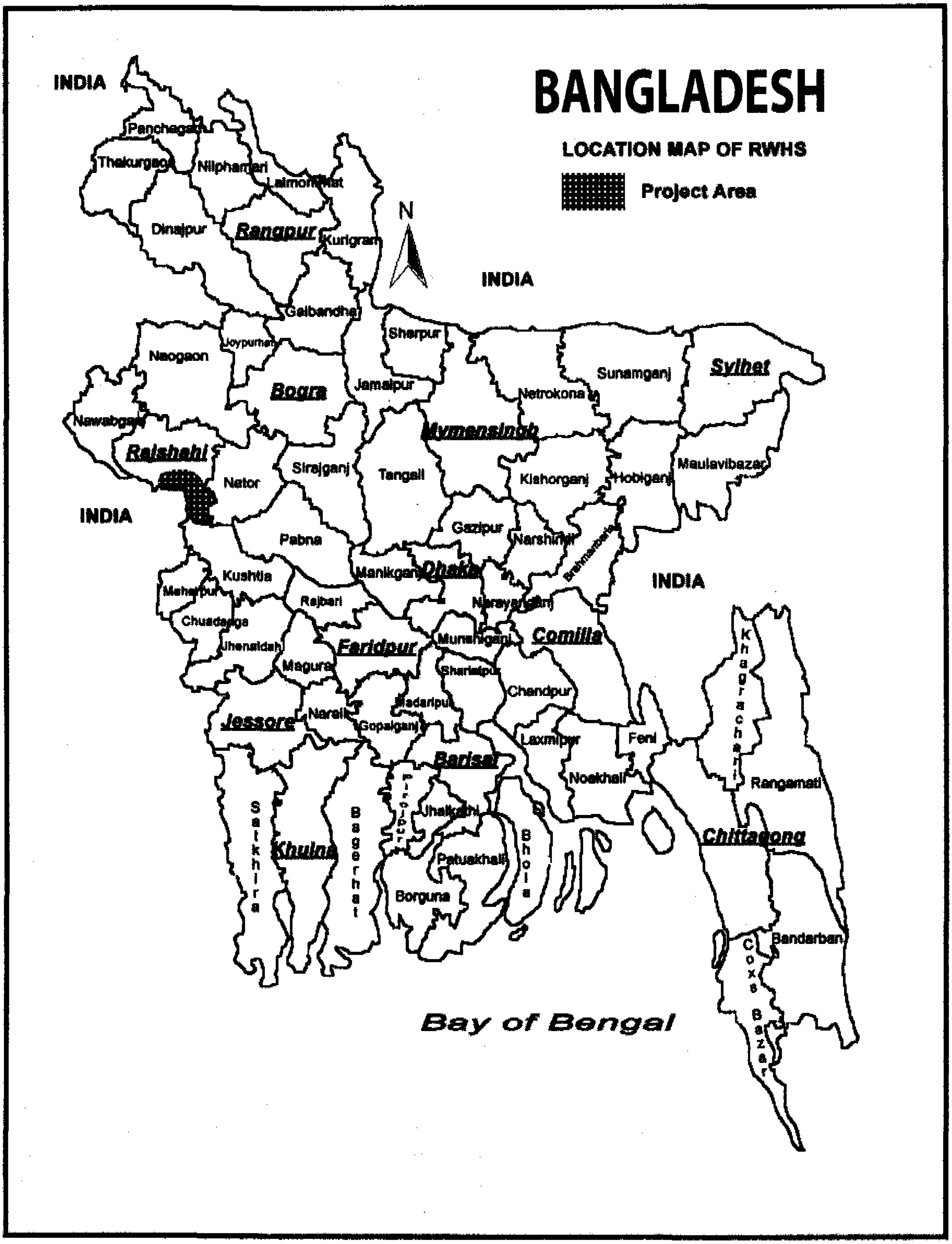


Figure 1.1 Map showing the location of the study area

1.3 Objectives of Technical and Social Evaluation

The primary objective of the evaluation exercise was to assess the important technical and social aspects of the action research project on domestic rainwater harvesting system in Charghat and Bagha Upazilas of Rajshahi district conducted by NGO Forum. The evaluation team randomly selected 14 RWHS units for the evaluation purpose. These 14 RWHS included RWH units of different materials and different capacities and some do-it-yourself models installed by NGO Forum. Following aspects were evaluated during the evaluation study:

- Design of RWHS components
- Construction methods and materials
- Operation and maintenance
- Water quality
- Socio-economic aspects related to RWHS
- Users' Acceptability
- Cost and affordability
- Long term sustainability

1.4 Scope of Evaluation Study

The scope of this quick evaluation study were as follows:

- Field visit to the project area representing mainly arsenic affected areas.
- Meet with different stakeholders in the research project area and colleting their views regarding RWHS as a source of water supply for drinking and cooking.
- Evaluating how far the local NGOs and VDCs have taken responsibilities and recommended further steps.
- Evaluating the extent of willingness of the community people to acquire a RWHS once the project supports are withdrawn.
- Questioning and evaluating the technical and socio-economic aspects of the action research.
- Evaluation of the combination of other sources of water supply.
- To recommend measures to make RWHS sustainable in arsenic affected rural areas of Bangladesh.

1.5 Methodology of the Evaluation Study

Technical and social evaluation of the RWHS was done through analysis of design considerations, field observation, and case studies and through interviewing users and caretakers on various technical and social aspects of rainwater harvesting as implemented during the action research project in Charghat and Bagha Upazilas. Important technical and social questions asked were as follows :

- What are the uses of stored rainwater?
- Is the quantity sufficient?
- Is the water quality satisfactory?
- Is the roof catchment cleaned before rain?

- Is the storage tank disinfected before storage?
- Are there any health problems from rainwater use?
- Are operation and maintenance easy?
- Is O & M costly?
- Stored water shared with neighbors?
- What are the other water sources when the tank is empty?

Apart from interviewing the users and the caretakers, literature including manuals, progress reports, monitoring reports mid-term evaluation reports provided by NGO Forum were consulted. A few randomly selected water samples were also tested in the laboratory for ascertaining quality of the stored rainwater. A presentation was also made in a seminar arranged by NGO Forum in order to interact with concerned professionals in the sector.

Chapter 2

An Overview of the Action Research Project

Introduction / Background of the study / Objectives of the Action Research Project / Setting of the Project Area / Project Approach / The Study Cycle and Methodologies / Activities implemented / Replication of RWHS / Monitoring & Evaluation / Major observations of the study /

2.1 Introduction

Ground water has for long been considered to be pure and safe to serve drinking purpose. Following a safe water campaign in the 1980s, extensive sinking of hand tube-wells by the Department of Public Health Engineering (DPHE) and private sectors and through individual initiatives supported by UNICEF, SDC and DANIDA resulted in around 95% of the country's population having access to 'safe' drinking water. This significant achievment had influence on water-borne diseases particularly in the reduction of incidences of diarrhoeal diseases. However, this tremendous achievement was overshadowed when the presence of arsenic in ground water was revealed in the early 90's. Efforts are being made by different agencies to develop technologies for arsenic mitigation, as there is no reliable household level solution available. On the other hand, different alternative sources of safe drinking water are being explored e.g, Rain Water Harvesting, Pond Sand Filter, Deep Tube Well and Dug well etc.

Rain Water Harvesting is an option, which has been adopted in many areas of the world where conventional water supply systems are not available or have failed to meet the needs and expectations of the people. It is a technique of water collection, which has been used since antiquity. Examples of RWH systems can be found in all the great civilization throughout history. RWH refers to both large and small scale. A simple affordable, technically feasible and socially acceptable safe drinking water supply system in the arsenic affected rural areas is very much in demand. In this context, Rain Water Harvesting can be considered as a probable solution of the drinking water problem in the arsenic affected areas. The rainwater is free from arsenic contamination and the physical, chemical and bacteriological characteristics of harvested rainwater represent a suitable and acceptable means of potable water.

The annual monsoon rainfall in Bangladesh represents a generous seasonal supply for safe drinking water and is often seen as a possible means of relieving water-stress at the household level. Numerous initiatives to promote domestic RWH in Bangladesh have been undertaken in recent years. Domestic RWH has recently been promoted as a realistic means for partially meeting annual household requirements of potable water. However, the degree to which DRWH is able to contribute to overall needs depends on a number of technical, socio-cultural and financial variables.

- On a financial level, the unit production cost for safe drinking water is generally influenced by the economies of scale that results from bulk treatment processes. Rain water harvesting on a modest, domestic (batch) scale is therefore a comparatively expensive method for obtaining water of potable quality, with water storage tanks representing the most significant cost for a domestic system.
- On a social level, many rural households no longer consider rainwater as a possible source of drinking water following the relatively recent and widespread proliferation of tube wells throughout Bangladesh.
- On a purely technical level, the design of good domestic rain water harvesting systems hinges on finding a socially acceptable balance between a system's cost and its reliability and over all annual performance.

An action research project had been undertaken, in order to evaluate the degree to which domestic RWH can realistically replace contaminated groundwater as an acceptable source of drinking water at household level. This research project is investigating the fine balance between socio-cultural, financial and technical considerations as mentioned above, with a view to making definitive and practical recommendations on optimal designs and promotion strategies for domestic RWH systems in Bangladesh. This research is being carried out by the NGO Forum for Drinking Water Supply and Sanitation and is being conducted in collaboration with the WatSan Partnership Project (WPP) with the financial support from Swiss Agency for Development and Cooperation (SDC).

2.2 Background of the study

NGO Forum is the apex networking and service delivery agency of partner NGOs, CBOs and private sector working in water supply and sanitation programme in direct interaction with the grassroots level beneficiaries. NGO Forum was selected to conduct the Action Research Project as it has previous experience of promoting domestic RWH in the coastal belt as a response to arsenic contamination and saltwater intrusion into groundwater. Nationally, NGO Forum had over 900 domestic RWH systems to its credit. It has accumulated a wide range of experience (about 8 years), knowledge and skills in promoting and making the coastal people well familiarized with this safe water supply technology.

Mr. Karl Wehrle from SKAT performed a short-term consultancy to NGO Forum to assess the potentiality of Domestic Rain Water Harvesting system in Bangladesh in May 1999 and preparing a report titles "Domestic Rain Water Harvesting in Bangladesh". As a result of recommendations contained in that document, an Action Research Project was set up to investigate DRWH options in western Bangladesh. The project is being conducted with financial support from SDC and is being implemented by NGO Forum within the working areas and collaboration of WatSan Partnership Project (WPP). The WatSan Partnership Project (WPP) is an innovative and participatory Action Research Project that places the user community at the centre of planning and implementation of water and sanitation intervention. The WPP is a demand-based project that operates through a partnership of NGOs working directly with Village Development Committees (VDCs). The WPP is applying field-tests on different low cost technologies for application in arsenic contaminated areas. The WPP, therefore, provides an appropriate context for demonstration and testing of Domestic Rain Water Harvesting in combination with other technologies.

The project started in June 2000 and was scheduled to end in December 2001. An evaluation of the Action Research Project was conducted in August 2001 by an assessment team comprised one external consultant from SKAT (Switzerland), NGO Forum and WPP personnels. The team visited new installations in the research project area. In order to obtain relevant baseline data, the team also visited installations constructed by NGO Forum in the coastal belt area (Khulna) and visited areas where traditional DRWH is still in evidence. Interviews and discussion forums were held with key stakeholders involved with the external support agencies, government officials, project staff, project partners, user groups and householders themselves. The outcome of the evaluation was documented in a report " Short Term Consultancy to NGO Forum for Drinking Water Supply and Sanitation on Action Research Project: Domestic Rainwater Harvesting in Bangladesh". The assessment mission discovered some important pending issues which were not possible to complete within the project period because the overall length of the project had been too short to extract the full potential value of the research conducted. So the team recommended that the research period be extended for another 2 seasonal cycles beyond December 2001. This would allow sufficient time to consolidate the work carried out so far, and to extend research towards replicable solutions for lower income groups. As per the recommendation, the project continued up to December 2003 with financial support from SDC.

At end of the project period, a total of 268 units of different size and shapes have been constructed with the project areas. These RWH systems are of eight types considering the capacity of storage tank (500 litres, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3) and the used construction materials included concrete ring, brick, Ferro cement, earthen Motka etc. This Action Research has covered the technological, social, institutional and environmental aspects of household based RWH. The expected outcome of the Action Research would be a cost effective, environment-friendly, sustainable household RWH technology in combination with other technologies in arsenic prone areas. The WatSan (Water & Sanitation) sector is expected to be benefited from the findings of this Action Research.

2.3 Objectives of the Action Research Project

Rain water harvesting offers a good arsenic free alternative drinking water source. However, to position rainwater harvesting properly in the range of options in the rural water supply, several aspects of its application in Bangladesh need to be investigated and clarified.

The overall objective of this action research project is to demonstate that rain water harvesting systems can provide a suitable, safe, socially acceptable and sustainable alternative source of water for drinking and cooking in rural Bangladesh for 8-10 months of the year.

