Experiences gained in tackling the arsenic disaster: Final report on arsenic mitigation project in Sonargaon and Jhikorgachha

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Executive summary

This report describes the experiences gained in the "action research on community-based arsenic mitigation project" implemented by BRAC in Sonargaon and Jhikorgachha upazilas of Bangladesh. The project was implemented in two phases. The first phase of the project was implemented during the period from June 1999 to December 2001. Experiences of the phase I have been described in BRAC report (Chowdhury et al. 2000). After completion of the phase I of the project some further works and follow-up activities were carried out during January 2001 to December 2001. The objectives of the phase II of the project were to: (i) assess the present status of arsenic concentration in all green, cross and at least 10% of the red tubewells marked in Phase I; (ii) involve community members in choosing, financing, implementing, and maintaining alternative sources for safe drinking water; (iii) provide alternative safe water options with active participation from the communities; (iv) identify arsenic affected patients in the project areas and provide treatment or referral whichever is appropriate; (v) make community people aware of dangers of arsenic poisoning; and (vi) develop a system involving local communities and local level officials in different phases of the project activities for the long-term sustainability of the safe water implementation plan.

A total of 26,058 tubewells, 10,062 from Sonargaon and 15,996 from Jhikorgachha was selected for re-testing in the Phase II. From the monitoring of the tubewells for more than two years it was found that there was no significant change in the concentration of arsenic in the tubewell water in both the project areas.

Participation of the different stakeholders of the community was ensured by involving them in different committees formed at upazila level to village level. The committees were: (a) Upazila Committee, (b) Union Committee, (c) Ward Arsenic Mitigation Committee, and (d) Village Arsenic mitigation Committee. In addition to these, Option Maintenance Committees were also formed to ensure maintenance and proper use of the safe water options implemented.

During the course of project implementation in Phase II about 6,434 families were provided with safe water through different options like hand-set deep tubewells, dugwells, and alcan filters. Water quality of all these options were monitored for arsenic and coliform bacteria.

In the Phase II, a total of 262 new patients were identified in addition to the 403 patients identified in the Phase I. These patients were kept under regular follow-up of the Medical Officer of health programme of BRAC. The patients received *Carocet* tablets (combination of vitamin A, C, and E) and salicylic acid as ointment supplied by UNICEF.

Social mobilisation was considered as one of the important components of the project activities. Village meeting, *Gano Natok* (Popular theatre), and *Uthan Baithak* (courtyard meeting) were conducted to make people aware of the problem.

The recommendations based on the experiences gained during the period of project implementation are as follows:

i. In order to make the different arsenic mitigation committees effective there should have a provision of incentives for the committee members.
ii. In most cases the responsibilities of the different arsenic mitigation committees were not specific. Activities of the committees, therefore, should be assigned based on extent of the problem of arsenic contamination of the area.
iii. Social mobilisation on the arsenic issues and its remedy may help people motivate to be aware and take initiatives by themselves.
iv. Due to presence of chemical and microbiological contamination surface water bodies were not suitable to use directly for drinking and domestic purposes. There should have a "reserve pond" in each and every village across the country.
v. NGOs having their grass root level net work throughout the country can help government in making the arsenic mitigation programme a success story. For

this a co-ordinated effort should be taken from both the government and non-government development organisations.

Chapter 1

INTRODUCTION

The arsenic problem in Bangladesh

The problem of arsenic poisoning in the groundwater of Bangladesh has been described as the largest mass poisoning of a population in history (Smith *et al.*, 2000). Estimates suggest that around 27% of the total tubewells installed over the years in the country have an arsenic concentration above the upper permissible limit of 50 µg per litre (DPHE/BGS/DFID, 2000; DoE, 1991). About half of the total population of the country spread over almost same proportion of the districts, are exposed to the threat of arsenic contamination (Munim K.M.A., 1997). A survey was conducted in 20 districts for arsenic patients, and in 18 districts people having arsenical lesions such as melanosis, leucomelanosis, keratosis, hyperkeratosis, dorsum, non-peting oedema, gangrene and skin cancer were identified (Dhar *et al.*, 1997).

Since the surface water sources of Bangladesh has been contaminated with micro-organisms causing a significant burden of disease and mortality people have become dependent on ground water use through tubewells since 1940s (UNICEF, 1999). The country has surpassed its goal of providing "safe" drinking water to more than 90% of the population by tubewells (Fazal *et al.*, 2001). The recent discovery of arsenic in ground water has become a new threat to the success of safe water supply in the country. It is estimated that there are more than four million tubewells in the country installed by both the government and the private sectors.

Immediately after discovery of arsenic poisoning in the ground water of Bangladesh many private organisations along with the government have been working in this field to combat the crisis. The main challenge, at this moment, is to provide the arsenic exposed people with safe drinking water. This is the hardest part of the arsenic mitigation activities as very little is known about various safe water options available in the country.

It is also a great challenge for the people working in the field of water supply to make community people agree to switch from the tubewells to the alternatives as well as to involve them in financing for these alternatives. In addition, the mitigation technologies invented, renovated, or introduced from foreign countries are expensive in some cases and users are not familiar with these systems.

Issues prevailing in the project areas

- There are many villages where no arsenic-safe tubewells are available.
- All villages are not equally affected and hence there is a need for prioritisation in intervention.
- Local women with limited educational background can also be trained on preliminary identification of arsenicosis patients, awareness development on the issue, alternative water supply options and monitoring of the options in the areas. Local masons can be trained on the construction and manufacture of different options so that their expertise can be used up to the maximum level.
- Community mobilisation and their involvement are essential for arsenic mitigation.
- People are willing to participate in testing, priority-setting, awareness-building, mitigation and cost sharing for the comfortable safe water options.
- The feasibility, effectiveness, and acceptance of the safe water options available vary from place to place. Some options have been found to be either technically inefficient or disliked by the community; others were found to have good potentials. There may not be a single but a combination of solutions.
- This project tested eleven options for arsenic safe water. Newer options such as piped water supply, deep wells, and 'reserved' ponds should also be tried for feasibility and cultural acceptance.
- The safe water options supplied/installed in the community should be constantly monitored on a regular interval; any option can go wrong for lack of maintenance or other reasons. Regular monitoring of water treated by technologies using either surface or groundwater arsenic concentration and in case of surface water it should be

tested for coliform bacteria. In Bangladesh, surface water is highly contaminated with coliform.

