Challenges for Implementation of Rain Water Harvesting Project in Arsenic Affected Areas of Bangladesh

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1. Background

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. 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. It 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 (Alam, 2006). 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.

People can construct storage reservoirs so that they can use rainwater during the entire rainy season and about 2-4 months of the dry period. The capacity and the construction materials of the reservoir and its maintenance depend on the socio-economic condition, population, educational background and awareness of the habitants of the area. This study put special emphasis on the construction and maintenance issue of the RWHS and also on the harvested water quality in Charghat and Bagha Upazilas of Rajshahi district.

2. Objectives of the Study

• To assess of the technical requirements and feasibility for efficient rainwater harvesting (e.g., evaluation of cost-effectiveness of tanks of various sizes considering the socio-economic condition of the people of the study area).

•To document of good experience and learning from the study and disseminate those among the sector agencies including the community people.

•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.

3. Study Area

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. 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. The villages had been selected considering the concentration of tube-wells contaminated with arsenic and availability of suitable safe water options. A total of 3,290 families were living in the 13 villages namely Miapur, Anupampur, Arazi Sadipur, Chandpur, Talbaria, Kaluhati, Batikamari, Fakirpara, Jotnasti, Kishorpur- Beelpara, Monigram, Habashpur and Bajubagha. The average family size ranged from 4.31 to 5.2. Agriculture is the main occupation of the villagers. About 61.29% of the villagers were related to agriculture and most of the people did not have strong educational background. Most of the villagers live below poverty line and some are hardcore poor living in extreme poverty conditions. In few villages like Kaluhati among 776 people 458 (59.2%) were living always in financial deficit.

4. Methodology of the Evaluation Study

Technical evaluation of the RWHS was done through analysis of design considerations, field observation, and case studies and through interviewing people of Charghat and Bagha Upazila of Rajshahi district on various technical and social aspects of rainwater harvesting as implemented during the study period. Interview was taken of 140 families (caretakers) for evaluating technical aspects of RWHS through base line studies. A few randomly selected water samples were also tested in the laboratory for ascertaining quality of the stored rainwater. Apart from interviewing the caretakers, literature including manuals, progress reports, monitoring reports, mid-term evaluation reports were consulted.

5. Data Collection and Analysis

5.1 Water Supply and Demand

In rain water-harvesting calculation of supply and demand of water is very important. Storage is the difference between actual supply of fresh water and the demand. Different methods can be used to calculate water demand and supply from rainwater. One method is shown below:

Supply:

Average catchment area for rainwater harvesting=20m^2 (approximately)
Run-off coefficient = 0.8 (assuming for ideal CI roof catchment)
Average yearly rainfall = 1400 mm
Average yearly water supply from rainfall = 20 m^2 *0.8*1.4 m =22.4 m^3

Demand:

Consumption per capita per day, C = 7.5 liters
Number of people per household, n = 6
Monthly water demand = 7.5*6*30 = 1350 liters = 1.35 m^3
Yearly demand = 1.35* 12 =16.2 m^3
Storage volume required for a nuclear family = 22.4-16.2=6.2 m^3

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. Run-off coefficient values vary between 0.3 and 0.9 depending on the material of the catchment area. It takes into consideration losses due to percolation, evaporation, etc.

5.2 Rainwater Storage Reservoir

It was observed from the study that 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. The different types of tanks were FC tiles tank, FC Jar, RCC ring, Brick tank, Chari tank, Plastic motka and plastic tank.

Brick tank of capacity 2500 liter and cost 5000 Tk were in use in large number (Fig.1) among the same capacity's other tanks because of its reasonable cost, durability and better performance. FC jar, RCC ring and brick tanks of 1000 liter were used at a less frequency (Fig. 2).

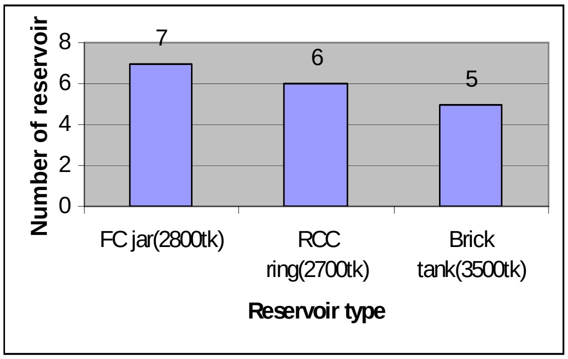

Figure 1. Number and types of reservoir of capacity 2500 liter and catchment area 90-100 sft.

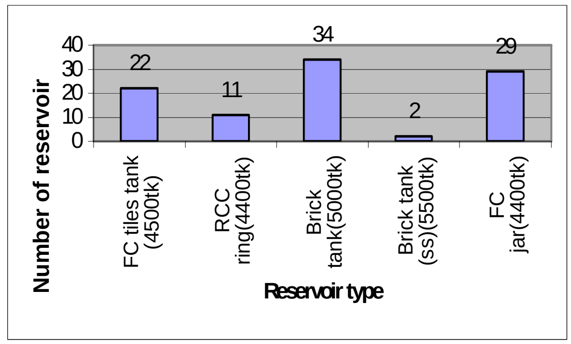

Figure 2. Number and types of reservoirs of capacity 1000 liter and catchment area 70-80 sft.

