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WATER, SANITATION AND HYGIENE: CHALLENGES OF THE MILLENNIUM

Safe water options – community acceptance and sustainability

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OUT OF THE worlds water resources only 2 per cent is useable by human. A large part of this resource is preserved in underground. Remaining amount of water that is sweet is existing in the surface. In Bangladesh, surface water consists of water in more than two hundred rivers, thousands of oxbow lakes, bills, lagoons etc. Traditionally Bangladesh was also habituated to use this second sources of water until before three decades. Per capita reserve of sweet water in Bangladesh is still second in the world. The amount is about 11000 liters. The level of contamination of all these water bodies were detected so high that at times epidemic incidences of diarrhoeal diseases were blamed to this water. This led to the insertion of tube-wells in Bangladesh as a safe source of drinking water from under ground. So far from different reports, more than 95 per cent of our population are now using under ground water and green revolution was also possible due to massive use of the same water. Now this water is carrying a deadly poison leading to wide spread health problems almost through the country. More than 90 million of its 120 million people are now in the risk drinking arsenic contaminated water and 50 million are estimated to be exposed to arsenic more than WHO recommended value. There are now many incidences of ground water contamination through out the world. These contamination are not only by arsenic but also by many other different elements like fluoride, boron etc. In Bangladesh researchers are almost certain that hydrogeological conditions of our soil is responsible for present arsenic contamination. The surface water was polluted because of our indiscriminate use of these sources and now we understood that ground water is poisonous by nature. After three decades of our experiments we now understand that we still need a safe water source. In this study we tried to find out alternate options of potable water at the community level.

Selection of options

We can get arsenic safe potable water by two ways- arsenic removal and arsenic avoidance. DCH prefers arsenic avoidance method than removal.

Considering the immediate need for communities some removal methods can be practiced as short-term measures. We can use the score form " Find the Options" in selecting option

(Table-1). We have considered 6 options and considered different parameters including cost management and technology aspect. Higher score can be a score of better option.

Removal of arsenic can be done by different methods. Two methods are very familiarly in use in our country- One of them is "Safi" filter in which one filtration candle has been used for arsenic removal. There is no known use of any chemicals but the method need enough development to reach its efficiency. With time its rate of filtration goes down and removal of arsenic is not satisfactory. The next popular method that is widely distributed in communities called the "two bucket filter". Use of potassium permanganate and alum is involved in this method. So far regarding its efficacy different opinions are there. We are testing the

Table 1. Find the option

SOURCE	BACT.	CHEM.	COST			EASILY AVAILABLE	ALWAYS AVAILABLE	MANAGED BY COMMUNITY EASILY	LOCAL TECHNOLOGY
			NO	LOW	HIGH				
DEEP									
STW									
REMOVAL									
SURFACE									
RWH									
DUG WELL									

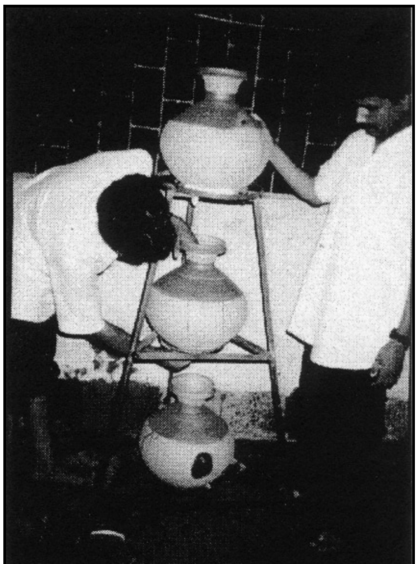

Figure 1. Pitcher Filter

filters in field. Our main concern for such filter is its efficiency in removing arsenic and possibility of residual effects of the used chemicals on human health.

Most of the other methods are either involves use of chemicals or some higher technologies. The problem of sludge management is still in debate. DCH studied very limited removal methods just to meet the need of community. One of that is the method has long been in use in Bangladeshi community as traditional house hold iron removal method popularly known as Kalshi/ Chari filter or three Kalshi (3-Pitcher filter) filter. While working in the field the DCH field workers found this filter can also remove arsenic from water. DCH now trying to improve its efficiency at community level. Depending upon the concentration of arsenic in water, number of the filter steps can be increased. So it can be called 3 or 4 pitcher filter too. It can also be made locally with even bamboo and earthen pitcher (Fig-1) costing about USD 5.00 only.

It may need to change the stand once in a year.