- Awareness level varies from village to village, and hence the rate of people's switching from contaminated tubewells to 'safe' sources varies. Villages with arsenicosis patients have the highest consciousness. Effective awareness campaign is necessary to motivate people to drink arsenic safe water. Anecdotal evidence suggests not all options provided by that project are equally used.
- Many arsenicosis patients have been identified so far and more patients are being identified every day. Action must be taken immediately to avert the threat to health that is looming for much of the nation's population. The first priority to the arsenic exposed people is to provide them with arsenic safe water for both drinking and cooking purposes.
- Following provision of safe water and some treatments many of the arsenicosis patients report an improvement; research is needed to find out effective treatments regimes for patients in different stages of arsenicosis.
- Many treatment units, either home-based or community-based, produce sludge that contains high concentration of arsenic. A countrywide proper management system for this sludge should be set up so that rural people can manage this in a convenient way.
- There should be more co-ordination among different governmental and non-governmental agencies working in the country. NGOs with their base at the grassroots level and wide network throughout the country are capable of scaling up the arsenic mitigation programme rapidly on emergency basis, particularly in the worst affected upazilas.
- Water supply systems should be long term and community based options should be community based.

Development of the Phase II of the action research into arsenic mitigation

After completion of the Phase I of the project demand for safe water was created among the people exposed to arsenic contaminated water. Besides, it was also necessary to conduct communication campaign activities in the areas. Some of the alternative safe water devices implemented in the phase I needed to be monitored for their technical viability, water quality parameters, and community acceptance. It was therefore, necessary to extend the project period to execute some works like increasing safe water coverage through alternative safe water sources, formation of different committees for arsenic mitigation involving the community people as well as the local government officials, and creating awareness among the people.

Purposes of the project

The objectives of the project were to

1. assess whether any change in concentration of arsenic in tubewell water occurred over the period of two and half years after screening in June 1999.
2. involve community members in choosing, financing, implementing, and maintaining alternative sources for safe drinking water;
3. ensure community participation in sharing cost for safe water in order to achieve sustainability of the project;
4. identify arsenic affected patients in the project areas and provide treatment or referral whichever is appropriate; and
5. make community people aware of dangers of arsenic poisoning; and develop a system involving local communities and local level officials (DPHE, Union Parishad representatives, upazilas health complex etc.) in different phases of project activities for the long-term sustainability of the safe water implementation plan.

Major activities executed in the project

The following activities were performed during the project implementation period

1. retain community members to test tubewell water using the newly developed Merck field test kit (*sensitiv*), and mark all tested tubewell spouts with appropriate signs of red and green colour;
2. reassess the strategy to raise community awareness about arsenic contamination and its health effects through inter-personal contact and various media;
3. identify arsenic patients in the community and provide treatment and basic health information for them;
4. conduct PRA (Participatory Rapid Appraisal) to map resources in the remaining potentially arsenic affected villages to the project areas to develop ideas for safe water implementation plan; co-ordinate with other agencies including DPHE, local government and upazila health personnel on different project activities; and
5. develop and ensure the mechanism of cost sharing with villagers for alternative drinking water.

Purpose of the report

This is the phase-ending report for the "Action research on community-based arsenic mitigation project-Phase II, follow up and further work in Sonargaon and Jhikorgachha" project for the period December 15, 2000 to December 14, 2001. Experiences gained during the course of project implementation have been documented in this report. It covers results of re-testing of all green, cross and 10% of the red tubewells marked in the Phase I, resource mapping and village meetings, provision of safe water through alternative safe water options, arsenicosis patient screening and their treatment, maintenance of the safe water devices implemented in the Phase I, mobilising and organising the community through formation of committees and activation of the committees formed by the government.

Chapter 2

RETESTING OF THE TUBEWELL WATER FOR ARSENIC

Testing methodology

Testing of tubewell water for arsenic was done using the modified version of Merck arsenic field test kit (version: *sensitiv*, 1.17926.0001, method: analytical test stripe, made by Merck KGaA, Germany). This test kit can detect arsenic ($As^{3+/5+}$) content from 0.01 to 0.5 mg/l. The Village Health Workers (VHW) of BRAC did the field level testing work. The selected VHWs were given two days training on testing of arsenic using field test kit by BRAC and then sent to do the testing work door to door. A total of 99 VHWs, 57from Sonargaon and 42 from Jhikorgachha were involved in this work. Field level testing by the VHWs was monitored by the Field Supervisors. Refreshers training was also arranged for the VHWs in order to ensure the quality of testing.

If the tubewell water was found to contain arsenic concentration above the upper permissible limit of 0.05mg/L then the spouts of the tubewells were marked with red paints and those contained arsenic concentration of 0.05mg/L and below that then the spouts of those tubewells were marked with green paints. Thus, the green marked tubewells were safe and the red marked were dangerous for drinking and cooking. Due to limitation with the old version of Merck arsenic test kit in detecting arsenic concentration below 0.1mg/L, tubewell spouts were marked with a "red cross" sign when water of those tubewells were found to contain arsenic concentration below 0.1mg/L in the Phase I (Chowdhury, AMR. *et al* 2000).

Table 2.1: Qualitative and field specification of different levels of arsenic contamination in Phase I.

Level of arsenic (mg/l)	Qualitative specification	Tubewell spouts painted with
0	Safe	Green
>0-<0.1	Potentially dangerous	Red cross
0.1+	Dangerous	Red

Table 2.2: Qualitative and field specification of different levels of arsenic contamination in Phase II.

