OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

22676

FINAL REPORT
FR/C. 2000/088
NC/IND/88/P67

Cc: Ms Duff

Report on Socio-economic, Marketing & Training Issues

Prepared under the Project

Concerted Action on Elimination/Reduction of Arsenic in Ground Water, West Bengal, India

Prepared by: Development Consultant Group, Calcutta

Executed by: United Nations Industrial Development Organization

New Delhi
July, 2001

KEY FINDINGS

COMPARATIVE ASSESSMENT

MARKETING ISSUES

TRAINING ISSUES

CONTROL VILLAGES

BACKGROUND

Introduction

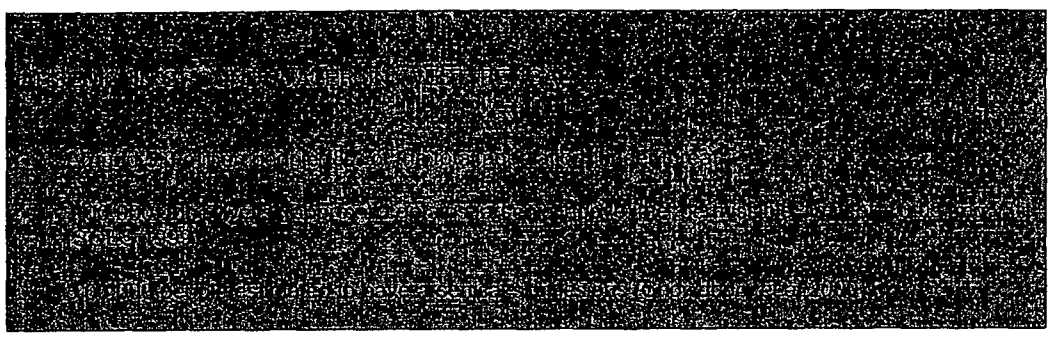
In the early eighties, a few cases of arsenical dermatitis were reported from some districts of West Bengal. It was gathered through analysis of water samples that the ground water was contaminated by arsenic in these districts.
As ground water serves more than 80% of the drinking water requirements in the state, **the Government of West Bengal formed an Experts' Committee in order to ascertain the cause, extent and magnitude of the problem, as well as to suggest remedial measures for the same.**

The Cause

The present crisis in West Bengal has been found to be precipitated by **geogenic** factors. As such, the control of the problem is more complicated than had it been due to **anthropogenic** factors.

Extent and Magnitude

According to studies carried out by various agencies, it has been noted that **1312 mouzas** and **15 non-municipal / outer growths in 68 blocks** and **9 municipalities within 8 districts** are prone to arsenic contamination. The 8 districts include Malda, Murshidabad, Nadia, North 24-Parganas, South 24-Parganas, Burdwan, Howrah and Hooghly. At present, some parts of Calcutta have also been identified as arsenic affected areas. A CGWB report of 1999 says that around 5.3 million people, i.e., 8% of the total population of West Bengal are reliant on arsenic contaminated ground water. Due to continuous movement of ground water and certain peculiarities in the geochemical conditions, the extent of the problem may increase over time.



Mitigation Measures

As there is hardly any clinical treatment of arsenicosis, provision of arsenic-free water is considered to be of prime importance in tackling the problem. Towards this end, some work has already been initiated in West Bengal. The Government of West Bengal, with financial support from the Government of India, has undertaken a number of measures, both long term and short term in nature. Moreover, various institutes like the All India Institute of Hygiene and Public Health, Bengal Engineering College and Jadavpur University, as well as some private organizations, have developed technologies for arsenic removal.

A Joint Plan of Action to address Arsenic Contamination of Drinking Water has been launched in a collaborative manner by the Public Health Engineering Department (PHED), Government of West Bengal and UNICEF.
Apart from awareness generation and water quality surveillance, this project is also evaluating the performance of the various arsenic removal technologies mentioned earlier.

Population Status of Arsenic-Risk Districts and Blocks

SL	Districts (At-risk / tot blocks)	Total Population of the District (1991 census)			Total Population of the Blocks at Arsenic-Risk		
No	District	Total	Rural	Urban	Total	Rural	Urban
1.	Malta (5/15)	2637032	2450495	186537	980385	980385	-
2.	Murshidabad (15/26)	4740149	4245802	494347	2546303	2435710	110593
3.	Nadia(13/17)	3852097	2980279	871818	2431494	2289091	142403
4.	N-24Pgs (19/22)	7281881	3551581	3730300	3643683	3183296	460387
5.	S-24Pgs (10/29)	5715030	4954653	760377	2061146	1889191	171955
6.	Howrah (3/14)	3729644	1880530	1849114	439998	295935	144063
7.	Hooghly (1/18)	4355230	2996979	1358251	186056	171390	12866
8.	Burdwan (2/31)	6050605	3927613	2122992	310208	310208	-
	8 Districts (68/172)	38361668	26987932	11373736	12599273	11557006	1042267

Explanation of the Table

1. Total population of 8 districts (1991): 38.36 million

2. Total population of 68 arsenic-risk block (1991) : 12.6 million (33% of districts)

3 Any village, any non-municipal or municipal urban area having a tubewell with water of 0.05 ppm or more of arsenic concentration, is designated as arsenic-risk.

1. Estimated population of arsenic-risk villages and urban areas : 6 million

2. Figure 6 million constitutes 48% of block population and 16% of district population.

SOURCE: JOINT PLAN OF ACTION FOR ARSENIC MITIGATION IN WEST BENGAL (PHED & UNICEF)

STUDY RATIONALE AND SCOPE

Arsenic contamination of ground water has assumed menacing proportions in West Bengal. Several studies have established the presence of arsenic in about 68 blocks of 8 districts of West Bengal - Malda, Murshidabad, Nadia, North 24 parganas, Burdwan, Howrah and Hoogly.

Initiatives are being taken for the mitigation of arsenic related problems – e.g., the Government of West Bengal, with support form the Government of India, has launched a number of large River Water Based Piped Water Supply Scheme Projects in the affected areas. Simultaneously, a number of institutes / companies have been developing units, based on various technologies, for providing relief to the affected people.

However, most of these technologies are still at the **Research & Development level** – substantial effort is required, before they can be utilized for **large –scale, commercial purposes.**

Certain studies have been undertaken by different institutes to carry out comparative assessments of these arsenic removal technologies. However, while they have focussed on the **technical aspects** (efficacy of removal of arsenic, etc.), **the socio – economic and marketing aspects have largely been left out.** The aspect of long-term sustainability of these various technologies has also not been covered properly. Moreover, since these studies have primarily been conducted by the very agencies who have developed the arsenic removal units, there is, understandably, an inherent **bias in these studies.**
In this backdrop, the scope of the present study encompassed the following:

1. To synthesize knowledge and perception and take an integrated view of the arsenic problem by better understanding socio-economic issues and potential solutions.
2. To assess capacities and identify training needs at different levels and suggest broad mechanisms for capacity building.

3. To assess the opportunities and constraints in privatization of adopted technologies and suggest ways and means of ensuring acceptability at the grass roots level.

STUDY OBJECTIVES

1. AWARENESS

Assessment of the extent and depth of awareness amongst the community On problem of arsenic and related social, environmental and health issues;

2. Health Implication

Assessment of the health implications of arsenic contamination
- the number of people affected
- the source of contaminated water
- the manifestation of the health problem and its severity
- the number of death caused by arsenic contamination
- mechanisms to address the health problem caused
- extent of awareness on the arsenic-health linkage

3. Technology

Identification and socio-economic assessment of the mechanisms being used (in terms of technology introduction) to address the arsenic problem
- the specific technology being used
- the decision makers for technology selection
- the basis for selection (such as cost, maintenance aspects, available information etc.)
- the extent of information available with the community on different technologies available and specifically on the one selected
- the extent of acceptance of the technologies and its reasons
- the extent to which technology is community based
- Environmental implications of technology being used, such as sludge/waste water disposal etc.

4. Location of Treatment Units

Analysis of the community's choice regarding location of the technology
- the implication of choice of location
- identification of the decision makers regarding location
- Problems relating to location

5. Operation and maintenance

Identification of existing mechanism for maintenance of treatment units
- extent of community involvement and their specific role in operation and maintenance
- in absence of community involvement, who carried out O&M and the bottlenecks, if any

- In case of community plants, the existence of a committee (community based organization) for maintenance. If so, the constitution of such a committee and mechanism for its constitution
- Source of funds for O&M
- Training needs for O&M
- Availability of raw material and any other input for O&M

6. Existing Capacity and Training Needs

Assessment of capacity and identification of training needs of local stakeholders, institutions, based on existing capacities and community needs. This will include training for planning, implementation and O&M.

7. Privatization and Marketing

Analysis of issues relating to privatization and marketing of adopted technologies, keeping in mind community needs and their paying capacity. The possibility of involving local entrepreneurs to manufactures and market ARP units would be explored.

- Opportunities for privatization of treatment units;
- Constraints relating to privatization and marketing;
- Paying capacity of community - for community and households units.

STUDY METHODOLOGY

Approach

The approach of the present study has been both **investigative** as well as **exploratory** in nature In the investigative part, the precise nature of the situation or circumstances in which the arsenic affected patients as also the community at large are living and look upon the arsenic menace, have been studied.

In the exploratory part, the main task was to explore the nature and extent of various essential services that have been rendered by governmental and non-governmental agencies to ward off the menace of arsenic contamination of ground water, as also those who have been affected by arsenicosis. The exploratory part also dealt with the **motivation of the various private agencies** that have started to produce ARPs, with regard to their marketing activities and how far they have tried to make it popular among the population residing in the arsenic-risk areas.

Target Segments

a) Users of Arsenic Removal Plants (ARP) – both community, as well as domestic units

b) Non-users-residents of Control Villages, falling under the Arsenic zone, but with no intervention yet.

c) Panchayat members

d) Company/ institution personnel, involved in developing / marketing Arsenic Removal Plants.

e) Dealer personnel, marketing ARPs

f) Maintenance personnel of community – based ARPs

g) Community opinion leaders

h) Training Institutions

i) NGOs involved in the arsenic mitigation process

Survey Technique:

LOGY	INSTALLED				SIZE
AIIH & PH	14	S-24 PGS: 8 N-24 PGS: 2 NADIA : 4	3	S-24 PGS: SARDAR PARA (BARUIPUR) N-24 PGS: GAIGHATA NADIA : BETAI (TEHATTA-I)	42

[illegible]					(BARUIPUR)
AIIH & PH	150	N-24 PGS	15	N-24 PGS	LAKSHMIPUR & ADJ.VILLGS (HABRA– 1)
JADAVPUR UNIVER SITY	150	N-24 PGS	15	N-24 PGS	SHIMULPUR & ADJ.VILLGS
B.E. COLLEGE (AMAL)	200	MALDA/ MURSID-ABAD / N-24 PGS	16	MALDA :12 MURSI-DABAD : 3 N-24 PGS 1	

Total number of respondents (community + domestic + control) = Two hundred and Ninety five only.

Other segments covered

1. Technology Provider

- Institute / Organisation
- Company

2. Training Institute : 6

3. Dealer : 2
4. Maintenance Personnel : 5
5. Panchayat : 5

Data Collection

A number of investigators, who were conversant in administering such instruments were recruited. However, researchers also visited a fair number of sites of each technology in all the districts covered. The fieldwork was conducted during July – Nov, 2000.

Data Analysis

The data collected from the Field Survey were subsequently analyzed and the report written on the basis of the computed information.

KEY FINDINGS

PERCEPTIONS ABOUT ARSENIC

Awareness

Level of awareness varied from site to site, ranging from low in some areas to very high in others. The awareness level was generally positively co-related to the following:
i) Incidence of arsenicosis in the village and/or adjoining areas

ii) Arsenic-related activities, e.g., water quality tests, mitigation measures, etc. undertaken by various governmental and non-governmental organizations. Understandably, the level of concern regarding the arsenic issue was also higher in these areas.

Thus, we found people more aware in Baruipur (South 24 Parganas), Betai (Nadia) and Nonaghata (Nadia), where NGOs are active in spreading awareness about it and urging people to avail of arsenic-free water of the various ARPs.

On the other hand, villagers, especially the women, in some parts of North 24 Parganas (e.g., Joypur) seemed to have a very poor understanding of the term arsenic, since they had hardly seen any arsenic-affected patients, and moreover, NGOs were hardly active in these regions.

Arsenic is commonly referred to as 'poison' which is present in 'tubewell' water. Some educated persons mentioned that arsenic is a metal, which remains dissolved in water. Several illiterate people thought arsenic was the name of a disease. Even if knowledge about arsenic is poor in most places, it is nevertheless perceived as an extremely 'harmful' substance, which enters the human body via consumption of contaminated water.

Health Concern

Awareness of the physical consequences of arsenic contamination was again directly co-related with the prevalence of arsenicosis in a particular village.
Thus, people in Baruipur (South 24 Parganas) and Nonaghata Uttarpara (Nadia) were quite well aware of the consequences, while those in Sadpur (North 24 Parganas - very few reported cases of arsenicosis) were not.

The most commonly mentioned symptoms of arsenicosis were:
Skin Diseases: black spots on hands/feet/body, roughness of skin warts.

Other symptoms mentioned were:
- Acidity
- General weakness (sometimes affecting one's capacity to work)
- Respiratory trouble

Patients and members of patients' families pointed out that these symptoms usually require 3-5 years to set in.

Medical cases

Villagers were aware of arsenic afflicted patients in almost all the sites we visited. However, more number of these cases were reported from:
(i) Baruipur area of South 24 Parganas
(ii) Betai area of Nadia
(iii) Nonaghata Uttarpara and Sangrampur of North 24 Parganas

While several deaths have been reported in the Baruipur region, villagers were aware of fewer deaths in Nonaghata and Sangrampur.
The reported cases of arsenicosis were least in the villages visited in Malda and Murshidabad.
Interestingly, villagers were not aware of any arsenic - induced death in Adahata (North 24 Parganas), where the concentration of arsenic appeared to be the highest.

