# Efficiency and Effectiveness of Point-of Use Technologies in Emergency Drinking Water: An Evaluation of PUR and Aquatab in Rural Bangladesh

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# Efficiency and Effectiveness of Point-of Use Technologies in Emergency Drinking Water: An Evaluation of PUR and Aquatab in Rural Bangladesh

**(Supported by: DPHE – UNICEF Bangladesh)**

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## List of Abbreviations

| | |
|---|---|
| DPHE | Department of Public Health and Engineering |
| NGO | non-government organization |
| UNICEF | United Nations International Children's Emergency Fund |
| DTW | Deep Tube well |
| STW | Shallow Tube well |
| TTC | Thermo tolerant coliform Bacteria |
| RCL | Residual Chlorine |
| POU | Point of use method (here referred to PUR and aqua tabs) |
| WHO | World Health Organization |
| BDS | Bangladesh Standard |
| O&M | operation and maintenance |
| PUR | Powdered Mixture for Purifier of Water |

# Executive Summary

## Introduction

Access to safe drinking water in emergency situations has been a continuing and growing challenge.. Here we present the results of testing of two point-of-use (POU) methods: PUR-Purifier of Water manufactured by Procter and Gamble and Aqua tabs Medentech Ltd, Wexford, Ireland. PUR is a relatively new product and has been tested in other countries, such as Pakistan, Afghanistan and other countries and found efficient and acceptable. Aquatabs are often distributed during floods in Bangladesh.

The objectives of the study are as follows:

1. To train extension officials about the use of PUR and Aquatabs in flood and other conditions.
2. To assess the efficacy of those two water purification method (POU) based on UNICEF-DPHE specified outlines.
3. To assess the effectiveness and acceptability of PUR and Aquatab in UNICEF-DPHE suggested areas.
4. To disseminate the experiences gained based on a workshop (organized by DPHE and UNICEF) and a report submitted to UNICEF.

## Methods

The study was implemented during September 2006 to February 2007. It followed cross-sectional observation method of evaluation. It was done by Environment and Population Research Center (EPRC), a non-government and non-profit research and training organization, in response to a DPHE-UNICEF's call for assessment of POU in flood/disaster mitigation based on an outline provided by UNICEF (RPF)/2006-029).

The POUs were distributed with food and other relief packages by Oxfam International through its relief partner NGOs; Bachteshekha and Uttaran (partner NGOs of Oxfam). It was distributed among selected priority water logged poor families in three sub-districts Abhoynagar, Keshabpur and Monirampur of Jessore district, Bangladesh. Oxfam selected those families based on impacts of water related problems and poor economic status. The NGOs distributed food among approximately 15000 families. Out of those 15000 families PUR & Aquatabs were included in the relief packages of 4800 families (beneficiaries) in 67 villages. The NGO partners of Oxfam distributed POUs (20 sachets of PUR and 20 Aquatabs), food, two buckets of 20-liter capacity, one plastic water container (jug)

of 3-liter capacity and other items in the relief packages. One sachet of PUR can provide 10 liters of clean drinking water and cost US $ 0.10. One Aquatab can provide 4-5 liters of clean water. The process involves mixing an Aquatab in 4-5 liters of water for a few minutes, letting the mixed water stand for 30 minutes and safe storage in a suitable container.

The partner NGOs were trained on importance of drinking and promotion of safe water in disasters, ways of water treatment, treatment by the POUs (demonstration), distribution plan, education method about how to use the POUs by the beneficiaries, and other issues by EPRC. The training plan and materials were developed based on consultations with the field staff of the relief NGOs and instruction on use of POUs as provided by UNICEF.

Out of the 4800 beneficiary households 200 households which had treated water during our visit were systematically randomly selected from 17 villages by EPRC. Two hundred water samples were collected and tested for Thermotolerant Coliform bacteria (TTC in colony forming unit, cfu/100 ml), pH, turbidity and residual chlorine (RCL in mg/l) from the households, which had treated water during the sample collection visits. The evaluation techniques included testing of the specified water quality parameters by the kit instruments provided by UNICEF, interviewing of the caretaker of water in the household on the use and views about the POUs, and treatment demonstrated by 35% of the 200 households on request by EPRC staff. The pH, turbidity and RCL were tested at the household level after water collection. About 300 ml of the same water was collected in sterilized glass bottles and transported in sample collection boxes (which maintained temperature below 4 degree C with ice packs) to EPRC field Laboratory. The water samples were tested for TTC by Wegtech Potatest FC Count Instruments within approximately 5 hours of its sampling from the households.

The relief NGOs demonstrated the use of the POUs among all the beneficiaries in the 17 villages during the distribution with assistance from EPRC members. Out of the 17 sampled villages, 14 received follow-up education by EPRC community educators.

**Efficiency of the POUs**

All the tested stored 200 drinking water samples were found with ‘ nil’ TTC cfu/100 ml of TTC. Presence of RCL was observed in all water samples. The mean and median values of RCL in water treated by PUR were respectively 0.28 mg/l and 0.19 mg/l and those by Aquatabs were 1.45 mg/l and 1.08 mg/l. The values of pH varied over 6.3 – 8.6 for PUR and 6.5 - 8.8 for Aquatabs. The results of turbidity varied over 0 -18 NTU for PUR and 0-18 NTU for Aquatab treated samples.

## Effectiveness and acceptance of the POUs

The acceptance and effectiveness of PUR was found significantly higher than that of Aquatab. It In response to which of the POUs the beneficiaries' preferred, significantly higher proportion of them preferred PUR than Aquatab (78% vs. 28%, $p<0.001$). Although both the POUs showed presence of RCL and 'nil detectable' TTC, the concentration of RCl in most Aquatabs were significantly higher than the usually recommended 0.3-0.4 mg/l.

## Conclusions and Recommendations

*Conclusions and Discussions*

The study clearly reconfirmed the remarkable efficiency, effectiveness and acceptance potentials of PUR as reported elsewhere.

The main conclusions were as follows:

i.) Both PUR and Aquatabs were efficient in destroying and/or maintaining the TTC concentration at 'nil' or not detectable level by the instrument. The pH and turbidity values of the treated water were also within acceptable range. The source of almost all tested treated 200 stored samples was tube well water, except 21 samples. Those 21 samples were pond water. The concentrations of TTC in those treated all stored surface water were also found 'nil'. Overall, this means that the two POUs were 100% efficient in treating and managing the specified quality of water.

ii.) The two POUs maintained the TTC/bacteriological quality of water at the 'nil 'standard/safe level over almost 24 hours. As TTC was not detected in any sample, the effectiveness of the POUs in terms of the most common bacteriological parameter was at the expected safe drinking water level. The concentrations of TTCs in 5 surface water samples (ponds) collected by us from those ponds used by the users were found greater than 5,000 cfu/100 ml. Literatures reported few to high concentrations of TTCs, cfu/100ml in most of the stored water samples and water becoming contaminated after collection. The results also suggest that any TTC recontamination of water was also controlled.

iii.) The presence of RCL was observed in all samples. This reconfirms that both the POUs had the potentials to destroy TTC and check its recontamination. The mean, median and maximum values of concentrations of RCL in PUR treated samples were 0.28 mg/l, 0.19 mg/l and 2.16 mg/l. The mean, median and maximum values of Aquatabs were 1.45 mg/l,

1.08 mg/l and 4.5 mg/l. The mean value of RCL in PUR treated water samples was statistically significantly lower than that of RCL in Aquatab treated samples. The threshold concentration of residual chlorine is usually recommended 0.3 – 0.5 mg/l mg/L. The median RCL in Aquatab treated water was significantly higher than the threshold concentration.

***iv.)*** The demonstration about the use of the POUs during its distribution with other relief materials created awareness among almost all beneficiaries. But the follow-up education about the use of POUs at community level impacted, both, on the higher use of PUR as well as on the proper implementation of the treatment process when compared between follow-up and not follow-up villages.

***v.)*** The 'nil' TTC concentration in all samples may indicate that the lack in the implementation process did not affect its efficiency. But the lack in implementation process included differences by a few minutes or by little volumes in almost all cases. This indicates that the POUs included reasonable safety protections. Here the beneficiaries of the both kinds of POUs were provided with the required numbers of containers and marked at the amount of water to use. Also the size of samples from highly contaminated sources like surface water was small and low.

***vi.)*** Acceptance or rate of use of any of the POUs was 83% remarkably high. The majority of the 17% beneficiaries, who had no POU treated water in their households during our visit, claimed that did not use any of the POUs as they were drinking tube well water.

***vii.)*** The rates of expressed overall satisfaction about the two POUs those who used it were high and similar (more than 80%). However, about one third of PUR and more than 40% of Aquatab users claimed that the smell of PUR or Aquatab was not normal. And more than 60% of the both the POU users expressed problems with the time required in the treatment of water.

***viii.)*** Chlorine smell was observed in most of the samples. We have found in an earlier study on chlorination of dug well water by bleaching powder that the users did not like the water when the RCL was higher than 0.3 mg/l. More than half of the PUR treated water had RCL concentration less than 0.3 mg/l but more than half of the Aquatab treated water had RCL higher than 0.3 mg/l.

ix.) The beneficiaries were educated to disposal of the filtered PUR wastes to the pits of latrines or holes. But almost all (89%) threw the wastes indiscriminately.

***x.)*** Overall, the acceptance and effectiveness of PUR were significantly higher than that of Aquatab. The Health curative or drug perception about PUR was strong and significantly higher than that of Aquatab. They very impression about PUR's health curative/health comfort impacts contributed to its high demand.

xi.) Although majority of the beneficiaries of PUR or that of Aquatab did not express willingness to buy any of the POUs, a substantial number of the beneficiaries (44% PUR and 31% Aquatabs) were willing to buy it. This interest for buying POUs or investing money for drinking water is noticeable considering the fact that almost no practice about buying water exists in the country. Hundred percent of the beneficiaries were interested to use PUR or Aquatab at free of costs. Probably the concern about contamination of tube wells during the immediate post water -logged condition influenced their interest in using the POUs even when they felt problem about the time required for the treatment.

*Issues and Recommendations*

The findings have important policy and programmatic implications for response to people needs based water safety in disasters in Bangladesh. High and repeated demands for reliable POUs and in adequate amount in earlier disasters, such as floods and cyclones, have been claimed by both relief personnel and affected populations reported. It is likely that most of the disaster affected population may not be able to afford the costs of the POUs considering their sufferings, priorities, loss of employments and beliefs in tube well water. Therefore it is important that the Government of Bangladesh and its development partners undertake urgent appropriate actions to promote and make accessible POUs appropriately.

As PUR showed high efficiency, effectives and acceptance potentials, ways for proper access to it among disaster affected people should be considered. Also the manufacturer of PUR suggested use of PUR in arsenic removal emergency but it was beyond the scope of the study. Urgent planning and actions for promotion and accessibility to PUR in disasters and its related epidemics are important. The disposal aspect may be given adequate consideration recognizing the fact that the majority/many population may not have a pit latrines or a place to dig hole.

The following issues and limitations of the study should be given due consideration before its wide promotion.