Level of arsenic (mg/l)	Qualitative specification	Tubewell spouts painted with
0-0.05	Safe	Green
>0.05	Dangerous	Red

Re-testing results of the tubewells

A total of 26,058 tubewells, 10,062 from Sonargaon and 15,996 from Jhikorgachha which were tested in the Phase I were selected to for re-testing in the Phase II. Number of tubewells of different categories of safe, dangerous and potentially dangerous tubewells selected for re-testing have been shown in the Table 2.3.

Table 2.3: Number of tubewells of different categories selected for re-testing.

Upazila	Dangerous tubewells	Safe tubewells	Potentially dangerous tubewells	Newly installed tubewells	Total
Sonargaon	1,396	4,508	567	3,591	10,062
Jhikorgachha	1,092	11,070	2,217	1,617	15,996
Total	2,488	15,578	2,784	5,208	**26,058**

In both of the upazilas a total of 15,306 tubewells were re-tested for arsenic and it was found that almost 93% remained unchanged. In Sonargaon, out of 4,508 safe tubewells 91% were found unchanged and in Jhikorgachha of the total 10,798 safe tubewells re-

tested 93% were found unchanged. The re-testing results of the safe marked tubewells have been given in the Table 2.4.

Table 2.4: Re-testing results of the safe tubewells.

Upazila	Safe tubewells	Re-testing results	
		Dangerous	Safe
Sonargaon	4,508	392	4,116
	(100)	(9)	(91)
Jhikorgachha	10,770	708	10,062
	(100)	(7)	(93)
Total	15,278	1,100	14,178
	(100)	(7)	(93)

N.B.: Values within parentheses indicate percentage

Re-testing results of a total of 2,784 tubewells which were identified as potentially dangerous (red cross) in Phase I revealed that 65% of them were found safe and the rest were found in the dangerous category in terms of contamination. Re-testing results have been shown in the Table 2.5.

Table 2.5: Re-testing results of potentially dangerous tubewells.

Upazila	Potentially dangerous tubewell	Re-testing results	
		Dangerous	Safe
Sonargaon	567	206	361
	(100)	(36)	(64)
Jhikorgachha	2,217	759	1,458
	(100)	(34)	(66)
Total	2,784	965	1,819
	(100)	(35)	(65)

N.B.: Values within parentheses indicate percentage

A total of 2,488 tubewells found unsafe in the Phase I was re-tested and 79% of them were found unchanged and 21% were safe. Thus, 21% deferred from the previous test result. Results have been shown in the Table 2.6.

Table 2.6: Re-testing results of dangerous tubewells

Upazila	Dangerous tubewells	Re-testing results	
		Dangerous	Safe
Sonargaon	1,396	1,096	300
	(100)	(79)	(21)
Jhikorgachha	1,092	879	213
	(100)	(80)	(20)
Total	2,488	1,975	513
	(100)	(79)	(21)

N.B.: Values within parentheses indicate percentage

After screening of the tubewells for arsenic in the Phase I in September 1999 many villagers in the project areas who found their tubewell water contaminated with arsenic re-installed their wells. The re-installation was done by adding more pipes into the deeper aquifer. The villagers took this initiative themselves with the help of some of the tubewell mechanics. A total of 5,208 tubewells were re-installed in both the upazilas. Among these 28% were unsafe and the rest 72% were safe. Results of testing for arsenic in the newly installed tubewell water have been shown in the Table 2.7. Thus re-sinking tubewells in the deeper aquifer in Sanargaon helped people overcome the problem of arsenic contaminated water.

Table 2.7: Test results of the newly installed tubewell water.

Upazila	Newly installed tubewells	Re-testing results	
		Red	Green
Sonargaon	3,591	1,092	2,499
	(100)	(30)	(70)
Jhikorgachha	1,617	347	1,270
	(100)	(21)	(79)
Total	5,208	1,439	3,769
	(100)	(28)	(72)

N.B.: Values within parentheses indicate percentage

A total of 52 tubewells were found out of order in both the upazilas. These were recorded by the VHWs while testing tubewell water door to door in the villages. The owners themselves made these tubewells inactive when these were identified as contaminated with arsenic.

Chapter 3

COMMUNITY INVOLVEMENT IN THE PROJECT

Formation of arsenic mitigation committees

One of the activities of the project was to ensure participation of the different stakeholders in the project in order to achieve sustainability. This was done by organising the community people through formation of different types of committee in the project areas. The committees formed were as follows

b. Upazila Committee
c. Union Committee
d. Ward Arsenic Mitigation Committee
e. Village Arsenic Mitigation Committee
f. Option Maintenance Committee

These committees were formed after a series of discussion with the members of the committees. Except the village level committees, achievement of formation of the committees was 100%. At the village level it was found that all villages were not severely affected and in some villages contamination level was low. For this reason village arsenic mitigation committee was not formed in every village. The types and number of the committees formed have been shown in the Table 3.1.

Upazila Arsenic Mitigation Committee

At the upazila committee the respective UNO (Upazila Nirbahi Officer), Medical officer of the Upazila Health Complex, the Sub-assistant Engineer of the Upazila Public Health Engineering Department, and the Upazila arsenic mitigation project co-ordinator of BRAC were the members of the committee. The meeting was held monthly at the Upazila office in the chair of the Upazila Nirbahi Officer. The meeting was held

immediately after finishing the monthly Upazila Development Co-ordination meeting. The Upazila arsenic mitigation co-ordinator of BRAC presented the updated information and the action plan of the project in the meeting.

Union Arsenic Mitigation Committee

The Union arsenic mitigation Committee was formed in the union level among the Union Parishad Chairman, members and arsenic mitigation co-ordinator of BRAC. The elected Union Parishad members took part in selection of the safe water options.