Effects on Agriculture / Livestock

People in general are not aware of any adverse effects of arsenic contamination on agriculture or livestock. In fact, to most, it appeared to be too remote a concept, with which they were not at all familiar.
However, one respondent each in Nonaghata and Sangrampur remarked that arsenic present below ground level affects crops (fruits and vegetables), and in turn affects the human system. They have come to know of this either from PhD students of Kalyani University who had visited their village to collect samples (Nonaghata), or heard it in a seminar which they had attended (Sangrampur). The person who mentioned this phenomenon in Nonaghata also said that arsenic is so highly poisonous that plants die in the vicinity of arsenic-contaminated tubewells and it can affect fishes, too, if this water is allowed to drain into ponds.

Social Implications

By and large, incidence of social ostracization was not noticed anywhere. People generally do not perceive arsenicosis to be a contagious disease.
However, patients are concerned that it gives them a 'dirty' or 'ugly' look. They point out that people visiting their houses hesitate to accept water from them, asking them as to why they are looking so dirty? (Dark spots / warts on their bodies).
A doctor we spoke to in Nadia said that many of his arsenic-affected patients, especially the women, expressed concern about the fact that it made them appear dark and ugly.
Since it is thought to mar one's looks, some people feel that it could cause problem in getting a girl married off.

TECHNOLOGY OPTIONS

PAL TROCKNER

Community based

FGDs were conducted at two Pal Trockner community - based sites:
i. Moyna village of North 24 Parganas.
ii. Sherpur village of South 24 Parganas.

While the former unit is on its trial run, having been set up by the PHED, the latter was set up on the initiative of the NGO, Ram Krishna Mission Lokashisksha Parishad (RKLMSP). When we visited the first site, it was out of order. Moreover, since it is located within the prmises of an individual's house, it is being used only by the family members of that particular household. The other villagers preferred fetching water from a nearby deep tubewell. Water quality tests are being conducted by PHED from time to time, as part of its monitoring execise of various Arsenic removal technologies. The costs of installation and maintenance are being borne by the company itself.

The second ARP has been set up in a highly arsenic affected area (Sherpur) of South 24 Parganas. RKMLSP played the key role. They involved the community and the Panchayat in the project, especially in taking key decisions like choice of location of unit, etc. The choice of technology was made by RKMLSP, while the cost of installation was borne by the company.
Day-to-day maintenance is done by a caretaker at Sherpur – he has been suitably trained by the Company to carry out backwashing ,etc. In case of any problem , he gets in touch with the Company personnel.The Company personnel visit it as and when required.
There have been teething problems with the plant - e.g, there was no provision for iron removal, which happens to be a sevre problem of the area. On being notified, the company introduced an iron removal filter in the unit.

Unit Efficacy

While the Pal Trockner model seems to remove arsenic effectively (as revealed by water quality tests conducted by RKLMSP for the second unit), the issue of waste water / sludge management still remains.

According to the Company personnel, the sludge will ultimately be removed during replacement of the media after three - four years and disposed through cement based stabilization to be used in bricks, etc. However, the waste water was being drained off into the adjacent pond. On being notified, the company has set up a sand bed, through which the waste water is being passed at present - this helps in retaining arsenic, while the water slowly drains off.

Initially, the community members were quite satisfied with the plant (after installation of the iron filter). However, on our subsequesnt visit, we found they had several complaints, i.e.

- An oily layer forms on the water, if stored
- The water turns reddish on storing
- Rice does not cook well in it ("looks blackish--")

Some community members felt that the water of a nearby 1000 ft. tubewell tastes better. At present the ARP Unit has been modified and is working satisfactorily.
About 100 families are drawing water from the plant, which is mostly used for drinking and cooking purposes.
Daily water output : 2000 litre (approx)
Monthly O&M costs : Rs.300 /-, which is borne by the Company itself.
Although the community does not at present contribute towards plant maintenance, they are not completely averse to the idea, provided they get uninterrupted supply of clean and safe water.

DOMESTIC ARP

We interviewed 15 respondents who had installed the Pal Trockner domestic ARP model in their houses. These were all in the highly arsenic affected block of Baruipur in South 24 Parganas. These households were quite well-off, where the main earner was employed in Banks, ONGC or engaged in business.

The general level of awareness and concern about arsenic was quite high here, especially because there are quite a few affected patients in this zone.

A local club, Antodaya Surya Sangha, has held several arsenic awareness camps in this area. This club, with the active cooperation of RKMLSP, and the local Panchayat, has been instrumental in promoting domestic ARPs here. These Pal Trockner ARPs have been supplied at a price of Rs. 1000/- (50% subsidy borne by RKLMSP). Two patients have been supplied free of cost as a goodwill gesture by the company. Most of the respondents were of the opinion that if the filter is to be accepted by the masses, it should be priced around Rs.500/-.

The particular model was chosen by RKLMSP. The filter is a compact unit with in-built media,which pre-empts the necessity for chemical dosing. The system is an "on line" one - this is possible only in households with taps - in other houses, the pipe of the ARP is immersed in a bucketful of water, from which, water is drawn when required.

In most households, the filter has been installed close to the kitchen. The housewife is primarily responsible for looking afetr the filter, although in some houses, male members also share these responsibilities,. Respondents pointed out that there is no need for any daily maintenance job - the filter only has to be backwashed, usually once a week, to clean the system of various deposits, i.e. iron. The waste water thus generated is thrown into open drains. This process has been explained to them either by the company personnel, or members of Antodaya Surya Sangha.

Again it has been brought to the notice of the company by RKMLSP that arsenic is being recycled into underground water by this method of waste water disposal. The company has looked into the matter and has suggested plastic buckets to the users, where the waste water can be stored. Afetr a certain period of time, this can be removed by the company personnel. However, this proposal is yet to be finalised.
Most respondents said, they used the filtered water for drinking and cooking purposes. The users appeared to be satisfied with the qulaity of the treated water, especially since it has helped to get rid of various common stomach ailments, i.e. acidity, indigestion, constipation, etc.
Of the two patient users, one felt the black spots on his hands had reduced somewhat, while the other could not discern any apparent improvement.

Role of Panchayat

The panchayat has taken steps to make the community aware about arsenic and its ill effects. It has sunk deep tubewells in the locality and has fully cooperated with RKMLSP and the Rotary Club to install ARPs. It is also trying to procure vitamin tablets and distribute them among arsenic affected patients.

The panchayat reported that it has scanty information regarding domestic ARPs – it came to know about these from a seminar which was organised in the area. The panchayat pradhan felt that domestic ARP was a good proposition, but at its prevailing price, hardly 10% of the households can afford it.

When asked whether the panchayat could possibly subsidise these domestic filters, the Panchayat Pradhan pointed out that it would require budgetary allocation, which, apparently, is a cumbersome process.

Conclusion:

1. As far as the community based ARP is concerned, there seems to be a certain lack of coordination between beneficiaries, the implementing agency and the company. One way to get over this problem is - encouraging community participation at the grass roots level, e.g., a local club could be involved in plant
O & M and could serve as a link between the beneficiaries and the company,keeping RKMLSP informed about developments, instead of depending on it for every requirement. Moreover, if community contribution is initiated by the club, minor maintenance jobs can be handled by the community itself, instead of waiting for company personnel to come and do it.

2. As far as domestic ARPs are concerned, we have the following observations

- the cost of Rs.2000 per filter can be afforded only by the well - off; the company should also look into the possibility of developing a low cost option in order to gain mass acceptance

- there is a strong felt need to gain assurance that the treated water is actually arsenic – free – thus, periodic water quality tests need to be carried out here, again, if a link organisation can be trained in conducting water quality tests, etc., by the company, they could conduct regular tests to the satisfaction of the users.

3. For both the models, the issue of sludge / waste water disposal is of utmost concern. We hope that the various proposals mooted by the company in this regard translate into effective implementation.

4. Clear instructions in the form of a guide book /manual,in simple language, for operation and maintenance is required for the beneficiaries.

B.E. COLLEGE – AMAL

Community-based

We conducted FGDs at three community-based sites of AMAL filter of BE college:
(i) Sadpur of North 24 Parganas
(ii) Sangrampur of North 24 Parganas
(iii) Itkhola (Betai region) of Nadia.
Although all three are arsenic-affected areas, the last two are more severely affected than the first.
In all the above sites, local NGOs played a key role in ARP installation-e.g. , Breakthrough Science Society in Sangrampur and Chandranath Basu Seva Sangha (CBSS) in Betai took the initiative in providing a solution to the arsenic menace in their respective zones. Whereas in the first two, the NGOs got in touch with B.E. College directly, CBSS was introduced to it via Jadavpur University - here, Dr. Dipankar Chakrabarty of the University took the initiative.

In all the above sites, B.E. College personnel held meetings with the local people and helped in forming committees to look after its O&M. The Panchayat seemed to have been involved only in Sangrampur.

Whereas in Sadpur and Sangrampur, the installation costs were borne by B.E. College, in case of Itkhola, CBSS paid Rs. 60,000/- for it, out of funds received from a Japan Government grant (the total grant was for Rs.15 lakhs, which was spent on installation of seven ARPs in Betai).

Community Participation was clearly evident in Sadpur and Itkhola, whereas in Sangrampur, it was somewhat missing because of intra-committee bickering. Maintenance Committees have been constituted in Sadpur, comprising seven members. Whereas in Sadpur, two caretakers have been appointed (who work in shifts), in Itkhola, several community members take turns in plant maintenance. These caretakers have been trained in backwash procedure (which is usually done twice a week) and handling of minor repair jobs. The two caretakers together receive Rs.1700/- p.m. in Sadpur, whereas they do it free of cost in Itkhola. In Sangrampur, also, two caretakers had been appointed, but due to charges of favouritism, etc., may be replaced soon.

Community contributes towards O & M in both Sadpur and Itkhola. In the former, a Water Committee has been formed of nine members, including a President and a Secretary. About 300 households contribute towards plant upkeep - Rs.25/- when it becomes a member for the first time and Rs. 15/- thereafter in every subsequent month. In the latter, seventy families pay 50 paise per bucket of water drawn from the unit; while another thirty-four pay a monthly subscription. The money thus collected is deposited in a UCO bank account in Sadpur, whereas it is kept in the cashier's custody at Itkhola. In Sangrampur, although contribution had been initiated, at present it is on hold due to differences among committee members themselves. Their O & M fund meets caretakers' salaries in Sadpur, minor repair jobs in both the sites and the balance is being accumulated for plant re-charging, when it becomes due. The re-charging is done by Kar Enterprises, a service agency of B.E.College.
Water quality tests are carried out regularly by B.E. College - however, whereas they are conducted every week in Sadpur, it is done only once in three months in Itkhola. The test results are shared with the Committee members in Sadpur.

The community members of Sadpur and Itkhola appeared to be quite satisfied with the plant. They mentioned having been cured of stomach disorders, e.g., acidity, indigestion, lack of appetite etc. and pointed out that they had come to depend totally on it for drinking purpose. However, most people in all the three sites prefer either pond water or water from their private tube wells for cooking purpose. This is either because they feel that food, especially rice, does not cook well in it, or because they are unwilling to pay for it (Itkhola). ARP treated water is perceived to be 'light', but not as tasty as water drawn from a deep tube well. In Sadpur, some beneficiaries pointed out that it smelt of 'chemicals' after every backwash.

All three units were centrally located and thus there was no cause for complaint with regard to ARP location.

The ARP at Sangrampur appeared to be a little neglected and ill maintained, although perhaps, it was heavily used.
None of the beneficiaries in any site were aware of any other ARP model.

Daily ARP treated water consumed: about 5000 liters on an average in Sadpur (according to the Committee President) and about 1400 liters in Itkhola.

Sludge Disposal
The wastewater generated during plant backwash and regeneration flows into a sand filter adjacent to the plant and gets stored there. Once it is full, B.E. College will remove it for final disposal
The sludge that gets adsorbed within the media will be removed, once the media is replaced on exhaustion. In both the cases, the arsenic will be subjected to cement-based stabilization.

However, in none of the plants has the need arisen to remove the sludge, as yet.

Domestic

Sixteen beneficiaries who have installed 'AMAL', the domestic arsenic removal filter developed by B.E. College and manufactured and marketed by Oxide India Pvt. Ltd, were interviewed. Of the 16 beneficiaries, 12 beneficiaries were from Malda district, 3 from Murshidabad district, whereas one from North 24 Parganas. 8 of the beneficiaries happened to be Muslim, while another 8 belonged to the Hindu Community; of the 8 who belonged to the Hindu Community, 5 belonged to Scheduled Caste, while 3 hailed from General Caste. Some were traders, others engaged in the silk export-import business; while others included teachers and government employees.

Of the 16 beneficiaries, 6 had first hand experience of arsenic poisoning. Two of the beneficiaries were afflicted with arsenicosis, while 4 of the beneficiaries had come across arsenic poisoning of their near and dear ones, mostly relatives and other family members. The rest 10 beneficiaries had gathered information about arsenic from media sources, like television / newspaper and even from awareness camps organized by Panchayat and the Indian Medical Association.

All the respondents pointed out that they were very much concerned about arsenic and to counter the problem of arsenic contamination of water, they have installed domestic filters, which can remove arsenic from water. All the respondents reported that they have been using the ARP (domestic) for the last 6-12 months. None of them were aware of any other model of ARP.

They could learn about the present ARP from various sources, like relatives, the dealer directly approached the respondent, demonstration at exhibitions organized by Panchayat / Indian Medical Association and NGOs.
All of them reported that the 'AMAL' variety of ARP costs about Rs.2400.00. The respondents further stated that arsenic free water derived from the ARP, has been found to be very helpful to reduce indigestion / acidity / general weakness and so on. Moreover, one of the respondents reported that the black warts on his father's body were gradually disappearing and there had been no fresh emergence of black warts / spots, on drinking the filtered water.
The filtered water is chiefly used for drinking purpose – several families use it for cooking, as well.
All of them admitted that since the installation of the filters, there had been no effort to test the quality of the filtered water. Although they were not having any problem, all of them expressed the opinion that such tests need to be carried out, as it would make them feel more reassured.

The respondents reported that the maintenance of the ARP was not much of a problem. The water has to be poured into the upper container. The water percolates through the media, which is placed in a cloth bag in the upper container and the filtered water settles into the lower container, from where it is collected. All the respondents reported that once in a month, the media is washed with water and that water was thrown away down the drain.

Conclusion

While the plant is being well maintained by the community at some sites, the Committee needs to be strengthened at the others. Also, the Committees require to be trained in financial matters – e.g., system of collecting community contributions, depositing the same into bank accounts and handling the same, etc.