The specific objectives of the project include -

- To assess of the technical requirements for efficient rainwater harvesting. Test and improve existing models (e.g., design of cost-effective tank of various sizes).
- To demonstrate simple technical models of do-it-yourself (DIY) for the very poor, without abandoning the high profile and established Ferro-cement systems for financially solvent households.
- To document of good experience and learning from the project and disseminate those among the sector agencies including the community people.
- To promote and encourage the private sector actors so that they could play an effective role for supplying of hardware materials as per the community needs during and after the project period.
- To monitor and document construction and performance of the RWHS in terms of users acceptance and user friendliness, water quality, water security and general system management, and
- To develop construction manuals and procedures for the implementation of rainwater harvesting as an option for rural water supply.

2.4 Setting of the Project Area

The study area is located in the western part of the country and north bank of the river Padma. The project was within the working areas of WatSan Partnership Project (WPP). It was in 15 arsenic affected villages at Bagha and Charghat Upazilas in Rajshahi district. The villages had been selected considering the concentration of tube-wells contaminated with arsenic and the absent of suitable safe water options. A total of 3,290 families were living in the 15 villages namely Miapur, Anupampur, Arazi Sadipur, Chandpur, Talbaria, Kaluhati (West), Kaluhati (east), Batikamari, Fakirpara, Jotnasti, Kishorpur, Beelpara, Monigram, Habashpur and Bajubagha.

Socio-economic profile of the villagers, health and WatSan situation and information related to RWHS of the selected villages for the action research was collected through a baseline survey. About

1700 families having a family size of 5 reside in the selected 8 villages of the project area. Agriculture is the main occupation of the villagers. Most of the villagers live below poverty line and some are hardcore poor living in extreme poverty conditions.

Groundwater (Shallow TW) was the primary source of water in all villages and a significant number of Tara pump were also in use. The presence of arsenic and iron in tube well water, beyond the acceptable limit were identified as one of the major problems for safe water supply. Baseline survey revealed that about 40% of the tube wells were contaminated with high concentration of arsenic. A total of 65 people from 34 families were identified the arsenicosis patients. Many of them were severely affected and two had died.

As mentioned earlier, the average annual rainfall of the study area is around 1400 mm and the highest rainfall occurs in the month of July, which is 300 mm. Over 75% rainfall occurs from the month of April to October. More than 70% catchment (house roof) was in usable condition for rain water harvesting system. A significant number of roof catchments were made of CI sheet and others were RCC, Tiles, thatched etc. The survey results reflects that most of the villages do not collect rainwater for drinking and a small portion of households used to collect rainwater for cooking and washing purposes.

2.5 Project Approach

In the Action Research on Rain Water Harvesting participatory approaches were followed. The WatSan Partnership Project (WPP) is an Action Research Project that placed the user community at the centre of planning and implementation of the safe water supply and sanitation intervention. The research carried out under the purview of WatSan Partnership Project (WPP) is a demand based project that operated its activities through partner NGOs directly working with Village Development Committees (VDC) in the project area. Within the project boundary there were some arsenic affected areas. Through these VDCs the Rain Water Harvesting System (RWHS) has been testing as a suitable, safe, socially acceptable and sustainable alternative source of arsenic contaminated under groundwater (tube well). NGO Forum channeled its inputs through the partner NGOs that are common to WPP and coordinated with the WPP.

The project work started with promotional activities of mobilizing the community and disseminating information on arsenic and its harmful effects on public health, and safe water options (Rain Water Harvesting, its cost and implications). The partner NGOs and VDCs worked closely in dissemination of information on arsenic, rain water harvesting and selected households to demonstrate and test rainwater harvesting systems. As the action research on RWHS has responded to demand for services, the numbers of RWHS were not fixed. The actual number of system depended on users demand, because the community had the choice and voice on a range of rainwater harvesting options. Different types of promotional activities such as courtyard meetings, community meetings were conducted at the community level.

The concept of action research on rain water harvesting system and technology was new to the partner staffs, private sector and the community. Therefore, different training programmes were organised and conducted to impart knowledge, skills on RWHS to different groups to build up the capacity. Trainings were organized and conducted for partner NGO staffs, mason/craftsmen on construction of RWHS, potter on producing large capacity Motka and caretakers on proper O & M of the system.

Initially without spending time in designing the RWHS it was tried to develop storage tanks of proven models which developed elsewhere in the region and improved on the models during testing and monitoring. Emphasis was given on the construction of systems that use locally available materials such as Motkas for storage, polythene sheet for collection etc.

Monitoring of all the systems installed in the project was continued using monitoring tools. Participatory monitoring activities started later. Community based monitoring system was developed and introduced to involve the community in the monitoring process. Water quality was tested at laboratory on a regular basis. Computerised data base was developed to analyse the monitoring information. Monthly VDC meetings which created scope to exchange and disseminate information between the project staff and community.

2.6 The Study Cycle and Methodologies

Research methods have been defined as tools to be used for answering specific questions and for solving different scientific or practical problems. The action research on Rain Water Harvesting determined how the community groups could participated themselves in the operation and maintaining the system. It was a process in assessing the views of the community as to how does rain water harvesting systems can provide a suitable, safe, socially acceptable and sustainable alternative source of water for drinking and cooking in rural Bangladesh for 8-10 months of the year. i.e. the study was organized as a community self study, the project staffs and partner NGOs facilitated the whole process following the methodology. In the action research on Rain water Harvesting System the qualitative and quantitative methods were followed. Participatory and community based monitoring techniques were followed for the collection of information. Simple questionnaires, checklists, pictures were used as tools. Computer based data processing technique was applied for analysis of collected information and providing necessary feedback.

The project started with promotional activities for disseminating information on rainwater harvesting, its costs and implications. In the first cycle, the project started with rainwater harvesting systems which had been proven elsewhere in the region and improved on the models during testing and monitoring. Concomitantly with standard models the project worked closely with the user community in improving elementary existing user practices of harvesting water for immediate use. Attemps were made to construct systems using locally available materials. Training was organised and conducted for project & PNGO staffs, private producers & professional masons, community on RWHS. At the end of this cycle technical details of the systems were built, approaches and lesson were complied in forms of manuals, training modules and flyers.

In the second cycle, these materials were used and tested at the project areas. This testing cycle was in particular focused on providing rainwater harvesting options that users felt comfortable with and private sectors were encouraged to participate. Local potters were trained up on making large capacity Motka and oriented the shopkeepers for the availability of essential materials in the project areas. The progress of project was shared by organizing a regional workshop with the participation stakeholders, mass media, and beneficiaries. The progress of the project was evaluated by an external agency (SKAT).

In the final cycle, the project activities were consolidated. Main attention was given on community participation & ownership, user operation & maintenance, market promotion, water security by using dual water options (Rainwater in the rainy season with other option in the dry season), expansion of do-it-yourself model with out abandoning standard ferro-cement models. Participatory and community based monitoring of all the systems installed in the project were continued. Through the monitoring and feedback from the community replicable model of Rain Water Harvesting Systems had been developed. Two issue based study were conducted on "Ethnographic study on using of Rain water" and "Mineral deficiency of rainwater users". The project concluded by the end of 2003 with publication of brochure and evaluation of the project which covered technical, social and managerial aspect. The experiences of the project were shared by organizing a one day national workshop.

2.7 Activities implemented

Action Research programme was undertaken to study the issues pertinent to rain water harvesting and find answers to questions in order to be able to establish the applicability of Rain Water Harvesting as a common option in rural water supply in Bangladesh. The approach was to promotion and application of rainwater harvesting at household level must be through the VDC in conformity with established practices first start in the project areas. Considering the objectives and goals of the project different activities (promotional, training, information & communication, monitoring, hardware etc.) were designed and planned to conduct for mobilizing and responding the demand in the view of the community. Activities are also finding out and accomplishing to extend research towards replicable solutions for lower income groups. The construction of RWHSs was not restricted, first series of RWHSs were built based on proven models and unspecified do-it-yourself models in the following years. As per the Project Plan implemented the activities are described below:

2.7.1 Software

Software activities were very significant to analyze the prevailing situation, mobilizing the community, impart knowledge & skill on the rain water harvesting system and arsenic. Likewise, software activities were effective to ensure the participation of the community with the study and sharing the learning & experiences with concerned stakeholders. The software activities are as follows:

Promotional: Promotional activities are the best approach for sharing information, exchanging views and awareness rising of the targeted community on the Rain Water Harvesting System (RWHS). The project had achieved substantial progress in creating awareness and also in disseminating of information regarding arsenic and rainwater. Special emphasis was given among the community on the promotion of community participation and ownership, hygiene promotion, perception on water as economic commodity and strengthens the Village Development Committee (VDC) on organizing the community people on arsenic issue and construction of new system and ensuring proper O&M of the systems. During the project period, Baseline Survey, Project Launching Meeting, Survey on Willingness to Pay, Courtyard Meeting and Community Meeting were organized and conducted in the community.

Training: A good product and a genuine market opportunity provide a significance to attract the private sector. Rain Water Harvesting System (RWHS) is an unfamiliar technology in Bangladesh, so it is needed to encourage the private entrepreneurs to take risks. The Action Research identified requirement to train masons in the construction of new technologies and local potter to develop large capacity Motka for low income group people, build-up awareness amongst the retailers of developing market for certain goods and sustainable operation and maintenance for caretakers. Ultimately, the private sector's motive of making money from the technology being promoted by the project and it is important that an information loop has been established between product development and training initiatives so that the most appropriate messages could be injected through the project concerning technology options into the private sector.

Information and Communication: It was an important objective of the action research project to document and disseminate the good learning and experiences through different printing, electronic media and discussion forum. Different IEC/BCC materials were prepared such as Construction Manual, Consolidated design and construction manual, O&M manual, flyers and brochure etc. Under information services different activities were performed such as case study, experience sharing workshop, hosting web site etc.

2.7.2 Hardware

The project started with the installation of available proven regional (Thai, Sri Lanka, Nepali) models of storage tanks and built 10 – 12 test tanks in sizes of 500 litres, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3. Concrete ring, brick, Ferro – cement, Earthen Motka etc. were used as construction materials. The aim was to develop range of technological options considering the different buying capacity of the community and the cost was Tk. 2.5 to Tk. 1.5 per litre. The concept of combined water supply system was introduced, that as the storage of rainwater to meet the total needs in the dry season would not be realistic, rainwater harvesting would be in combination with other water supply options in the project area. i.e. It might be rainwater harvesting in the monsoons and dugwell/distant arsenic free TW in the dry seasons. Hardware activities summarized below:

Design of Rain Water Harvesting System: During the design of RWHS, emphasis was given on both technical and social aspects so that it could provide a suitable, affordable, safe, socially acceptable and sustainable alternative water source for drinking and cooking for 8-10 months of the year. The design was prepared following the available regional (Nepal, Thailand and Sri Lanka) models of storage tanks of 500, 1000 and 2500 litres capacity and using different materials such as concrete ring, brick, and Ferro-cement.

The rainfall pattern of the project area, family size (nuclear family), consumption per capita per day, suitable roof size and roof material, socio-economic status, cost of the plants and availability of the construction material were also considered during the design of RWHS.

The primary design consideration of rainwater harvesting system in the project area was based on the concept of "combined water supply system" Rainwater Harvesting as the sole source of water supply is costly particularly because of the large storage required for reliable supply throughout the year. In this research project, household rainwater harvesting was designed in combination with other suitable community water sources to make the system cost effective, affordable for low income groups, and to provide water security round the year.

Very simple do-it-yourself models were introduced at the community so that people can construct storage reservoirs of less capacity so that they can use rainwater during the entire rainy season and about 2 – 4 months of the dry period. For the rest 2 – 4 dry months the users can collect water from any communal system such as nearby or distant arsenic free tubewells, filtered pond water, dugwell or even from a large community rainwater storage reservoir, e.g., at schools or colleges where large roof catchment areas are available.

The important components of RWHS that were considered in the design include:

I. Storage Tank
II. Roof Catchment
III. Gutter
IV. Flushing system and
V. Collection point

I. Storage Tank: The main variables of designing different models of RWHS considered are as follows because more than 80% of the system cost is borne for the construction of storage reservoirs. So different strategies were taken to reduce the cost of construction such as: a) use combined water supply system; b) storage tanks were designed of sizes, e.g. 500 litres, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3; c) locally available construction materials: concrete rings, bricks, Ferro-cement, and burnt clay Motkas were used d) In designing and construction of storage tanks different cement mortar of different proportions and thicknesses of storage reservoir were used.

II. Roof Catchment: The baseline survey revealed that a considerable percentage of house roofs was made with CGI sheet and suitable to use as the catchment of RWHS. Moreover to get the answers to many question (water quality, water collection efficiency, suitability for maintaining) different types of roofs were used as catchment such as CI sheet roof, polythene sheet over thatched roof, tiles roof etc. Where suitable roof is not available, CI sheets have been provided for roof catchment. In some households a combination of tiles and CI sheet roofs are also used.