Ward Arsenic Mitigation Committee (WAMC)

The Local Government Engineering Department of the Government of Bangladesh issued a notice dated 30 November 2000 to the concerned office to form ward arsenic mitigation committee in each and every union across the country. The members of the Ward Arsenic Mitigation Committee were as follows

i) Elected female Member of the ward- as advisor
ii) Elected Member of the ward- President
iii) One Health worker/Family planning worker
iv) One Block supervisor
v) One Ansar/ VDP worker
vi) One Freedom fighter
vii) One Imam of the mosque
viii) One Teacher of the educational institution

Activities of the Ward Arsenic Mitigation Committee

The activities of this committee were to

i) form the survey team to conduct the testing of tubewell water for arsenic at the grass root level
ii) schedule the training programmes for tubewell testing using field test kit.
iii) test the water of tubewells for arsenic
iv) identify arsenicosis patients
v) develop awareness on arsenic problem
vi) provide arsenic safe water to the exposed people in the rural areas

In fact, it was found that in most cases these committees were not formed in the field. In some cases there existed some committees but were not functional. BRAC had, therefore, to do; firstly, formation of new WAMC where there was no committee and, secondly, strengthen the committee where these were declared but not active.

Village Arsenic Mitigation Committee

Village arsenic mitigation committees were formed almost in all villages except few where the arsenic problem was not severe. The members of the committee include the village elites, local leader, Imam of the mosque, schoolteacher, and the village health worker of BRAC.

Water Option Committee

Water option committees were formed to ensure proper use of the safe water devices implemented and maintenance of the system. It also aimed to collect contribution money for implementation of the option and also for the maintenance and operation of the system. The committees were formed only in case of the community based options. Option committees consist of nine to eleven members. In case where the option is

constructed near the mosque or school ground, the respective mosque committee or school managing committee is responsible for taking care. The members of the Water Option Committee were as follows

i) owner of the land where the system is constructed-as President
ii) one member of the user families-as General Secretary
iii) eight members of the user families

Table 3.1: Number of different committees formed in the project areas.

Activities	Sonargaon			Jhikorgachha		
	Planned	Held	Achieve-ment	Planned	Held	Achieve-ment
Committee Formation						
i) Upazila committee	1	1	100%	1	1	100%
ii) Union committee	11	11	100%	11	11	100%
iii) Ward committee	81	81	100%	90	90	100%
iv) Village committee	160	144	90%	163	163	100%
v) Water option committee	57	57	100%	155	155	100%

Follow-up meetings

These meetings were held for several purposes like involving community in implementing the project activities, awareness raising, distribution of safe water options, training on option use and maintenance etc. Follow-up meetings were also conducted to

ensure the proper use of the water options by the people. Number of the follow-up meetings at the village level was not fixed before starting the intervention.

Table 3.2: Formation of different committees in the project areas.

Activities	Sonargaon			Jhikorgachha		
	Planned	Actual	Achieve-ment	Planned	Actual	Achieve-ment
a. Upazila committee	12	6	50%	12	12	100%
b. Union committee	81	64	79%	54	50	93%
c. Ward committee	60	53	88%	60	56	93%
d. Village committee	-	226	-	-	590	-
e. Resource map	60	53	88%	40	30	75%

Revisit of the safe water option committees

In order to organise, activate, and strengthen the different arsenic mitigation committees another approach of monitoring-visit was conducted regularly by the field based project staff. During these visits, particularly in the options sites, village meetings were held to ensure operation and maintenance of the options and to motivate people through the committees for the optimum use of safe water. A total of 1,080 such meetings, 490 in Sonargaon and 590 in Jhikorgachha were conducted during this period.

Resource mapping and GIS study

Resource maps were prepared in the arsenic affected villages where safe water options were constructed. Sources of water, and the other natural as well as social infrastructures

were shown in these maps. In addition to the maps prepared in the Phase I a total of 83 such maps were prepared in the Phase II. A GIS study was conducted for the green tubewells in Sonargaon.

Chapter 4

IMPLEMENTATION OF SAFE WATER OPTIONS

Based on the lessons learned from the experiences with 11 different types of options tested during the course of the project implementation in the Phase I only three types of options were promoted in the Phase II. These are Deep hand set tubewells, dugwells, and alcan filters. Technical details of these options have been given in the final report of the Phase I of the action research project (Chowdhury, AMR 2000) Details of these options have been shown in the Table 4.1.

Table 4.1: Type of options selected in the Phase II.

Option	Type	Method	Families covered by one unit
Deep tubewell	Community- based	Groundwater abstraction	40-50
Dugwell	Community-based	Groundwater abstraction	20
Alcan filter	Household & Community-based	Chemical-treatment	1 (Household-based) and 20 (Community-based)

Hand-set deep tubewell

The hand-set deep tubewells were installed up to the depth of 800 feet. The platform of the tubewell was made of concrete. Total installation cost of a hand-set deep tubewell ranged from Tk. 35,000.00 to 40,000.00. Twenty percent of the total installation cost was beard by the user families and the mitigation committee collected the contribution money. The committee also selected the site to install the well. These tubewells were installed by a construction farm selected through an open competition called by a tender.

Dugwell

Dugwells were constructed by following the design of 'converted hand-pumped dugwell' given in WHO Guidelines for Drinking Water Quality Vol. 3 (1997). The old wells were renovated by adding a hand pump to draw water comfortably. A cover-lid was constructed around the well to prevent contamination from the surface. Water samples from some selected wells were tested for monitoring arsenic and coliform bacteria. The cost was as high as Tk. 6,000.00 to 8,000.00 to renovate a dugwell.

Alcan filter

The basic principle of this system was adsorption of arsenic by activated alumina. Two different types; household- and community-based units were available. Monitoring of this type of filter for arsenic and coliform bacteria reveals that its performance is satisfactory. Price of the small size was Tk. 2000.00 and that of the large size was Tk. 20,000.00.

In addition to these three options described above some other household based filters like *Bishuddhya* filter (introduced by PROSHIKA from Canada), *Shapla* filters (introduced by IDE, International Development Agency) were also given to the villagers for demonstration. A total of 10 *Safi* filters were also distributed among the villagers in Sonargaon. These were distributed on trial basis to observe their effectiveness.

Some water options like dugwells, PSF Pond sand filter), TSF (Tubwell sand filter), and rainwater harvesters implemented in the Phase I were repaired in Phase II. Table 4.2 shows the type and number of water options implemented and renovated in Phase II.