As far as the domestic filters are concerned, the following points are worth considering:

Regular water quality tests are a legitimate demand of the users – this should be considered for providing assurance to the users
The filter worth Rs. 2, 400/- cannot be afforded by the majority of the people at risk – the Company needs to look into the possibility of developing a low cost option, as well.

Water System International Ltd (W.S.I)

Community – based

So far, only one community - based unit of W.S.I. has come up at Joypur in North 24 Parganas - we conducted an FGD next to the plant itself.

This particular ARP is a trial one, set up by the company in collaboration with PHED. As such, its efficacy is being monitored by PHED by conducting periodic water quality checks.

The community members are aware that it is primarily a government project, in which the Panchayat was also involved in matters of site selection, etc.

The community members were apprised of the project, but not involved in the decision - making process. They were not aware of any other technology options.
Earlier, very few people were drawing water from this unit- however, at present, about a hundred families are drawing water from it – 2000 liters daily output (approx.).
The community seemed to be quite satisfied with the working of the ARP, as also its location - a busy roadside spot, accessible to all. They felt that the ARP- treated water is 'clean' and believe it is arsenic - free. They also mentioned that they use this water primarily for drinking purpose - for other purposes, including cooking, they are continuing to use water from private tubewells (which are very common here). It was somewhat alarming to note that they are extensively using water of tubewells whose water they think is arsenic - contaminated (via tests carried out by NGOs mostly). This is mainly because there are very few patients in this particular locality, and as such the level of concern is also low. The general consensus was - " we have been using water from these private tubewells for so long, nothing has gone wrong so far..... so, why change now?"

There is a brewing notion that plant maintenance be handed over to the beneficiaries. In a place where the majority of the villagers live under the poverty line, this is viewed as a possible source of income generation.

The community members had no idea about waste water or sludge management and were not concerned about it, either.

Regarding O &M contribution, there was a general apathy; however, some felt that "if others contribute, we can also do the same".

They were aware that the company has borne the costs of installation, and is also responsible for maintaining the ARP. One particular company personnel, Mr. Raju Sharma, have been designated as plant caretaker - it is his job to visit the plant regularly (six days a week), to ensure its smooth functioning. He has been trained by the company in matters of plant backwash, which he carries out once a fortnight. The wastewater is drained off in the adjoining land itself.

Mr. Sharma further pointed out that the media of the ARP has to be recharged after approximately 2,00,000 liters water is discharged - however, the need has not arisen as yet for it.
Monthly maintenance cost of the plant works out to about Rs. 4, 000/-, inclusive of the caretaker's salary, travel, etc., which forms the major component.

ION EXCHANGE

Community - based

FGD was conducted at the lone site of ARP installed by the company at Nonaghata Uttarpara in Haringhata block of Nadia district. The maintenance staff deputed by the company, Mr. Gautam Kumar Dey, was also present and we spoke to him, too.
This particular ARP has also been set up as part of PHED's trial run of various arsenic removal technologies.
This area is a severely affected one, where, according to local estimates, there are more than two hundred arsenic affected patients. Of them, a group of young boys had met the Block Development Officer, the Block Medical Officer and other functionaries, some time back. Subsequently, PHED people had come over and conducted water quality tests of the tube wells in the vicinity. Of these, one tube well was found to have a high concentration of arsenic, which was chosen for installation of the ARP. This was followed by visits of the Company personnel, who spoke to the local educated people (including a Doctor) about the benefits of having such an ARP in the village. Ultimately, the Company set up the plant in August 2000, which has borne all the costs of installation.

The beneficiaries have not been exposed to any other technology.

Of a total of about two hundred families in the village, about fifty-sixty families are drawing water from this ARP, the others draw water from the three deep tube wells installed by the Panchayat in and around the village. Several women we spoke to mentioned that they fetch water both from the ARP, as well as the deep tube wells. The flow of water of the ARP being less, they go to the tube well to fetch water when they are in a hurry. However, they are quite satisfied with the ARP treated water because of the following reasons:

-Food cooks well in it ('rice looks white')
-No iron/yellow sedimentation as in case of tube well water
-Stomach problems have reduced
One young, educated girl felt that it has also helped her to overcome 'physical weakness'.

A couple of patients present said that they had started getting spots on their body after drinking shallow tube well water for several years. A doctor who had visited them advised them to eat vegetables like carrot, tomatoes etc, and had given them some ointment, which was of no use. However, on using the ARP treated water, they feel that the outbreak of spots on their body has been checked, although they have not faded. They wanted to know how long it would take for the spots to disappear.
The ARP treated water is used for drinking and cooking purposes. However, pond water is also used for drinking (by some) and cooking purposes, as well.

Plant O&M

Mr. Goutam Dey is in charge of plant O&M. He visits the plant everyday. He has trained a local person as caretaker (whose house is situated next to the ARP) to carry out the following activities:

(a) Plant backwash- this is done every day, early in the morning, to remove iron deposits, etc-this takes about fifteen minutes to complete. The wastewater is disposed in the nearby land, itself.

(b) Drain out the water present inside the plant
- This is done every evening, so that fresh water may be pumped into the system the following morning.

The caretaker is paid Rs. 1,700 per month to discharge his duties. Certain small parts and tools required for plant maintenance are also stored in his house.

Mr. Dey, who also ensures that people who come to fetch water do not have to face any problem, supervises these activities. Water quality tests are carried out both by PHED (bi-weekly), as well as by Mr.Dey or any other company personnel visiting the site (weekly). For this purpose, the company uses Field Test Kits.
The entire O&M costs are borne by the company itself.

The media (resin in this case) has not yet been re-charged - it is expected to run continuously for at least five-six years. Thereafter, the exhausted resin will be removed, treated at the company's Central Regeneration Facility to leach out arsenic, the sludge neutralized by adding iron salts and ultimately used for land filling and industrial purposes – e.g., as raw material for production of certain goods, mirror polishing, etc.

Although the community does not contribute towards O&M, they reacted positively to the idea of doing so. They mentioned that they collect money to carry out repair work on the Panchayat tube well; moreover, people chip in to pay for the transport costs for patients to go to Calcutta (School of Tropical Medicine) for treatment

The Panchayat has played no role in the installation of the unit, or its operations.

Note:
This village is predominantly a Muslim one, where most inhabitants depend on agriculture. The general economic condition of this village is quite poor. Concentration of arsenic affected patients observed was also among the highest among all the villages visited by us.
One redeeming feature noticed was the initiative taken by local young boys, both in influencing the administration to take steps against arsenic, as well as promote usage of safe water by persuading the people to avail of these arsenic-free, safe water sources. These boys spread awareness regarding arsenic and its effects by carrying out door-to-door visits; they try to convince people to use the ARP water instead of shallow tube well water. Responses have been mixed, so far.

Conclusion

(1) Although community participation has been initiated, it can be further strengthened by:

(a) Training the caretaker in minor repair works

(b) Involving the local youth (who are high enthusiasm) to carry out water quality tests-results of these tests can thus be known to all, through these youth- which will further espouse the cause of using the ARP treated water

(2) Being the first unit to be set up by the company, several parameters have still not been defined/determined e.g, when to carry out regeneration exercise? at what cost,etc? These need to be worked upon

(3) Waste water disposal

APYRON

Community - based

FGDs were conducted at the following sites:

(I) Shibalay (North 24 Parganas)

(ii) Adahata (North 24 Parganas)

Both the above-mentioned ARPs have been set up as part of PHEDs trial run of various arsenic-removal technologies.

Water Quality tests conducted by PHED revealed presence of arsenic in these tube wells-subsequently, the company personnel came over to install the ARPs. The Panchayat was informed about installation plans, but did not play any role here in project implementation.

In Shibalay, the ARP is located within the premises of an arsenic-affected family's household (of whom one lady has expired due to arsenicosis)- the male members of this family were taken into confidence during ARP installation.
The community members have no idea about any other technology options.

Plant Location

While the ARP at Adalata is centrally located, the one at Shibalay (as pointed out earlier) has been located in private premises. As such, although there was no complaint about plant location in the former, beneficiaries were understandably dissatisfied with the latter.

About sixty families draw water from the former (1200L. approximately), while only two families (those adjacent to the ARP) draw water from the latter. Even those who had started drawing water earlier shifted to piped water supply, when it was introduced at the latter site.
The beneficiaries use the treated water primarily for drinking purpose in Adahata, while it is used both for drinking and cooking purposes in Shibalay. In Adahata, pond water is preferred for cooking because:

(a) Food tastes/looks better if cooked in pond water
(b) In order to minimize the 'load' on the ARP
(c) ARP treated water is perceived to be 'expensive' and thus, needs to be sparingly used

The level of satisfaction with ARP treated water was higher in Adahata, where people mentioned that it was 'clean' and 'white' water; moreover, it is perceived to stimulate appetite and ensure peace of mind.

In Shibalay, the beneficiaries mentioned that sometimes, the unit is not cleaned regularly- at such times, the water turns red and gives off a foul odor.

Some beneficiaries at Adahata remarked that the treated water smells of chlorine each time 'medicine' is added to it.

In neither site was the community responsible for plant O&M, nor did they contribute towards it.
Both the capital costs, as well as the O&M costs, are being borne by the company itself.

Plant O&M

The ARPs set up by Apyron do not require any chemical dosing. It needs to be backwashed regularly- usually, twice a week- to remove iron deposits, etc. This is done by company personnel, Mr. Rabi Ojha. The beneficiaries also mentioned that he adds some 'medicine' to the unit.
Mr.Ojha clarified that this medicine was actually chlorine tablets, which are replaced usually once a month. He said that the media at Shibalay has been changed five times; however, that at Adalata has not been done so.
Periodic water quality tests are conducted by Mr.Ojha, who has been provided with a Field Test Kit for this purpose, as also by PHED personnel, from time to time.
Mr. Ojha has received training from Apyron regarding aspects of plant maintenance, e.g., backwash process, minor repairs, as also conducting water quality tests.

Waste water / Sludge disposal

The wastewater generated due to plant backwash is thrown into the adjoining soil. The sludge that gets trapped in the media will ultimately be used up in manufacturing construction material (once the media is replaced).
There is no provision for media regeneration in this case.

Accordingly to company personnel, around Rs.3000. is spent on plant O&M per month, of which around 90% is travel/food costs of the maintenance staff.

Conclusion

- Choice of site needs to be more carefully done in order to facilitate trial and ensure wider acceptance
- For long term sustainability, community participation is mandatory – mobilization needs to be initiated now itself; also, training aspects need to be looked into
- Explore possibility of introducing domestic filters
- Consider regeneration/ recharging options, if feasible.

AIIH & PH

Community - based

FGDs were conducted at the following sites where community- based arsenic removal plants have been set up by AIIH & PH:

(i) Sardarpara (South 24 Parganas)
(ii) Gaighata (North 24 Parganas)
(iii) Jitpur (Nadia)
All the three units have been set up with NGOs playing a key role in installation:
Ramakrishna Mission Lokashiksha Parishad (RKMLSP), Vigyan Mancha and Chandranath Basu Seva Sangha respectively.

While RKMLSP installed it as part of its Programme to provide safe drinking water to arsenic affected areas of West Bengal and was assisted by a local NGO, Antoday Surya Sangha, CBSS was guided by Jadavpur University in its project installation. Vigyan Mancha interacted directly with AIIH&PH.

The local Panchayat was apprised of the project and involved in certain decision-making processes by RKMLSP in Baruipur- they did not seem to have been included in the other two sites. In fact, in the case of Gaighata, the Panchayat members were either totally unaware or only vaguely aware of the ARP, although it is situated at a stone's throw distance from their office building.

The costs of installation were shared in Sardarpara (70% by Rajiv Gandhi National Drinking Water Mission, Government of India and 30% by the community), provided by the Japanese Government in Jitpur and borne by AIIH&PH in Gaighata. In the case of CBSS, Jadavpur University assisted them in developing Project Proposal, interact with the Japanese Consulate etc.

Costs- Rs.25,000/- in Sardarpara, Rs. 35,000/- in Jitpur (free technical support was provided in the latter)

Choice of technology was made by the respective NGOs-in the case of Jitpur, it was influenced by Jadavpur University.
The beneficiaries were unaware of any alternate technologies in any site.

Choice of location was usually a joint decision between the implementing organisation and the community members. All three units are conveniently located at central spots of the respective villages.

Present status

The unit at Gaighata is defunct-it was in operation for just two months after installation.
About forty-five families were earlier using the ARP at Sardarpara however; the number has come down to only eighteen now (reasons given later).

The ARP at Jitpur is being mostly used by twenty-four families, situated close to the plant. Besides, villagers working in nearby fields also avail of its water.

The ARP treated water is primarily used for drinking purpose in both Sardarpara and Jitpur. Respondents mentioned that they generally prefer using pond water for cooking purpose. However, some women in Jitpur remarked that they prefer using ARP - treated water for cooking, as well, since 'Rice looks white' and 'Dal cooks well' in it.

The general consensus was that the ARP - treated water is 'light' compared to ordinary tube well water. Respondents in Jitpur were pleased that it had helped them to get rid of stomach ailments, e.g., diarrhoea, acidity, etc.
However, in Sardarpara, the beneficiaries were dissatisfied on the following counts:
(i) the plant is not properly protected against the elements - as a result, they often come across dirt and worms in the water discharged by it
(ii) the galvanized iron sheet cover becomes very hot in summer - as a result, the temperature of the water shoots up, as well, and therefore, 'does not quench thirst'

Moreover, various organizations conducting water quality tests with varying results of arsenic in treated water, has understandably resulted in confusion and frustration among the beneficiaries. RKMLSP has been apprised of all these problems and have taken them up with AIIH&PH. However, no visible improvement has occurred, as yet.

Plant O&M

Caretakers have been assigned from the community itself in Sardarpara and Jitpur. While the former, Rizia Bibi, was trained by AIIH&PH, Gobinda Poddar (Jitpur) was trained by CBSS in matters of plant operation and maintenance.
Both of them stay very close to the respective ARPs.
Their duties include:

(i) daily chemical dosing (alum and bleaching powder). Mr.Poddar mentioned that he adds 2.5 gram alum and 25 gram bleaching powder to the raw water every day.