(i) Studies on earlier disasters found that majority and/or significant proportion of the POUs distributed in earlier floods or cyclones had lost potency and did not purify the water to the safe level. Improper: storage and handling of the POUs, problems in its manufacturing and/or it's distribution after manufacturer recommended periods contributed to the loss in potency. Proper and regular monitoring of the quality of POUs at the procurement and distribution needed, provided it is found that its performance remain same over the required shelf life.

(ii) Many people were reported not using the POUs properly in those earlier disasters. Here the beneficiaries were given education on the use of PUR and Aquatab during relief distribution and after that during follow-up visits. The follow-up education showed significant positive impacts on the proper implementation of the treatment methods. The use of PUR requires two containers of specified size. The project provided with the required containers for both PUR and Aquatabs. It also probably procured the POUs for the research study with care. Therefore the conditions for facilitating/promoting the use of PUR and Aquatabs in the presented study and in the earlier reported disasters were not similar. This means the chances for problems faced with in earlier reported situations might not be fully ruled out.

(iii) Water supply mitigation of arsenic contamination has been repeatedly challenged by the lack of appropriate technologies. Alternative water technologies have been widely promoted in arsenic affected areas. But most of those alternative water technologies produced microbiologically contaminated water. As the study area did not have the arsenic contamination problem, the suitability of PUR or Aquatab for that purpose was not assessed. Furthermore, the impacts and/or reactions of PUR and Aquatab on iron (a common problem) and other not tested important qualities of water were not studied.

The following recommendations before wide promotion and/or marketing of PUR may be considered:

a) PUR may be further researched in real disaster conditions at both household and shelter levels in Bangladesh. It may be tested for arsenic mitigation water supply as well.
b) The feasibility of distribution of buckets, its use and impacts of use/not use during different stages of the disasters may be observed.
c) The shelf life and potency of PUR may be studied based on its different distribution, storage and handling conditions. Similarly its marketing feasibility may be assessed too.
***d)*** Proper planning and its implementation for monitoring the quality of PUR and any other POUs by the concerned authority may be established.

# Chapter 1

## INTRODUCTION

### 1.1 Background

Floods are one of the most common hazards and/or disasters in the world. Flood or emergency relief for affected people almost universally includes water relief and restoration activities in various forms, such as transportation of safe water, repair of damaged water technologies, distribution of water purification tablets and and/or installation of new options. Safe drinking supply water systems are often damaged in floods, cyclones and other disasters, meaning access to safe drinking water reduced. The situation is further worsened when the water system is flooded or polluted water enters the system and deteriorates the quality of Water. Qualities of both tube well and pond water deteriorated significantly during and/or after 1991 cyclones and floods in Bangladesh (Ref: 1,2,3). Most of the people drink flooded or not flooded tube well water. But majority people use pond/surface water for cooking and other domestic purposes and those people also usually use tube well water during or after flood. That often led to scarcity of potable water.

Although floods are almost annual events and often post-flood epidemics contribute significantly to the burdens of diarrhea in Bangladesh, lack of adequate access to as well as lack of appropriate effective point-of-use technologies have been a continuing challenge (Ref: 1,2, 3). Also high contamination of thermo-tolerant coliform bacteria has been reported in stored drinking water in both normal and disaster conditions. A state-of-the art literature review of 144 studies revealed that the expected reduction in diarrhoeal disease morbidity from improvements in water quality (alone) and water quantity (alone) were 15% and 20 % respectively. Additional studies have shown that "point of use" water quality interventions significantly reduce diarrhoeal disease stemming from pathogens in the household water supply (Ref: 4). A preliminary study on disinfection (chlorination) of water by using bleaching powder solution at household level has shown significant reduction in Thermotolerant Coliform Bacteria count (TTC) in a few villages in Bangladesh (Ref: 5). But lack of availability of bleaching powder and/or affordability to buy bleaching powder discouraged the use of point-of-use method after the project. Therefore, there is an urgent need for locating and field testing and/or developing appropriate point-of-use water treatment technologies (POU) in Bangladesh.

Procter and Gamble (P&G) have developed a safe water intervention for POU called PUR for household treatment of contaminated drinking water, particularly in less developed countries. PUR has been demonstrated in a variety of emergency situations and shown to effectively treat water and reduce diarrheal disease. It got 2005 Stockholm Industry Water Award. This paper presents our findings during 'Assessment of PUR Water Treatment for Flood Mitigation (RFP)2/006-029' commissioned by UNICEF-DPHE. We have tested Aquatab with PUR. Aquatab is a locally manufactured and one of the commonly promoted POU in Bangladesh. .

## 1.2 Objective

The objectives of the study are as follows:

I. To train extension officials about the use of PUR and Aquatab in flood and other conditions.

II. To assess the efficacy of PUR and Aquatab based on concentration of Thermotolerant coliform bacteria (count of colony forming unit per 100 ml of water (cfu/100 ml), turbidity (NTU), pH and residual chlorine (mg/l) ) as specified by UNICEF-DPHE.

III. To assess the effectiveness and acceptability of PUR and Aquatab.

IV. To share of the findings through an interim and a final reports.

## 1.3 Description of PUR and Aquatab

PUR is a powdered mixture that removes pathogenic microorganisms and suspended matter, rendering previously contaminated water safe to drink. PUR was developed by Procter & Gamble (P&G) in collaboration with the US Centers for Disease Control and Prevention (CDC). PUR contains a chlorine disinfectant (calcium hypochlorite) for killing bacteria and an iron salt coagulant (ferric sulfate) for removing suspended matter, protozoa, and viruses. It also contains a buffer, clay and polymer to provide good coagulation and flocculation. All of the ingredients used in PUR are used to purify drinking water in the United States and other developed countries. The difference is that PUR provides these ingredients at the household level rather than in a centralized treatment facility. PUR is safe for long-term use by the entire family, including infants, and is considered an effective technology by the World Health Organization (WHO). PUR's application results in water quality that meets WHO guidelines. PUR comes in a 4 gram sachet labeled in English. Each sachet treats 10 liters of water. The sachets arrive from the manufacturing facility in cartons containing 20 strips of 12 sachets each, for a total of 240 sachets per carton. Each carton is 25 cm x 11 cm x 15.5 cm (length, width, height).

The treatment procedure is as follows:

1. Open a PUR sachet using a pair of scissors. Add the contents of the sachet to a vessel containing 10 liters (2.5 gallons) of contaminated water. One simple way to measure a 10 liter volume is to use a 2-liter bottle five times. Extreme precision is unnecessary: if there are slightly more or less than 10 liters, the treatment procedure will still be effective.

2. Stir the powder steadily and vigorously in the water for five minutes. After adding the powder to the water, the water will become temporarily colored, and after a minute or two, large particles or "floc" will begin to form, with the water becoming clear in the process. At the end of five minutes, stop stirring and let the floc settle to the bottom of the container. If the water is still colored, it can be mixed again and left to rest for another few minutes.

3. Once the water looks clear, and the floc, or precipitated material, is at the bottom of the bucket, filter the water through a clean cloth into a clean storage container. The filter must be a cotton cloth that prevents the floc particles from passing through.

4. Wait 20 minutes before drinking the water. This is an important step; because it is during this time that remaining pathogenic bacteria are killed. The water should be stored in a container with a lid if available to keep it safe from recontamination.

Aquatab is a chlorine compound based POU also. It is manufactured by Medentech Ltd, Wexford, Ireland. Add one tablet to 4-5 liters of clean water. Leave 30 minutas before using. Each tablet contains 33 mg sodium dichlorolsocyanurate.

# Chapter 2

## METHODOLOGY

The study was conducted in water logged villages of three sub-districts; Abhoynagar, Keshabpur and Monirampur upazillas in Jessore district. It was done during September 2006 to February 2007. A proposal was prepared and proposed by Environment and Population Research Center (EPRC) to UNICEF- Bangladesh, in response to their call for assessment of PUR water treatment in flood mitigation (RPF)/2006-029). Environmental and Population Research Center (EPRC) was selected and conducted the study in collaboration with DPHE-UNICEF Bangladesh.

### 2.1 Design

A cross-sectional observational design of evaluation was adopted to determine the efficiency, effectiveness and acceptance of PUR and Aquatab among the households provided with the POU technologies. Oxfam arranged the distribution of the POUs with other relief items among specified water logging affected families by its relief partner NGOs. Out of the 4800 relief distributed households, 200 households that had POU treated stored water during our visit was randomly selected for the study. The 200 households were selected from 17 villages. The treated water samples were tested to determine the efficiency based on the specified microbiological and chemical water quality parameters. The members of those same households, in particular the women caretakers of respective household water management, were interviewed and observed to determine the effectiveness and acceptance of the POU technologies.

Various kinds of trainings were given to the trainers of the partner NGOs who distributed the POUs and to the Project staff based on their responsibilities and needs. The partner NGOs gave education about the POUs during its distribution to the beneficiaries in all villages. The project conducted follow-up community education in 14 of the 17 villages. The beneficiaries in the 3 villages were not provided with the follow-up community education on POUs to study the impacts of field level education on the use of POU.

### 2.2 Study Areas and sampling of households

The study areas included villages in three Upazillas. The PUR and Aquatabs were distributed with food relief by Oxfam through Bachteshekha and Uttaran (partner NGOs of Oxfam) among selected water logged poor families in those areas. Oxfam selected those families based on impacts of water

related problems and poor economic status. The NGOs distributed food among approximately 15000 families. Out of the 15000 families PUR and Aquatab were included/distributed in the relief packages of 4800 families in 67 villages in 8 unions. The NGO partners of Oxfam distributed PUR and Aquatab with their relief materials.

The pre-selected families were organized in a specified site and asked to sit/wait while they distribute the packages. One woman per pre-selected family was registered as relief cardholder. Approximately 60- more than 120 cardholders were registered per village. The relief packages were distributed in batches of villages.

Two hundred households were systematically randomly selected by EPRC for the evaluation purpose. It was done from the 4800 families who were provided with both PUR and Aquatab. EPRC selected those households based on existing water logging and/or poor environmental (muddy, broken, etc) conditions.

Table 2.1 shows the distribution of relief materials and sampled households. EPRC selected 17 villages from the PUR and WPT distributed 67 villages based on existing floodwater and/or existing worst flood impacts during November 21- 22, 2006. They visited the sites and accordingly selected the villages.

Table 2. 1: Relief and Sample distribution patterns.

| **Distributed food and water treatment packages** | | | | | **Evaluation (sampled households)** | |
|---|---|---|---|---|---|---|
| **Field NGO Name** | **Upazilla** | **Union** | **#of village** | **#of Beneficiaries** | **#of selected village** | **#of selected hhs for survey** |
| Bachteshekha | Abhoynagar | Sundoli | 12 | 2054 | 7 | 80 |
| | | Chalisia | 7 | 647 | 4 | 48 |
| | | Payra | 4 | 449 | 2 | 24 |
| Uttaran | Keshabpur | Panjia | 14 | 308 | - | |
| | | Suffakati | 13 | 379 | 2 | 24 |
| | | Pauroshava | 7 | 285 | - | |
| | | Sadar | 7 | 278 | - | |
| Uttaran | Monirampur | Nehalpur | 3 | 400 | 2 | 24 |
| ***Total*** | ***3 upazillas*** | ***8 unions*** | ***67 villages*** | ***4800house holds*** | ***17 villages*** | ***200hhs*** |

## 2.3 Implementation Process

All activities were completed as proposed in the proposal. Main activities and results may be summarized as in table 2.2. EPRC implemented the study in consultation with UNICEF. EPRC also appreciates the collaboration of Oxfam and partner NGOs.