Table 4.2: Number of different safe water options implemented.

Activities	Sonargaon	Jhikorgachha
Dugwell renovated	49	136
Hand-set deep tubewell	20	38
ALCAN (Community-based)	5	5
ALCAN (Household-based)	55	20
Bishudha Filter (Proshika filter)	10	20
Shapla Filter	50	-
Safi Filter	20	-
Piped line water system	1	-
Repairing of the water options implemented in Phase I		
Dugwell	5	4
Rain Water Harvester (RWH)	1	8
Pond Sand Filter (PSF)	2	12
Tubewell Sand Filter (TSF)	-	2

Criteria for distribution of the options

i) The areas found highly arsenic contaminated were selected for implementation of water options. Before starting intervention of safe water supply the areas were categorised based on the level of contamination.

ii) The areas where there was no intervention of arsenic mitigation taken by other agencies.

iii) The area where there was demand of safe water by the local people.

iv) Availability of the options allocated in the project

v) Feasibility of implementation of the options in the areas.

The demand for the deep hand set tubewells was high and common in all the arsenic affected areas. Due to limited number of option allocated in the project only the severely affected villages were selected for distribution of the option. The dugwells were renovated in the area where the old ones were found and where there was a demand for

arsenic safe water. The alcan filters, both family size and the household size were given to those who paid the 20% contribution money individually or in the form of a committee.

Coverage of safe water through different alternative options

In Phase II about 6,434 families were provided with safe water through different water options. Although the number of the families covered by safe water options was almost same in both the upazilas but the percentage of coverage was low in Sonargaon because of the increased number of families exposed. Although about 23% of the families were covered in Phase I the percentage of coverage reduced later on because many options became non-functional due to technical reasons as well as community unacceptance. In the Phase II a total of 6,434 families were provided with safe water through different water options. At the end of the Phase II the coverage of safe water was 34% including the coverage of 23% in the Phase I (Table 4.3).

Table 4.3: Coverage by safe water options in the project areas.

	Sonargaon	Jhikorgachha	Total
Total exposed population	165,000	115,000	280,000
Number of exposed families	33000	23000	56,000
Number of families covered			
Phase I	7750	4980	12730 (23%)
Phase II	2079	4355	6434
Total families covered	9829	9335	19164
% of families covered	30	41	34

Monitoring of water quality parameters

In order to observe whether any change occurred overtime in the concentration of arsenic in the tubewell water a total of 524 tubewells were tested using AAS (Atomic Absorption Spectrophotometer). The tests were done in Tetrahedron Inc.-a private water quality

testing laboratory in Dhaka. Water samples were collected from the field in the sample bottles supplied by the laboratory and then sent to the laboratory for analysis.

To assess the coliform load in the water of dugwells some selected samples were tested. Microbial analysis was done in the Environmental Microbiology Laboratory at ICDDR,B in Dhaka. The water samples were collected in sterilised bottles supplied by ICDDR,B and sent to the laboratory within 24 hours from the sample collection time. Number of tests for arsenic and coliform using different methodologies have been shown in the Table 4.4.

Table 4.4: Number of laboratory tests for different parameters of water quality.

Parameter	Sonargaon	Jhikorgachha	Total
Tests for arsenic using AAS	177	347	524
Tests for coliform 1st lot	71	70	141
2nd lot	80	76	156

Present use status of the safe water options

Some selected options like hand-set deep tubewells, dugwells, PSF, TSF, rain water harvester, and alcan filters implemented in the project areas were visited in June 2002 to see their use status by the people.. Table 4.5 describes the present use status of the options as well as the reasons for not being used by the community people.

In case of the dugwells the problems of lowering the water table was noted. This problem is temporary for a particular period, specially in the dry season. So, there is a potential risk of unavailability of water in dugwells during the dry season. Most of the PSF were found unused by the people in both the areas. People were found reluctant to use PSF water. There were some technical faults with some of the rain water harvesters in manufacturing the system. The technical faults during manufacturing were found high in Jhikorgachha. Out of total 10 TSFs manufactured in both the areas, 9 were inactive due to

technical faults of iron clogging and lack of maintenance. Although there was no problem with hand-set deep tubewells in Sonargaon but some problems of presence of arsenic above the acceptable limit and excess iron in water were noted in Jhikorgachha. The other filters were kept under trial and no data on their use status were collected.

Table 4.5: Present use status of the safe water options (as of 25 June 2002).

Option	Total units	Present use status				Remarks
		Sonargaon		Jhikorgachha		
		Active	Inactive	Active	Inactive	
Dugwell	221	81	4	98	38	Temporary inactive due to lowering water table during dry season.
PSF	37	-	4	9	24	Due to reluctance of the users to use pond water most of the PSFs were unused.
RWH	90	24	46	12	8	In Jhikorgachha 8 jars were cracked. In Sonargaon people preferred other alternative options like re-installation of shallow tubewell in the deeper aquifer.
TSF	10	-	8	1	1	Became inactive due to technical faults of iron clogging and proper maintenance.
Hand-set deep tubewell	58	20	-	30	8	Due to presence of arsenic of above acceptable limit and technical faults of pumping fine sands with the abstracted water.
Alcan large	10	4	1	5	-	Media became exhausted.
Alcan small	75	55	-	20	-	
Bishudhya Filter	30	9	1	20	-	
SIDKO	1	-	-	1	-	
Safi filter	20	20	-	-	-	Modified units under experiment.
Piped water system	1	1	-	-	-	Under trial.
Shapla Filter	50	50	-	-	-	

Chapter 5

COMMUNITY PARTICIPATION IN COST SHARING

Cost sharing for safe water

Experiences with different safe water options implemented in the Phase I suggested that participation of the people in sharing cost for safe water is essential for the sustainability of the systems. Although in the Phase I no deliberate effort was made to recover costs because the main objective of that stage was to demonstrate the potentials of alternative safe drinking water sources in the context of rural Bangladesh. Community involvement in sharing cost for the safe water options, therefore, was ensured in the Phase II. All of the options were distributed with 20% contribution money of the total cost of the option from the community. In case of community-based option this money was collected from the users through the option committee.