(ii) backwash-done at an interval of one month or maybe even more at times.
Sludge Disposal – the wastewater is kept stored in a tank for the time being – arrangement for its proper disposal will be made once it is full.
In Jitpur, bleaching powder is procured by a local person, free of cost from the hospital in Baharampore, where she is an employee, while alum is bought from the local market. In Sardarpara, although bleaching powder is purchased locally, alum is being supplied by RKMISP, since the local variety was found to be of suspect quality.

O&M Costs

In Sardarpara, the eighteen families drawing water from the ARP contribute towards its O&M costs. In Jitpur, contributions come in irregularly from the families using the ARP-most of the time, the responsibility falls on the caretaker, Mr.Poddar, to provide the necessary funds.

Average monthly O&M costs works out to around Rs.600/- at the SardarPara plant. Water quality samples are collected from time to time - once every two months by Jadavpur University in Jitpur. However, respondents were not aware of AIIH&PH personnel carrying out any such tests.

Common problems noticed with the AIIH&PH model:

(a) Daily dosing of chemicals - not user-friendly, open to risk of miscalculated doses
(b) The handpump (with which the ARP is attached) is located on a raised platform - so, most users avoid climbing up and pumping it as they are supposed to do (in Jitpur, there are no steps to climb - women, therefore, do not perform this duty at all)
(c) No standardization of the chemicals used is possible – thus, their quality varies from place to place

DOMESTIC

15 respondents who have been using domestic based ARP developed by AIIH &PH have been interviewed. All the respondents were Hindus belonging to General caste and hailed from Lakshmipur and surrounding villages under Habra No. 1 Block, Dist – South 24 Parganas. 5 of the respondents were engaged in small business, 9 of the respondents were service holders while on happened to be daily wage labour.

All the respondents reported that the term 'Arsenic' was not foreign to them and even that arsenic was found in water below the surface and consumption of arsenic contaminated water led to serious physical complications and prolonged drinking of arsenic contaminated water might even lead to death. The respondents reported that they came to know about 'arsenic' from T.V./ Newspaper, awareness camp organised by NGO/ Panchayat and through first hand experience. They conveyed that consumption of arsenic contaminated water generally entailed arsenical skin lesions and the most visible signs were black spots on palm/ feet/ all over the body, blisters on hand / feet and black warts. The respondents further pointed out that consumption of arsenic contaminated water was likely to cause various other complication, loss of appetite, stomach disorders, acute indigestion, hair loss and fading eyesight. The respondents submitted that arsenic affected patients have not suffered from any kind of social ostracization.
Rather the patients themselves felt bit shy, because of the blisters and black spots. The people at large in the beginning felt helpless, because they were not familiar with such type of skin eruptions. But now this uncertain situation has subsided because the presence of arsenic and arsenic skin lesions could be diagnosed.

The respondents reported that to overcome arsenic contamination, have installed domestic filters capable of removing arsenic from water. AIIH in collaboration with the local NGO has installed the domestic filters. The households using the aforesaid domestic ARPs did not have the option to decide between other technologies, because the local NGO has made arrangements with AIIH to install the same. Infact they reported that they were not in the know about the availability of domestic ARPs, other than that installed by AIIH. The respondents had to pay Rs. 100/- towards the installation of arsenic removal filter. The respondents reported that the treated water was primarily used for drinking. For cooking and drinking. Respondents pointed out that daily maintenance related to the adding of chemicals to the water for treatment otherwise there is not much to it. The process of treatment is as follows: un-treated water is stored in a bucket and the minimum quality ought to be 10 ltrs. In 10 ltrs. of water 20 drops of liquid bleaching and ½ teaspoon full of alum are added and stirred briskly, so that it gets dissolved completely. The water is kept in this state for three hours. After that 3/4th of the aforesaid water is poured in the upper chamber of two-chambered filter, which is made up of clay. The upper chamber has candles and the water therein percolates through the candle to the lower chamber and that water is arsenic free. 1/4th of the water is disposed of as that contains arsenic and which is termed as sludge. The sludge is thrown in the pan as per the instruction of AIIH &PH. Monthly maintenance cost worked out to Rs. 10/-. The respondents reported that initially water quality tests used to be carried out but of late such water quality test have been discontinued. The respondents insisted that such water quality test need to be organised periodically. All the respondents reported that there was no problem to handle the domestic ARP, except that **one has to be cautious about dosing** and the availability of chemicals. At present the chemicals were being supplied by the local NGO, but if at anytime the said NGO stopped selling the chemicals, the respondents would in a fix. The respondents opined that using of treated water has had the following effects: stomach problems had been greatly reduced, the treated water tasted good, acidity had also come under control and there was no eruption of arsenic related skin lesions.

The panchayat reported that the main problem was arsenic contamination of ground water. The main casualty of this menace has been the poor people. The Panchayat Pradhan reported that it has taken the initiative to make the people conscious about 'arsenic' and how it entered the human body and the impact thereof. The tubewells, which had been found to disgorge arsenic contaminated water, had been identified but they were yet to be sealed. Ten deep tube wells had been sunk. The Pradhan reported that water quality test of existing tubewells and of deep tubewells were carried out by Public Health Engineering. He also submitted that four arsenic affected patients have been identified. The people of the area did not have any reservation against them. The Pradhan further stated that Shibpur B.E. college has installed a community based ARP, while AIIH &PH has taken the initiative to install domestic ARP. The Pradhan expressed ignorance about the modus operandi of community based as also of domestic based ARP. He reported that panchayat had no role in the selection of site where B.E. College has installed community based ARP. Similarly panchayat had no role in the selection of beneficiaries where domestic ARPs had been installed. He reported that he had no knowledge if at all any training was organised on O&M aspects. The Pradhan reported that he had heard that a committee has been constituted to look after the maintenance of the community based ARP. There was no panchayat member on the committee. The beneficiaries were supposed to pay Rs.15/- every month to meet the maintenance cost of the ARP. Pradhan was of the opinion that domestic ARP was quite helpful because that would ensure arsenic free water to the household and they would not have to depend on external sources. Pradhan pointed out that G.P. had very little fund to organise the installation of community based ARP. He was of the opinion that the panchayat samity should come forward to install community based ARP. He further mentioned that community contribution could be mobilized if there was intensive persuasion and counselling. The pradhan

expressed that to ensure proper maintenance of ARPs, easy availability of chemicals and proper disposed of sludge need to be given due attention.

Conclusion

- Address inherent weaknesses in an effort to make the system user-friendly
- AIIH&PH should take initiative in plant performance monitoring and provide re-assurance to users about the safety of the water it provides
- Closer co-ordination and better liaisoning between AIIH&PH and the implementation NGOs is essential for smooth functioning of the units.

At present, the organization is playing the role of only 'technology-provider'; for commercial success, a far more professional and marketing-driven approach is required, especially in terms of suitable product modification to make it more user- friendly and strengthen after sales and other back-up services..

Jadavpur University

Fifteen beneficiaries who are using domestic arsenic removal filter developed by the School of Environmental Studies, Jadavpur University have been interviewed. Of the fifteen beneficiaries, eleven beneficiaries hailed from village Kolsur under North 24 Parganas district two from Amkhola and two from Deoganga under the same district. Thirteen of the respondents happened to be Muslims, while two were Hindus who again belonged to scheduled caste community. The occupation of seven of the beneficiaries happened to be business, while seven respondents were daily wage laborers and one was a bidi worker.

Of the 15 respondents, 10 respondents have been affected by arsenic, while the family members of the two have been affected by arsenic, and remaining three respondents did not have any such arsenic patient. 12 of the respondents reported that a team from Jadavpur University came to the village, examined them as also the water and from them, the respondents could come to know about the presence of arsenic in ground water. The other three respondents approached the doctors at the hospitals to find out the reason for the appearance of warts on their skin and from those doctors they could learn about arsenic.

It transpired from the discussion with the respondents that earlier they were using the tubewells which have been found to disgorge arsenic contaminated water, because those tubewells were yet to be sealed and no alternative handpump have been installed. The respondents have installed domestic ARP, and the ARP was helping them to get arsenic free water.

The respondents reported that domestic ARP has been made available to them by Jadavpur University free of cost. They have been using the filter for the last three to four years. The filter consists of two chambers made of plastic. In the upper chamber, there is a candle. The water is poured into the upper chamber and it then percolates down to the lower chamber. At first the unfiltered water is collected in a bucket. One black tablet, which is also supplied by Jadavpur University free of cost, is put into water and stirred vigorously to ensure that the tablet gets dissolved completely. After that the water is poured into the filter. The water that comes out of the filter is arsenic free.

All the respondents replied that since they have started to take arsenic free water, they have experienced certain very positive results, like, black spots have started to fade away, there has been no fresh spots on the body, indigestion and other stomach problems have been reduced.

It could be garnered from the respondents that previously twice in a month water quality test used to be carried out but this has been discontinued for quite sometime, though all of them were very much in favour of testing the water periodically.

They reported that domestic ARP was easy to maintain. Ten of the respondents reported that they disposed the sludge at the end of every month. While five of them reported that they disposed the sludge every fortnight. The sludge was disposed in a dug out hole, especially made for the disposal of the sludge.

All the respondents reported that sometimes the candle broke or became loose, the tablet got exhausted in that case they had to secure the tablets or mend the candle with the help of the designated person authorized by Jadavpur University. He was not always available, and so the replacement of tablets or candle was bit of a problem.

The Panchayat reported that the community has become well aware about arsenic, but it has yet to grasp the depth and gravity of the problem. The Panchayat has taken the initiative to make the people aware about the menace of arsenic. The Panchayat has identified the affected tube-wells, but they have not been sealed; though the beneficiaries had been asked to refrain from using those tube-well. The Panchayat was aware of the fact that a number of persons had died due to arsenic poisoning and quite a good number of people have been suffering from arsenic poisoning. The Panchayat was trying to solicit the support of Government and non-government agencies to counter the menace of arsenic. AIIH & PH have taken the initiative to install community based ARP in their locality but the selection of site for the setting-up of community based ARP and the identification of beneficiaries for the supply of domestic ARP have been done at the behest or AIIAH & J.U. The panchayat did not know much about the operation of community and domestic based ARP. But it has come to know that the units were performing well. The Panchayat was of the opinion that domestic based ARP was quite a feasible proposition, but how far the common people would be able to buy it would depend on the cost of the filter, as most of them depend on agriculture. The Panchayat felt that alternative source of drinking water needs to be arranged, but it hardly has the means to do so. The Gram Panchayat felt that the Panchayat Samity ought to come forward in this regard.

Conclusion

On the whole it can be said that, due to the intervention of Jadavpur University, the menace of arsenic has become quite well known in the community. The community at large, is very much concerned about the arsenic contamination of ground water. But owing to the lack of alternative arrangements, the community was forced to take arsenic contaminated water. Jadavpur University has taken the initiative to supply domestic ARP free of charge to some of the families, but that hardly has helped to meet the demand for such filters.

Periodic testing of water quality needs to be conducted, which of late has been discontinued. Moreover, the replacement of the media (tablet) or candle depends on the designated person authorized by J.U. and which has posed a problem to get these things in time. Thus, the supply chain needs to be strengthened. In the long term, it would have been better, if the domestic ARPs could have been manufactured locally and the tablet also sold through a local outlet. Moreover, the beneficiaries need to get exposure regarding the other Technologies for arsenic removal

PHED

FGDs were conducted at the following sites:

1.	Bakharpur	(Malda) –	15 Female participents
2.	Masimpur	(Malda) –	20 do
3.	Jhaudia	(Murshidabad) - 12	do
4.	Gobardanga	(North 24 pgs.) - 20	do

The treatment plants were located in Bakharpur and Gobardanga., from where the treated water is supplied through pipes to adjoining villages and Jhaudia, where it is attached to a hand pump. Masimpur was chosen as a tail-end village of the Piped Water Scheme of Bakharpur.

The first three villages were Muslim dominated, while the last was predominantly a Hindu one. While Bakharpur was a poor Muslim village, villagers of Masimpur were relatively prosperous. Occupation of the Malda villagers was mostly silk worm rearing, whereas that in Murshidabad was primarily agriculture.
In Gobardanga, which is a municipal area, there are comparatively more affluent-class people, mix of service men and businessmen, with higher standards of education, as well.

The PHED played the key role in plant design and implementation at all the above sites. While in Gobardanga, the Gobardanga Municipality was apprised of its plants, in Bakharpur, the local panchayat was informed of the same. The respondents of Jhaudia were not sure whether the panchayat was involved at any stage of the installation process in their village or not.

Choice of location

This was a joint decision in Gobardanga (PHED & the Municipal authorities) and Jhaudia (PHED and some influential villagers, e.g., schoolteacher). However it was solely the decision of PHED in Bakharpur.

Treated water usage – in Bakharpur, there are three standpoints supplying the treated water from the plant, while in Jhaudia, there is only one. In Gobardanga, where about 60 – 70,000 litre of water is supplied per day, most of the respondents we spoke to, said they availed of this water. They used this water both for drinking, as well as cooking purpose.

Usage is limited in both Malda and Murshidabad for the following reasons:

(i) Irregular water supply

(ii) Inadequate flow of water

(iii) Presence of impurities, e.g., worms etc.(Jhaudia)

Moreover, since this water is available only during certain fixed hours (usually, 10 – 11.30 A.M. and 4 – 5 P.M.); this results in long queues, which act as a disincentive to drawing water from it.

Thus, we found only seven – eight families regularly using water from one tap in Bakharpur and around fifteen from the lone tap in Jhaudia. In the tail – end village of Masimpur, the water is available for only two hours a day – this creates a lot of pressure on the four taps supplying it. Thus, majority of the respondents avoids it, preferring to avail water from their own tubwell for drinking and cooking purposes. The few, who do avail it, use it only for drinking purpose. In most places, pond water was used for cleaning and washing purposes

Perceptions about treated water:

- Light water
- White water
- Not as tasty as regular tube well water

However, respondents were aware that tap water is free from arsenic. Moreover, the users pointed out that it has helped them get rid of common stomach problems (e.g. gas acidity etc.)

Plant O & M

These community plants require chemical closing, of which the respondents were unaware. However, we came to know of the following chemical dosing from the plant caretakers two of the sites:

i) Gobardanga – Potassium permanganate, bleaching powder and alum – daily basis.
ii) Bakharpur - Ferric chloride, bleaching powder

Caretakers have been appointed by PHED to take care of the respective plants. Apart from chemical dosing, they carry out plant back wash, usually once a week. Moreover, the Bakharpur caretaker claimed to collect water samples for periodic (usually, once a month) quality checks at the PHED lab in Malda. Chemicals required are supplied by PHED itself.