Table 2.2: Activity chart during the reported period

| Month | Activity done |
|---|---|
| September,2006 | Preparatory Activities:<br>-Draft work plan<br>-Staff setup and training<br>-Discussion with Oxfam on working area & Methods (General)<br>-One Field visits to collect basic information about the potential villages<br>-Refining EPRC activity plan |
| October,2006 | -EPRC project team staff training in Dhaka<br>-Received training from Unicef on water quality testing<br>-Discussion with local Oxfam partners on working methods & area<br>-Two visits the potential area<br>-Working on training needs (distribution) assessments, work plan, and discussion with Oxfam partners NGO<br>-Area & hhs selection/finalization (Field visit & discussion methods)<br>-EPRC local management set up<br>-Train off EPRC Local staff on water quality testing<br>-KAP questionnaire preparation and pre-testing in Abhoynagar<br>-Preparation of training modules & materials<br>-Survey planning |
| November,2007 | -KAP questionnaire finalization<br>-Refining of the field modules & materials<br>-Training of field staff on KAP survey water test<br>-Training of Oxfam 2 partners NGO in two areas separately<br>-Handover PUR & Aquatab and materials to Oxfam NGOs<br>-Revision of selected working area & hhs due to distribution delay.<br>-PUR & Aquatab distribution by Oxfam NGOs<br>-Education about PUR and Aquatab by the NGOs in presence of EPRC Staffs<br>-Community education about PUR and Aquatab by EPRC<br>-Start assessment: data collection & water quality test |
| December | -PUR & Aquatab distribution by Oxfam NGOs<br>-Data collection & water quality test<br>-Education and motivation about PUR & Aquatab use by EPRC<br>- Data collection supervision and repeat<br>-EPRC Staff Refresher training<br>- Observed about PUR & Aquatab use system<br>- Data cleaning & management<br>- Interim Report submission |
| January | - Data entry and analysis<br>- Discussion with community people and LGI<br>- Preparing outline of the final report |
| February 15 | - Submission of the Draft Final report |
| March | -Submission of the Final report |

## 2.4 Education and promotion about Aquatab and PUR among the beneficiaries

The education and promotion about use of PUR and Aquatab were done by two channels: (i) partner NGOs did it in collaboration with EPRC during its distribution and, (ii) EPRC at the community level after distribution of the relief and water treatment packages.

The Partner NGOs (relief distributing NGOs) made the cardholders ( 60-150 persons ) of one village to sit/wait in one area. The trained NGO officers (with support from EPRC officers) educated cardholders of one village (at a time) about the needs and benefits of using the water treatment followed by demonstration on use techniques of both PUR and Aquatab. The education session was conducted over a period of 45 minutes to 1 hour. After that education the cardholders were given their relief packages. Approximately 3-4 villages/batches of distribution and its related education were done per day. They included 20 PUR packets and 20 Aquatabs in every relief package of the identified 4800 families. They also distributed two bucket & using system sticker (PUR use system) to those families

EPRC had a team of motivators who promoted and gave education on PUR and Aqua tab at village level. Three numbers of community/courtyard- based education sessions were done by a motivator per day. Three to six numbers of community based education sessions were done per village, depending on the distribution pattern of the relief packages and sizes of the villages. About 25 to 35 persons (mostly women) attended a session. The education sessions were conducted over a period of 2-3 hours. In total approximately 1410 women and men (mostly women) from POUs received households and about 278 from households who did not receive any POUs. The education sessions were more or less organized at the central position/courtyard of a community cluster of a village.

EPRC motivation started after distribution of the tablets. They did motivation/education in 14 villages out of the 17 sampled villages. They discussed the needs and benefits of using water purification tablets, the purpose of the study, discussed the leaflets, demonstrated both the methods and made a 2-3 participants do it practically in front of the community. The motivators and community demonstrators drank the treated water after its demonstration.

## 2.5 Training

Separate daylong formal trainings were conducted for the NGO partners and EPRC staffs. It is summarized in Table 2.3. In addition to those, weekly discussions on the issues and progress experienced were done among the EPRC members at field level and reported to the Head office.

Two separate one-day long trainings were conducted in Bachteshekha and Uttaran training rooms before distribution of the relief packages on November 13 and November 14, 2006 respectively. There were 28 participants in Bachteshekha (4 Oxfam and 24 Bachteshekha) and 24 participants in Uttaran ( 3 Oxfam and 21 Uttaran) trainings. The participants were provided with training materials in Bangla. It was prepared by EPRC based on materials provided with by UNICEF and related information in literatures and Internet. The senior officials of the NGO partners were consulted to incorporate the needs and suggestions of the trainees in the materials as well as during the training sessions. A copy of the training materials and schedules attached with the report (Annex-III). The training was done from 10 a.m to 5.30 p.m. It included both lecture and demonstration methods.

Table 2.3: Summary of Formal Training Activities

| **Training place & date** | **Main Issues** | **Organizations attend** | **Participation** | | |
|---|---|---|---|---|---|
| | | | *Total* | *Male* | *Female* |
| Banchte Sheka auditorium, Avaynagar<br>13 –11 -2006 | (i) Benefits of water treatments, (ii) the Project and its design, (iii) POU methods and its demonstration, (iv) size of POU beneficiaries and planning distribution of the POUs, (iv) education and demonstration on use of the POUs during its distribution among the beneficiaries, (v) planning, timeline and roles and responsibilities of the activities. | Banchte Sheka<br>Oxfam | 24<br>4 | 24<br>3 | -<br>1 |
| Uttoron meeting room, Sathkhira<br>14 –11 2006 | i) Benefits of water treatments, (ii) the Project and its design, (iii) POU methods and its demonstration, (iv) size of POU beneficiaries and planning distribution of the POUs, (iv) education and demonstration on use of the POUs during its distribution among the beneficiaries, (v) planning, timeline and roles and responsibilities of the activities. | Uttron<br>Oxfam | 21<br>3 | 16<br>3 | 5<br>- |
| EPRC meeting room, Dhaka<br>28 –10 – 2006 | -Objective, Design, methodology, treatment methods, data collection, supervision and management, roles and action plan | -Coordinator and Research. Supervisors<br>-Field supervisors<br>-Data collectors samplers<br>-Data quality controller and management | 3<br>4<br>8<br>3 | 2<br>4<br>2<br>3 | 1<br>-<br>6<br>- |
| EPRC field office, Avaynagar<br>25 –11 – 2006<br>26-11-2006 | Project, water treatment methods, motivation, sampling, data collection, water tests, quality control, roles, and action plan | -Field motivators<br>-Community Observers<br>-Field Supervisors<br>-Data collectors | 14<br>4<br>4<br>8 | 2<br>-<br>4<br>2 | 12<br>4<br>-<br>6 |
| EPRC Dhaka Office<br>10- 12-2006<br>11-12-2006 | Refresher training, data management and its input to the process | -Field Supervisors<br>-Data quality controllers<br>-data technicians | 4<br>1<br>2 | 4<br>-<br>1 | -<br>1<br>1 |

## 2.6 Data collection

Data was collected under the following themes: socio-economic status, water use, PUR and Aquatab use, acceptance of the water purification tablets & PUR, knowledge and satisfaction about the use, and quality of treated water. Multiple data collection techniques such as interview, observation, demonstration (of use by the users) and water quality analysis were implemented.

Two teams comprising of five sub-teams such as four data collections and one motivation worked simultaneously as follows: (i) on-site water quality test, (ii) interview, (iii) thermo-tolerant coliform bacteria (TTC) water collection and transportation, (v) observation of procedures implemented by the sampled caretakers and, (v) motivation/education about the POUs. The motivation sub-teams worked in different areas while the 4 other sub-teams of a team worked simultaneously at the same household.

The water samples were tested for pH, turbidity and residual chlorine at the household/field by the field water quality team by using Wegtech Photometer 5000 (residual chlorine), Wegtech Protatest pH meter and Wegtech & Del Agua (Turbidity) field kits. Samples from the tested water were brought in ice- boxes to the EPRC field office and tested for Thermotolerant Coliform bacteria by Wegtech Potatest Fc count.

The water caretakers of the households, which were sampled for observations on how they treated water, were asked to treat the water in presence of EPRC observers. The observation team noted the steps followed for water treatment by the selected respondents.

## 2.7 Data Collection process

Approximately 12 households were selected in a village considering communication problems, time required for data collection and the UNICEF suggested sample size (200 water tests). The EPRC sampling team roughly marked a selected village into two similar food distributed population parts. Six households were selected in each part. EPRC staff went to the center of a part and threw a pencil two times to select two different directions. Three households were randomly selected in each direction starting from the end of the direction. Of these 6 households respondents for the first and fourth households were requested to demonstrate how they used Aquatab and/or PUR.

When water treated sample was not found in a sampled household, the next household/s were approached until a household was found with treated water in storage container. The Figure 2.1 shows

the distribution pattern of the period between distribution of POUs by the NGOs and water sampling/interview by EPRC.

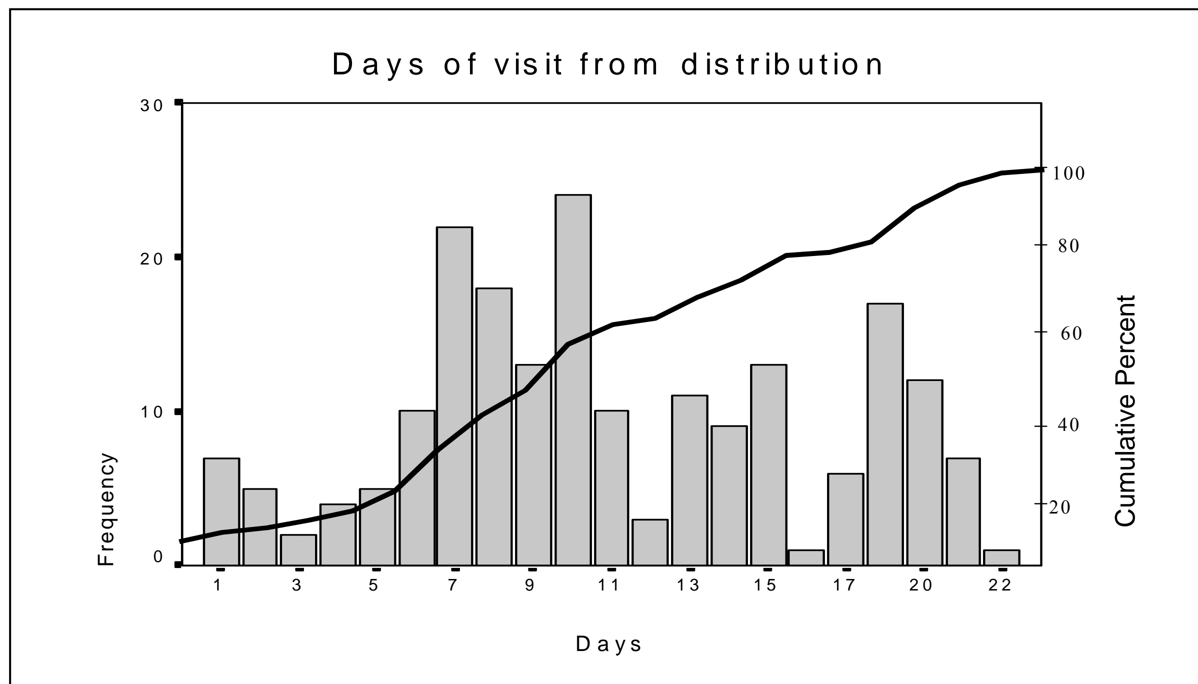



Figure: 2.1

Representatives, preferably water caretaker, of all sampled households were interviewed. Water samples were collected and tested from the households those claimed that they used the water purification tablets or PUR. If water was treated by PUR and Aquatab, samples were collected from both water containers. Water samples were collected after shaking the containers and pouring water into sterilized glass water sample bottles. In addition, one focus group discussion was conducted in every village to understand and/or clarify the findings related to why they used the POUs, the observed benefits and problems faced with the use of the POUs. The filled questionnaires were sent to Dhaka office every two days by courier services.