Cost for renovation of a dugwell ranged from Tk. 6000.00 to 8000.00 of which 20% was borne by the villagers. Installation cost of a hand-set deep tubewell was around Tk. 35,000.00 to 40,000.00 of which 20% money was collected from the community through the committee. In some cases some villagers who were well-off showed their interest to pay the whole contribution money by themselves alone but BRAC did not agree to allocate the hand-set deep tubewells for those people. The options were given to those places where there were community participation in sharing cost and there was equal access for all to the water sources.

It was also learnt that rural people were willing to pay for a comfortable water source even if it is expensive like piped water supply. Implementation of rural multipurpose safe water supply project in Pakunda village in Sonargaon has become a milestone in the field of safe water supply in the arsenic affected rural areas of Bangladesh. The initial construction cost of the project was about Taka 18 lacs of which the villagers contributed

20% of the total. Each of the user families paid initial membership money of Tk. 2500.00. They also agreed to bear the electricity bill and the maintenance cost as well.

Cost-sharing of the people for water testing for arsenic

BRAC also tried to initiate community involvement in bearing cost for the test of the tubewell water for arsenic. For this purpose, it arranged a system of arsenic testing using field test kit with Tk. 30.00 for each test in the project field offices. Project field supervisors conducted this test. Response of the people in this respect was noted. People those who re-installed or installed tubewells newly usually did this test. About 110 people in Sonargaon did this test paying the cost.

Chapter 6

ARSENICOSIS PATIENT MANAGEMENT

During the course of the project implementation started in 1999 a total of 665 arsenicosis patients of different stage were identified in the two upazilas. In the Phase II, a total of 262 new patients were identified in addition to the 403 patients identified in the Phase I. The status of the arsenicosis patients have been shown in the Table 6.1. All the patients were kept under the regular follow-up of the medical officer of the health programme of BRAC. The patients received *Carocet* tablets (combination of vitamin A, C, and E) and salicylic acid as ointment supplied by UNCEF. All the arsenicosis patients were provided with arsenic safe water.

There was also a system of arsenic patient management developed in *Shushasthya* (BRAC Health Centre) at Sonargaon. The arsenicosis patients could get the facilities of identification and treatment from the health centre in exchange of a token money of Tk. 10.00. The arsenicosis patients, as prescribed by the medical officer, were provided with *Carocet* tablets free of cost from the local BRAC office.

Table 6.1: Number of arsenicosis patients identified in the project areas.

	Sonargaon	Jhikorgachha	Total
Phase I	252	151	403
Phase II	236	26	262
Total	488	177	665

Assessment of the health condition of the arsenicosis patients

All of the patients were revisited to see whether any improvements occurred. A physician in the middle of March 2002 did this revisit. The detailed health condition of the patients diagnosed by the physician has been shown in the Table 6.2.

Table 6.2: Impacts of project interventions on the health of the arsenicosis patients.

Examination period	Stage (of arsenicosis)	Sonargaon	Jhikorgachha	Total
Identified in 1999	1st	170	107	277 (68.7)
	2nd	77	43	120 (29.8)
	3rd	5	1	6 (1.5)
	Total	252	151	403 (100)
Revisited in March 2002	1st	172	107	279 (80.9)
	2nd	17	16	33 (9.6)
	3rd	0	1	1 (0.3)
	Improved	29	3	32 (9.3)
	Total	218	127	345 (100)
	Not found	35	25	60 (14.8)

Note: Figures in the parentheses indicate percentages.

It was interesting to note that maximum patients remained in the 1st stage of the prevalence of arsenicosis, which indicated that the poisoning effect of arsenic did not deteriorate. On the other hand, the number of the 2nd stage patients reduced to half of that in the 1st stage which clearly shows that the overall situation of the disease improved.

Chapter 7

SOCIAL MOBILISATION

Social mobilisation was considered as one of the important components of the project. The mobilising activities aimed to create awareness among the people about the problem of arsenic, alternative safe water sources, consequences of arsenic poisoning on human health, and all possible remedies of the problem. Different types of printed materials were used to create awareness among in the Phase I (Chowdhury AMR, *et al.*, 2000). Activities related to social mobilisation were done involving people. Emphasis was given to direct personal contact with different lively programmes like *Gano Natok* (Popular theatre), *Uthan Baithak* (courtyard meeting), and Village meetings. The local artists played the drama *Gano Natok* organised by the Social Development Programme of BRAC. It created great interest among the people. Besides these, three slides on messages of arsenic problem and its remedy were shown before starting the shows in a cinema hall in Jhikorgachha. This slide-show in the cinema hall was continued for one month.

Table 7.1: Awareness raising activities in the project areas.

Parameter	Sonargaon	Jhikorgachha
Gano Natok (Popular theatre) staged	30	60
Uthan Baithak (courtyard meeting) held	127	389
Village meeting held	134	426
Slide show in the Cinema Hall	-	1 month in 1 hall

Chapter 8

TIME LINE STUDY ON SETTINGS OF WATER OPTIONS

Providing people exposed to arsenic with safe water through alternate sources was not easy as very little was known about the different water technologies. The options available at the time were introduced and distributed among the people at different stages during the course of project implementation. A time line for settings of different safe water options has been given below

Time	Event
February 1999	Commencement of the community based arsenic mitigation project in Boidderbazar union of Sonargaon upazila.
March 1999	Distribution of 264 Safi filters in the project area. Construction of Rain Water Harvester and Pond Sand Filter started in Sonargaon.
June 1999	Extension of the project in the whole upazilas of Sonargaon and Jhikorgachha and increase of safe water supply. Construction of RWH and PSF started.
August 1999	Renovation of dugwells started
December 1999	All Safi filters were found out of order and were removed from the field. Distribution of three-pitcher filters started.
January 2000	Construction of Tubewell Sand Filters. Except 1 in Jhikorgachha, the people did not accept none of this option.
April 2000	Introduction of alcan filters.
June 2000	Manufacture and distribution of Tin filter (Modified three-pitcher filters) and *Motka* (clay made water reservoir). The people rejected these options.
July 2000	Phase II started. Only 3 types of water options, hand-set deep tubewell, dugwell, and alcan filters were selected as alternative water source.
January 2002	Rural multipurpose safe piped water supply project was implemented in Sonargaon. People shared 20% of the whole cost of Tk. 18,000,00.00. It has the provision of supplying water for both domestic and irrigation purposes.