III. Gutter System: Different types of locally materials were used in the design and construction of RWHS, such as GI sheet, 3" dia PVC pipe and Split Bamboo. The important design consideration for gutter design is the appropriate slope required for transporting rainwater to the collection point and into the storage reservoir.

IV. Flushing System: Flushing system has also been designed which consists of 38 mm dia PVC pipe along with GI elbow and a screw cap at the end. The important design consideration for Flushing System was that the easy flushing the first foul rainwater.

V. Collection Point: A Collection point was designed to maximize water storage, to ease water collection into the tank and to ensure that the water entering the tank is safe.

Computer Modeling: Computer modeling is an important tool for verifying the designed models of RWHS considering different technical and economic aspects. Computer software was developed to assess reliability of supply, degree of security and the cost effectiveness of RWHS. The computer modeling was performed on the basis of rainfall pattern of the project area, consumption pattern per nuclear household of 45 L/day and the variables were roof size, reservoir size and expected costing.

In the modeling, the mass curve analysis was adopted to calculate the size of the storage device. Input variables include monthly average rainfall data, catchment area, roof run off coefficient, per capita water consumption per day and the size of the population using the storage reservoir. From the curve different determinants could be determined such as reliability, degree of security, required storage volume, catchment size, user group etc.

Forecasting of the situation was very efficient while constructing of a tank smaller than the design size for the low income groups. The constructed tank of sufficient volume provides the security that rainwater will not spill over the tank for certain span of time (few years). Tank volume from different security level was calculated pending on the demand and the roof area, cost effectiveness of different RWHS options. Since many uncertain factors are involved, the reliability concept was introduced with rain water harvesting. Reliability means the probability that a given size of tank will be sufficient to supply necessary quantity of water for a period of 8 to 10 months in a year. The probability that a tank of a given size is sufficient to store required quantity of water over a certain span of time is also important. It is determined by introducing a term "Degree of Security".

Construction of RWHS: Construction work was started with the available proven regional (Thai, Sri Lanka, Nepali) models of RWHSs. In the first phase that is up to December 2000, the target was to construct 50 RWHS in the selected villages of households with arsenic contaminated TW to provide safe drinking and cooking water. To meet up the demand of the community 51 RWHS were constructed. The second series of RWHSs were constructed following the design considerations of tank, catchment, gutter, flushing and water collection point. A range of technological options were demonstrated considering the affordability of the community.

Up to December 2003 a total 268 RWHS were constructed which were of different capacities ranging from 300 liters, 500 litters, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3 and of different materials such as RCC ring, brick, Ferro-cement, plastic tank, Earthen Motka etc. Some do-it-yourself models were also constructed. In the project area almost all the catchments are of CI sheet roof with an average area of 20 m^2 used for rainwater collection. A construction manual was prepared showing construction details of storage tanks of different sizes and materials, and other components of RWHS. Private sector (private producer, hardware shopkeeper, welding shop, Potter) played an effective role for the promotion of rain water harvesting system in the project areas. After receiving training on RWHS construction, the private producers produced innovative low cost models of RWHS. Local potters trained up on producing large capacity earthen Motka (300 – 500 litres capacity). These Motkas are very cheap, which is used as storage reservoir of RWHS and other household purposes. The hardware shopkeepers made available the essential materials as per the demand of the community.

2.8 Replication of RWHS

NGO Forum undertook the Action Research programme to study the issues pertinent to Domestic Rain Water Harvesting System and found answers to questions in order to establish the applicability of Rain Water Harvesting as a common option in the rural water supply in Bangladesh. The project aimed to support the development of a replicable and accessible approach to domestic RWH as one possible component of a much wider dual - supply package at household level. This incremental and compartmentalised approach to DRWH was designed to enable low income families to meet part of their immediate needs in a safe manner and developed convenient, affordable and safe household water supply systems over time as they saw fit. The project could prove that the range of technological options with combined water supply system can be replicated in the other geo hydrological areas of Bangladesh. For ensuring 100% water security community based water supply system should be installed such as PSF, Dugwell, AIRP, etc.

2.9 Monitoring and Evaluation

Monitoring was considered as an essential tool for project management. Systematic collection, processing and presentation of relevant data fall primarily under monitoring activity. It provides the management at all levels with information required for measuring progress and effectiveness of activities to adjust policies, strategies and institutional arrangement and collection of resources where necessary.

During the project period, a regular information exchange and participatory monitoring mechanism was created between households and between the field staffs. The project field staffs together with the households performed a regular sanitary inspection of the systems and advised the users on keeping the various parts of the system clean and checked the first flush device. Water samples were collected on a regular basis which was then tested in the laboratory for water quality parameters.

Monitoring reports were prepared that reflected important aspects of system's performance such as quality of construction, functioning of RWHS i.e. operation and maintenance by caretakers, quality of water i.e., physical, chemical and bacteriological quality and use of water for drinking and cooking.

In the project cycle two external evaluations were organized and conducted. One evaluation was conducted at the middle of the project period (in August 2001) by an assessment team comprised one external consultant from SKAT (Switzerland), one representative of the engineering desk at NGO Forum and one representative from the project management unit of the WPP. Another evaluation was conducted at the end of the project period (in December 2003) by an assessment team comprised two external national consultant (one Water supply expert from BUET and another Social expert from Rajshahi University).

2.10 Major Observations of the Study

268 RWHSs were monitored on monthly basis by the project staff, partner NGOs staff and community (VDC, Caretakers). VDC members actively involved themselves with the activities of Action Research Project, such as information dissemination, site selection, and collection of contribution money, construction supervision and monitoring of RWHS. The major monitoring findings were illustrated in the following section:

2.10.1 Technical

Storage Tank: To offer the advantages of RWHS to classes of community different strategies were taken to reduce the cost of construction such as: a) use combined water supply system; b) storage tanks were designed of sizes, e.g. 500 litres, 1.0 m^3, 2.0 m^3, 2.5 m^3, 3.2m^3; c) locally available construction materials: concrete rings, bricks, Ferro-cement, and burnt clay Motkas were used d) In designing and construction of storage tanks different cement mortar of different proportions and thicknesses of storage reservoir were used. The monitoring observation revealed that the construction quality of all the RWHSs was good and all the models are sustainable. Demand of Do-It-Yourself (DIY) model was significantly increased among the poor due to cheaper option. Potter training on making large capacity Motka was very much fruitful for imparting knowledge & skill on new technique and potters were encouraged in producing large capacity Motka. Some trained up private masons are found enthusiastic on the Rain Water Harvesting System. They have developed innovative model of RWHS using locally available materials.

Catchment: A considerable percentage of house roofs in the project areas were made with CGI sheet and suitable to use as the catchment of RWHS. To search out the answers to many question (water quality, water collection efficiency, suitability for maintaining) different types of roofs were used as catchment such as CI sheet roof, polythene sheet over thatched roof, tiles roof etc. Where suitable roof is not available, CI sheets have been provided for roof catchment. In some households a combination of tiles and CI sheet roofs are also used. It was observed that the Thatched roof is not suitable as Catchments of Rain Water Harvesting System (RWHS). Because some problems were experienced inherent to this type of catchment i.e. more water needs to flush at the beginning (flushing first foul water), water became coloured, poor bacteriological quality and not accepted by community due to aesthetic reason. On the other hand CGI sheet roof is good for rainwater harvesting.

Gutter System: GI sheet made gutter is available at the local market in different quality and price. To give the answer to many questions different types of locally materials were used in the construction of RWHS as per the design, such as GI sheet, 3" dia PVC pipe and Split Bamboo. Appropriate slope was provided for transporting rainwater to the collection point and into the storage reservoir. The monitoring observation showed that the GI sheet made gutter worked well and easy to operate and maintain by the caretakers. PVC pipe made gutter did not perform satisfactorily, dust stick in the inner side of the pipe and algae grown which need extra care to ensure the quality of water.

Flushing System: Flushing system was installed with the Rain Water Harvesting System for easy flushing the first foul water by the caretakers. It was consists of 38 mm dia PVC pipe along with GI elbow and a screw cap at the end. It was observed that the design of flushing system was sustainable and adequate to flushing the first foul rainwater. The caretakers and users could easily operate and maintain the system.

Collection Point: A water collection point was constructed to maximize water storage, to ease water collection from the tank and to ensure that the water entering the tank is safe. It was observed that for hygienic collection of water from the tap it is essential to constructed water collection point.

2.10.2 Water Quality

The quality of rainwater was questionable or unclear to most of the professional of WatSan sector and user community. To disclose the confusion and give answer of all question about water quality of rainwater especial attention was given on the testing the water quality parameters. Physical, Chemical and Bacteriological quality of stored rainwater was tested at laboratory on regular basis.

Bacteriological quality: To examine the quality of stored water the Total Coliform (TC) and Fecal Coliform (FC) were monitored and tested at laboratory from each of the plant on regular basis. In this connection about 1340 water samples of TC and FC were tested. Regarding the test result of TC, out of total samples 894 were bacteria free and 446 were contaminated. On the subject of FC, out of total tested samples 1083 were bacteria free and 254 were contaminated.

The test result revealed that the bacteriological contamination was observed at the initial stage of commissioning the RWHS, because capacity of the caretakers was not built up within the short on the water quality aspects. The field monitors found that it happened due to improper collection of water. The quality of rainwater is good if it is operate and maintain properly. The bacteria did not find in the stored rainwater even one year after the collection of rainwater. At the beginning of the project the incidence of bacteria was more but with the passage time the users group were imparted the skill ness on harvesting and preserved rainwater as a result it was reduced.

p^H: Universally pH is used to express the intensity of the acid or alkaline condition of a solution/water sources. In the aqueous solution the value of pH is used an important determinants. Therefore the parameter pH was tested regularly from each of the RWHS. The acceptable limit of pH in drinking water supply system lies within the range of 6.5 – 8.5. Regarding the pH about 2419 water samples were tested, out of total samples 335 samples were found within the acceptable limit. Most the test result of beyond the acceptable limit and was greater than 8.5.

The result shows that the pH values of the water still high then the WHO guide line. Even the sample of rainwater collected from open air in different places of the project areas and tested. In this case, the value of pH was also greater than 7.5. It was revealed that the value of pH in rainwater is always greater than equilibrium position (7.0) i.e. in Bangladesh the rainwater is alkaline. The main causes for the higher range of pH value could not be identified.

Turbidity: Turbidity occurs in most waters due to the presence of suspended clay, silt, finely divided organic and inorganic matters, plankton (algae) and micro organisms. Turbidity in excess of 5 NTU is generally objectionable to consumers. WHO standard of turbidity in drinking water is 5 NTU. In rainwater turbidity more than the acceptable limit may be occurred due to the improperly collection of water from the catchment i.e. harvesting of rainwater without flushing the first foul water for 10 to 15 minutes.

In the action research project the turbidity of the stored was tested regularly. About 1035 water samples concerning turbidity was tested and only 50 samples were found unacceptable. This was happed at the initial stage of the project and after follow up & monitoring this situation was improved.

Test of Other Parameters: Other water quality parameters such as Iron, Arsenic, Electric Conductivity, Calcium, Magnesium, Zinc, Lead and Fluoride were collected from RWH tank on random basis and tested at the laboratory. The mention water parameters of following number were such as: 58 Iron, 12 Arsenic, 46 Electric Conductivity, 23 Calcium, 22 Magnesium, 11 Zinc, 14 Lead and 18 Fluoride from different RWHSs were tested to justify and validate the quality of rainwater to the professionals and practitioners of RWHS. The test result of all the water samples within the acceptable limit.

2.10.3 Use of Rainwater

Rainwater is the purest water in nature. Physically, it is clear, bright and sparkling. Chemically, it is a very soft water. It is also naturally free from bacteria, arsenic and even any kind of minerals which normally present in under groundwater e.g. salts of calcium and magnesium, compounds of iron and manganese, fluorides, nitrates etc. So the taste of rainwater is flat taste (no taste). Initially the users of rainwater opined that the taste of water was bitter, but after some period people were habituated with quality of rainwater. It was accepted by the users. They were using this water for cooking and drinking purposes. Beliefs in rainwater for using drinking purpose were increased day by day among the users. The users shared their experiences in cooking with rainwater that it is very well in cooking. The taste of cooking rice, pulse, meat etc. with rainwater is considerably delicious than TW water. Users also shared that cooking with rainwater takes less time and fuel than TW water. And the food cooked with rainwater last longer time than the TW water.

More observations in the water quality aspects revealed that some intestinal disease like gastric, dysentery, indigestion etc. had decreased remarkably among the users of RWHS. Field observation also showed that underground water (TW) contains high level of iron and these diseases may be occurred due to intake irons TW water.