## 2.8 Water quality tests

Water quality tests such as TTC, residual chlorine, turbidity and pH were determined for all the collected 200 water samples. All the tests were performed with field kits and portable instruments as shown in the following Table 2.4

Water in the stored household containers were gently stirred and poured on three sampling containers; one container for the on-site pH and turbidity, one for residual chlorine and another container for transportation to the field Laboratory for TTC tests.

Table 2. 4 : Summary of Methods Used for the water Quality Tests

| **Name of the Parameter** | **Name of instrument** | **Detection Limit** | **Unit** | **Bangladesh Standard** | **Site of test performed** |
|---|---|---|---|---|---|
| Thermo tolerant Coliform Bacteria (TTC) | Wegtech Potatest FC Count | - | cfu / 100 ml | 0 | EPRC field laboratory |
| Residual Chlorine | Wegtech Photometer 5000 | 0 – 5.0 | mg / l | 0.6 – 1 mg/l | On-site |
| Turbidity | Del Agua & Wegtech 3 Tubes | 0 – 500 | NTU | 5 NTU | On-site |
| pH | Wegtech Portatest PH meter | 0.00 – 14.00 | - | 6.5 – 8.0 | On-site |

Glass bottles of approximately 300 ml volume were washed by powder detergent, soaked overnight in approximately 1% sulfuric acid solution, cleaned with lots of tap water and then autoclaved in EPRC Dhaka Laboratory. The sterilized bottles were packed in plastic bags; six bottles in one bag, and sent to the EPRC field Laboratory from EPRC Dhaka Laboratory. The sterilized bottles were only opened at the sampled household and rinsed with the water to be sampled before sampling.

The bottles were filled with the sampled water to about two-thirds of its volume and closed by aluminum foil followed by corks of the bottles and masking tapes. The bottles were placed in a sample transportation ice box. The temperatures inside ice boxes were maintained at about $4^0$ C by using dry ice packs. One sub-team collected two TTC samples from two sampled households and transported the samples to the EPRC Field Laboratory within about 3.5 hours. The samples were immediately tested at the Field laboratory. Overall, all the samples were placed in the incubators within about 5 hours from its collection. That soap of the same water was collected in sterilized glass bottles and transported in sample collection boxes (which maintained temperature below $4^0$ C with ice packs) to EPRC field Laboratory. The water samples were tested for TTC by Wegtech Potatest FC Count Instruments within approximately 5 hours of its sampling from the households.

The perti-dishes and different parts of the TTC measuring instruments were sterilized as follows: wash by diluted soap water, washed by deep tubewell water & mineral water (MUM) and boiled over 20 minutes in bottled drinking water (MUM) inside a pressure cooker every day at the EPRC field Laboratories. Boiled bottled drinking water was also used to prepare the media. Ten spoons (provided by the manufacturer) of the MFC Broth media (provided by the manufacturer) was mixed in 20 ml of

the bottled water. One media pad was gently placed in a sterilized petri dish. The pad was soaked with drops of the media solution and closed the petri dish. The sampled water was filtered through a filter paper (also provided by the manufacturer) using a hand pump. The filtered paper was then placed on the media pad inside a petri- dish using a sterilized forceps. The forceps was sterilized by heating it on the flame of a burner (burner provided in the instrument). The petri dish was then placed inside the incubator for 20 hours. The incubator was set at $44^0$ C temperature. After 20 hours the number of colored colonies on the filter papers were looked for or counted. One hundred ml of all samples were filtered. Duplicates of 50 ml samples were filtered for about 18% of the samples; one in every 6 samples. The results were then reported as cfu/100 ml. The average of the duplicates were calculated and reported.

### 2.9 Quality Control

Field Quality Control Supervisors repeat- checked 2 forms from every 12 sampled households every day. They discussed their findings with the field teams on the following morning before the team went out for sampling. Senior staffs from EPRC Dhaka office visited five times to train and plan, and check data collection, and discuss with the communities. .

In water quality; one TTC count was repeated in every six water samples. One field blank and one laboratory blank were done in every six samples.

The results of the quality control checks were discussed in weekly field meetings and sent to head office.

### 2.10 Management and Implementation

The study was conducted by Environment and Population Research Center (EPRC) in collaboration with DPHE-UNICEF Bangladesh. Environment and Population Research Center Organization (EPRC) is a multi-disciplinary non-government and not-for-profit research, education, training and networking organization. The areas of its interest includes: Environment, Water and Wastewater, Hygiene and Sanitation, Water Quality, Public Health, Education, Fisheries, Disaster Risks Management, Climate Variability and its impacts, Energy, Infrastructure, and Micro-credit for environmental and social development. EPRC has special interest in working for: small NGO capacity building, community participation, multi-sector & multi-agency collaboration at local and international levels and women development. It has been working in rural, urban and disaster conditions. EPRC coordinates an information exchange network, the Global Applied Research Network for Water Supply and Sanitation in South Asia (GARNET-SA) among more than 430 organization members.

# Chapter 3

## CHARACTERISTICS OF THE STUDY HOUSEHOLDS

The study households were selected from 5 Unions of three Upazilas namely as mentioned in Table 2.1. The Maps (Annex -I) show the 8 Unions where PUR and Aquatab were distributed. Of those 8 Unions 5 were sampled for the study based on existing worst impacts of the water logging hazard during the sampling design.

### 3.1 Socio-economic and demographic characteristics

Selected socio-economic and demographic characteristics of the 200 households from where water samples were tested are summarized in Table 3.1. The respondents of the interviews were almost all females and water takers; except 3 male caretakers.

Table 3.1: Selected socio-economic and demographic characteristics of the study population and households

| **Variables** | **Name of Union** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | ***Cholisia* *N=48*** | ***Nehalpur* *N=24*** | ***Paira* *N=24*** | ***Sufalakati* *N=24*** | ***Sundoli* *N=80*** | **N = 200** |
| I..Education of Head of hh(%) | | | | | | |
| No Schooling | 31 | 50 | 50 | 63 | 35 | 41 |
| 1-2 years Schooling | - | - | - | - | 4 | 1.5 |
| 3-5 years Schooling | 16.7 | 29 | 17 | 17 | 14 | 17 |
| >5 years schooling | 41.7 | 8 | 17 | 16 | 34 | 28.5 |
| >10 years schooling | 10.3 | 13 | 16 | 4 | 13 | 12.0 |
| II. Education of Water Caretaker/respondents(%) | | | | | | |
| No schooling | 35.4 | 58.3 | 33.3 | 52.2 | 40.5 | 42 |
| 1-2 years schooling | 4.2 | - | 4.2 | 4.3 | 1.3 | 2.5 |
| 3-5 years schooling | 22.9 | 29.2 | 20.8 | 17.4 | 12.7 | 18.7 |
| >5 years schooling | 35.4 | 12.5 | 25.0 | 21.7 | 30.4 | 27.8 |
| >10 years schooling | 2.1 | - | 16.7 | 4.3 | 15.2 | 9 |

| III. Total land owned decimals | | | | | | |
|---|---|---|---|---|---|---|
| Mean | 72 | 49 | 38 | 21 | 111 | 74.6 |
| Median | 55 | 22 | 21 | 4 | 74 | 44 |
| Minimum | 2 | 2 | 2 | 2 | 2 | 2 |
| Maximum | 328 | 200 | 210 | 150 | 510 | 510 |
| IV. Family size | | | | | | |
| Mean | 4.6 | 4.6 | 4.5 | 5.0 | 4.6 | 4.6 |
| Median | 4 | 4 | 4 | 5.0 | 4 | 4 |
| Minimum | 2 | 2 | 2 | 3 | 2 | 2 |
| Maximum | 9 | 15 | 10 | 10 | 13 | 15 |
| V.Profession | | | | | | |
| Agriculture | 50 | 25 | 25 | 21 | 66 | 47 |
| Fisherman | 12.5 | 33 | 29.2 | 38 | 10 | 19 |
| Service | 8.4 | 12.5 | 4.2 | - | 8.8 | 7.5 |
| Business | 8.3 | 8.3 | 12.5 | 17 | 12.5 | 11.5 |
| Day laborer | 20.8 | 20.9 | 29.2 | 25 | 2.6 | 15 |
| Vi. Possessed (%) | | | | | | |
| - Radio | 18.8 | 20.8 | 16.7 | 8.3 | 13.8 | 15.5 |
| - TV | 37.5 | 41.7 | 33.3 | 16.7 | 38.8 | 35.5 |
| - Cell Phone | 10.4 | 4.2 | 12.5 | 0 | 8.8 | 8.0 |

The studied socio-economic and demographic variables appeared to be similar among the sampled households in Union basis. There were some differences in the ownership of land; the mean and median values of the land owned were noticeably highest among the study households in Sundoli Union.

## 3.2 Water and sanitation Practices

The reported sources and use of water for domestic purposes were similar at Union level. Table 3.2 presents the reported practices about water use for drinking and cooking purposes. Hundred percent of the members of the households drank tubewell water. Substantial proportion of the households used pond water for cooking purposes.