Waste water / Sludge disposal

The sludge is being stored in confined containers. It is proposed to be disposed by absorption through common aquatic plants, or cement based stabilization process.

Costs:

The entire installation, as well as maintenance costs, are borne by PHED. When we asked the respondents whether they would be willing to contribute towards its maintenance, several replied what they wouldn't mind pay Rs.1/- per month towards this end. However, they were categorical that for this to materialize, the following conditions will have to be fulfilled:

i) The water supplied must be 'clean'and free of impurities
ii) Regularity of supply should be ensured and quantum should be increase
iii) More number of taps should be set up, even deep into villages and spread out, so as to reduce the pressure per tap.

CONCLUSION

While PHED's forays into developing long-term solutions for the arsenic menace are commendable, the following needs to be noted:

i) Side by side with the Piped Water Supply Schemes, smaller and low cost projects, e.g., ARP attached to hand pump need to be further popularized, to provide immediate relief to the suffering population.

ii) Community involvement is absent at all the sites – for their success, PHED has to involve the community members at all the relevant stages- planning, implementation and maintenance. This will help to portray a friendly, human face of the Department, which is sadly missing at present. Towards this end, it would make sense to make the units more user-friendly, so that the O & M aspects can easily be taken care of by the local caretakers.

COMPARATIVE ASSESSMENT OF VARIOUS ARSENIC REMOVAL TECHNOLOGIES

COMMUNITY

	AGENCY / DESIGNER	SITE	STATUS	NO.OF FAMILI-ES USING	LEVEL OF ACCEPTA NCE / SATISFAC TION	COMMUN ITY PARTICIP ATION	CONTRI-BUTION		REMARKS
						COMMITE	O & M		
1.	AIIH & pH	SANDRA PAR	WORKING	18	LOW & DECLINI NG	EXISTS	FEMALE CARETA-KER LOOKS AFTER O & M	18 FAMILI S	NIL
2.	DO	GAIGH-ATA	NOT WORKING						COMMUNITY PARTICIPATION WAS NEVER INITIATED
3.	DO	BETAI	WORKING	24	MODERAT E	EXISTS	1 LOCAL YOUTH APPOIN-TED AS CARE TAKER LOOKS AFTER O & M	24 FAMILI ES CONTR IBU-TE , BUT IRREG UL-ARLY	
4.	PAL TROCK NER	SHER PUR	WORKING	100	HIGH	ON PROCE SS			

AGENCY / DESIGNER		SITE	STATUS	NO. OF FAMILIES USING	LEVEL OF ACCEPTANCE / SATISFACTION	COMMU-NITY PARTICIP ATION	CONTRI-BUTION		REMARKS
						COMMITTE	O & M		
5	PAL TROCK-NER	MOYNA	NOT WORKING	2	DIFFICULT TO ASSESS				COMMUNITY PARTICIPATION NEVER INITIATED.
6	B.E. COLL-EGE	SADPUR	WORKING	300 +	HIGH	COMMITTE EXISTS & FUNCTIO-NING SMOOTHLY	2 CARE TAKERS WORK IN SHIFTS TO DISCHA-RGE O & M DUTIES	300 FAMILIES CONTRIBUTE MEMBERSHIP FEE: RS.25/- MONTHLY SUBSCRIPTION : RS. 15/-	
7	DO	SANG RAMPUR	WORKING	200 +	MODE-RATE	FORMED, BUT NOT FUNCTIO-NING PROPERLY	2 CARE TAKERE APPOIN-TED		ILL-MAINTAINED UNIT LEADING TO USER DISSATISFAC-TION
8	DO	BETAI	WORKING	120	HIGH	EXISTS	LOCAL SHOPK-EEPER ACTS AS CARE TAKER	REGULAR USERS PAY MONTHLY SUBSCRIPTION @ RS.5/- 75 CASUAL USERS:50 P/ BUCKET	

AGENCY / DESIGNER		SITE	STATUS	NO. OF FAMIL-IES USING	LEVEL OF ACCEP-TANCE / SATISF-ACTION	COMMUN ITY PARTICIP ATION	CONTRI-BUTION		REMARKS
						COMMITT EE	O & M		
9.	APYRON	SHIBA-LAY	WORKING	2	LOW				DUE TO LOCATION ALL DISADVANTAGE (PVT. PREMISE), POOR ACCEPTANCE
10	DO	ADAH-ATA	WORKING	60	HIGH				
11	PHED	GOBAR DANGA	WORKING	WATER SUPPLIED TO 8	MODE RATE				ACTUAL NO DIFFICULT TO ASSESS, SINCE ITS PIPED WATER SUPPLY

				WARDS					SCHEME
12	DO	SUJAPUR	WORKING	NOT KNOWN	MODE RATE				SAME ABOVE
13	DO	JHAUDIA	WORKING	15 – 20	MODE RATE				
14	W.S.I	JOYPUR	WORKING	100	MODE RATE, PICK ING UP				
15	ION EXCHA NGE	NONA GHATA	WORKING	50 – 60	MODE RATE		LOCAL VILLAGE R APPOIN TED AS CARETA KER,O & M DUTIES SUPERV ISED BY COMP-ANY PERSON NEL		

NOTE: FOR 10, 11,12,13 & 15 - O & M TAKEN CARE OF BY THE iMPLEMENTING AGENCY.

COMPARATIVE ASSESSMENT OF VARIOUS ARSENIC REMOVAL TECHNOLOIES

DOMESTIC

Sr. No.	Agency/ Dealer	No. of units Installed	District	Level of acceptance	Remarks
1.	Paul Trockner	15	S-24 Pgs	Initially High, Gradually Decreasing	Leakage in the body and facing problem for back washing
2.	B.ECollege(Amal)	15	Malda, Murshida-bad and N-24 Pgs	High	Easy to operate compact and light
3.	AIIH & PH	15	N-24 Pgs	Initially High Gradually decreasing	Daily dosing is a major problem
4.	Jadavpur University	16	N-24 Pgs	Do	Weak supply chain for ,Filter reagent, Chemical etc.

MARKETING ISSUES

All the major companies manufacturing ARPs are primarily banking on the government, specifically, the PHED, for bulk orders for their community plants. At present, four of them, viz, Pal Trockner, Apyron, WSI and Amal (B.E. College) have procured trial orders as part of the Arsenic Mitigation Joint Action Programme of PHED and UNICEF. Besides, they expect to participate in the India-Canada Environment Facility - AIIH&PH sponsored Arsenic Mitigation Programme launched recently.

SALIENT FEATURES OF ARSENIC REMOVAL FILTERS (DOMESTIC)
(IRON POINT OF VIEW)

		No. of samples collected		Iron Content in mg/l					
Arsenic Removal filters	**No. of locations where introduced**	**Raw/Tubewell water (Having iron content >1.00 mg/l)**	**Treated water (after treatment of raw water having > 1.00 mg/l of Fe)**	**Raw Water**		Treated Water		**No. of Treated samples Having >1.00 mg/l of Fe**	**Max. Iron content in Raw Water removed by filters below 1.00 mg/l of Fe.**
				Max.	**Min.**	**Max**	**Min.**		
AIIH & PH	10	30	29	14.26	2.53	5.89	<.01	3	14.26
PALTROCKNER	10	26	26	22.60	0.10	5.38	<.01	12	13.92
AMAL	10	25	25	22.00	0.10	1.4	<.01	01	22.00
J.U (CSIR)	10	24	24	11.58	0.23	1.47	<.01	05	8.95

CHEMICAL ANALYSIS RESULTS OF HEAVY METALS
(SOURCE WATER FOR COMMUN1TY BASED PLANTS)
Results in micrograms per litre

Sl. No.	Sample No.	District	Block	Location	Name of the Plant	Al	Cd.	Cr.	Cu	Mn	Pb	Zn
1.	1	N.24 Parganas	Barasat-I	Joypur	WSI	19	1	3	2	817	Nd	416
2.	2	-Do-	-Do-	Sibalaya	AP1RON	34	1	5	Nd	1339	Nd	3
3.	3	-Do-	Amdanga	Adahata	AP1RON	59	1	5	Nd	1421	Nd	Nd
4.	4	-Do-	Gaighata	Amkhola	AIIH & PH	64	Nd	5	Nd	94	Nd	5
5.	11	S. 24 Parganas	Baruipur	Sardarpara	-Do-	88	Nd	10	1	924	40	125
6.	33	Nadia	Tehatta-I	Betai	-Do-	52	Nd	Nd	Nd	870	Nd	8
7.	26	N. 24 Parganas	Barasat-I	Mayna	Pal Trocknar	52	Nd	11	Nd	65	8	9
8.	25	-Do-	Bas1Rhat	Shibhari	-Do-	1721	Nd	11	Nd	36	Nd	9
9.	10	S-24 Parganas	Baruipur	Serpur	-Do-	75	Nd	8	6	204	4	43
10.	35	Murshidabad	Jalangi	Jaudia	PHED	19	Nd	1	Nd	760	2	35
11.	22	N-24 Parganas	Habra-I	Sabpur	Amal	67	Nd	7	Nd	74	Nd	7
12.	34	Nadia	Tehatta-I	Betai	Amal	29	Nd	1	Nd	385	4	27
13.	23	N-24 Parganms	Bas1Rhat-I	Sangrampur	-Do-	64	Nd	9	Nd	162	10	10
14.	8	N-24 parganas	Habra-I	Laxmipur	-Do-	91	Nd	8	Nd	Nd	Nd	5

Nd = not detected

CHEMICAL ANALYSIS RESULTS OF HEAVY METALS
(SOURCE WATER FOR DOMESTIC FILTERS)
Results in micrograms per litre

Sl. No.	Sample No.	District	Block	Location	Name of filter	Al	Cd.	Cr.	Cu	Mn	Pb	Zn
1.	5	N-24 Parganas	Gaighata	Amkhola	CS1R (ju)	76	Nd	7	Nd	141	Nd	5
2.	6	-Do-	-Do-	-Do-	-Do-	127	Nd	6	Nd	82	Nd	132
3.	21	-Do-	Habra-I	Shimulpur	-Do-	51	Nd	7	Nd	167	Nd	212
4.	65	-Do-	Deganga	Berachanpa	-Do-	75	Nd	5	Nd	1267	1	21
5.	66	-Do-	-Do-	-Do-	-Do-	78	Nd	5	Nd	446	Nd	363
6.	67	-Do-	-Do-	Uttar Kolsur	-Do-	9	Nd	6	Nd	258	Nd	3
7.	68	-Do-	-Do-	-Do-	-Do-	25	Nd	5	Nd	70	Nd	56
8.	69	-Do-	-Do-	-Do-	-Do-	41	Nd	7	Nd	1756	Nd	2
9.	70	-Do	-Do-	-Do-	-Do-	63	Nd	7	Nd	81	1	30
10.	71	-Do	-Do-	-Do-	-Do-	51	Nd	7	Nd	736	Nd	10
11.	72	-Do	-Do-	-Do-	-Do-	145	Nd	6	Nd	357	Nd	1
12.	24	-Do-	Bas1Rhat	Sangrampur	Amal	5	Nd	11	Nd	Nd	Nd	Nd
13.	36	Malda	Kaliachak –I	Kaliachak	-do-	24	Nd	2	6	894	5	562
14.	37	-Do	-Do-	-Do-	-Do-	24	Nd	2	6	894	5	562
15.	39	-Do-	-Do-	Uttar Dinajpur	-Do-	82	Nd	3	Nd	461	1	30
16.	41	-Do-	-Do-	Dakshin Laxmipur	-Do-	68	Nd	3	2	1427	6	197
17.	42	-Do	-Do-	-Do-	-Do-	37	Nd	3	Nd	978	8	75
18.	43	-Do	-Do-	-Do-	-Do-	40	Nd	4	3	1248	7	96
19.	44	-Do-	-Do-	Kaliachak	-Do-	18	Nd	4	3	840	10	192
20.	45	-Do	-Do-	-Do-	-Do-	28	Nd	6	Nd	1032	10	7
21.	48	-Do-	-Do-	Jalalpur	-Do-	38	Nd	8	Nd	110	9	91
Sl. No.	**Sample No.**	**District**	**Block**	**Location**	**Name of filter**	**Al**	**Cd.**	**Cr.**	**Cu**	**Mn**	**Pb**	**Zn**
22.	49	Murshidabad	Barhampur	Khagra	-Do-	26	Nd	8	Nd	113	5	567
23.	12	S-24 Parganas	Barulpur	Chandrakhali	Pal Trockner	67	Nd	9	2	706	8	34
24.	13	-Do-	-Do-	Shakharipukur	-Do-	34	Nd	10	1	665	7	65
25.	14	-Do	-Do-	-Do-	-Do-	13	Nd	11	Nd	364	Nd	198
26.	29	-Do-	-Do-	Barulpur	-Do-	43	Nd	1	2	1002	Nd	94
27.	31	-Do-	-Do-	P.Mallickpur	-Do-	34	Nd	1	Nd	1156	Nd	150
28.	38	-Do-	Do-	Barulpur	-Do-	25	Nd	1	25	247	Nd	201
29.	60	-Do-	-Do-	Dhabbhabi	-Do-	47	Nd	2	Nd	276	2	117
30.	61	-Do	-Do-	-Do-	-Do-	73	Nd	3	Nd	786	4	134
31.	62	-Do	-Do-	-Do-	-Do-	280	Nd	3	Nd	678	3	146
32.	63	-Do	-Do-	-Do-	-Do-	280	Nd	3	Nd	678	3	141
33.	64	-Do	-Do-	-Do-	-Do-	85	Nd	4	Nd	725	1	13
34.	15	N-24 Parganas	Habra-I	Laxmipur	All & PH	40	Nd	10	Nd	41	7	41
35.	9	-Do	-Do-	-Do-	-Do-	180	Nd	9	Nd	5	Nd	Nd
36.	16	-Do	-Do-	-Do-	-Do-	46	Nd	11	1	56	2	25
37.	17	-Do	-Do-	-Do-	-Do-	40	Nd	11	Nd	59	5	91
38.	20	-Do	-Do-	-Do-	-Do-	64	Nd	10	Nd	129	1	24
39.	52	-Do	-Do-	-Do-	-Do-	38	Nd	10	Nd	150	9	128
40.	56	-Do	-Do-	-Do-	Do-	44	2	1	12	140	3	40
41.	57	-Do	-Do-	-Do-	-Do-	54	Nd	2	Nd	283	12	25
42.	58	-Do	-Do-	-Do-	-Do-	38	Nd	2	3	254	8	323
43.	59	-Do	-Do-	-Do-	-Do-	52	Nd	3	Nd	110	3	18