2.10.4 O&M by Caretaker and Users

Proper O&M is important to ensure the quality of water and the sustainability of the system. Collected water should satisfy the guidelines of WHO drinking water standards i.e. physical, chemical and bacteriological quality of stored water should be safe enough for drinking and household use. O&M and management of rainwater harvesting systems are less complex than most other technologies.

The field observation revealed that before storing water the caretaker/users clean the entire system and disinfect the storage reservoir with bleaching power. And properly flush the first foul rainwater for 10 – 15 minutes depending on the intensity of rain. They learnt that debris, dirt and dust normally stick on the roof of a building or other collection roof and water quality mainly depend on the properly harvesting of rainwater. The action research project adopted the VLOM (Village Level Operation and Maintenance) concept in rainwater harvesting system. The sustainability of a technology also depends on the regular repairing and maintenance. The caretakers of the RWHSs can repair the minor problems of the technology and keeps clean the surrounding of the tank.

2.10.5 Social aspects

People are becoming aware of the RWHS as alternative water sources. People are being habituated and practiced the dual water supply options i.e. Rainwater in the rainy season and distant safe tube well water or other suitable options in the dry months. Ownership feeling has increased among the beneficiaries and they were involved with the construction process of RWHS specially the women members of the family. Caretakers acquired knowledge about hygienic collection; preservation and use of rainwater and most of the beneficiaries were also skilled on proper management of stored water. Community people are aware on the effect of arsenic contamination and also its remedial measures.

It offers immense convenience equal to piped water supply during the rainy season simultaneously reducing time and energy spent on water collection for drinking and cooking even during a part of the dry period. RWHS could be constructed every nearer to the kitchen. Moreover, it potentially improves the position of women and girls as less time and energy is spent on water collection chores. 20% cost sharing for the hard core poor is beyond their capacity. Demand has been created among the people of neighbouring villages and they are ready to contribute about 50% of the total cost.

2.10.6 Findings of Special Studies under the Project

Under the project two studies were conducted on special to search out the answer of social, cultural, behavioural and health aspects in promoting of Rain Water Harvesting Systems in the project areas. The study finding is briefly described as follows:

Ethnographic Study

Rainwater harvesting offers a good arsenic free alternative source of drinking water. However, to promote the rainwater among the users, the social issues related with the use of rainwater needs to be investigated and clarified properly. Objective was to investigate the views of the community that rainwater-harvesting systems is a suitable, safe, socially acceptable alternative source of water for drinking and cooking in rural Bangladesh for 8-10 months of the year. An external consultant conducted this ethnographic study. The study revealed important insight information, which enrich the research programme and help the stakeholders in implementation of RWHS in different areas of the country.

At the initial stage people were not infavour of using rainwater for drinking and cooking purposes. Because it is thought that preserved rainwater is stale and this may be polluted for preservation for long-time and it would be harmful for health. After motivation, discussion, orientation and training; people are very conscious about the economic value of rainwater especially in dry season. About 85% of the people of RWHS user family use rainwater for drinking and cooking purposes.

Study on Mineral Contents on Rainwater users

Rainwater is a natural source of fresh water; it offers good arsenic free at the same time alternative source of drinking water. Rainwater is also free from all kind of mineral compositions, which are normally present in under ground water. However, to promote rainwater among other alternative safe water sources the mineral deficiency of the users communities has been investigated and clarified.

The main objective was to investigate the mineral deficiencies (calcium, iron and magnesium) of the people who are using rainwater as alternative source of water for drinking and cooking purposes in project areas during 8 - 10 months in the year. This study was conducted by an external consultant, which also provided important information.

This was a prospective cohort study which has been conducted in the Action Research Project areas (15 arsenic contaminated villages of Charghat & Bagha Upazillas of Rajshahi district where RWHSs were constructed). The 'rainwater exposure Cohort' of 11 to 60 years age groups were selected and constituted as the study population. A group of 50 apparently healthy exposures to rainwater was selected randomly from the sample frame of the study population by stratification for 12 months follow up. The stratification was designed to assure proportionately roughly equal representation of all subgroups of the study population by age, gender, and socio-economic status. After identification of the probable exposure cohorts for the follow up, half of the exposures that means 25 apparently healthy individuals were selected among the nearest neighbors' sample frame of tube well water consumers by matching of age, sex and socio-economic status insuring roughly half in numbers of each subgroups of the selected cohort as controls. The exposures and controls with abnormal biochemical status {not within the reference values of the concerned minerals (serum calcium: 2.10 - 2.60 μmol/L, serum iron: male 10.60 - 28.30 mmol/L and female 6.60 - 26.0 mmol/L, and serum magnesium: 0.75 - 1.25 mmol/L)} and having anemia (hemoglobin level $\leq$ 11g/dl) were replaced by others with normal biochemical parameters (concerned minerals and hemoglobin level) from the prepared sample frames matching age, sex and economic status. Both the sample frames of rainwater and tube well water consumers were prepared by a survey at the beginning of the study among the rainwater consumers and their nearest tube well water consumer neighbours. Minerals have been analysed of the existing 8 water sources (4 rainwater and 4 tube well water) which were used by study cohorts and their controls from different sources (reservoirs) were also collected by randomly.

The result of the study showed that there was a remarkable incidence of mineral deficiency either iron or magnesium or both among the participants of exposure and control groups. There was no incidence of calcium deficiency among the participants. Incidence of iron deficiency anaemia was the only deficiency disorder found among the participants in this study. But the incidence of mineral deficiency and it's related disorders were not significantly higher among the rainwater than that of tube well water consumers.

2.10.7 Lesson Learnt from the Study

- Community participation is essential to introduce a new technology and to mitigate problems.
- Communities are practicing and habituated with combined water supply systems, i.e. Rain in the rainy season and other options in the dry season.
- Skill building of the private sector (mason, potter etc) should be ensured before introducing new technologies. They can produce law cost innovative model of RWHS.
- Rain Water Harvesting System can be constructed with locally available materials.
- Skill of the caretakers or users should be built- up on proper operation and maintenance of RWHS.
- Caretaker and user can harvest rainwater properly.
- The quality (bacteriological, chemical, physical) of rainwater is good compare to other technology.
- Community based monitoring system is the key tools for the sustainability of RWHS.
- Ownership development among the community on RWHS is very essential for the sustainability of the technology.
- Community accepted RWHS socially and using rainwater for drinking & cooking purpose.
- Market of Rain Water Harvesting System has been created through mobilization.

Chapter 3

Technical Evaluation of the Research Project

Introduction / Supply and Demand of Rainwater / Rainwater Storage Reservoir / Quality of Harvested Rainwater / Other Components of RWHS / Construction Methods and Materials / Operation, Maintenance and Monitoring / Some Minor Problems / Important Achievements /

3.1 Introduction

Under the Action Research Project a total of 268 units of rainwater harvesting system have been installed among the arsenic affected communities in 15 villages of Charghat and Bagha Upazilas. This task has been accomplished with the help of local partner NGOs, through different village development committees (VDC), for achieving greater acceptability within communities. One of the primary objectives of RWHS action research project was to ensure access to arsenic free safe water for at least 8 to 10 months of the year in combination with other community based water supply options such as distant arsenic free shallow or deep tubewells, large community rainwater storage, filtered pond water, and protected dugwell for 2 to 4 months of the dry period.

An earlier evaluation of the action research project in August 2001 recommended an extension of the research project for at least two more seasonal cycles before the social acceptability, and techno-economic viability of RWH system could be fully ascertained. The extended project has just ended in December 2003. However, the project time span still seems not long enough particularly for a research project that seeks solutions to issues related to people's acceptability, affordability, and long term sustainability despite the very critical situation of arsenic contamination of shallow groundwater aquifers. After all it took us decades to achieve acceptability of shallow handpump tubewells first through heavily subsidized government programs and later accelerated through private sector participation. It is in this context that the evaluation of rainwater harvesting in terms of both technical and socio-cultural aspects, becomes difficult, although the technology is being widely used under different conditions in many different parts of the world.

This chapter considers the technical aspects of the just completed action research project by NGO Forum for drinking water supply and sanitation on rainwater harvesting at two selected locations. The evaluation focuses on important parameters that include rainwater quantity, i.e., the supply and demand, design of RWHS components, rainwater quality, construction methods and materials for storage reservoir, operation and maintenance, system cost and acceptability.

3.2 Supply and Demand of Rainwater

The initial consideration of the feasibility of RWHS concerns availability of rainwater compared to its use or demand. Although rainfall is abundant globally, its distribution in both time and space is erratic. In this consideration, Charghat and Bagha Upazilas seem to have reasonable amount of rainfall throughout the rainy season with identifiable dry weather period between November and April. For designing the rainwater harvesting system, monthly average rainfall (averaged over a period of 30 years) data of the project area as shown in Figure 3.1, was used.

Figure 3.1 shows that there occurs sufficient rainfall particularly during the rainy season (from May to October). Average catchment area used for rainwater harvesting in the project area ranged between 200 and 250 ft^2 (i.e., approximately 20 m^2). The available catchment area in most households however, is well above 20 m^2. Assuming a run-off co-efficient 0.8 for an ideal CI roof catchment, average yearly supply form rainfall = 20 m^2 X 0.8 X 1.4 m = 22.4 m^3.

This reveals that average rainwater supply is abundant in terms of rainfall provided sufficient roof area is available. In the project area, in most cases, only a part the total roof catchment is being used for rainwater harvesting purpose. This means that larger roof catchment area could be used for rainwater supply throughout the year if larger storage facilities could be provided.

In the action research project, average water demand for drinking and cooking was assumed to be 7.5 litres per person per day. Therefore, monthly water demand for a family of six members stands at (7.5 X 6 X 30) = 1.35 m^3 and yearly demand 16.2 m^3. The rainwater supply thus exceeds the demand and therefore, proves to be a feasible water supply option in terms of water availability.

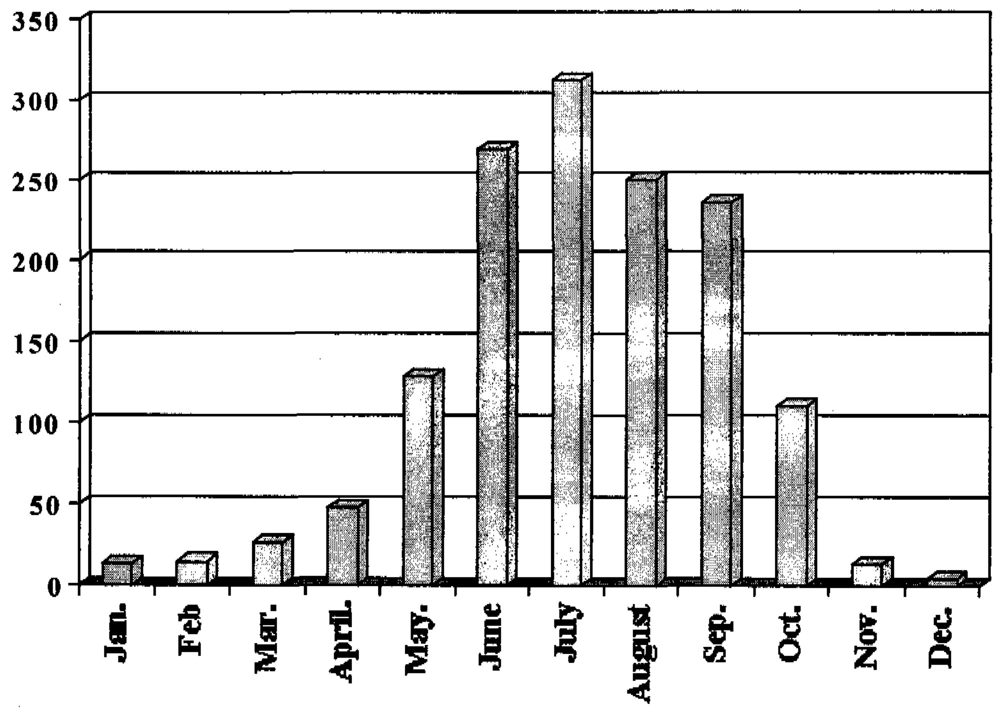


Figure 3.1 Monthly rainfall data (averaged over 30 years) for the project area

Field observation suggests that the average rainwater demand is actually less than 7.5 L/ person/ day in most of the families as rainwater is used only for drinking and cooking purposes. This is due to the fact that people use other available sources of water for bathing, washing and other household purposes. People of these arsenic affected areas are now very careful about use of rainwater and they follow strict rationing of the use of rainwater as they approach dry months of the year.

3.3 Rainwater Storage Reservoir

Different techniques are in use for determining sizes of rainwater storage tanks. Dry season demand versus supply is the simplest approach and appropriate where distinct dry season exists. In this approach the tank is designed to accommodate necessary water demand throughout the dry season and does not take into account variations in rainfall, and ignores rainfall input and catchment capacity to fill the tank.

Graphical method also provides a reasonable estimate of storage requirement. The approach plots a cumulative roof runoff graph and a line is drawn showing cumulative water use. The maximum difference between these two lines represents the storage volume needed.