A survey had been made among 140 families through interview. It had been observed that FC jar, Brick tank, Earthen motka and plastic tank were being used by 35, 39, 37 and 2 families respectively (Fig.4). It is because of the low cost, availability of the reservoir materials as well as the reservoir capacity and durability of the reservoirs. Another observation was made from the survey that Earthen motka which was widely used (Fig.3) was preferred by mainly the people of low income group (such as agri-labor and day labor), whose monthly income was less than 1500 Tk generally.

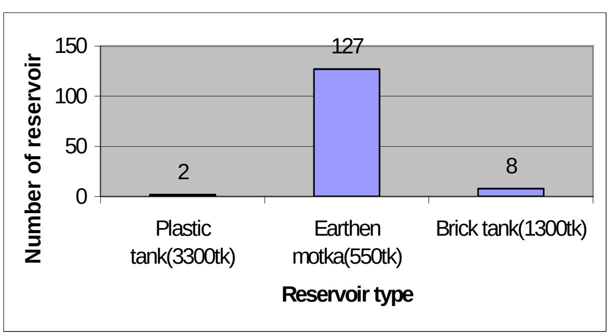

Figure 3. Relation between the number of reservoir and type of reservoir of capacity 500 liter and catchment area 60-70 sft.

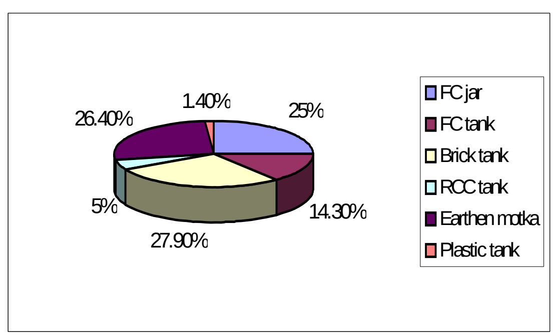

Figure 4. Percentage of different types of reservoir was in use during survey period.

The FC tiles tanks of capacity 3200 liter, RCC ring tanks of capacity 2000 liter and plastic tanks have limited use probably because of their relatively higher cost against capacity and for the need of high catchment area. The use of Chari tank was also very negligible for its low performance.

5.3 Quality of Harvested Rainwater

The concentration of As and Fe were monitored in the tubewell and pumps of the villages (data for 12 villages are available). A relationship between As and Fe can be introduced (Fig.5). It had been observed that in almost all cases (with few exceptions) with the increase of the percentage of As contaminated underground water sources the percentage of the Fe contaminated water sources increases.

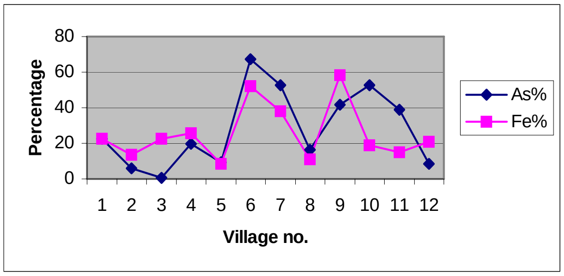

Figure 5. Relationship between As and Fe affected underground water sources.

In this study 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. 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. 2419 water samples were tested for pH. pH of 335 samples were found within the acceptable limit (6.5-8.5). About 1035 water samples concerning turbidity was tested and only 50 samples were found unacceptable (greater than 5 NTU). It may be occurred due to the improper collection of water from the catchment i.e. harvesting of rainwater without flushing the first foul water for 10 to 15 minutes. Testing 5 random water samples collected by NGO Forum, it was found that Pb and Zn were within acceptable limit. Iron and Fluoride concentration were below detectable range of measurement, i.e., < 0.05 mg/L (NGO forum, 2000-2003).

6. Operation & Maintenance

It was found that the average cost of O&M in Rainwater harvesting is very negligible, nearly 20 Tk/ year. Lack of education and awareness of the caretakers were the major reasons of poor operation and maintenance of the RWHSs. The study had been made among 140 families having different types of reservoirs.

Table1: Types of caretakers considering quality of O&M of different types of reservoirs

Type of reservoir	Good	Medium	Bad	Total no. of reservoir
FC jar	12	14	9	35
FC tank	5	9	6	20
Brick tank	23	8	8	39
RCC ring	3	2	2	7
Earthen motka	6	21	10	37
Plastic tank	0	0	2	2

The number of good caretakers of Earthen motka is relatively less (Table 1) because it is mainly used by the people of low income group who have almost no educational background.

7. Conclusion

The action research study 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. RWHS can be widely used because different types of reservoirs are available and people of different income level can afford it according to their income level. Other important conclusions drawn from evaluations of the research 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. Brick tank and Earthen motka are widely used because of its performance and low initial cost and suitable capacity for nuclear family.

References

1. NGO Forum, (2000-2003) Monitoring Reports on “Rainwater Harvesting in Bangladesh-Action Research Project”, Dhaka.
2. Alam M.A. (2006) Technical And Social Assessment of Alternative Water Supply Options in Arsenic Affected Areas, M.Sc. (Civil and Environmental) thesis submitted to the Department of Civil Engineering of Bangladesh University of Engineering And Technology(BUET),September 2006.