Chronology of the settings of different safe water options in the action research into community-based arsenic mitigation project revealed that although a number of options were initially introduced only three namely deep hand-set tubewells, dugwells and alcan filters seemed comparatively to be accepted by the people. It could also be said that, if people felt comfortable, they were willing to pay for an expensive project like piped water supply in the rural areas.

Chapter 9

PAKUNDA MULTIPURPOSE RURAL WATER SUPPLY PROJECT

A milestone in rural water supply

Background

Experiences gained from working in the field of arsenic mitigation over the years revealed that there should be a sustainable system of water supply in the arsenic affected areas of rural Bangladesh. As part of its project activities implemented over more than three years BRAC, approached people of different villages of both Sonargaon and Jhikorgachha upazilas whether they were interested in setting up a pipeline water supply system in their villages. After a long mobilisation by BRAC workers finally the villagers of Pakunda of Sonargaon showed their keen interest to have this system.

People of Pakunda village were facing scarcity of safe water for a long time. The ground water was contaminated with arsenic and iron. Of the total tubewells 50% was found contaminated with arsenic above the upper permissible limit for Bangladesh. On the other hand, the surface water including that of the river Brahmaputra was polluted with industrial wastes. All these situations have created an acute crisis for safe water of all the inhabitants of the village.

Socio-economic condition of the village Pakunda

Household information

Total Household	449
Population	2456

Sex of the household head

Male	437 (97%)
Female	12 (3%)

Educational status of the household head (change the classification)

Illiterate	180 (40%)
Can read only	5 (1%)
Can write only	21 (5%)
Can read and write	186 (41%)
S.S.C. passed	23 (5%)
H.S.C. passed	20 (4%)
B.A. passed	12 (3%)
M.A. passed	2 (0.4%)
Total	449 (100%)

Occupation of the household head

Unemployed	17 (5%)
Agriculture	86 (19%)
Service	117 (26%)
Business	108 (24%)
Day labourer	73 (16%)
Fishing	3 (1%)
Household work	16 (4%)
Village transport	27 (6%)
Others	2 (0.4%)
Total	449 (100%)
Total earning members	650

Poverty Self Assessment

Chronic deficit	67 (15%)
Deficit	98 (22%)
Break through	150 (33%)
Surplus	134 (30%)
Total	449 (100%)

Source: Field survey, December 2001.

NGOs working in the village

Some non-governmental developmental organisations were working in the village Pakunda. BRAC has been working in this village over the years in the field of poverty elevation through credit programme, education, health and sanitation etc. There were 77 VOs (Village Organisation) members of BRAC under 2 VOs. Besides, BRAC some other NGOs like ASA, Grameen Bank and a local NGO named RASUS were also working in the village in different fields of developmental activities.

Current water source of the village

For drinking purposes, out of the total 449 families in the village 96 were found to use arsenic contaminated tubewell water. Among the rest, 327 used arsenic safe tubewells and 26 were found to use dugwell water. A total of 58 families was using arsenic contaminated tubewell for cooking and most was using pond or river water for the same purpose. The main source of bathing water of the villagers was pond or rivers.

Description of the project

Objective of the project

Considering the needs of safe water in the village Pakunda BRAC took initiative to implement a multipurpose piped water supply system with a view to serve the people with both domestic and irrigation water to all of the 449 families of the village.

Capacity of the system

Although the storage capacity of the overhead water tank was 35,000 litres and it could serve water automatically whenever it required.

Coverage by the system

Two separate lines were constructed to supply water for irrigation and domestic purposes. Initially a total of 8,500 feet of domestic water supply line was constructed to cover the 82 families of the village. At the same time 900 feet irrigation line was also constructed to provide water in the agricultural filed. It was expected that gradually the whole village would be covered under the project.

Cost, maintenance and operation

The initial construction cost of the project was about Tk. 18 lacs of which 20% was collected from the community. Each and every family deposited Tk. 2500.00 as the initial membership money. They beard the electric bill as well as the maintenance cost of the system. A maintenance committee of 13 members including 2 female representatives from the village was formed. They were responsible to take care of the system.

Implementing agencies

BRAC implemented the project in collaboration with the DPHE, UNICEF, and the Rural Development Academy (RDA), Bogra. UNICEF and RDA, Bogra provided the financial support. RDA, Bogra, provided the technical assistance. The people of the village Pakunda participated in sharing the cost for implementing the project. The experiences gained from this project, ever first in the country, can be used in other similar projects in the country.

Chapter 10

CONCLUSION AND RECOMMENDATIONS

The recommendations based on the experiences gained in implementing the action research project into community based arsenic mitigation have been described below

i. Monitoring of the tubewells water for two and half an year indicates that no significant change occurs in the concentration of arsenic in tubewell water in the two project areas.

ii. Screening of the tubewells for arsenic should be done immediately across the country to identify the safe and unsafe tubewells. After marking the tubewells, people can avoid the unsafe sources and share the safe ones among them.

iii. Social mobilisation on the issues of health and economic consequences of arsenic poisoning and its remedy should be done through more lively programmes like interpersonal communication campaign, popular theatre etc.

iv. Community-based safe water option should be promoted in order to ensure easy and cost effective monitoring of water quality parameters.

v. Subsidy should be considered for implementing safe water supply projects among the rural poor villagers.

vi. Formation of arsenic mitigation committee among the exposed committees is essential to organise the people and take the necessary initiatives. To make the arsenic mitigation committees effective in implementing projects on arsenic there should be a provision of incentives for the members of the committees and at the same time concerned departments of the government should have a monitoring system.

vii. In most cases the assignments/responsibilities of the different arsenic mitigation committees were not specific. Activities of the committees, therefore, should be assigned based on the need and the extent of the problem of the area.

viii. NGOs having their grass root level net work throughout the country could help the Government in making the arsenic mitigation programme a success story. For

this a co-ordinated effort should be taken from both the government and non-government development organisations.