Mass curve analysis involves identification of critical periods in data where the difference between critical run-off volume and cumulative demand are at a maximum. This difference represents the maximum volume available for future use.

Computer based models were developed by NGO Forum employing mass curve analysis to calculate the size of the storage tank. Monthly average rainfall data, catchment area, roof runoff coefficient, per capita water demand and family size were the input variables for determining the storage volume sufficient to supply water for a period of 8 – 10 months in a year. Reliability analysis of varying degree of security, 80, 90, or 99%, associated with given roof and tank system was performed to determine appropriate water usage rates.

For the purpose of this evaluation a simple graphical approach is used to determine the required storage volume for an average family in the project area as shown in Figure 3.2. The analysis assumes an average roof catchment area of about 20 m^2 based on field estimation, although larger catchment areas were available. Monthly average rainfall data of the project area (averaged over a period of 30 years) is used and cumulative water use line is drawn for a family of 6 members according to the assumptions mentioned earlier.

Figure 3.2 shows that storage volume required for a nuclear family is around 6.5 m^3. As mentioned earlier, rainwater supply is sufficient to justify the design of 6.5 m^3 storage tank. However, the high cost of storage reservoir and space constraints in most cases were the limiting factors and the tank storage capacity used was well below 6.5 m^3.

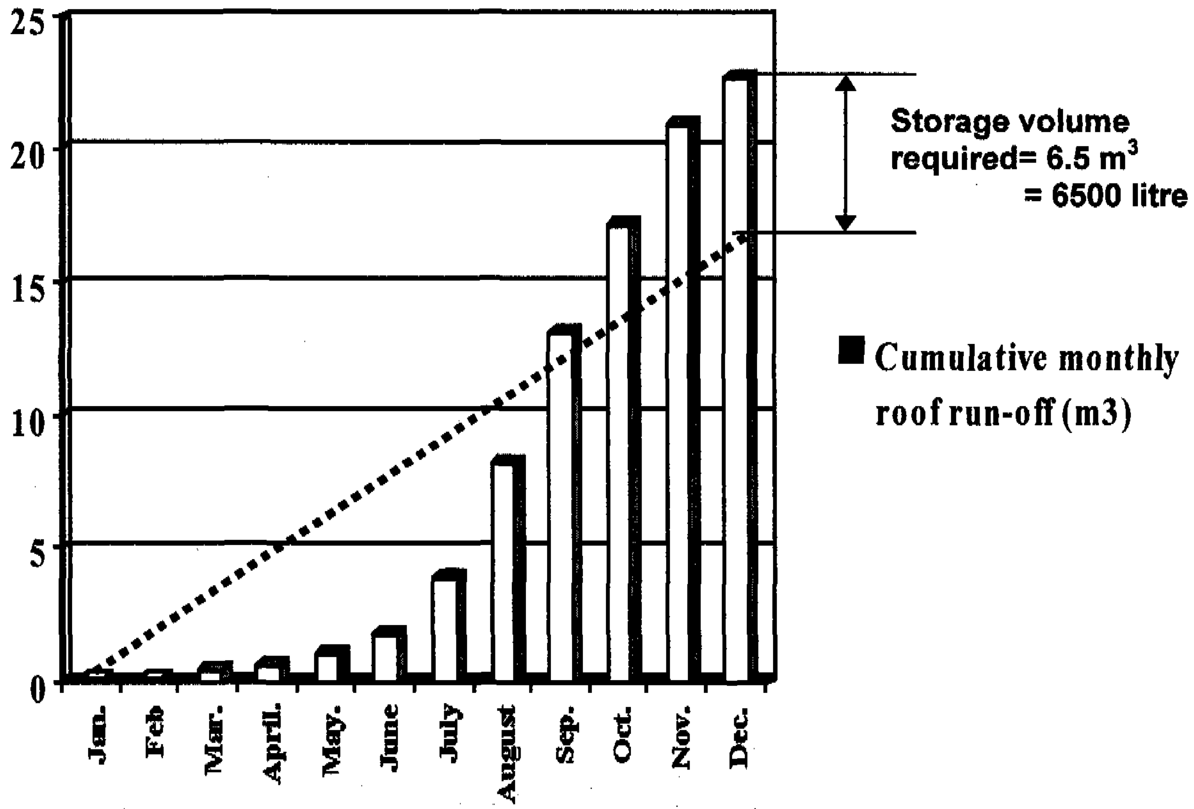


Figure 3.2 Storage tank volume determination using graphical method

instead of considering the demand and supply analysis. In most cases, the capacity of the storage tank was determined considering use of stored water for at least 2 – 3 months, assuming longest average dry period of 5 months. This implies that people will have to rely on other sources like collecting water from distant arsenic free shallow or deep tubewells, dugwells, filtered pond water or large community rainwater reserve e.g., at schools and colleges.

Therefore, average tank size determination in order to supply rainwater (for drinking and cooking) for 8 - 10 months of the year may be justified in combination with other reliable water sources to meet the demand for the rest of the months during dry period. In combination with an appropriate community water source for about 2 – 4 dry months, the rainwater harvesting, storage and use for drinking and cooking for most part of the year can therefore, be a viable alternative option for arsenic affected areas.

3.4 Quality of Harvested Rainwater

Rainwater quality was evaluated considering relevant water quality parameters that include pH, Turbidity, Total Coliform, Fecal Coliform, Iron, Zinc, Calcium, Magnesium, Fluoride and Lead. However, pH and Fecal Coliform (FC) are considered to be of special interest because of exposure of rainwater to atmospheric contamination and settled particles and bird droppings on the roof catchment. Atmospheric contamination may occur from gaseous emissions from nearby or distant industrial installations. Contamination with bird droppings or solid particles is common in rainwater harvesting and constitutes the major water quality concern unless the roof catchment area and other system components are kept clean before each rainfall event. NGO Forum conducted water quality monitoring at regular interval taking samples from different types of storage tanks. Some randomly selected water quality test results were assessed during this evaluation.

3.4.1 p^H

pH values of rainwater from storage tanks of different materials were analyzed as shown in Figure 3.3. All the samples showed pH values on the higher side ranging between 7.5 and 9.5, and initially a few samples showed even higher values up to about 11.0, which could be attributed to the use of cement containing lime. Later tests from the same storage tanks showed slightly lower pH values but still remaining high in the region of 8.0 of the pH scale.

To confirm this high pH value, tests were conducted on rainwater samples collected from open rainfall and not from roof or storage tanks. The results shown in Table 3.1 confirm higher pH value of rainwater, in the range of 7.5 to 8.0, but within drinking water quality standards. This can be attributed to the fact that the research area of Charghat and Bagha are located in a region not polluted by industrial emissions and therefore the rainwater is not acidic. However, further study would be needed to establish this conjecture. The other reason of high pH value could be the pH meter itself, which are very sensitive and may give erratic results if not calibrated regularly before use. The present quality of rainwater however, has brought some positive impacts on the quality of food cooked using rainwater, as claimed by the users.

3.4.2 Fecal Coliform

A similar analysis of test results for fecal coliform was performed for water samples collected from different types of storage tanks. The analysis is shown in Figure 3.4, which shows that during early project period until about middle of the year 2002, some samples showed high counts of FC. This could be attributed to some operation and maintenance problems, such as not cleaning the roof catchment and the inlet gutter before rain events, not opening the screw cap to divert the first flush water, and not washing the empty storage tank with bleaching powder. However, situation improved afterwards as indicated in Figure 3.4, which was possible through motivational campaign, user orientation and caretaker training. No significant concern for health risk was indicated in the test results of other water quality parameters.

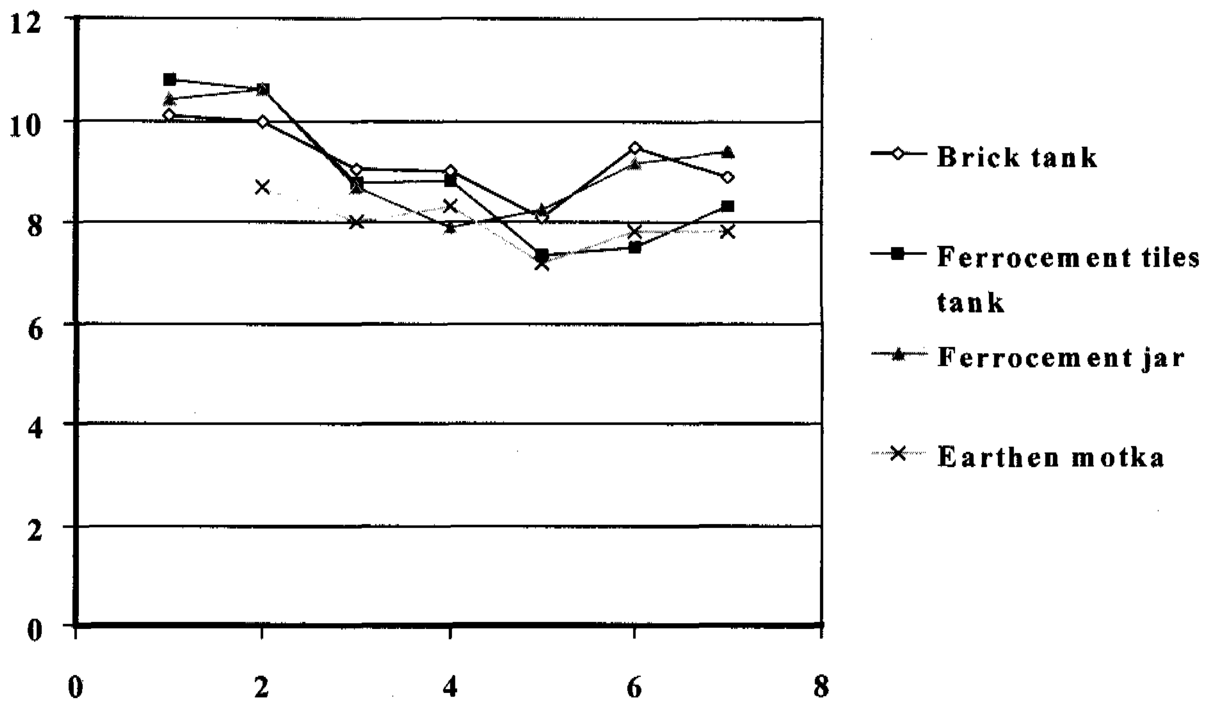


Figure 3.3 pH values of rainwater stored in storage tanks of different materials monitored during the period from October 2000 to September 2003

Table 3.1 pH values of open rainwater at different location of project area

Name of Village	Name of Upazilla	Testing date	pH value of open rain water
Monigram	Bagha	7/10/03	7.80
Habashpur	Bagha	7/10/03	7.89
Bajubagha	Bagha	8/10/03	8.00
Beelpara	Bagha	9/10/03	7.95
Bagha	Bagha	9/10/03	7.99
Kaluhati	Charghat	7/10/03	7.79
Fakirpara	Charghat	8/10/03	7.52
Arazisadhipur	Charghat	8/10/03	7.67
Miapur	Charghat	9/10/03	7.86
Chandpur	Charghat	9/10/03	7.93

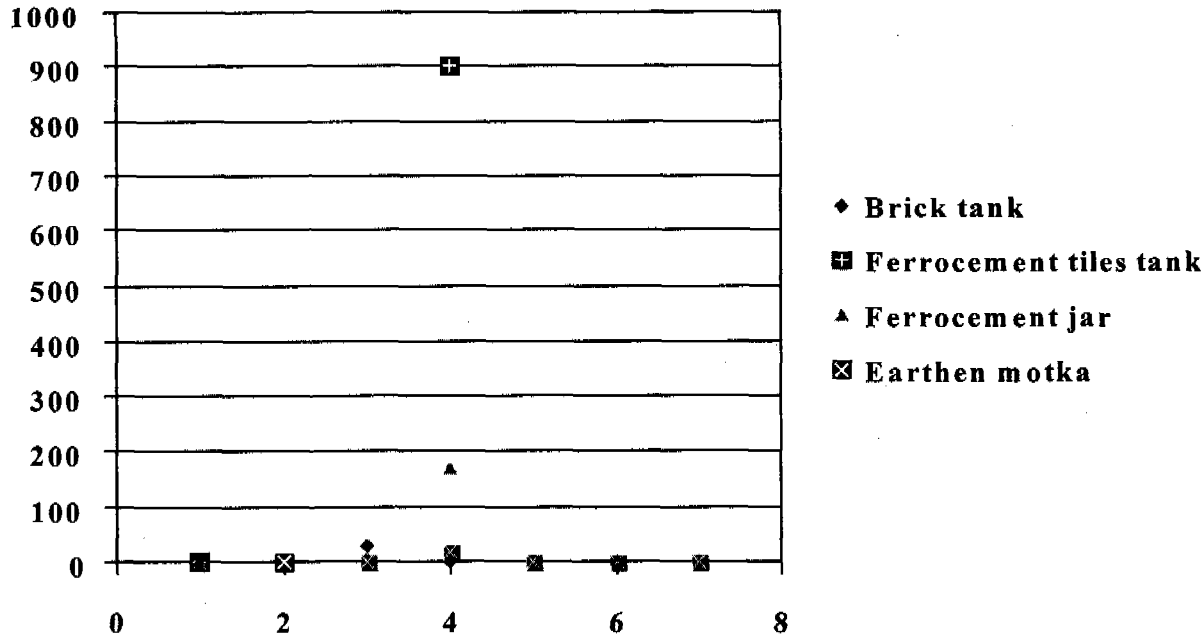


Figure 3.4 FC counts in rainwater stored in storage tanks of different materials monitored during the period from October 2000 to September 2003

3.4.3 Rainwater Quality Monitoring During Evaluation

To confirm the assessment of test results of different parameters conducted by NGO Forum over the project period, 5 random samples were collected from 5 different types of storage tanks, as shown in Table 3.2, during this evaluation.