Manganese content of treated water incase of Pal Trockener treatment plant and Domestic Filter

.Sr. No.	Sample No.	Location	Type of Plant/Filter	Manganese content (micro gram/ L)
1.	10 T	Serpur	Community	407
2.	25 T	Sibhati	do	602
3.	26 T	Moyana	do	nd
4.	12 T	Chandokholi	Domestic	8
5.	13 T	Sakharipukur	do	34
6.	14 T	Sakharipukur	do	9
7.	29 T	Baruipur	do	66
8.	31 T	P. Mallickpur	do	766
9.	32 T	Baruipur	do	nd
10.	60 T	Dhabdhabi	do	4
11.	61 T	do	do	28
12.	62 T	do	do	1110
13.	63 T	do	do	30

Appendix-13

RESULTS OF BACK WASH SAMPLES

COMMUNITY BASED

Sl.No.	Lab.No. Almg/L	Type	Location	Dist	Fe mg/L	Asmg/L	
1	1B 0.21	WSI-C	JOYPUR	N24pgs.	0.56	0.184	
2	3B 0.22	APIRON-C	ACHATA	N24pgs.	28.02	1.36	
3	7B	PHED-C	GOBARDANGA	N24pgs.	0.18	0.78	0.1
4	8B 0.121	AMAL-C	LAXMIPUR	N24pgs	0.18	0.02	
5	10B	PT-C	SERPUR	S24pgs.	32.54	1.11	
6	11B 0.095	AIIHPH-C	SARDARPARA	S24pgs.	1.8	2.52	
7	23B 0.065	AMAL-C	SANGRAMPARA	S24pgs.	4.18	0.035	
8	33B 0.056	AIIHPH-C	BETAI	NADIA	2.52	0.01	
9	34B 0.03	AMAL-C	BETAI	NADIA	0.38	1.89	

DOMESTIC BASED

SI.No.	Lab.No. Almg/L	Type	Location	Dist	Femg/L	Asmg/L
1	9B 0.198	AIIHPH-D	LAXMIPUR	N24pgs.	0.14	0.005
2	12B	PT-D	CHANDOKHALI	S24pgs.	32.54	0.15
3	13B	PT-D	CHANDOKHALI	S24pgs.	21.9	0.03
4	14B	PT-D	SAKHARIPUKUR	S24pgs.	22.04	0.025
5	26B	PT-D	MOYNA	S24pgs.	9.02	0.16
6	28B	PT-D	BARUIPUR	S24pgs.	2.06	0.005
7	29B	PT-D	BARUIPUR	S24pgs.	33.28	0.005
8	30B	PT-D	BARUIPUR	S24pgs.	3.48	0.005
9	60B	PT-D	BARUIPUR	S24pgs.	21.6	0.03
10	61B	PT-D	DHABDHABI	S24pgs	29.5	0.131
11	62B	PT-D	DHABDHABI	S24pgs	14.22	0.016
12	63B	PT-D	DHABDHABI	S24pgs	22.04	0.005
13	64B	PT-D	DHABDHABI	S24pgs	4.98	0.005
14	36B 0.024	AMAL-D	KALIACHAK	MALDA	0.2	0.005
15	41B 0.072	AMAL-D	D.LAXMIPUR	MALDA	0.174	1.4
16	42B 0.038	AMAL-D	D.LAXMIPUR	MALDA	0.62	2.04
17	65B 0.082	CSIR(JU)D	BEHRACHAMPA	N-24pgs.	4.98	0.01
18	66b 0.088	CSIR(JU)D	BEHRACHAMPA	N-24pgs.	0.44	2.23

PT: PAL TROCKNER C= Community basic plants
D= Domestic filter.

Appendix-14

CHANGES IN CHEMICAL PARAMETERS CON SEQUENT TO PUMPING AT MOYNA, NORTH 24 PARGANAS

Pumping well:

Sl.No.	Hours As mg/	Date	Location	E.C.	pH	Cl mg/L	Fe mg/L
1	12.30 0.214	19-03-2001	MOYNA	772	7.42	21	10.28
2	1300 0.21	19-03-2001	MOYNA				10.36
3	1330 0.21	19-03-2001	MOYNA	773	7.41	19	10.14
4	1400 0.21	19-03-2001	MOYNA				10.26
5	1430 0.214	19-03-2001	MOYNA	775	7.43	19	1018
6	1500 0.21	19-03-2001	MOYNA				10
7	1530 0.22	19-03-2001	MOYNA	776	7.43	21	10.04
8	1600 0.2	19-03-2001	MOYNA	776	7.44	21	10.02

MAIN WELL:

Location	Moyana
Block	Barasat-I
District	North 24 Parganas
Pumping Well	Irrigation Well
Owner	Mr. Dewan sarif
Pump	5HP Centrifugal Pump
SWL	5.6 mbgl
Duration of Pumping	210min.
Discharge	6.71ps=24m3/hr=405.3lpm.
Draw Down	0.87m
Recuperation	0.752 in 30min.

OBSERVATION WELL:

	Domestic
Owner	Mr. Gopal ch. Biswas
Depth	130 ft
SWL	5.79 mbgl
DD	0.235 mafter 210 min.
Distance of MW&OW	17.2m
Recuperation	0.12in 30 min.

VALUES OF IRON AND ARSENIC OBTAINED DURING COMPARISON OF SELECTED ADSORPTION MEDIA UNDER CONTROLLED CONDITION

FLOW RATE 43 L/H(APPROX)

SL.NO.	TIME	DISCRIPTION	LOCATION	Fe mg/L	As mg/L
3	1230PT		DHABDHABI 0.89	0.258	
4	1230	AMAL	DHABDHABI 0.75	1.32	
5	1230	ALCON	DHABDHABI 0.23	0.373	
6	1300PT		DHABDHABI 0.78	0.248	
7	1300	AMAL	DHABDHABI 1.52	1.47	
8	1300	ALCON	DHABDHABI 0.36	0.476	
9	1330PT		DHABDHABI 0.62	0.229	
10	1330	AMAL	DHABDHABI 2.25	1.27	
11	1330	ALCON	DHABDHABI 0.89	0.476	

FLOW RATE 36 L/H (APPROX)

12	1430PT		DHABDHABI 0.63	0.165	
13	1430	AMAL	DHABDHABI 0.5	1.6	
14	1430	ALCON	DHABDHABI 0.18	0.245	
15	1500PT		DHABDHABI 0.74	0.176	
16	1500	AMAL	DHABDHABI 0.55	1.465	
17	1500	ALCON	DHABDHABI 0.31	0.293	
18	1530PT		DHABDHABI 0.56	0.189	
19	1530	AMAL	DHABDHABI 0.39	1.4	
20	1530	ALCON	DHABDHABI 0.22	0.304	

FLOW RATE 14 L/H (APPROX)

21	1630PT		DHABDHABI 0.5	0.14	
22	1630	AMAL	DHABDHABI 2.06	1.2	
23	1630	ALCON	DHABDHABI 0.44	0.474	
24	1700PT		DHABDHABI 0.51	0.176	
25	1700	AMAL	DHABDHABI 2.39	1.18	
26	1700	ALCON	DHABDHABI 0.47	0.462	
27	1730PT		DHABDHABI 2.03	0.204	
28	1730	AMAL	DHABDHABI 1.99	1.16	
29	1730	ALCON	DHABDHABI 10.37	0.372	

PT. Pal Trockner (granulated ferric hydroxide)
Amal: Oxide India limited (activated alumina)
Alcon: Activated Alum

PR

C. 2000/OPP

NC/IND/99/967

Report on Financial Appraisal of Action Programmes on Alternate Technologies

Prepared under the Project

Concerted Action on Elimination/Reduction of Arsenic in Ground Water, West Bengal, India

Prepared by: K S R N Sarma

Executed by: United Nations Industrial Development Organization

New Delhi
AUGUST, 2001

Concerted Action on Elimination/ Reduction of Arsenic in Ground Water, West Bengal, India (Volume II)

Contributions:

Don Ratanayaka- Water treatment and Technology.

CGWB (Easter Region) – Water Quality Analytical work.

Development Consultant Group – Socio-economic, Training & Privatization issues.

K S R N Sarma – Financial Appraisal

Financial Appraisal of Action Programmes based on Alternative Technologies

Introduction

The quality aspects of community water supply schemes in India have of late received considerable attention of the policy planners at the National as well as at State levels. Urgency is felt for major initiatives in the matter, particularly for maintaining the desired quality standards in rural water supply schemes as recent investigations revealed increasing contamination of their principal source viz. ground water in many parts of the country. The levels of toxics in ground water such as arsenic, fluoride, salinity and iron are observed to be going up at alarming rates. Search is on to find appropriate technologies to control and minimize their adverse impacts. A case in point is the efforts initiated in recent years by the Government of West Bengal to combat the problems posed by the high levels of arsenic found in ground water in wide tracts spread over as many as eight districts viz. Malda, Murshidabad, Nadia, North 24 Paraganas, South 24 Paraganas, Hugli, Haora, and Bardhaman. Action programmes were initiated for provision of arsenic free water for domestic use on three planks (i) Digging deep tube wells to tap arsenic free aquifers at depths and pump that water to reach the domestic clients (mostly through public stand posts). (ii) Installing Arsenic Removal Plants (ARPs) at community hand pumps (iii) Encouraging the households to purchase and use Domestic Arsenic Removal Filters (DARFs) Under strategy planks (ii) and(iii), a number of arsenic removal technologies are being tried at selected locations on experimental basis. Need is generally felt for having an objective assessment of the approaches and technologies to help the choices in their regard for formulation of perspective plan for future development. Hence the genesis of the UNIDO aided project on 'Concerted Action on Elimination/Reduction of Arsenic in Ground Water – West Bengal, India'. The terms of reference of the project required, inter alia evaluation of present action programmes from a number of techno-engineering and other angles. Present study is part of those evaluations. It is focused mainly on aspects relating to finance. The first part of study attempted to determine the costs of provision of arsenic free water using different technologies under different strategy planks and in the second the scope for cost-recovery under alternative action programmes is discussed.

The setting

The Experts Committee Constituted by the Government of West Bengal in 1992 (Chairman : Dr S.P. Sinha Ray) to investigate into the problem of arsenic contamination of ground water, found that the tracts affected in the above mentioned eight districts covered in all 3113 rural habitations (1312 Mouzas), 15 non-municipal areas and 9 municipalities. The population living in these areas, according to the 1991 Census, is 12.6 million and of whom 92 percent are from the rural habitations. Further it is observed that and out of the above population, 5.32 million are highly exposed to health risks such as arsenicosis. It may be pertinent to mention here that from the First Five-Year Plan on wards, extension of safe water facilities in the rural areas has been one of the priority thrusts of development efforts in the country. Towards that end two major schemes have been in operation in the state quite for some time now. These are; State sector's Minimum Needs Programme and Central Government-sponsored, Accelerated Rural Water Supply Scheme. Emphasis under these schemes all along has been on physical extension of coverage. Quality aspects till recently, however, do not seem to have received due attention. Ground water is generally assumed to be a safe and hand pump, because of its low capital investment requirement, has been adopted as the principal vehicle. Even so, the progress of rural water schemes is generally found to be very slow. Till the end of November 2000, only 74 percent of the rural habitations in West Bengal could be fully covered under community water supply facilities and rest 26 percent were only partially covered. The accomplishments compare poorly even with All India Averages. The observed positions with regard to the latter are 84.5percent fully covered villages; 13.7percent partially covered; and 1.7 percent non-covered under community water schemes. Efforts, therefore, need to be considerably stepped up. Now a double urgency in the matter has arisen with the investigations revealing contamination of ground water. In shaping the future plans two factors may, however, be given due cognisance. First is that huge investments have already been made in setting up hand pumps/ tube wells in the affected areas, they may not be discarded without exploring fully all the alternatives for their continued usage. Second is the predominance of small size rural habitations in West-Bengal. According to the 1991 Census, 35.54% of rural habitations in the state have population less than 500; 24.34% have population in the range of 500-999; and 21.22% have population in the range of 1000-1999. (vide Table 1 in Appendix A)An inference that could be drawn from this position is that at least some time to come, the hand pumps may still have to be relied upon for extension of water supply facilities to the rural habitants. While still on the subject of role of hand pumps, some interesting observations in their regard from the recent report of National Sample Survey may be stated. First is that 78.42 percent of rural households in the state of West Bengal depend upon hand pump/tube well, as the principal source for meeting their drinking water requirements (column 13 of Table 2 in Appendix A). Out of these households 72 percent draw their daily water from the hand pump/tube well located outside their

residential premises (community facility). The second observation is that 70.5 percent of households that relied on hand pump/tube well for meeting their drinking water requirements draw water from that source for cooking as well. However, for bathing and washing utensils, majority of rural households in the state are observed to prefer local tank and pond water. (Table 3 in Appendix A). A third observation is that a very few households are found to filter, chemically treat or boil their drinking water. (Table 4 in Appendix A). An inference that could be drawn from these findings is that, since ground water drawn through hand pump is used by the households primarily for purposes of drinking and cooking only, the state government is advised to go about in establishing the facilities for arsenic removal from ground water in phased manner. .In the initial phase the treatment facilities may be installed on a limited scale. to supply 40 litres of arsenic free water to household per day. This should suffice to meet its requirement for drinking and cooking.