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Annex

1. No. of cross marked tubewells tested by VHWs in Phase II in Sonargaon.

Union	Cross	Re-tested results by VHWs	
		Red	Green
Aminpur	30	11	19
Sonmandi	60	23	37
Barodi	83	48	35
Zampur	69	14	55
Sadipur	9	1	8
Kanchpur	23	23	0
Noagaon	82	31	51
Baidderbazar	50	14	36
Samvupura	77	9	68
Pirojpur	34	4	30
Mograpara	50	28	22
Grand total	**567**	**206**	**361**

2. No. of green marked tubewells tested by VHWs in Phase II in Sonargaon.

Union	Total Green Tubewells	Re-tested results by VHWs	
		Red	Green
Aminpur	606	43	563
Sonmandi	343	64	279
Barodi	190	26	164
Zampur	1638	47	1591
Sadipur	371	01	370
Kanchpur	130	00	130
Noagaon	149	26	123
Baidderbazar	339	58	281
Samvupura	47	10	37
Pirojpur	349	39	310
Mograpara	346	78	268
Grand Total	**4508**	**392**	**4116**

3. No. of red marked tubewells tested by VHWs in Phase II in Sonargaon.

Union	Total Red Tubewells	Re-tested results by VHWs	
		Red	Green
Aminpur	146	107	39
Sonmandi	193	131	62
Barodi	112	102	10
Zampur	116	99	17
Sadipur	31	02	29
Kanchpur	64	16	48
Noagaon	93	77	16
Baidderbazar	136	121	15
Samvupura	105	95	10
Pirojpur	132	106	26
Mograpara	268	240	28
Grand Total	**1396**	**1096**	**300**

4. No. of newly installed tubewells tested by VHWs in Phase II in Sonargaon.

Union	Total no. of newly installed tubewells	Newly installed tubewells	
		Red	Green
Aminpur	383	39	344
Sonmandi	238	150	88
Barodi	155	88	67
Zampur	334	110	224
Sadipur	535	26	509
Kanchpur	157	5	152
Noagaon	118	73	45
Baidderbazar	230	88	142
Samvupura	205	85	120
Pirojpur	564	269	595
Mograpara	372	159	213
Grand total	**2,791**	**1,092**	**3,591**

5. No. of green marked tubewells in Phase II in Jhikorgachha.

Union	Total no. of Green marked Tubewells	Re-tested results by VHWs		
		Red	Green	Inactive
Jhikargacha	2990	52	2757	5
Magura	563	42	508	4
Shimulia	904	111	772	2
Bankra	323	115	199	4
Nirbashkhola	896	107	786	1
Navaron	1424	62	1332	1
Sankarpur	344	66	275	3
G-nandapur	863	34	821	1
Hazirbagh	844	34	808	1
Panisara	906	47	855	2
Godkhali	1013	38	949	2
Grand Total	**11070**	**708**	**10062**	**28**

6. No. of newly installed tuebwells in Phase II in Jhikorgachha.

Union	Total no. of newly installed tubewells	Newly installed tubewells		
		Red	Green	Total
Jhikargacha	560	76	371	450
Magura	194	57	72	129
Shimulia	278	7	52	59
Bankra	399	24	19	43
Nirbashkhola	280	25	104	129
Navaron	243	53	154	207
Sankarpur	138	19	45	64
G-nandapur	179	12	106	121
Hazirbagh	107	15	65	80
Panisara	319	20	180	200
Godkhali	251	39	102	141
Grand Total	**2,948**	**350**	**1273**	**1623**

6. Total no. of cross marked tubewells in Phase II in Jhikorgachha.

Union	Total no. of Cross marked tubewells	No. of re-tested tubewells by VHWs		
		Red	Green	Inactive
Jhikargacha	252	84	128	3
Magura	132	39	90	2
Shimulia	138	22	110	1
Bankra	105	52	53	-
Nirbashkhola	200	107	85	-
Navaron	346	56	239	4
Sankarpur	140	100	37	2
G-nandapur	84	48	27	-
Hazirbagh	75	50	6	-
Panisara	468	91	373	3
Godkhali	438	110	310	3
Grand Total	**2378**	**759**	**1454**	**18**

8. **Total no. of red marked tubewells re-tested in Phase II in Jhikorgachha.**

Union	Total no. of Red marked tubewells	No. of re-tested tubewells by VHWs		
		Red	Green	Inactive
Jhikargacha	145	112	25	-
Magura	140	103	26	2
Shimulia	93	75	15	-
Bankra	150	108	33	2
Nirbashkhola	83	66	17	-
Navaron	102	61	29	1
Sankarpur	129	112	12	2
G-nandapur	92	69	14	-
Hazirbagh	68	45	18	-
Panisara	96	79	8	-
Godkhali	84	49	16	1
Grand Total	**1182**	**879**	**213**	**8**

Table 9: Results of newly installed tubewells.

Upazila	Total TW installed newly	Test results	
		Red	Green
Sonargaon	3591	1092 (30.4)	2499 (69.6)
Jhikorgachha	1617	347 (21.5)	1270 (78.5)
Total	5208	1439 (27.6)	3769 (72.4)

Note: Figures in the parentheses indicate percentages.

Table 10: Number of re-tested tubewells of different categories.

Upazila	Total re-tested TW (Red)	Total re-tested TW (Green)	Total re-tested TW (Cross)	Total re-tested TW installed newly	Total
Sonargaon	1,396	4,508	567	3,591	10,062
Jhikorgachha	1,092	11,070	2,117	1,617	15,896
Total	2,488	15,578	2,684	5,208	25,958