Table3.2: Source and Purpose of Water Use in the Unions

| | Name of Union and number of household visited | | | | | Total |
|---|---|---|---|---|---|---|
| | ***Cholisia N=48*** | ***Nehalpur N=24*** | ***Paira N=24*** | ***Sufalakati N=24*** | ***Sundoli N=80*** | **N = 200** |
| Drinking (%) | | | | | | |
| Shallow TWs | 91.7 | 79.2 | 50 | 95.8 | 88.8 | 84.5 |
| Deep TWs | 8.3 | 12.5 | 50 | 4.2 | 11.2 | 14.5 |
| Ponds | - | 8.3 | - | - | - | 1 |
| Cooking (%) | | | | | | |
| Shallow TWs | 33.3 | 66.7 | 4.2 | 95.8 | 50 | 48 |
| Deep TWs | 4.2 | 25 | 50 | 4.2 | 8.8 | 14 |
| Pond | 62.5 | 8.3 | 45.8 | - | 41.3 | 38 |

The latrine use practices are presented in the following Table 3.3. There were significant differential patterns in the types of latrines used. Households in Sufalakati Union mostly (75%) used unsanitary

Table 3.3: Types of Latrine Used

| **Type of Latrines** | **Name of Union and number of household visited** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | ***Cholisia N=48*** | ***Nehalpur N=24*** | ***Paira N=24*** | ***Sufalakati N=24*** | ***Sundoli N=80*** | |
| Ring slab latrines (shared and Family latrines) | 43.8 | 70.8 | 70.8 | 25 | 77.5 | 61.5 |
| Unsanitary/open Latrines | 56.2 | 29.2 | 29.2 | 75 | 22.5 | 38.5 |

latrines. Reportedly the relief agencies installed several ring slab latrines and most shared those latrines as the original latrines were damaged due to water logging problems.

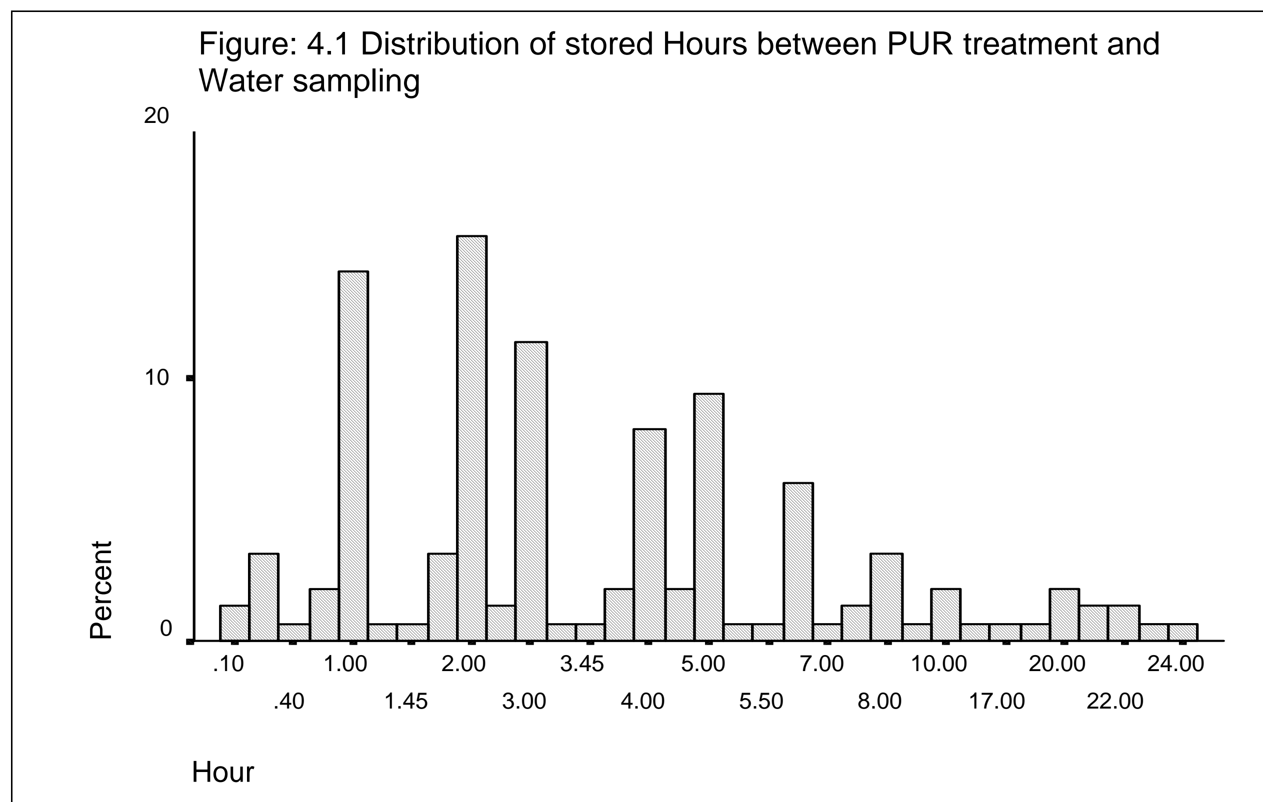
# Chapter 4

## EFFICIENCY OF THE WATER TREATMENT TECHNOLOGIES

All households were distributed with PUR and Aquatab. Out of the 200 sampled households, all received PUR and 176 received Aquatab. Both the POUs were found highly efficient in purifying and maintaining the TTC quality of water safe at 'nil' cfu/100ml or not detectable level of the instrument used. Here we present results and discussions on the quality of water observed at the study household level.

### 4.1 Thermo tolerant Coliform Bacteria (TTC)

TTC count/100 ml was found 'nil' or not detected in all POU treated 200 tested water samples, irrespective of the type of POU technology. The residual chlorine and TTC results were measured between less than an hours to more than 24 hours after the reported treatment of water by POU as and when the water was sampled. The following Figures 4.1 and 4.2 shows the distribution patterns of frequency of storage hours from treatment to sampling of water.



Both the POUs were equally efficient in maintaining TTC values at 'nil' cfu/100 ml (not detectable) over about 24 hours after its treatment as shown below in the following Figure: 4.3 and Figure: 4.4. As the TTCs were not detected this means that the risks for re-contamination and re-growth over wide range of storage hours were also checked by the POU technologies. Presence of high TTC concentrations have been often observed in stored drinking water Bangladesh and other countries (Ref: 6,7)

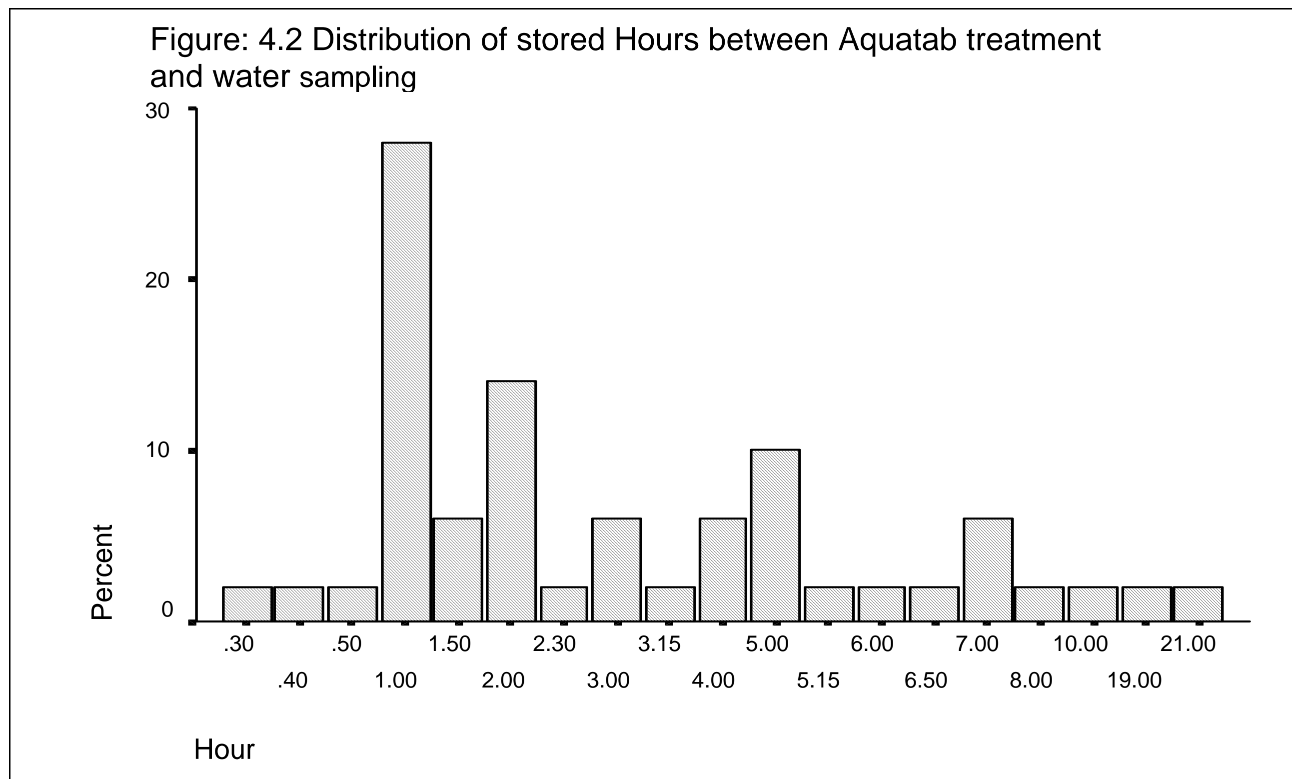


Figure: 4.2 Distribution of stored Hours between Aquatab treatment and water sampling

## 4.2 Residual Chlorine

Some residual chlorine was detected in all POU treated samples (Table 4.1 of the summary). The distribution of concentrations of residual chlorine mg/l, in the samples are shown below in Figures 4.3 And 4.4.

When the means of residual chlorine of PUR and Aquatab were compared after the normal tests for large samples (Ref: 8), z= - 6.34, P< 0.001 .This result is significant at the at the 0.1 % level. This means that residual chlorine of PUR was significantly lower than that of Aquatabs.