Deep Tube Wells:

Digging deep tube wells is one of the options that could be pursued for provision of arsenic free water to the domestic users. Some strongly recommend the proposition on two counts. First is that it would facilitate the provision of water to large number of clients from a single location and this in turn, helps inter alia, to keep a close tab on the quality of service provided Second is that since water is supplied with some pressure, the clients need not have to wait for long duration in a queue to collect their daily requirements. As against these advantages claimed, there are many arguments advanced against the proposition. Foremost is that it would involves huge capital investments. From the data given in col 8 of table in Appendix B, it may be seen that the installation of a deep tube well calls for an initial investment of about Rs1.1 million. A unit can serve about 10-12 thousand population. The capital investments work out to Rs.9000-10000 per capita. In case all the hand pumps in the arsenic affected areas are to be replaced by the piped water supply from deep wells, the capital investments required would be of the order of Rs12600 million. It is highly doubtful whether the state government would be in a position to mobilize funds of this order to a sectoral programme and that too, to the one intended to benefit 7.8 percent of State's population. Even one were to assume that funds of such high order would some how be mobilized, it might take years to execute piped water schemes and commission them. A major hurdle here is locating the aquifers of adequate size at central locations. It may be seen from Col.7 of the table under reference, that out of the eight deep tube wells covered in the sample study, only in the case of three the water supplied is observed to meet the per capita norm of 40 litres per day. In the case of three viz, Kantanagar, Mithipur and Chhaygham, the per capita daily supplies are observed to be as low as 6.7 litres, 14.00 litres and 16.38 litres respectively. Progress in the execution of deep wells could be tardy also on account of the lengthy procedures that are to be usually to be followed in the execution of large civil works, non -cooperation from contractors etc. Here it may be mentioned, that against an allocation of Rs.700 million proposed for the rural water supply under the State's MNP for the year 2000-2001, the amounts released were only Rs 379.987 million and expenditure actually incurred was Rs.304.056 million (i.e. 35% of the allocation). Similarly under the Accelerated Rural Water Supply Scheme of the State, as against an allocation of Rs.789.5 million up to the end of 2000, expenditure incurred was just Rs 260.162 million (32.95% of allocation)*

A frequent complaint against the piped water supply schemes of the rural areas is that the villages at the tail end of the systems hardly get any water. Electricity/ Diesel, required to run the motors to pump the water are items that are often in short supply. Whenever there is a disruption in their availability, water supply gets affected. Irregular supply is another frequent complaint against several piped water supply schemes.

Now the examination may be turned to compare the costs under each of the 8 deep tube wells covered in the sample study. The expenditure (costs) presently incurred for providing 100 litres of water are given in column 15 of the table. It may be seen that the amounts vary from 0.86 in the case of Natra unit to Rs 7.27 in the case Kanta nagar unit. The monthly charges that a household has full cost recovery are given in column 18 of the table. The lowest amount is Rs74.75 in the case of Natna Unit and the highest is Rs245.01 in the case of Iswarachandrapur.

A proposal under the Central government sponsored Accelerated Rural Water Scheme, is that water charges may be so fixed as to recover from the direct beneficiaries only 10% of the capital costs and full amount of the O & M expenditures. The charges that households have to pay as per this proposal are given in Col. 19 of the table. These again are found to vary considerably across the units. The lowest is Rs 10.91 in the case of Natna unit and the highest is Rs.48.41in the case of Iswarachandrapur unit.

*Annual Administrative Report, Min of Rural Development, Govt. of India. 2000.

Community Arsenic Removal Plants (ARP)

The strategy of installing ARP at the community hand pump for provision of arsenic free water is strongly advocated on the ground that it involves relatively very low initial (capital) investment (say in comparison to the amount required for digging a deep tube well). As already explained in the earlier paragraph, considerable investments have already been made in setting up community hand pumps, and most rural households in the State are observed to be drawing water from them for meeting their drinking and cooking requirements. Additional investments that are required are only for the acquisition of ARPs and their installations. Another advantage of the proposition is that the installation and commissioning of ARPs do not take much time and so the benefit-flows from the investments are almost immediate. The operation of community ARP does not require high technical skills and the community volunteers could be trained to perform the tasks of a caretaker. This incidentally would save a lot of botheration to the government in appointing personnel, paying their salaries supervising their work etc. The beneficiary communities could be easily persuaded to take over the responsibilities of eventual operation and maintenance. As against these advantages, one major problem anticipated is the conducting of periodic quality control inspections. Then there is the need for arrangements to attend to the repairs etc. Thus even in the event of concerned community agreeing to take over the routine operation responsibilities of their of ARP, government would still be duty bound to maintain a well equipped water testing laboratories, appoint Inspectors to conduct the regular quality control checks and Mechanics to attend to the repairs.

Now we may proceed to the estimation of costs of provision of arsenic free water from ARP plants employing different technologies. The technologies that are being put on test at present are (i) Amal (Bengal Engineering College), (ii) Paltrockner (iii) WSI (iv) Apyron (v) Ion Exchange (vi) AIIH&PH and (vii) PHED. With a view to facilitate the comparisons two uniform norms have been adopted. First is cost per 100 litres of supply and the second is the costs of provision of a minimum of 40 litres of arsenic free water per day to a family. As already explained earlier, a supply of 40 litres per day should be adequate to meet a family's need for water for drinking and cooking. It is assumed that an ARP plant would be installed to serve 50 families only, so that they are ensured of above mentioned quantity of supply and also could easily be organized into water committees to look after their ARP. The details of estimation of costs** under different scenarios are

---

**The assumptions made with regard to the 'discounting' in cost calculations are as under.

i) In the case of capital expenditures the discount rate is 12 percent per annum.

ii) In the case of O&M expenditures the replenishment expenditure is incurred at the beginning of the year/period and in the case of other items of O & M the expenditures are incurred in the middle of the year. The discount rate applicable in their case is one percent per month /part of it.

iii) Costs of stoppage of service due to break downs, annual maintenance, sludge removal etc, are not taken into reckoning. Only a mention about them is made.

---

given in the Tables 1-7 in Appendix C. Table8 of the Appendix C gives a comparative picture of unit-costs and also the monthly charges that a client household has to pay for availing 40 litres per day of arsenic free water. From column14 of that table it may be seen that lowest cost per 100 litres of supply is Rs 3.75 in case of Amal unit and the highest is Rs29.10 in the case of Apyron unit. The monthly charges that a household has to pay for availing daily 40 litres of arsenic free water are given in col 11 . Here again the lowest is Rs45.05 in the case of Amal unit and the highest is Rs 350.94 in the case of Apyron unit. When the expenditures on account of capital component and replenihment are born by government the monthly charges are observed to come down significantly as could be seen from col 12. Here the lowest is Rs23.35 in case of Amal unit and the highest is Rs 144.68 in the case of Apyron unit. The charges that households have to pay in the event of their community organisations taking over the responsibilities for routine operations are given in col13. The lowest charge Rs8.34 is in the case of Amal unit and the highest Rs39.95 in case of Ion Exchange unit.

Domestic Arsenic Removal Filters (DARF)

The strategy that emphasize the use of domestic filters by the households for obtaining arsenic free water is quite different from the earlier discussed deep tube well and ARP strategies. It is 'household' centered, where as the other two are based on the 'community' approach. It expects the market-forces to play a major role in the realization of the objective set, whereas in the earlier mentioned strategy planks, the responsibility for effectuation of the objective is assumed to be entirely that of the government. Under the domestic filters strategy the role envisaged to government is largely that of a facilitator. It of course, is expected shoulder

major responsibilities in regard to extension work among the potential purchasers of domestic filters- educating them about the advantages that could accrue to them from a domestic filter, helping them in conducting assessments about the technical efficiency, informing them about the prices of different models etc. The government is also expected to mobilize efforts on two other fronts. First is to encourage the entrepreneurs to set up manufacturing facilities for domestic filters and market them in large numbers. For, competition is the sure way to ensure the best value for money to the clients. The second is that the government may have to establish suitable regulatory mechanisms for conducting periodic tests and ensure the quality of water produced by domestic filters and that vendors of filters do fulfil all the obligations promises that they made as part after sales service..

Major advantage of the domestic filter is that a householder need not have to wait in a queue for long hours at a public stand post of deep tube well or community ARP unit to collect his/her daily requirement of water. The required arsenic free water could be collected from the filter whenever needed. The water from the household's own source i.e. hand pump/dug well could used as the input.

The biggest roadblock to the strategy, however, is making households to mobilize 3 to 4 thousand rupees for the purchase of a filter. Not that many of them do not have the required economic capacity, but the matter is more to do with their mind set -. willingness to spend that much of money on a water filter. Published data on household expenditures of 'Below Poverty Line' families indicate that many among them purchase durable assets such as bicycle, colour T.V. wrist watch, radios and electric fan (Table 6 in Appendix D). It is true that all along rural households are accustomed to get free water supply from government facilities and it would not be easy for them to come out of that mind set. It would require considerable amount of extension work by government; voluntary agencies to convince them about the advantages that could accrue to them from 'domestic filters'. The vendors may also have to adopt considerable amount of ingenuity in their marketing approaches. To help the poorest among the rural poor, government may consider giving them some price subsides or introduce loan schemes on easy terms. The past experience, however, indicates that in all such schemes, the best results are obtained when community based approach' is adopted rather than the ones that try to reach the subsidies/loans directly to the individuals. These approaches may preferably be further modified to meet location specific conditions.

At present domestic filters employing four different technologies are under experiment. These are filters developed by Bengal Engineering College (Amal), Paltrocknor, AIIH&PH and Jadavpur University. The total costs that a consumer has to bear during the economic life (5years) of a filter are worked out and given in Table 1 of Appendix D. The unit developed by the AIIH&PH is observed to be the cheapest.. But then one also has to take into consideration the cumbersome processes that its use involves. Many consumers may not like to use iton that count. This leaves the choice to other three. Here Amal filers seems to have gone in for aggressive marketing. It is reported that its agent viz Exide India has already sold a couple of hundreds of them. Most of its clients belong to the educated and economically better off sections of the society. The socio-economic profiles of the users of domestic filters of all the four makes based on sample surveys are given in tables 2 to 5 of Appendix D. It is observed that their average household size is 6.1; in the case of Hindu households it is 5.4 and in the case of Muslim households it is 6.8. Nearly 60 percent of the clients are high school and above educated. The average monthly income clients of Amal filters isRs10466.67; Paltroknor's clients is Rs7566.67; AIIH&PH's users is Rs4166.67 and that of the users of Jadavpur University filter is Rs2010. While Amal and AIIH & PH filters were sold to clients with no subsidy, the buyers of Paltrockner received a 50 percent subsidy and Jadavpur filters were supplied free of cost.

Cost comparisons over the three Strategy Planks

Two benchmarks have been adopted for purposes of inter strategy/plank cost comparisons. First is the capital investment required per client served and second is the cost per 100 litres of supply. As regards per client capital investments they are observed to be around Rs 1000 in the case deep tube wells. In the case of community ARP the per capita investments are observed to differ significantly over the technologies employed. The lowest figure Rs48 is in the case of AIIH&PH unit and the highest Rs 1312 is in the case of Apyron Unit (vide col 15 of table 8 of appendix C). The per capita investments in the case of domestic filters are also observed to differ significantly. In case of Amal it is around Rs 330; in the other cases they are -Paltrockner Rs 700 (10 litres)and Rs 900 (30 Litres); AIIH&PH Rs 10 and Jadavpur Rs 120. Turning to the cost per 100 litres of supply they are observed to range between Rs 0.86 to Rs 7.27 in the case of deep tube wells (average around Rs 2.63) The per 100 litres cost in the case of community ARP vary from Rs 3.75 in the case of Amal to Rs 29.25 in the case of Apyron. In the case of domestic filters the cost per 100litres is Amal Rs 5.80; Paltrockner Rs 9,26; AIIH&PH Rs 3.17 and Jadavpur University Rs 3.50.

Cost Recovery

It is held by many that for ensuring speedy and sustained development of a public service it is essential that full cost recovery is effected from its direct clients. An incidental advantage of the proposition is that it would help to improve efficiency and accountability in service delivery. In the case of a basic service such as water supply, it is generally agreed that tariff fixation has to take into cognizance not only revenue and efficiency objectives but also the equity aspects as well.. It is to be noted that the paramount consideration in provision of water supply under public auspices is to ensure that all sections of the population have a fair access to this essential service. Certain minimum quality and quantity of water are reached to all sections to help them to maintain good health and well being. No citizen is priced out from availing the socially desirable minimum level of service. All these would no doubt make the water supply tariff fixation an exacting exercise to accomplish. Delicate balancing may have to be arrived at to steer clear conflicting considerations. Once the level of tariffs to be recovered from the clients is estimated, then the next step is identify the right vehicle/s for revenue raising. These vehicles need chosen carefully to suit to the administrative convenience. A multi part differential tariff structure is therefore, generally suggested to be adopted. Such tariffs are relatively easy to adopt in an urban setting because the clients there comprise besides domestic users, industrial, commercial and institutional users with good paying capacities. Differential pricing and cross subsidization are not difficult to adopt in a rural setting because the clients of rural water supply schemes are all domestic users. The charges, have to be uniform and preferably in the from of periodic payment say monthly payment per family (irrespective of its economic status and the amount of water drawn). This being the framework, the moot point for consideration is how one could go about fixing the rural water supply tariffs.

The exercises here has to take into reckoning not only the costs of service provision, but also two other factors viz. `affordability' and `willingness to pay' of the clients. `Affordability' is the term associated with the clients' paying capacity and it is usually expressed as a certain percentage of the monthly income. It gives an idea of the amount that a client can easily spare for availing the service, without adversely affecting the consumption levels of other essential items. There are two major data sources that one could rely upon to for estimation of affordability' of clients. First is the data about poverty brought out by the Planning Commission. According to the recent estimations the poverty level applicable to the rural population of West Bengal is Rs 350.17 per capita per month in 1999-2000. The population below the poverty line in the state is 18.011 million and they constitute 31.85%of the total. Assuming that the average size of family to be 5,then all families with monthly income of Rs 1750.85 and below could be taken as poor. If one adopts this household income level as standard and assume 1.5 percent of it as the `affordability' level towards water supply service availed, then nearly 70 percent of rural households should be in a position to pay easily about Rs 26.per month towards that service.