Table 3.2 List of different types of RWHS selected for testing water quality parameters

Sl. No	Storage tank type	Roof catchment type
1.	Brick tank	CI sheet
2.	Ferro-cement jar	CI sheet
3.	Brick tank	RCC roof catchment
4.	Ferro-cement tank	Tiles
5.	DIY model (chari made)	CI sheet

The samples were tested at NGO Forum Laboratory in Dhaka except heavy metals, which were carried out at BUET Environmental Laboratory. The test results are shown in Table 3.3.

Table 3.3 Test results of some important water quality parameters

Sl. No.	Water quality parameters									
	pH	TC	FC	Iron (mg/L)	Ca (mg/L)	Mg (mg/L)	Pb (mg/L)	Zn (mg/L)	Turbidity (NTU)	Fluoride (mg/L)
1.	8.45	0	0	<.05	36	90	0.0110	0.1075	9.1	<.05
2.	9.06	0	0	<.05	39	39	0.0123	0.3725	9.2	<.05
3.	11.02	0	0	<.05	4	38	0.0138	0.0630	0.5	<.05
4.	7.32	0	0	<.05	27	45	0.0109	0.1056	0.4	<.05
5.	8.79	0	0	<.05	40	22	0.0103	0.1816	5.2	<.05

RCC roof catchment and that from DIY (Do It Yourself) model showed this result. The caretaker of the RWH unit with RCC roof catchment finds it difficult to clean the catchment. Again, DIY model has newly been installed. These factors may give rise to increased pH value in the rainwater.

Fecal Coliform was completely absent in all 5 samples, pH values are in the alkaline range, and Pb and Zn are within acceptable limit. Iron and Fluoride concentration are below detectable range of measurement, i.e., < 0.05 mg/L. A major change in water quality between rainwater and previously used groundwater is that of iron, manganese and hardness concentration. The problems associated with high iron and hardness in groundwater are not present in rainwater, which increases the acceptability of rainwater among users. A common concern about absence of fluoride in rainwater and consequent dental health problem is often raised. However, it can be noted that fluoride is also less than acceptable value of 1.0 mg/L in tubewell waters in most parts of the country. Test results for water quality parameters such as Fe, Ca, Mg, Pb, Zn, Turbidity, Fluoride etc. are within the drinking water guideline value and acceptable.

In general, the quality of harvested rainwater in project area has been found suitable for drinking provided the system is properly operated and maintained.

3.5 Other Components of RWHS

3.5.1 The Roof Catchment Area

To collect rainfall the roof must be constructed of appropriate material, have sufficient surface area, and be adequately sloped to allow runoff to be collected easily into the storage tank. Suitable materials for RWH roof catchment include corrugated metal sheet, clay tile, and RCC slab. In the project area most of the catchment are made of CI sheets.

In the study area of Charghat and Bagha most of the households surveyed have their roofs made of CI sheet, which made excellent catchment area for rainwater harvesting supplying most of the runoff into the collection system. The assumed runoff coefficient of 0.8 in the design was therefore justified. One roof was found to be made of a combination of clay tiles and CI sheet. The tiled portion of the roof accumulated solid particles thereby influencing the quality of water as reported by monitoring team.

For many poor households it is not always possible to use hard-surface roofs e.g., CI sheet for RWHS because of higher costs. Roofs constructed of thatched materials, such as grass and palm leaf, are inexpensive and used by many poor families. The disadvantage of using thatched roofs is that the runoff contains organic matter, is yellowish in color, and smells of decomposed leaves. Users prefer roofs of CI sheet, as they are easy to clean and maintain. A few households who could not afford to have CI sheet as their roofing material, provided a portion of their roofs with CI sheet sufficient for required runoff.

3.5.2 The Gutter System

Effective guttering is an important part of the rainwater harvesting system. Water must be efficiently conveyed from the roof to the tank to meet the homeowner's demand. A good gutter material should be lightweight, water resistant, and easy to join. To reduce the number of joints and thus the likelihood of leakages, a material, which is available in long, straight section is preferred. Examples of materials used for gutters include bamboo, wood and sheet metal. The gutter must be well supported – most gutters should be supported at every 50 or 60 cm.

In the project area most gutters were fastened to the roof just by tying them around with galvanized wires. Alternative means of fastening include nailing the gutter to the roof or supporting it with wood. It is important to ensure that all joints be leak proof. Joints can be sealed with tar or rubber. The joining pH values of two water samples were found above the drinking water standard. Water samples from compound however, should not contaminate the water. In the study area some gutters were found not properly sloped but didn't pose any problem because of abundant rainwater supply. Providing adequate slope of gutter is an important consideration in collecting most of the runoff without much wastage.

3.5.3 The First Flush Device

During periods of no rain, dust, bird droppings, and dead plant matter will accumulate on the roof. These materials are washed off with the first rain and may contaminate the water in the tank. Contamination can be avoided by diverting the first few minutes of rain from the tank. Flush traps can be used to prevent the first flush from reaching the tank. In this case, the plastic pipe system collects the first flush water from the roof and the removable end cap allows discharge of first flush water. Figure 3.5 shows the gutter and the first flush diversion system used in most households of the study areas.

Filter is a possible solution to keeping sediment and contaminants out of the storage tank. However, they have a high maintenance requirement; such filters require inspection and flushing to prevent bacterial buildup on the filter medium. Diversion of the first flush from the tank is more practical than investing in filters.

Other small but important component of the system includes fly/ insect guard net used at water collection point, first flush diversion cap and the functioning tap.

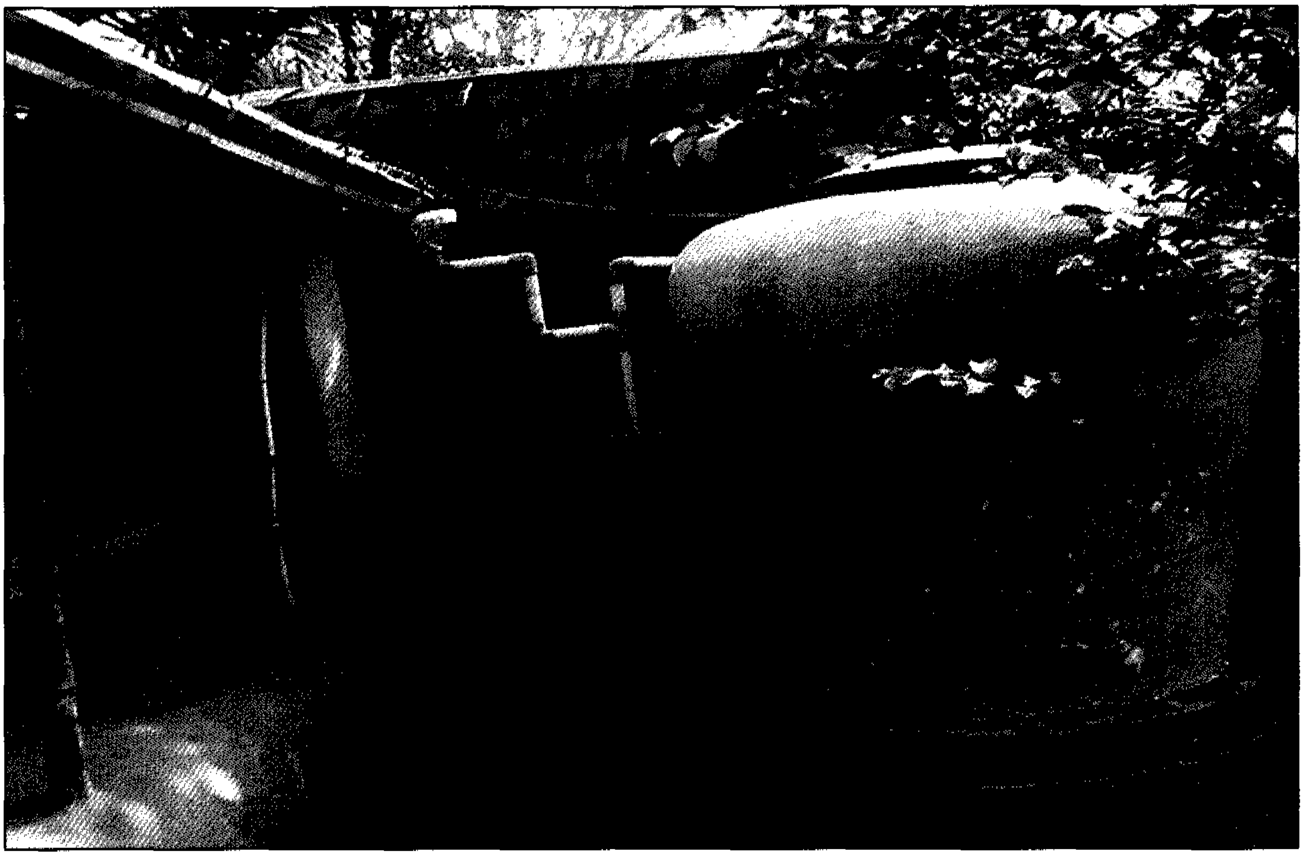


Figure 3.5 Rainwater collection system showing gutter and first flush diversion

3.6 Construction Methods and Materials for Storage Reservoirs

In this action research project six types of rainwater harvesting system units were constructed and tested for user's acceptability. These are ferro-cement tank, ferro-cement jar, brick tank, sub-surface brick tank, RCC ring tank, and earthen motka. Different models were used with different capacities to suit different user group's requirements. Figure 3.5, 3.6 and 3.7 show several types of units used and Table 3.4 gives the capacity and costs of different units. Details of constuction methods and materials are given in the design and construction manual prepared by NGO Forum and SDC (2001).

The storage tank is obviously the most costly component of the RWHS and therefore any attempt to reduce cost of the system will depend on the size and materials used for the storage tank. Since the present action research project does not seek a solution for year round storage of rainwater, the sizes of the storage units could be reduced according the affordability and the desirability of the users as to how long they would like to depend on distant communal water sources. This combination household rainwater harvesting and communal water source (in most cases distant arsenic free tubewells) offers flexibility to users to choose from a variety of options for rainwater storage tank.

Other ways for cost reduction for water storage that were tried during the project period include construction of low cost concrete ring tanks, brick built tanks, thin walled ferro-cement tanks and low cost burnt clay jar, locally known as clay motka. The cost is also optimized by using shorter gutters (Figure 3.6) covering only a portion of the roof area required for the storage tank capacity with provision for future expansion.