The 1st pitcher acts as a reservoir for contaminated water with whole just at its bottom. Through this whole water passes slowly down to 2nd. pitcher and then to 3rd pitcher. 2nd and 3rd. pitcher have got one whole each just at the bottom. To allow water to pass slowly to next pitcher a wick made of synthetic thread passed through the hole. Last pitcher is also a reservoir of filtered water. Filtration takes place in the 2nd. and 3rd. pitchers. These pitchers contain clear fine and coarse sand up to two third of the vertical height of pitcher. To increase the efficacy, 200 to 250 gram of non galvanized iron chips can be used in the 2nd. and 3rd. pitchers on the sand just below, where drops of water from upper pitcher fall. DCH found the result very encouraging. We have provided about 2000 such in our project area. It is observed that double the amount of filters have been set by communities with their own initiative. 10 per cent of these filter water randomly collected, using different concentration of arsenic and were tested in our laboratory for arsenic concentration before and after filtration for six months with out any problem (Table-2).

The concentrations of arsenic in water before filtration were considered from 0.08 to 1.5 mg/l. All water samples after filtration, were found arsenic safe. Tests were done every month for six months from November, 1999 to April, 2000 in our own laboratory by Silver D.D.T.C method.. During this period we did not also change the sand of our filters. It is still under study.

The arsenic avoidance that DCH prefers to removal methods includes mostly use of surface water. By filtering the protected surface water (Pond or Tank etc.) through sand and other locally available things to remove saline and

Table 2. Six Months (Nov/99 to April/2000) quality control for arsenic removal in Kalshi Filter
(Arsenic concentration in mg/l; BF- Before Filter, AF- After Filter)

Nov/99		Dec/99		Jan/00		Feb/00		Mar/00		Aprl/00	
BF	AF	BF	AF	BF	AF	BF	AF	BF	AF	BF	AF
.08 to 0.1	<.01 -.02	0.08 to 0.1	<.01 to .02	0.08 to 0.1	<.01 to .03	0.08 to 0.1	<.01 to .02	0.08 to 0.1	<.01 to .03	0.08 to 0.1	<.01 to .03
1 to 0.5	<.01 to 0.03	0.1 to 0.5	<.01 to 0.03	0.1 to 0.5	<.01 to 0.03	0.1 to 0.5	<.01 to 0.05	<.1 to 0.5	<.01 to 0.05	<.1 to 0.5	<.01 to 0.05
0.5 to 1.0	<.02 to 0.05	0.5 to 1.0	<.02 to 0.05	0.5 to 1.0	<.02 to 0.05	0.5 to 1.0	.02 to 0.05	0.5 to 1.0	0.02 to 0.05	0.5 to 1.0	0.02 to 0.05
1.0 to 1.5	0.02 to 0.05	1.0 to 1.5	<.02 to 0.05	1.0 to 1.5	<.02 to 0.05	1.0 to 1.5	0.02 to 0.05	1.0 to 1.5	0.02 to 0.06	1.0 to 1.5	0.02 to 0.055

bacteria too is recognized by UNICEF for southern part of Bangladesh is well known. This type of filters are known as PSF (Pond Sand Filtration). This water is truly rainwater too. PSF, we found very effective but community participation need to be ensured both for its establishment and maintenance. Selection of the pond is very vital. It involves protection of pond from contamination by many sources. Cost of one PSF for coverage of fifty families of 5 members per family is equivalent to about USD 650.00. The monthly maintenance may reach USD 2.00. Monthly maintenance includes washing of sand with plain water and preferably drying in sun. So the per family cost is about USD 13.00 for a period of 12 to 15 years. A continuous care is needed to maintain the quality of water. For smooth running community awareness and participation is essential.

Usually arsenic can be avoided if rainwater can be collected directly for consumption. Bangladesh has more than 2000 mm rainfall every year. This water can be collected from the tinned roof by channeling rainwater to a reservoir. Water from thatch roof is not suitable for use. Before collecting water the roof must be allowed to wash by one by rain for 5 to 6 minutes. Putting a plastic sheet sufficiently high from the ground like a tent can also make collection. The concavity of the tent should face upwards and a collecting hole is made just at the bottom. This needs almost a negligible cost. The main cost is needed for a reservoir. DCH made a reservoir for one family consisting 5 members. Per head use of water was calculated to 6-liters/ day and it comes to about 3000 liters for a period of three months. The cost of this establishment came to around USD 115.00 to 120.00. It will go higher if reserve tank is bigger. Considering the dry season for at least 6 months and cost for such a unit for a single family, DCH modified this unit for use in 12 months.