Figure: 4.3 Distribution of Residual Chlorine (RCL mg/l) in PUR treated water samples

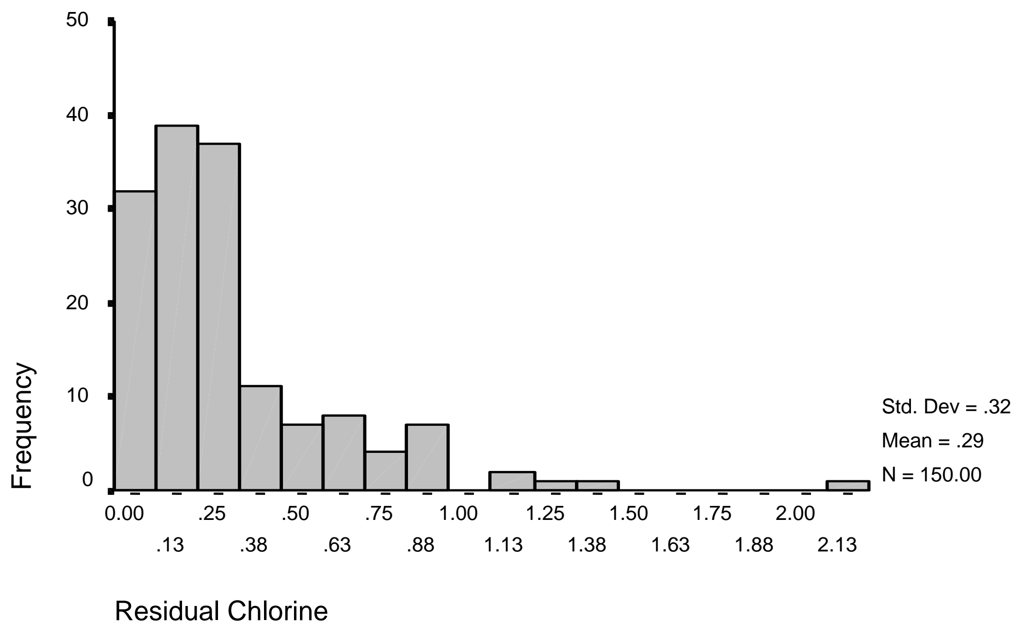
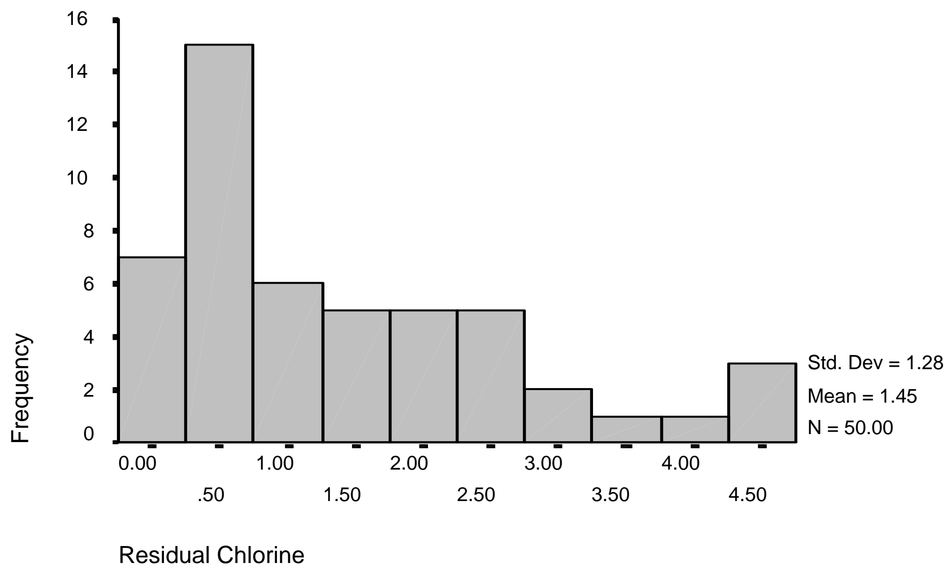



Figure: 4.4 Distribution of Residual Chlorine (RCL mg/l) in Aquatab treated water samples




## 4.3 Overall statistics of water quality

The summary of the statistics of the water quality results is presented in the following table 4.1. Although most of the treated stored samples were shallow and deep tube wells, there were a few pond water sources. TTC, cfu/100 ml, was not detected in any of the treated shallow tube well, deep tube well or pond water samples irrespective of the type of POU. These results also showed that both the

POU technologies were 100% efficient in destroying and/or maintaining 'nil' detectable TTC in different water (in terms of sources) over several hours after the treatment. The mean of residual chlorine of shallow tube well water based PUR samples was significantly lower than the value of Aquatab samples. But the values did not differ significantly for deep tube wells. Although the means of residual chlorine of pond water samples were not compared due to the small sample size of pond water, the mean of pond water of Aquatab was remarkably higher than that of the PUR pond water samples. The values of turbidity and pH of all samples were within acceptable standards.

Table 4.1: Results of TTC (cfu/100ml), pH, turbidity (NTU) and residual chlorine (mg/l) in treated water samples and sources of water

| **Option Type** | | **PUR** | | | | **Aquatab** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *RCL Mg/l* | *Turbidity NTU* | *TTC Cfu/100ml* | *PH* | *RCL Mg/l* | *Turbidity NTU* | *TTC Cfu/100ml* | *pH* |
| STW | Mean | .29* | .47 | .00 | 7.4 | 1.60* | 1.60 | .00 | 7.54 |
| | N | 123 | 123 | 123 | 123 | 40 | 40 | 40 | 40 |
| | Median | 0.19 | .00 | .00 | 7.4 | 1.26 | .00 | .00 | 7.60 |
| | Minimum | 0.02 | 0 | 0 | 6.3 | .1 | 0 | 0 | 6.5 |
| | Maximum | 2.16 | 18 | 0 | 8.6 | 4.5 | 18 | 0 | 8.8 |
| DTW | Mean | 0.27 | 3.33 | .00 | 8.1 | 0.52 | .00 | .00 | 8.41 |
| | N | 9 | 9 | 9 | 9 | 7 | 7 | 7 | 7 |
| | Median | 0.19 | .00 | .00 | 8.5 | 0.48 | .00 | .00 | 8.50 |
| | Minimum | 0.02 | 0 | 0 | 7.1 | 0.3 | 0 | 0 | 8.0 |
| | Maximum | 0.89 | 12 | 0 | 8.5 | 1.2 | 0 | 0 | 8.5 |
| Pond | Mean | 0.23 | .00 | .00 | 7.9 | 2.00 | .00 | .00 | 8.67 |
| | N | 18 | 18 | 18 | 18 | 3 | 3 | 3 | 3 |
| | Median | 0.20 | .00 | .00 | 8.1 | 1.31 | .00 | .00 | 8.70 |
| | Minimum | 0.05 | 0 | 0 | 6.3 | 0.7 | 0 | 0 | 8.5 |
| | Maximum | 0.87 | 0 | 0 | 9.1 | 4.0 | 0 | 0 | 8.8 |
| Total | Mean | 0.28 | 0.59 | .0000 | 7.5 | 1.45 | 1.28 | .00 | 7.73 |
| | N | 150 | 150 | 150 | 150 | 50 | 50 | 50 | 50 |
| | Median | 0.19 | .00 | .00 | 7.5 | 1.08 | .00 | .00 | 8.0 |
| | Minimum | 0.02 | 0 | 0 | 6.3 | .06 | 0 | 0 | 6.5 |
| | Maximum | 2.16 | 18 | 0 | 9.1 | 4.5 | 18 | 0 | 8.8 |

Note: STW= shallow tube well; DTW= Deep tube well ; RCL=Residual Chlorine, *= mean values of the POUs significantly different at $p<0.001$

Overall the quality of all treated water was acceptable based on the measured parameters; except the residual chlorine in most of the aquatab treated water samples. Usually 0.4 to 0.5 mg/l of RCL recommended after 30 minutes (Ref: 9).

# Chapter 5

## EFFECTIVENESS AND ACCEPTANCE OF THE TECHNOLOGIES

The sample collection team visited 239 households to locate 200 treated water samples by any of the POU methods. That means the acceptance of POU was 84%; majority of the households who received POU used one of the kinds of POU. The effectiveness and acceptance of PUR technology was significantly higher than that of Aquatab when the use of those POUs were compared.

### 5.1 Use of Purification Technology (POUs)

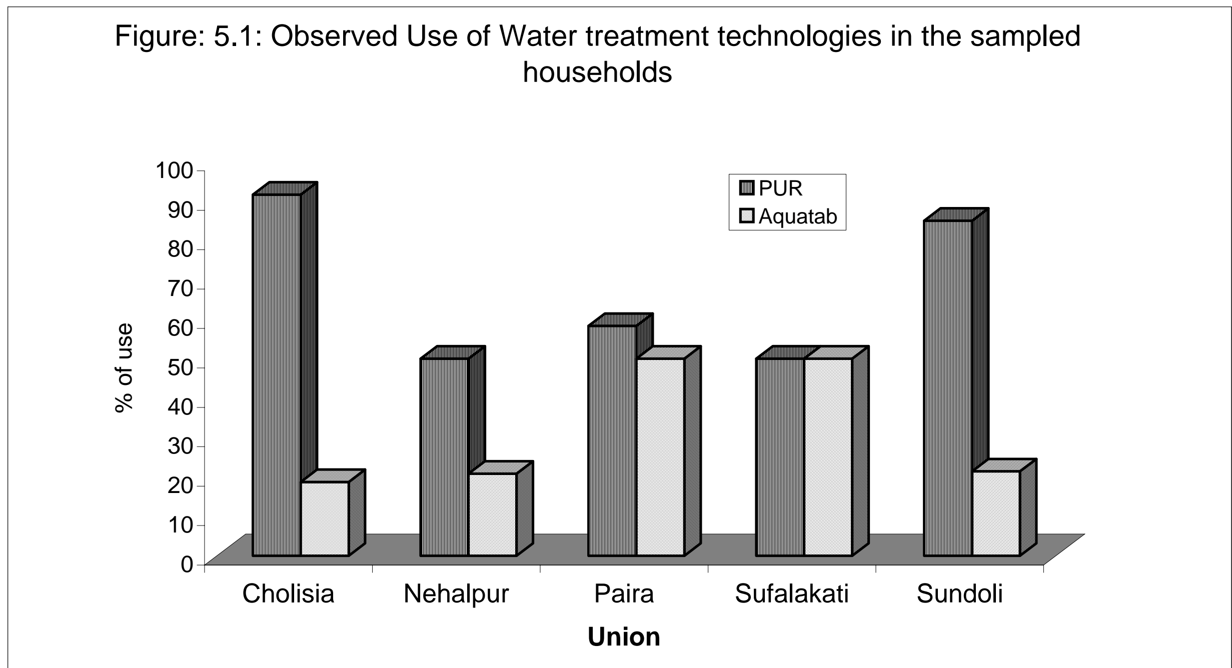
Out of 200 sampled households who received PUR; 150 used PUR (approximately 75%). But out of 176 who had Aquatabs; 50 households used it (28%). The rate of use PUR was significantly different than that of WPT; Chi square value was $r^2 = 161.4$ and p value is $p<0.001$.

The rate of use of the POUs (together) was about 80% in all the study Unions (Table 5.1). The total houses (239) visited to collect 200 samples are included in that table. Although most of the households were drinking and cooking tube well water, about 80% of the households in every Union used PUR or Aquatab.

Table 5.1: Rates of Use of the Purification technologies

| Union | Size of Targeted and water tested Households | Visited Household | Rate of Use of of the POU technology (%) |
|---|---|---|---|
| Sundoli | 80 | 101 | 79 |
| Paira | 24 | 27 | 89 |
| Chalisha | 48 | 55 | 87 |
| Sufalakati | 24 | 29 | 83 |
| Nehalpur | 24 | 27 | 89 |

The rates of use of the two different technologies are separately presented in Figure 5.1. The overall rates of use of PUR and Aquatab were 75% and 28%. The results are over 100% as there were 7 households where water samples treated by both the technologies were observed. However, the rates of use of PUR were about 50% in three Unions. The rates of use of Aquatab was highest in 2 Unions where the rates of use of PUR were lowest.




Both overall and Union level results of POUs showed that rate of use of PUR was significantly higher than those for Aqutab; except in two Unions.