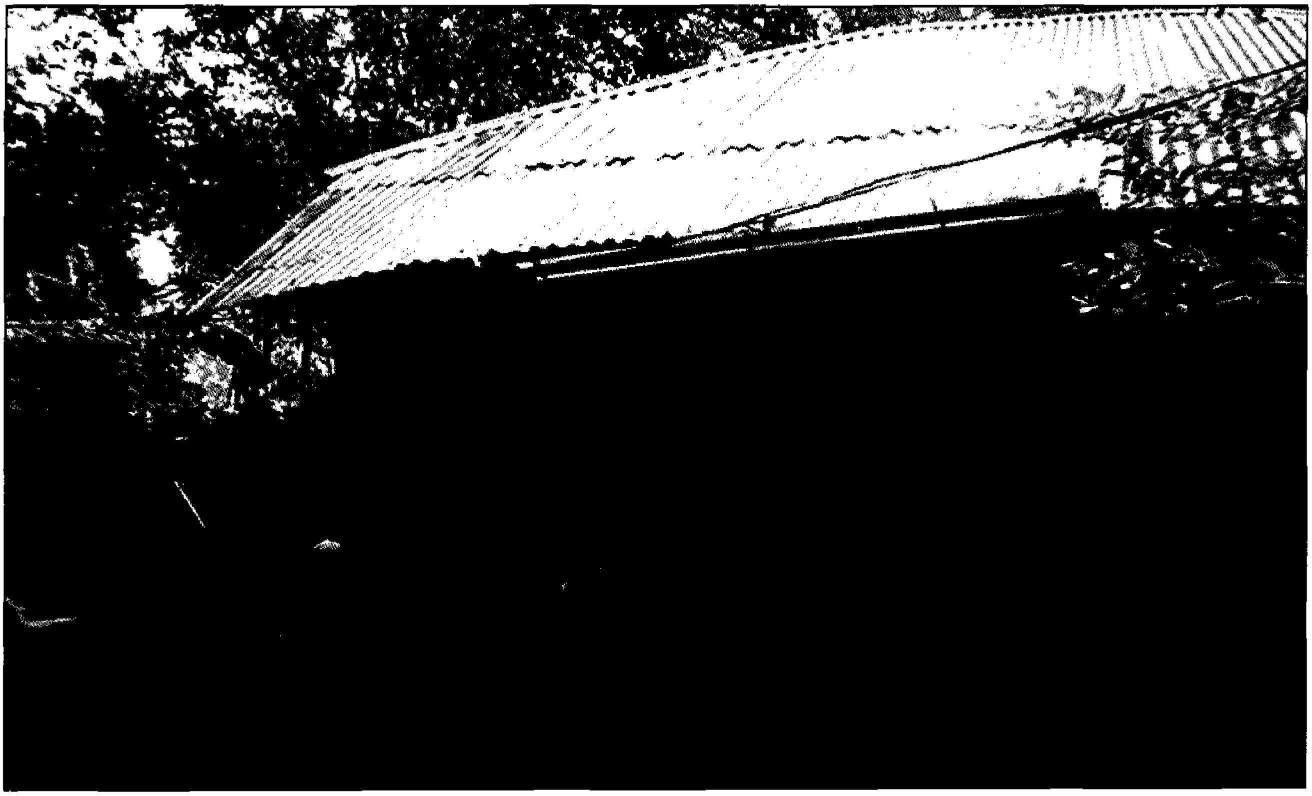


Figure 3.6 Earthen motka for Rainwater collection becoming popular among poor

Table 3.4 Capacity and costs of different types of RWHS units

Type-1: Ferro-Cement Tank	
Capacity 2,500 L	Cost Tk. 4,100.00
Capacity 3,200 L	Cost Tk. 5,200.00
Type-2: Ferro-Cement Jar	
Capacity 1,000 L	Cost Tk. 2,900.00
Capacity 2,000 L	Cost Tk. 3,500.00
Capacity 2,500 L	Cost Tk. 4,500.00
Type-3: Ferro-Cement Jar	
Capacity 500 L	Cost Tk. 2,200.00
Capacity 1,000 L	Cost Tk. 3,000.00
Capacity 2,500 L	Cost Tk. 5,500.00

3.7 Operation, Maintenance and Monitoring

Evaluation team put special emphasis on the maintenance issue of the RWHS. It was evaluated through field observation and through interviewing the caretakers and users about maintenance of different components of RWHS. It may be mentioned here that the team visited the project area during the dry period, which began two months back. Through field observation following facts about maintenance of the system were revealed.

- User groups of RWHS were found well aware about maintenance of catchment surface.
- Gutters and tanks are to be cleaned frequently to prevent over flow during heavy rains.
- First flash for more than 5 minutes divert the first 10 to 20 liters of rain water and prevent contamination of the water in the tank.
- Regular inspection and repair of system.
- Appropriate tank cover and filter nets on inlet and outlet holes to protect water quality.
- Down pipes, fly-guard-net etc. were in good condition.
- Water collection tap, first flashing system, over flow pipe etc. were properly positioned and were working properly.

It was also found that the cost of O&M of the rainwater harvesting system is negligible. Some users reported that they had to spent only about 60 taka in the last three years for replacing the tap that costs about Taka 10 each, buying a few fly guard nets costing Taka 2 to 3 each and buying some bleaching powder for cleaning the storage tank. No maintenance requirement of the storage tank was reported during the project period of over three years.

3.8 Some Minor Problems Identified During the Evaluation

Evaluation team visited the project area during the dry period. Last rainfall occurred two months back. The following minor problems were identified:

- 4 out of 14 roof catchments observed were rusted and not clean.
- 8 out of 14 catchments were not ready to collect any immediate rainfall.
- 1 catchment did not have proper slope.
- Some gutters were not well constructed.
- Some gutters did not have proper slope (1 to 3%)

However, the users responded that they would do the needful i.e., roof cleaning, fixing the gutter and the collection point as the rainy season approaches.

3.9 Important Achievements of RWHS Project

3.9.1 Safe and Affordable Water Supply Option

The rainwater harvesting system in combination with a suitable community water source for a period of 2 – 4 month during the dry period of the year appears to be a viable, safe water supply option particularly for arsenic affected areas of Bangladesh. Rainwater can be safely used for drinking and cooking throughout the entire rainy season and beyond depending on the water storage capacity. Size of the storage tank can be compromised and hence cost reduced with the period of use of the community water source. This provides a great flexibility for people to have safe water option. Further piloting in arsenic affected areas in other parts of the country may be needed to establish this combined water supply model as a safe, affordable and reliable water supply option.

3.9.2 Do It Yourself (DIY) Model

Some Do It Yourself models were introduced in the project area in order to provide rain water supply for the very poor. Motka (burnt clay) storage jars, double chari (two cement concrete made large bowl joined with or without RCC rings in the middle.) are found to be much cheaper than other options on offer. Such storage jars are produced locally in the project area and their total domestic storage capacity can be increased in stages. No problems with water quality or with other components of DIY models could be found during the evaluation of the system.

3.9.3 Productive Time Saving

Prior to the introduction of RWHS in the project households, especially women had to spent hours to fetch water often from remote sources of safe water supply, mostly from arsenic free tubewells. The introduction of RWHS has now resulted a significant time saving as households can easily get safe water supply from RWHS just beside or inside their kitchens (Figure 3.7). The time thus saved can be used for other productive purposes.

3.9.4 Increased Water Use Efficiency

Because of the combined household and community source system, people are now more careful in using the stored water. It was revealed from interviewing users during field visits that as the dry season approaches people become more cautious about water use. Leakage or wastage by any other means are strictly prevented by the householders themselves, so that a greater part of the dry period can be covered by the stored rainwater.

Figure 3.7 RWHS just beside or inside their kitchens

Chapter 4

Social Evaluation of the Research Project

Introduction / Economic Value of Water/ Beliefs in Arsenic Contamination / Beliefs in Rainwater /Attitude toward Rainwater / Measure of Diseases / Water Management Skill / Ownership Feelings / Enhancement of Status / Tendency toward Afforestation / Small Family Size Norm / Constraints of Rainwater Preservation /

4.1 Introduction

Ground water has for long been considered to be pure and safe to serve drinking purpose. Following a safe water campaign in the 1980s, extensive sinking of hand tube - wells by the Department of Public Health Engineering (DPHE), private sectors and through individual supported by UNICEF, SDC and DANIDA resulted in around 95% of the country's population having access to 'safe' drinking water. The use of tubewell water (groundwater) for domestic purposes is a long tradition in most of the part of the country. In order to evaluate the degree to which DRWH can realistically replace contaminated groundwater as an acceptable source of drinking water at household level. This research project is investigating the fine balance between socio-cultural, financial and technical considerations as mentioned above, with a view to making definitive and practical recommendations on optimal designs and promotion strategies for DRWH systems in Bangladesh.

The over all findings revealed that the use of rainwater is increasing among the people of two arsenic effected Upazilas of Rajshahi district. This chapter deals with the social evaluation of Rain Water Harvesting System under the Action Research Project, which includes the perception and attitude about rain water in connection with economic value of water, beliefs in arsenic contamination in ground water, beliefs in rain water, attitude toward rainwater as one of the measures of arsenicosis, water management skill at household level, ownership feelings, enhancement of social status, tendency toward afforestation, small family size norm and constraints of preservation of rainwater.

4.2 Economic Value of Water

It is believed that water is a natural resource and is given by God. It is free of cost and is also sanctioned for the people according to the will of God. But the people under the action research project of rainwater harvesting realize that water is not free of cost like other necessary commodities primarily because of contamination of underground water with arsenic and pollution of surface water with the technological advancement. On the other hand, when people developed the habit of using groundwater to avoid waterborne diseases, unfortunately, the groundwater is contaminated in arsenic. People become confused as to where to get safe water. In such a circumstance, NGO Forum came forward in 2000 with action research project of RWHS in order to change the behavior and practice of water for drinking and cooking purposes.

About 268 families have different types of rainwater reservoirs in order to avoid arsenic contaminated ground water. To establish the reservoir, 70 - 90 percent of the cost is borne by the NGO Forum in order to build up capacity of the users as well as to change their behavior of using rainwater. The maintenance cost of the rain water harvesting is borne by the beneficiaries and the NGO forum. The existing cost of rainwater is about Tk. 1.00 to 1.50 per liter rainwater collected by standard and DIY models. The beneficiaries have to bear Tk. 0.25 to 0.30 per liter rainwater. Now the beneficiaries realize that the safe water is not free of cost and it has economic value. They also realize that the rainwater should be managed very carefully in order to reduce the cost. On the other hand, collection of rainwater is not time - consuming like the collection of tubewell water. Besides, it reduces the fuel cost because one time cooking of food cover the whole day. It has been reported that due to the constraint the rainwater, people hesitate to invite their relatives to participate in the festivals and ceremonies at their residences. Moreover, the rainwater is free of germs of different waterborne diseases and as a result it has economic value in avoiding treatment cost.

To quote arsenic affected woman:

Rainwater is used for drinking and cooking purposes as one the important preventive and curative measures not only to get rid of arsenicosis but also other diseases. Consequently, each and every one should use rainwater. We have already informed our relatives and neighbors to use rainwater instead of arsenic contaminated tubewell water to avoid arsenicosis. I am suffering form charama roge (melanosis) since 1998. I went to Upazila Health Complex for treatment of skin disease. After two years of my treatment I did not get any result. But after using rainwater since 2001 I am feeling better and my skin becoming fresh. But I do not get rainwater for the whole year. If I could get rainwater for the whole year my skin would be fresh like before.

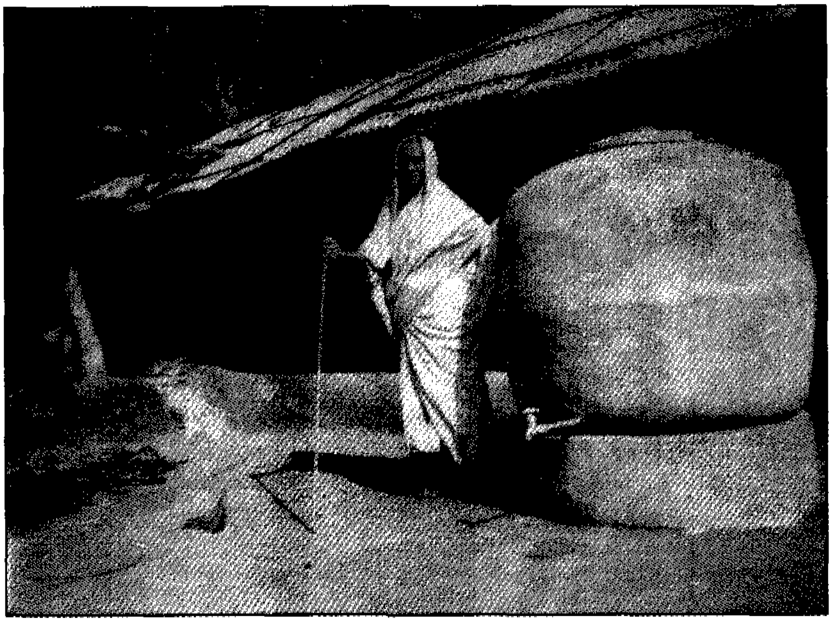
It is found that the beneficiaries do not face any problem for using rainwater in rainy season. But they have to face problem in dry season. Usually, they collect ground water in the dry season from the arsenic free tube well. Many of them reported that arsenic free tubewell is far away from their residence. In the circumstances, occasionally they have to depend upon arsenic contaminated tube well water. People waned to get rainwater for the whole year but due to less capacity of reservoir and natural calamities like draught they do not get sufficient rainwater. So mixed or combined system of water supply for drinking and cooking is found among the beneficiaries under the action research project especially in difficult circumstances.

4.3 Beliefs in Arsenic Contamination

This section deals with the belief system associated with the arsenic contamination in ground water and the use of rainwater. A significant number of elderly people believed that the causes of arsenic contamination in ground water depend on vagya (fate) and karma (past deed). Some of the people attribute that their tube well water is contaminated by arsenic because of fate and express the idea that what happened to their tubewell water is already written on their forehead (Sarker, 1999:219). A few Hindu beneficiaries cited the notion of Karma, the cosmic system of reward and punishment according to one's deeds in the past lives. Some of the Hindu and Muslim beneficiaries believed that the ground water is contaminated by arsenic because of the pap (sin) committed by them and their forefathers in the past.