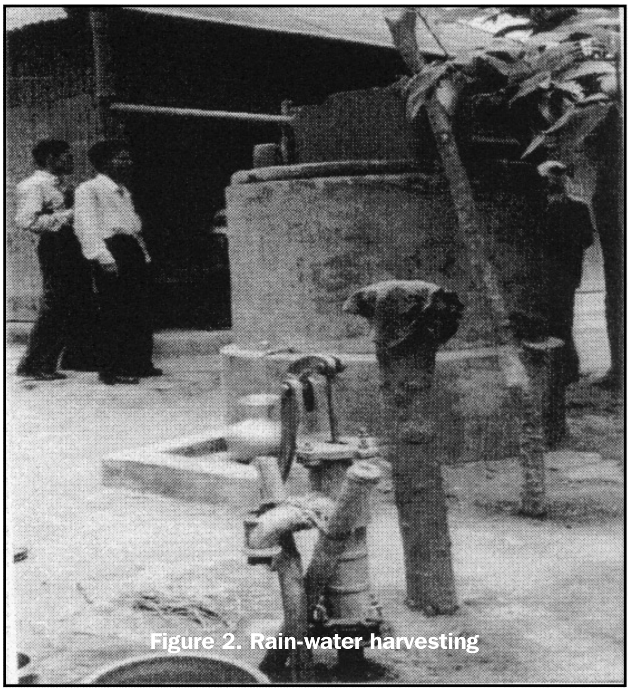

Figure 2. Rain-water harvesting

We divided the reservoir into two parts. The lower bigger one for reservoir only for dry season and the upper one for filtering contaminated tube-well water (Fig-2). Fine sand layer of about one foot height is used for the purpose. This platform can be removed in the rainy season.

Use of rainwater for drinking and cooking is not in practice for whole year by all our communities in Bangladesh. Preservation of this water in big amount needs to be practiced. Enough training and knowledge need to be disseminated in communities regarding reservoir and possible contamination of the water. Continuous attention should be given for possible source that may contaminate the preserved water.

One of the oldest traditional sources of drinking water is dug well in Bangladesh. In its early period this wells were basically a whole in the ground with a depth of 15 to 20 feet. With the improvement of local technology, people started using earthen ring to save the wells from damage by erosion. Later on rod, cement and concrete (RCC) ring with a diameter of 2.5 to 3 feet were used to replace the earthen rings. The depth of the wells was also going high up to 35 to 40 feet. Rich people would make wells by using brick wall which was popularly known as Indara . Along with this, the diameter increased to 5 feet or more and depth to about 50 feet. Owner of this type of dug wells would share the water with community. Longevity of these wells is up to 100 years. After the insertion of hand tube-wells, these water sources were blamed to carry germ and were rejected. Recently we found the deadly poison arsenic in the hand tube-well and surprisingly observed that the dug well water though coming from almost same layer does not contain arsenic. In the mean time our knowledge about diarrhoeal diseases and its role in producing these diseases has improved. Researchers think hydro-geo-chemical changes in the ground is playing a role in contaminating ground water. Due to similar reason there are incidences of contamination of ground water by element other than arsenic in many countries. Fluoride is one of them. In this context DCH think this dug wells can rescue us from not only this arsenic disaster but also from other such poisons. Our community already knows the technology. We only need to apply our knowledge just to protect the water from contamination and revive the already ruined attitude and behavior of our communities.

After collecting basic information about contaminated tube-wells and available water sources in our projects we had series of meeting with different communities and under stood that dug wells may be still a affordable and sustainable option of choice for them. We had more than 100 abandoned wells in our working area. We excavated and renovated the wells. We also made platform around them and cleaned the surrounding of the wells. Protection for contamination from out side was done accordingly. Water lifting systems were also changed to an almost non-touch technique. Cemented canals were made for dirty water disposal in a safe distance. In fact the criteria given by

WHO safe water guide line were tried to be full filled. We divided the wells in three types:

- **Open dug wells**- means the well in an open place with no chance of external contamination.
- **Covered dug-wells**- means a dug well where chance of contamination is high from above is covered with a moveable device. It needs to remove the cover while lifting water from wells.
- **Covered dug-well with hand pump** - it means the well was covered permanently with space for passing air and sun light in side. One tube well is put in well water with its lifting head outside the well in a safe distance (Fig-4).