## 5.2 User's Perceptions and Comments about the technologies

Overall, more than 80% users of both the methods claimed satisfaction and no problems in the taste of water (Table 5.2). Initially there might have been some confusion about PUR as reflected in the following Boxes 1, 2 and 3.

**Name: Porna Roy, Age: 37**

**Village: Dumur tola, Union: Cholisia**

I got the 'new and old water medicines' with my relief materials. I have used the 'old medicine' last year. It had a smell, which I did not like. But as my tube well was flooded I used it. As I am using water from a not flooded tube well, I do not see the need to use the 'old or new medicine for water' this year. However, I showed the new 'medicine' to my educated neighbors. They told me that the new 'medicine' is brought for the first time from a foreign country and we should not use it right away. After 2/3 days EPRC told us that the medicine would help to cure my stomach ache and make my tube well water further better. She also demonstrated the method and drank the treated water in front of us. So we decided to try it. Within a week my stomach ache was cured. My neighbor friend's gastric pain was also cured by the new water 'medicine'. We will appreciate if you give us more new 'medicine' to treat our water.

**Name: Purnima sarkar, Age: 30 years**

**Village: Bughdanga, Union: Pajiya**

We have been suffering from drinking water and food problems over a few months due the water logged condition. The relief NGO gave us food, PUR (Guro) and the 'old water medicine' (Bori). I thought that PUR is a 'drink'. I mixed one packet with one kg of water and gave the 'drink' to my husband and children. We all had head ache and diarrhea. Then I realized my mistake in a few days when my neighbors told me about their health benefits after using PUR. Now I am using only PUR. I used to have ' no sleep and no appetite problems'. I have 'good sleep' and 'appetite' now. I thank the Government and foreign country for giving me the 'medicine' free and curing my problems.

*Note: 'Guro' means powder and 'Bori' means tablet.*

**Name: Valeka Mollik, Age: 60 years**

**Village: Gobindopur, Union: Sundori**

I have got water purifying tablet and PUR with my relief material from Banchte Shekha. I started using the water-purifying tablet as I have used a few of this kind in 2004 flood. But my neighbors tell me that PUR is good for health and water safety. I will use PUR after finishing the use of water purifying tablets. I would like to use any water purifying tablet through out a year to protect my family members from diarrhea and other diseases. But we cannot afford to buy it as most of my son's money goes in food and then for education of his children. There is no job for me, my daughter-in-law or women.

However, majority users in both PUR and Aquatab groups reported problem/concern with the time involved in treating with the POUs. There was no significant difference between the two rates of groups who claimed problems in the time required to treat the water. It may be pointed out that the right sizes of containers for treating and storing water by the two methods were separately provided with among the beneficiaries. So they did not had to arrange the containers or the container part was

easy. The table clearly shows that the preference for PUR was significantly higher than that of Aquatab ($p<0.001$). The health "health cure ($p<0.001$)' and ok smell ($p<0.005$)" related views were

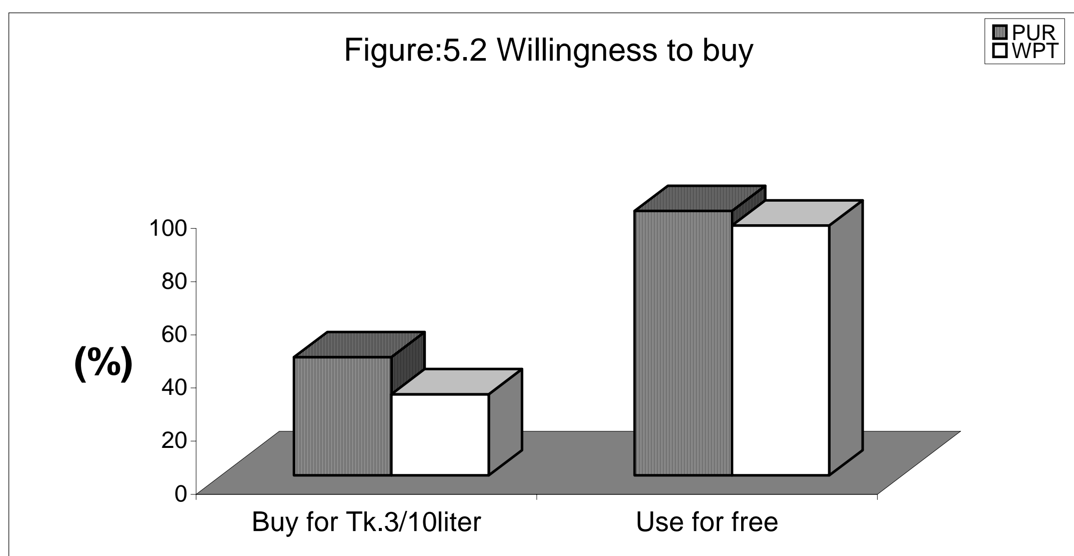
Table 5.2 : Comments about the treatment method

| Issues (N=200) | PUR (N=200) | Aquatab (N=176) | Chi-square values (p values) |
|---|---|---|---|
| 1. Satisfied (%)<br>No<br>Yes | <br>1.5<br>98.5 | <br>15.5<br>84.5 | <br>18.09<br>($p<0.001$) |
| 2. Taste of treated water (%)<br>- Ok<br>- Not normal | <br>92.8<br>7.2 | <br>86<br>14 | <br>2.14 |
| 3.Smell of treated water (%)<br>- Ok<br>- Not normal | <br>47<br>53 | <br>30<br>70 | <br>9.16<br>($p<0.005$) |
| 4. Time required for the treatment (%)<br>- No problem<br>- Yes, problems with the long time involved | <br>37<br>63 | <br>40<br>60 | <br>0.26 |
| 5. Why treated water (%). First reason:<br>- health cure related<br>- Not health cure (water safety )related | <br>95<br>5 | <br>66<br>34 | <br>41.03<br>($p<0.001$) |
| 6. Preferred method<br>Yes<br>No | <br>84<br>16 | <br>41<br>59 | <br>66.4<br>($p<0.001$) |

associated significantly with PUR use. This means that significantly higher proportion of respondents had complaints of chlorine smell in Aquatab treated water than in PUR treated water. Most of the users of PUR (95%) reported health benefits, such as reduction in: gastric pains, stomach pains, dysentery, sleep problems; diarrhea etc. after drinking the PUR treated water. The health benefits mentioned with WPT included reduction in diarrhea only.

## 5.3 Willingness to Pay

When the respondents were interviewed if they would buy and use the water purification technologies, most were not willing to buy it (Figure 5.2 ). Almost all were willing to use at free of costs.




The breakdown of willingness to buy by the different Unions are presented in table 5.3. It showed the same results as the overall results, that most of the beneficiaries in all Unions were not willing to buy it but willing to use it at free of costs.

Table 5.3: Willingness to buy

| Willingness | Name of Unions | | | | | Total |
|---|---|---|---|---|---|---|
| | Cholisia | Nehalpur | Paira | Sufalakati | Sundoli | |
| 1.Would you buy for Tk.3/10 litre? (yes %) | | | | | | |
| PUR<br>WPT | 41.7<br>31.3 | 45.8<br>45.8 | 41.7<br>37.5 | 16.7<br>16.7 | 55<br>27.5 | 44.5<br>30.5 |
| 2.Would you use for free (yes %) | | | | | | |
| PUR<br>WPT | 100<br>100 | 100<br>100 | 100<br>100 | 100<br>100 | 98.8<br>85 | 99.5<br>94 |

***Focus Group Discussion***

Two focus group discussions were held in every union (10 in total) to discuss the main findings. The discussions indicated similar findings as presented in the earlier survey based results sections, except for willingness to pay related issues. The discussions on willingness to pay indicated that almost none were willing or be able to pay for POU during flood condition. When we shared the information (as found in the survey) that a substantial proportion of the interviewed families were willing to pay; they explained that the women did not consider the real flood situations during the interviews/answers. The interviewees probably considered the existing situation as the water- logging situation had improved and some job/earning opportunities were observed.

## 5.4 Impacts of Communication and Follow-up education

When asked if they had heard about the POUs, approximately 3% claimed that they did not hear about of Aquatab and 1% about PUR among those who received the POUs (200 samples). However, most of the beneficiaries claimed that the follow-up education by the EPRC/Project motivators helped them to better understand the use methods. The rates of use of PUR and Aquatabs in the 14 motivation follow-up villages were 89% and 30% respectively and in the 3 not follow-up villages were 54% and 26% respectively. The results are shown in the following table 5.4. The higher use of PUR than that of Aquatab were probably influenced by: (i) as the people were aware of Aquatabs the follow-up visits created more interest about the new product, PUR, (ii) as 'PUR' was a new product people had concerns about its safety as well as how to use it and they asked more questions about it. As a consequence as they were more motivated about its use, (iii) the motivators unknowingly emphasized PUR more than WPT and /or (iv) when the curative benefits related to 'PUR' spread, people became more interested to know about its use.

The follow-up education motivated higher use of the POUs; particularly that of PUR. Those who did not use it informed that the tubewell water was safe enough and/or they did not like the smell of the treated water.

The households were broken down by: (i) methods of data collections (that means between interviewed to report in detail the use of POUs and observed to reproduce the use of PUR and Aquatab) and, (ii) between motivated/follow-up (by EPRC) ant not-motivated villages (only education during relief distribution) to understand the impacts of the follow-up education on the use of the POUs (Table 5.4). The follow-up education made significant impacts on the proper use of PUR and it was found when they were asked to show how they did it (observation) as opposed to only question them. However, it may be mentioned that the sizes of the mistakes in contact time and amount of water used were small. For example, in most cases they rather waited for longer contact period or the amount of water used was slightly less or more than the marks on the containers. The stirring was done less than 50-60 times as suggested during the education. (Table 5. 4)

Table 5.4 Comparison of results between interviewed and observed groups in the EPRC motivated and not motivated (only education during relief distribution) villages.

| Item | Interviewed Households | | | Observed Households | | |
|---|---|---|---|---|---|---|
| | **Follow-up education Village N=103** | **Not Follow-up Village N = 26** | **Chi-square values (p values)** | **Follow-up Village N= 61** | **Not Follow-up Village N = 10** | **Chi-square values (p values)** |
| Know about WPT use (Yes) % | | | | | | |
| - Correct amount of water used, waiting time and stirring | 56.3 | 19.2 | 11.42 (p<0.001) | 34.2 | 30 | 0.075 |
| - Amount of water used | 59.2 | 19.2 | 13.29 (p<0.001) | 43 | 20 | 1.84 |
| - Waiting time | 73 | 56 | 25.30 (p<0.001) | 51 | 50 | 0.002 |
| Know about PUR use (Yes) % | | | | | | |
| - Correct all steps | 71 | 30.7 | 14.29 (p<0.001) | 70.5 | 30 | 6.17 p<0.025) |
| - Amount of water used | 91.3 | 88.4 | 0.19 | 84 | 30 | 13.56 p<0.001) |
| - Mixing proper time | 71 | 57.7 | 1.66 | 80.3 | 20 | 15.45 p<0.001) |
| - 5 minute Wait after mixing | 86.4 | 77 | 1.43 | 87 | 50 | 17.46 p<0.001) |
| - Filtering the water | 99 | 92.3 | 4.13 p<0.05) | 90.2 | 70 | 3.16 p<0.05) |
| - Use after 20 minutes of filtering | 80.6 | 77 | 0.17 | 82 | 30 | 12.26 p<0.001) |

The beneficiaries claimed that the distribution of 2 marked buckets for PUR and a 3-liter plastic jar for WPT facilitated the use of the technologies. It was also mentioned by the beneficiaries that the partner NGOs told them that they would not get relief package in next round if they do not use the purification methods.