To quote an elderly woman:

Arsenic contamination in ground water is a kind of Gajob (natural calamity) given by God because a huge number of iron rods have already been pushed on the chaste of bashumati (motherland) for the installation of tube well. Arsenic is nothing, it is the blood of motherland. People deserve arsenic contaminated groundwater for their Kukarma (misdeed).



Some of the people reported that arsenic was in the tubewell water in the past but it was obscure. The scientists could not discover it. Now it is found after the intensive research. Besides, some of the people also believed that the ground is contaminated by arsenic because of using fertilizers and pesticide for agricultural production.

4.4 Beliefs in Rainwater

At the initial stage of the project there was a negative attitude of the people about the use of rainwater for drinking and cooking purposes. It was a perception of the people about the use of preserved rainwater for health risk because it is stale water. It is also believed that the tank of rainwater would be a house of insects and germs of different diseases due to preservation of stale water for a long time.

Many people who belonged to the Hindu community did not use this stale water for preparation of prosad (food items offering to God) for religious festivals due to the consideration that stale water is polluted. It is also believed that contaminants may be leached from roof catchment and tank materials in the collected rainwater, which may be risky for health. However, after extensive motivation and monitoring these negative attitudes have changed toward use of rainwater. The users of rainwater also realized that rainwater is the only alternative source to get safe water for drinking and cooking purposes in the project area. Consequently, people are very much enthusiastic to use rainwater for avoiding arsenicosis and other diseases.

4.5 Attitude toward Rainwater

The users have reported that the rainwater at the initial stage was tasteless like tannin, bitter, etc. But after using a few months they gradually changed their habit and found taste of rainwater like tubewell water. About 70 percent of people among the beneficiaries drink rainwater regularly. The rest 30 percent drink both rainwater and arsenic free tubewell water. It has been also reported that the food cooked by rainwater is very testy. Moreover, when rice is cooked by rainwater it becomes fresh and white. The cooked rice lasts longer and, which reduces fuel consumption. Moreover innovative attitudes have already been developed among the users. By this time 6 families have already installed rainwater reservoirs by their own efforts without intervention of NGO Forum.

To quote a housewife:

When I was pregnant I could not move due to physical inability. It was not possible on my part to bring tubewell water from neighboring houses. The physician instructed me not to involve in heavy household activities because it might be a cause of abortion. The rainwater storage tank is very close to my kitchen. In the circumstance, rainwater is not only close to my hand for cooking and drinking but also it is helpful for my offspring to prevent arsenicosis. So rain water harvesting project is very essential in all respects.

4.6 Measure of Diseases

The attitude of the community people is observed that the rainwater is one of the preventive and curative measures not only to get rid of arsenicosis but also other diseases. A significant number of elderly people reported that they were suffering from stomach related problems before using rainwater but after using of rainwater they are feeling better without any treatment.

To quote a patient of keratosis :

"I am a patient of charmo roge (keratosis). I went to Rajshahi Medical College Hospital for treatment, they kept me one week in the hospital and took lot of photographs and send me back home without medication. After using rainwater, I am feeling better and it is my expectation that if I use rainwater for the rest of my life I shall get back my previous life. But the problem is that during the dry season I have to take tubewell water because I have no alternative option without tubewell water in dry season."

4.7 Water Management Skill

The beneficiaries believed that the rainwater is limited and there is a scarcity of rainwater especially during the dry season. In the circumstances, the housewife is very much careful about the use and misuse of rainwater. It has been observed that during the rainy season rainwater is shared with their neighbors if it is required but in the dry season they do not. It has been reported that the beneficiaries do not use rainwater for any domestic purpose except cooking and drinking. The housewives have developed the skill for rainwater management by their own efforts to meet up the need.

4.8 Ownership feelings

It has been observed that the people are involved in the Rainwater Harvesting Systems (RWHS) with the sharing of 10-30 percent of cost for installation of reservoir tanks. It is believed that this contribution stimulates them to become owner of their tank like other properties. The people repair their reservoir tanks by their own cost. The parts or ingredients of the reservoirs are available at the local markets in low cost price. It has been reported that many people are interested for installation of rainwater reservoir tank but they could not due to financial constraint. If it is installed once then they are willing to provide maintenance cost. Many of them have already been trained up in order to take care of their rain water reservoir tanks by their own efforts at the individual level. Moreover, it has been reported that the community caretakers play a vital role to keep this system of rainwater harvesting active.

4.9 Enhancement of Status

Status is a position of an individual in a group or in a society in which he or she lives. It has been reported that the rain water preservation tank at the household level enhanced the prestige and position of the owner in the community like wise the television, motor cycle, radio, etc. Many of the people from neighboring villages come to see and observe the rainwater reservoir tank and they realize its utility through interaction with the owners of the tank. In the circumstances, the owners feel that they have got position in the society through the installation of rainwater reservoir tank and they are also identified as knowledgeable and conscious persons in the community.

4.10 Tendency toward Afforestation

It has been observed that in many of the beneficiaries have already planted fruit trees very close to rainwater reservoir tank keeping in view that the water of the tank will remain cool especially during the dry season. This sort of attitude may be helpful for afforestation at the homestead of beneficiaries and which may also help to maintain balanced environment.

4.11 Small Family Size Norm

Many of the beneficiaries reported that the rain water reservoirs are not able to supply water for a longer time due to large number of family members. The limited amount of rainwater could not serve the large number of mouths.

To quote of housewife :

"Our family is a large one consisting of husband - wife and 6 children. Consequently, we do require huge amount of rainwater to meet up our need. But our rainwater reservoir is medium in size, which covers 6-7 months. If our number of children would be 2-3, then it would cover 10-12 months and as a result the scarcity of safe drinking water would be solved. I shall advice my children not to take more than 2-3 children in order to solve not only water scarcity but also other problems."

4.12 Constraints of Rainwater Preservation

Most of the people reported that the preserved rainwater is insufficient. It does not cover the demand for whole year. Usually, it covers 8-10 months where the family size is small. Consequently, small family size values are found among the people in relation to constraint of rainwater. Some of the people reported that they use both tubewell water and rainwater simultaneously to overcome this constraint. On the other hand, some of the people reported that they use tubewell water after the end of preserved rainwater. But it should be noted that there is a demand for rainwater for using whole year.

It has been mentioned that about 49.4 percent people use earthen motka for preservation of rainwater. The problems of using earthen motka are less capacity for preserving rainwater. It's durability is less compared to other reservoirs and it requires extra care for maintenance and as a result the owners of the earth made motka should be more conscious about its use. Usually, this type of reservoir is installed on the veranda of the bedroom, which creates problem of accommodation. Because most of the houses are smaller in size and based on one or two bed rooms. On the other hand, problems are found from the potter's side. It has been reported that the soil used to make motka is not available in this area. It is found at Atrai of Naogoan district, which is 80 km. from Charghat and Bagha. The cost of each earth made motka is about tk. 250. The cost of same size of reservoir made of ferro-cement, brick, RCC ring and plastic is about Tk. 1000-2500. But the longevity of these reservoirs is high compared to earth made motka. It should be pointed out that many people are not able to buy these costly reservoirs due to financial constraint. The potters also reported that they are not getting customers for their earth made motka and other pots because of availability of metal pot. The metal pots are durable and can be handled easily.

To quote a Nabadip Paul :

"About 40 years ago people in these areas were free from different types of diseases especially from stomach related diseases because they used earth made pot for cooking and using for cooked food items. The earth made pots are not only hygienic for cooking but also for preservation of water and other food items. But now a days many people are suffering from different types of diseases because of using metal pots for cooking, eating and preservation of food items. It is very difficult to clean metallic pots and as a result the unclean pots is one of the reasons for stomach related diseases in this area."

The poorer section of people has no capacity to buy the metal pots but still they are in favor of buying this pot. The elderly has reported that earth made pots is hygienic especially for cooking and eating purposes.

Chapter 5

Conclusions and Recommendations

Conclusions / Recommendations /

5.1 Conclusions

The action research project clearly identifies rainwater harvesting as a potentially safe, reliable and affordable alternative source of water supply for drinking and cooking for at least 8 – 10 months of the year. The project carried out by NGO Forum in two arsenic affected Upazilas reveals that the cost of rainwater harvesting can be brought down to affordable limits of people when used in combination with another safe communal water source for about 2 – 4 months during the dry spell of the year. The supplementary community water source could be an arsenic free tubewell, pond sand filter, a dugwell, or even a large community rainwater reservoir. It is however, important that such safe community water sources are available at reasonable distances.

The research project conducted in selected Upazilas further demonstrates that with the active participation of the users and the backup support by the local NGOs and VDCs can bring the desired changes in the water supply scenario of the arsenic affected areas. Other important conclusions drawn from evaluation of the action research project are as follows:

- The supply of rainwater, given the CI roof catchment area available, is much higher than the household demand for drinking and cooking.
- The rainwater can be stored in tanks, jars or pots of different sizes and materials of varying costs to match individual household's need and affordability.
- The household rainwater harvesting system in combination with a suitable communal safe water source can save a tremendous amount of productive time of people for a large part of the year (8 – 10 months).
- The "do it yourself" (DIY) model using burnt clay pot locally known as "motka" of smaller sizes (300 to 600 Litres each) is gaining popularity among the poor as a cheaper means of rainwater storage.
- Operation and maintenance of rainwater harvesting is very simple and can easily be done by the caretaker or even by any member of the family, and costs could be as little as Tk. 20/- per year for a household unit.
- Simple cleaning of roof catchment before rain events, flushing out of the first 5 – 15 minutes rainwater (depending on the rainfall intensity, and using the simple first flush outlet device) before each rain event, and occasional bleach washing of the storage reservoir, may provide bacteria free, safe drinking water to people.
- The quality of stored rainwater is well accepted by people of the project area, which according to the users, are beneficial in preserving cooked food for a longer period.

- The success of the action research project in promoting and in heightening confidence in people of rainwater harvesting was possible by the untiring efforts of the local NGOs and VDC staffs in providing motivation, orientation and training of users, caretakers, masons and the people in general.

- The project has also been successful in promoting private entrepreneurship development. A number of trained masons and skilled workers are now engaged in producing rainwater storage tank components, motkas and covers of varying sizes and costs in their own yards. A little guidance in product marketing could further influence promotion of rainwater harvesting option in the region.

5.2 Recommendations

This action research project has clearly demonstrated that proper collection and storage of rainwater can solve the acute problem of safe drinking water in arsenic affected areas, and that motivation and training has a key role in the success of the project. It can not be expected however, that the outcome of this single research project will be equally applicable to other arsenic affected areas throughout the country. It is therefore, important that similar action research projects be undertaken in other parts of the country to examine its effectiveness in different socio-economic and hydro-geological conditions. Even in the current research project area at Charghat and Bagha, further support is needed particularly in operation and maintenance of the installed units. Continued efforts in capacity building of the local entrepreneurs and of the users will bring total confidence in people that RWHS in combination with an appropriate community water source is a sustainable safe water supply option.

Based on the discussions with the users, local NGOs, VDC members, private entrepreneurs during this short evaluation, several important recommendations pertaining to policies, planning and strategies for the development of rainwater harvesting system as a potential safe water option are made as follows :

- The poorer section of the people are not in a position to bear the costs of installation of RWHS and therefore needs initial investment support along with active participation of VDCs and local NGOs.

- Community safe water source must be ensured through development of appropriate technological options. Proper management of khash ponds, regenerating inactive wells, or installing large community rainwater reservoirs appears to be the probable methods for community water supply for the dry period.

- The success story of rainwater harvesting should be replicated not only in arsenic affected areas, but also in other areas where there is a crisis of safe water for drinking and cooking.

- Rainwater management training focussing women, who use water from dawn to dusk for different purpose, should be promoted.

- A flow of client to client motivation i.e., rainwater users to not users motivation program should be encouraged for wider acceptance of rainwater harvesting system.

- Finally, motivation, monitoring, evaluation and follow up should be a continuous process in order to achieve long term sustainability of rainwater harvesting system.

Annex - A :

References

Heijnen, H. A. (2002) Towards water quality guidance for collected rainwater, in Water for Development: Safe Water for All, Bangladesh Perspective, DPHE-WHO, Dhaka

Mallick, D. (2002) Safe Drop – The Safer Source, edited by Halder Joseph, NGO Forum for Drinking Water Supply and Sanitation, Dhaka, Bangladesh.

NGO Forum, (2000 - 2003) Monitoring Reports on "Rainwater Harvesting in Bangladesh – Action Research Project", Dhaka.

Sarker, P. C. (1999) Beliefs and Arsenicosis and Their Impact on Social Disintegration in Bangladesh: Challenges to Social Work Interventions, Proceedings of joint conference of AASW, IFSW, APASW, & AAWWF, Brisbane, Australia.

World Bank, (1990) Rainwater Roof Catchment Systems, Participant' Notes, Information and Training for Low Cost Water Supply and Sanitation, Washington D.C., USA.