We provided the communities with 74 of such wells with some of them modified and monitoring water for presence of bacteria from randomly collected samples. Many of the dug wells were totally managed by the family or community after it is renovated. We monitored them for bacteria and incidences of diarrhoea randomly. So far in few months we did not have any incidences of diarrhoea. We tested the water for bacteria from ICDDRB. In table-3 we have shown randomly collected renovated dug wells managed by the family randomly in every month. Report from January/2000 to april/2000 is in the table. According to WHO guide line water is classified to safe, low risk,

Table 3. (Bacterial Count of randomly Collected Dug wells. Managed solely by community N-number of dug well tested. T.Coli- Total Coli-form; F. Coli- Foecal Coli-form.)

Bacteria	Number of dug wells							
	January N-30		February N-30		March N-40		April N-25	
Bacterial count /100 ml.	T. Coli	F.Coli	T. Coli	F.Coli	T. Coli	F.Coli	T. Coli	F.Coli
0 Safe	4 13%	4 13%	6 20%	6 20%	8 20%	8 20%	5 20%	5 20%
1-10 Low risk	5	5	7	8	7	7	5	5
11 to 100 Inter.risk	11	11	11	10	16	16	11	11
>100 High risk	10	10	6	6	9	9	4	4

Table 4. (Bacterial Count of randomly Collected from modified Dug wells. N-number of dug well tested. T.Coli- Total Coli-form; F. Coli- Foecal Coli-form.)

Bacteria	Number of dug wells							
	January N-3		February N-7		March. N-7		April N-7	
Bacteria count/100 ml	T.Coli	F.Coli	T.Coli	F.Coli	T.Coli	F.Coli	T.Coli	F.Coli
0 Safe	1 33%	1 33%	3 42%	3 42%	4 57%	4 57%	5 71%	5 71%
1to 10 Low risk	0	1	1	1	0	0	0	0
11 to 100 Inter. Risk	2	1	3	3	3	3	2	2
>100 High risk.	0	0	0	0	0	0	0	0

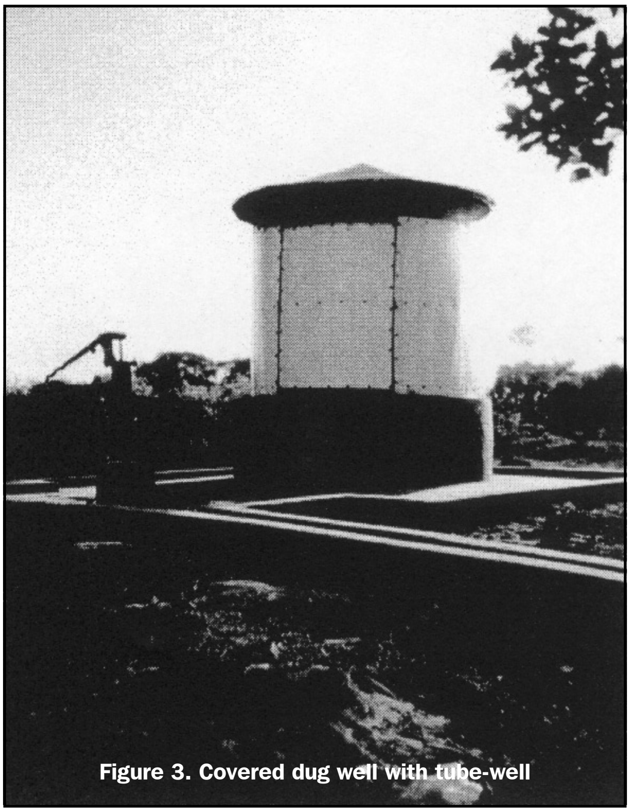

Figure 3. Covered dug well with tube-well

intermediate risk and high risk for bacterial count "0", "1 to 10", "11 to 100", and " more than 100" respectively.

Similarly some modified dug wells which were followed closely by DCH field workers were tested for bacteria and the result are shown in table-4. Gradually the wells are becoming safer. To understand the changes and seasonal variations in details this program needs continuation with close monitoring. Recently we have installed two new dug-wells in the community. Since beginning we have monitored the water quality. It was always found the bacteria free.

Recommendation

During our short field experiences here we found many changes in the community. People of this area now understand the need of quality water for them. They now also feel the need of monitoring for it. This is a program for only 8 months. To make these options replicable as a sustainable method these studies should more intensely be monitored for longer time. We feel dug well as a good option for permanent use. Monitoring for bacterial quality is needed. PSF is also good but selection of pond and monitoring is essential. Pitcher filters is a very good option for short term use. Its cost is also very low. Rainwater harvesting can also be promoted. This water can only be used for drinking and cooking. Technical support at the beginning is required. Removal methods need more field testing and research. Community motivation and participation should be encouraged along with close monitoring.

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