The results indicate that it was not difficult to communicate and motivate the effective use of the technologies when education and facilities were combined.

## 5.5 Disposal of the Filtered Waste

The beneficiaries were educated to dispose of the filtered PUR wastes to the pits of latrines or holes. But almost all (89%) threw the wastes indiscriminately. Most of the users of PUR (76%) did not perceive the waste harmful. Also majority (72%) claimed that they did have a pit latrine to dispose of the wastes.

# Chapter 6

## CONCLUSIONS AND RECOMMENDATIONS

### 6.1 Conclusions and Discussions

Disinfections /purification is of unquestionable importance in the supply of safe drinking water during both normal and disaster conditions. This study clearly reconfirmed the remarkable efficiency, effectiveness and acceptance potentials of PUR as reported elsewhere (Ref: 10).

The main conclusions were as follows:

i.) Both PUR and Aquatabs were efficient in destroying and/or maintaining the TTC concentration at 'nil' or not detectable level by the instrument. The pH and turbidity values of the treated water were also within acceptable range. The source of almost all tested treated 200 stored samples was tube well water, except 21 samples. Those 21 samples were pond water. The concentrations of TTC in those treated all stored surface water was also found 'nil'. Usually surface water shows several thousands to many thousands of TTC bacteria concentration in its water samples. Overall, this means that the two POUs were 100% efficient in treating and managing the tube well and surface water to the standard level of TTC (nil detectable TTC cfu/100ml); one of the most priority biological indicators for drinking water.

ii.) The two POUs maintained the TTC/bacteriological quality of water at the 'nil 'standard/safe level over almost 24 hours. As TTC was not detected in any sample irrespective of the hours stored between reported treatment by the users and our sampling of water, the effectiveness of the POUs in terms of the most common bacteriological parameter was at the expected safe drinking water level. The concentrations of TTCs in 5 surface water samples from the ponds used by the users were determined and all results found greater than 5,000 cfu/100 ml. Literatures reported few to high concentrations of TTCs, cfu/100ml in most of the stored water samples and water becoming contaminated after collection (Ref:3,5). The results also suggest that any TTC recontamination of water was also controlled.

iii.) The presence of RCL was observed in all samples. This reconfirms that both the POUs had the potentials to destroy TTC and check its recontamination. The use of chemical disinfectant in water treatment usually results in the formation of chemical by-products. The risks to health

from these by-products are extremely small in comparison with the risks associated with inadequate disinfection (Ref:11). The mean, median and maximum values of concentrations of RCL in PUR treated samples were 0.28 mg/l, 0.19 mg/l and 2.16 mg/l. The mean, median and maximum values of Aquatabs were 1.45 mg/l, 1.08 mg/l and 4.5 mg/l. The mean value of RCL in PUR treated water samples was statistically significantly lower than that of RCL in Aquatab treated samples. The threshold concentration of residual chlorine is usually recommended 0.3 – 0.5 mg/l mg/L. The median RCL in Aquatab treated water was significantly higher than the threshold concentration.

***iv.)*** The 'nil' TTC concentration in all samples may indicate that the lack in the implementation process did not affect its efficiency. But the lack in implementation process included differences by a few minutes or by little volumes in almost all cases. This indicates that the POUs included reasonable safety protections. Here the beneficiaries of the both kinds of POUs were provided with the required numbers of containers and marked at the amount of water to use. Also the size of samples from highly contaminated sources like surface water was small and low.

***v.)*** Acceptance or rate of use of any of the POUs was 83% remarkably high. The majority of the 17% beneficiaries, who had no POU treated water in their households during our visit, claimed that did not use any of the POUs as they were drinking tube well water. They felt that tube well water was safe.

vi.) The rates of expressed overall satisfaction about the two POUs those who used it were high and similar (more than 80%). However, about one third of PUR and more than 40% of Aquatab users claimed that the smell of PUR or Aquatab was not normal. And more than 60% of the both the POU users expressed problems with the time required in the treatment of water. Probably the concern about contamination of tube wells during the immediate post water -logged condition influenced their interest in using the POUs even when they felt problem about the time required for the treatment.

***vii.)*** Chlorine smell was observed in most of the samples. We have found in an earlier study on chlorination of dug well water by bleaching powder that the users did not like the water when the RCL was higher than 0.3 mg/l (Ref:5). More than half of the PUR treated water had RCL concentration less than 0.3 mg/l but more than half of the Aquatab treated water had RCL higher than 0.3 mg/l.

viii.) The beneficiaries were educated to dispose of the filtered PUR wastes to the pits of latrines or holes. But almost all (89%) threw the wastes indiscriminately.

***ix.)*** Overall, the acceptance and effectiveness of PUR were significantly higher than that of Aquatab. The rate of use of PUR (75%) was statistically significantly higher than that of Aquatab (28%); 75% vs. 28%; $p<0.001$).

***x.)*** The demonstration about the use of the POUs during its distribution with other relief materials created awareness among almost all beneficiaries. But the follow-up education about the use of POUs at community level impacted, both, on the higher use of PUR as well as on the proper implementation of the treatment process when compared between follow-up and not follow-up villages. The Health curative or drug perception about PUR was strong and significantly higher than that of Aquatab. Probably the positive and curative health impacts of PUR were focused more than Aquatab during the education about POUs. However, the very impression about PUR's health curative/health comfort impacts contributed to its high demand.

xi.) A substantial number of the beneficiaries (44% PUR and 31% Aquatabs) were willing to buy it. This interest for buying POUs or investing money for drinking water is noticeable considering the fact that almost no practice about buying water exists in the country. However, focus group discussion results revealed that almost none were willing to buy PUR/Aquatab or any POU during flood or cyclone conditions. Hundred percent of the beneficiaries were interested to use PUR or Aquatab at free of costs.

## 6.2 Issues and Recommendations

The findings have important policy and programmatic implications for response to people needs based water safety in disasters in Bangladesh. High and repeated demands for reliable POUs and in adequate amount in earlier disasters, such as floods and cyclones, have been claimed by both relief personnel and affected populations reported (Ref: 1). It is likely that most of the disaster affected population in Bangladesh may not be able to afford the costs of the POUs considering their sufferings, priorities, loss of employments and beliefs in tube well water. But the concerns about safe drinking water in floods may be noted when flood affected women were observed to undertake extra efforts and walk long distances to collect water from not flooded tube wells during Flood 2004 (Ref:3 ). Therefore it is important that the Government of Bangladesh and its development partners undertake urgent appropriate actions to promote and make accessible POUs appropriately. It may be mentioned that about 30% of the country is annually flooded, an increasing trend on the water related disasters observed and post-disaster epidemics contribute significantly to the occurrence of diarrhoeal diseases in Bangladesh.

As PUR showed high efficiency, effectives and acceptance potentials, ways for proper access to it among disaster affected people should be considered. Also the manufacturer of PUR suggested use of PUR in arsenic removal emergency but it was beyond the scope of the study. Urgent planning and actions for promotion and accessibility to PUR in disasters and its related epidemics are important. The disposal aspect may be given adequate consideration recognizing the fact that the majority/many population may not have a pit latrines or a place to dig hole.

The following issues and limitations of the study should be given due consideration before its wide promotion.

**(i)** Studies on earlier disasters found that majority and/or significant proportion of the POUs distributed in earlier floods or cyclones had lost potency and did not purify the water to the safe level *(Ref: 2,4,6)*. Improper: storage and handling of the POUs, problems in its manufacturing and/or it's distribution after manufacturer recommended periods contributed to the loss in potency. Proper and regular monitoring of the quality of POUs at the procurement and distribution needed, provided it is found that its performance remain same over the required shelf life.

**(ii)** Many people were reported not using the POUs properly in those earlier disasters. Here the beneficiaries were given education on the use of PUR and Aquatab during relief distribution and after that during follow-up visits. The follow-up education showed significant positive impacts on the proper implementation of the treatment methods. The use of PUR requires two containers of specified size. The project provided with the required containers for both PUR and Aquatabs. It also probably procured the POUs for the research study with care. Therefore the conditions for facilitating/promoting the use of PUR and Aquatabs in the presented study and in the earlier reported disasters were not similar. This means the chances for problems faced with in earlier reported situations might not be fully ruled out.

**(iii)** Water supply mitigation of arsenic contamination has been repeatedly challenged by the lack of appropriate technologies. Alternative water technologies have been widely promoted in arsenic affected areas. But most of those alternative water technologies produced microbiologically contaminated water (Ref: 5, 12). As the study area did not have the arsenic contamination problem, the suitability of PUR or Aquatab for that purpose was not assessed. Furthermore, the impacts and/or

reactions of PUR and Aquatab on iron (a common problem) and other not tested important qualities of water were not studied.

The following recommendations before wide promotion and/or marketing of PUR may be considered:

a) PUR may be further researched in real disaster conditions at both household and shelter levels in Bangladesh. It may be tested for arsenic mitigation water supply as well.
b) The feasibility of distribution of buckets, its use and impacts of use/not use during different stages of the disasters may be observed.
c) The shelf life and potency of PUR may be studied based on its different distribution, storage and handling conditions. Similarly its marketing feasibility may be assessed too.
d) Proper planning and its implementation for monitoring the quality of PUR and any other POUs by the concerned authority may be established.

## Dissemination Workshop

A dissemination workshop was held on April 30, 2007 at DPHE Conference room. Mr Amanullah al Mahmood, PD, GOB-UNICEF project, DPHE was the chief guest, Mr. S. M. Ihtishamul Huq, SE, Ground Water Circle, DPHE chaired the session and Mr. Richard Johnston presented an overview of the project. Dr Bilqis Amin Hoque presented the findings of the project.

There were about 35 participants from Government, Non Government and donor organizations in the workshop.

The presentation was followed by question and answer session. Overall, all appreciated the findings and expressed interest in PUR. They congratulated EPRC for the study on a new and important technology. They also thanked DPHE-UNICEF for supporting it

The participants recommended further study needs on PUR in real flood conditions.

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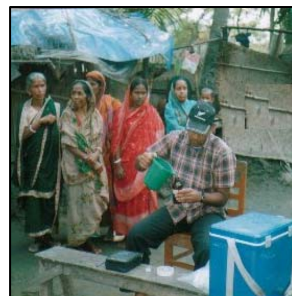
# Annex V: Selected Pictures of Study project

Water logged area & road site shelter place

Training of TOT

Motivation during distribution

Motivation activity by EPRC



Water test in field

Observation

Field visit by UNICEF