The second data source that could be utilized for determining the affordability levels is the household expenditure data from the National Sample Survey. The data about per thousand distribution of rural households in the state of West Bengal according to their per-capita monthly expenditure classifications (compiled in 54th Round of NSS Jan-June 1998) are given in Table 1 in Appendix E. The tables2 &3 indicate the amounts that families in different expenditure classifications spend on such non-essential and health injuring items such as `pan', tobacco and intoxicants. Table2 gives the All India position and Table 3 gives the position in the case of rural household of West Bengal. From the data given in these tables one could take the families in per capita expenditure classification of Rs 265-300 as the representative ones (there are only 38% of the households which have per-capita expenditure levels below that level). The amounts that the families are observed to be spending on above mentioned non-essential items is Rs 10.62 per capita per month i.e. a family is spending about Rs 53 per month on these items. Even if we take half of it as the affordability level for the water supply service availed, then it again works out to Rs 26 per month. The families in the lowest per capita expenditure classification i.e. Rs 0-120 per month are observed to be spending on pan, tobacco and intoxicants about Rs 3.2 per capita per month i.e. Rs 16 per the family per month. From the above accounts one could safely assume, that `affordability' to pay for water supply even in the case of lower income classes of rural households in West Bengal is about Rs 16 per month.

Willingness to Pay:

The term 'Willingness to Pay' in the present context refers to the amounts that clients would be paying on their own voluntarily and not under any external pressure/ compulsion. Since water is basic human need, the demand for it for domestic use is highly price inelastic in certain quantity ranges. People would be readily paying very high prices for water when it has to be purchased from a private vendor, when there is apprehension about its short supply or discontinuation. But once the public authority ensures adequate level of service, then one often notices sea change in peoples' attitudes.. They demand the service as a matter of

right and assume that government is duty bound to provide the service free of cost. It is these perceptions that have to be first changed for any cost recovery scheme to be successful. Fore most to be done is extensive education among water supply clients. Make people aware of the benefits that could accrue to them by consuming safe water and following hygienic waste disposal, the long-term consequences of subsidized provision of the service, low level of investments in the sector etc. Involving non-governmental agencies could be very effective in educating the clients. In addition there is a need to organize the local communities and get them involved in various stages of decision making, in planning execution and operation of water facilities in their respective localities. Informal associations and per functionary consultations might not be of much help. The committees of the clients should be formal bodies and they have to be bestowed suitable powers to take decisions about ways they would like to operate in maintaining their community water facility, finance its operations etc. One may emulate the example set-by Kerala with regard to the rural water supply schemes. The social surveys conducted in some of villages where the ARPs are installed throw valuable clues as how community organisations could be made to more effective. We cite the case of Nonaghata village (Nadia district) here to explain as how informal community organisations operate. This village is located in an area that is severely affected by the arsenic contamination of ground water. It is reported that there were more than 200 cases of arsenic affected people in that village. The local youth took initiative, made several representations to the higher authorities and finally got a community ARP of Ion Exchange technology located in their village. But once that unit is installed their enthusiasm seems to have waned. The company installed the Plant free of cost and is also presently meeting its O&M expenditure. It cannot be expected to do so in perpetuity. No thought seems been given at the time of Plant's installation as to who would take over the responsibility for its eventual operation and where from the finances required for it would be mobilized. This position may be compared with one obtaining in the three villages where the Amal plants are located. In these villages the NGOs who played major role in getting the ARP units installed, took care to involve the client communities right from the inception, in deciding about the location of the plant, who would look after the operation and maintenance and most importantly about the ways to finance the operations. The decisions with regard to financing and the charges to be collected from members were taken much before the plant's installation. The arrangements agreed to were on formal basis. In Sadhupur as many as 300 households are contributing to water collections from ARP at the rate of Rs 15 per month (to fully meet the O&M. Expenses of the plant). In Khaddar about 70 families are paying at the rate of Rs 0.50 per bucket and 34 families are paying monthly contributions to their Water Committee. The Water committees formed to run these plants take decisions not only in respect of water charges but also on matters such as appointment of care- takers and the salary to be paid to them. The arrangements are reported to be working fairly satisfactorily in the above mentioned places. The point for consideration, therefore, is when community organizations could be effective in above two villages, why not they made to be so in other villages.

Matching costs and water charges:

Working out affordability positions and putting institutional arrangements for collecting the revenues is only one part of the exercise, the second and equally important task is to match the costs with the charges that the clients could afford/willing to pay. This may entail some major policy decisions and exploring the ways by which the expenditures to be recovered from clients are brought down. Though one would not like the government to heavily subsidize the service, but since it has been providing the service all along almost free, the withdrawal of subsidies may be effected in a phased manner. This is necessary to control and minimize the political backlash. A major O&M expenditure in the case of community based ARPs is the one on periodic replenishment of the media. In the initial phase government may agree to bear capital as well as the replenishment expenditures. Staff salaries is another major item of O&M expenditure. Community volunteers could be trained to operate the systems and this would help to bring down the expenditure to be recovered through the charges still further. Another suggestion is that the dealers who get substantial margins from the manufacturers of the equipment for vending their wares may be persuaded to take care of some responsibilities with regard preventive maintenance for certain period after the sale. This also helps to lower the water charges.

Conclusion:

In conclusion some of the points emerging from the examinations in the foregoing may be briefly recapitulated. The estimations of costs of provision of arsenic free water indicate that they differ significantly not-only across the strategy planks, but also within the strategy planks according to the technology employed for the purpose of arsenic removal. Though cost is an important consideration, the perspective plans for extension of facilities for provision arsenic free water to the households in the affected areas cannot be guided by financial considerations alone. Equally important are the considerations with regard to reliability of the service technology, clients' convenience, and their willingness to pay. If one were to go by

the funds needed for initial capital investments, the strategy of deep tube wells does not appear to be a proposition that can be pursued extensively. Apart from the difficulties in mobilizing the needed capital funds, it is not easy to locate the arsenic free aquifers of sufficient size to meet the requirements. Similarly the strategy of Domestic Filters may have to over come the major obstacle of clients' unwillingness to spend a large sum of Rs 3-5 thousand for the purchase of those units. It is learnt efforts are presently on to bring down the prices of the filters to less than Rs 1000. In that event, the strategy of domestic filters may prove to be the best among the alternatives. Till that time the reliance has to be placed mainly on community ARPs for provision of arsenic free water. In order to effect cost recoveries, a pre requisite is the setting up formal community organizations and entrusting them with the responsibilities of routine operation of the systems. In places where the community water committees are formally established and given the authority to operate the plant and effect the cost recoveries the arrangements are reported to be working satisfactorily. To encourage the committees to come forward to take up the responsibility, government may agree to bear in the initial years not-only the capital investments but also expenditures on account of replenishment of the media. The withdrawal of subsidies should done in phased manner. In the case ARP strategy, an average rural household in the state of West Bengal should in a position pay about Rs 26 per month for drawing its daily requirements of arsenic free water for drinking and cooking purposes.

APPENDIX – A

TABLE – 1 : Size classification of rural habitations in West Bengal – 1991 Census.

Size of the habitation	Number	Percentage
1	2	3
Below 500	13,474	35.54
500-999	9,227	24.34
1000-1999	-.8,065	21.27
2000-4999	-5,819	15.35
5,000-9,999	-1,117	2.95
10,000-19,999	-190	0.80
20,000-49,999	-17	0.05
50,000-99,999	-1	0
1,00,000 & above	0	100.0

TABLE – 2 : Per 1000 distribution of households having Principal sources of drinking water by distance from source

S. No	Principal source of drinking water	Within the dwelling	Outside dwelling but within the premises	Outside the premises at a distance of in K.m.						All households	Sample of households
				<0.2	0.2-0.5	0.5-1.0	1.0-1.6	>1.6	Non response		
1	2	3	4	5	6	7	8	9	10	11	12
1	Tap	181	97	654	62	5	-	-	-	1000	219 (4.12)
2	Tubewell/ hand pump	82	186	637	77	12	2	2	1	1000	4014 (75.76)
	Well	-	195	747	0	1	1	48	-	1000	965 (18.17)
4.	Tank/Pond reserved for drinking	-	43	620	-	-	-	336	-	1000	46 (0.86)
5	Other tank/Pond	-	107	196	-	-	-	697	-	1000	13 (0.24)
6	River/Canal/ lake	-	-	829	-	-	-	171	-	1000	10 (0.19)
7	Spring	-	-	822	178	-	-	-	-	1000	12 (0.13)
8	Tanker/other	-	-	831	169	-	-	-	-	1000	-
9	Other	-	709	291	-	-	-	-	-	1000	3 (0.06)
10	Non Response	-	61	891	-	-	-	-	-	-	30 (0.56)
11	All sources	70	181	659	63	9	2	15	1	1000	5312 (100.00)

Source: Sarvekshana, Vol.XXIII, No.3, 82nd Issue (Special) Jan.-March 2000, National Sample Survey Organisation, Ministry of Statistics & Programme Implementation, Government of India, page S-119.

APPENDIX – A

TABLE – 3: Per 1000 distribution of households by principal and supplementary sources of water for cooking, bathing and washing utencils

S. No	Source of water	Number of Households using the source of water for					
		Cooking		Bathing		Washing Utencils	
		Principal Source	Supplementary source	Principal source	Supplementary source	Principal Source	Supplementary Source
1	Tap	39	88	13	18	13	40
2	Tubewell / handpumps	705	451	280	534	321	548
3	Well	109	123	60	68	72	55
4.	Tank/Pond reserved for drinking	3	5	9	13	8	17
5	Tank/Pond	139	255	595	262	573	267
6	River/canal	1	30	38	84	8	50
7	Spring	2	28	2	13	2	14
8	Tanker	-	-	-	-	-	-
9	Other	1	21	1	10	2	9
10	All sources	1000	1000	1000	1000	1000	1000
	Estimated No. of household	1,10,552	16,421	1,10,552	32,422	11,552	30,814
	Sample of households	5312	789	5312	1580	5312	1491

APPENDIX – A

TABLE – 4 : Number of Rural households per 1000 filtering/chemically treating/boiling their drinking water in different states.

State	Number of households in 1000 treating water					
	Filtering		Chemically treating	Boiling	No. of households	
	With plain cloth	By other process			Estimated	Sample
1	2	3	4	5	6	7
Andhra Pradesh	218	36	7	26	119333	5721
Assam	117	193	67	216	35114	3243
Bihar	32	18	5	7	150028	7464
Gujarat	745	64	5	4	54468	2939
Haryana	26	8	1	4	25388	1222
Karnataka	90	13	14	28	69692	3152
Kerala	84	33	50	493	45411	2911
Madhya Pradesh	243	31	13	4	107483	5802
Mahrashtra	415	26	19	12	111247	5359
Orissa	85	16	7	18	63451	3401
Punjab	1	11	4	3	27971	2533
Rajasthan	397	18	4	2	62377	3501
Tamil Nadu	76	16	15	81	96319	5324
Uttar Pradesh	3	11	7	2	230008	10003
West Bengal	46	17	8	13	110552	5312
North Eastern	81	200	28	340	15630	6273
North Western	43	24	14	86	21164	3816
Southern	173	77	9	366	3059	1014
India	152	29	12	43	1348695	78990

Ibid S-248

APPENDIX – B

TABLE : Operation of Deep Tubewells – sample study.

S. No	Name of the village/s (Number)	Population 1991	Estimated population 2001	No. of families (2001)	Volume of daily supply 000e	Per capita daily supply 'T'	Investment in Tubewell (Rs.000)	O&M Expenditure Rs.000
1	2	3	4	5	6	7	8	9
1	Iswara Chandrapur(1)	2,463	2,956	591	490.10	165.80	7696	200
2	Natna (4)	10,512	12,614	2,523	727.36	57.70	10805	120
3	Dhoradaha (2)	10,180	12,216	2, 443	395.50	32.40	10700	200
4	Narayanpur(2)	10,054	12,065	2,413	500.06	41.40	10530	300
5	Baria (3)	11,207	13,448	2,689	363.68	27.00	10791	230
6	Mithipur (1)	9,722	11,666	2,333	163.66	14.00	10009	180
7	Kantanagar(1)	11,208	13,450	2,690	90.92	6.76	11145	180
8	Chhayghan(1)	8,326	9,991	1,998	163.66	16.38	9506	200

Annual Expenditure Rs.'000			Expenditure per 100 litres of supply (Rs.)	Monthly charges to be paid by the existing clients of the facility towards covering the full cost of the service (Rs.)			Montly charges to be paid by the existing clients towards covering full costs of O&M component and 10% of capital component (Rs.)
Capital	O&M	Total		Capital component	O&M component	Total	
10	11	12	13	14	15	16	17
1549.20	188.40	1737.60	0.97	218.44	26.57	254.01	48.41
2175.05	113.04	2288.09	0.86	71.84	3.73	75.57	10.91
2153.91	188.40	2342.31	1.62	73.47	6.43	79.90	13.78
2119.69	282.60	2402.29	1.32	73.20	9.76	82.96	17.08
2172.23	216.66	2388.89	1.80	67.32	8.76	76.08	15.49
2014.81	169.56	2184.34	3.66	71.98	6.06	78.04	13.26
2243.49	169.56	2413.05	7.27	69.50	5.25	74.75	12.20
1913.56	188.40	2101.96	3.52	79.81	7.86	87.67	15.84

Source: Sample surveys carried out as part of the project

Assumptions :

1. **Average life of Tubewell and associated pump hand etc. 8 years**
2. **Discount rate is 12%.**

APPENDIX – C
Community ARPs Using different technologies.
Table 1 - AMAL

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	5,000	8	1006.50
2	Plant	45,000	8	9058.00
	Total of capital			10064.50
B	O&M Expenditures			
3	Replenishment	5,000	2	2958.50
4	Maintenance of civil Works	500.00	1	471.00
5	Recharging	-	-	-
6	Quality Control Inspection	250	1/12	2813.78
7	Preventive Maintenance	700	1	659.40
8	Salary and Wages of Staff	800	1/12	9004.08
9	Waste Disposal	1000	2	591.70
10	Chemicals & Consumables	500	1	471.00
11	Costs Stoppage of Supply		2/3 days in a year	-
	Total of O & M			16969.46
	Total			27,033.96

A. Annual expenditure

	Rs.
Towards Capital component	10,064.50
Towards O&M component	16,969.46
Total:	27,033.96

B. Monthly charges a family has to pay towards covering full costs of drawing @ 40 litres per day when a Unit is allotted to serve 50 families only

Towards Capital Expenditure	16.77
Towards O&M Expenditure	28.28
	45.05

C. Monthly charges a family has to pay to meet O & M Expenditure, when capital and replenishment expenditure is Borne by the government = Rs.23.35

D. Monthly charges a family has to pay to meet O & M Expenses when capital and replenishment to expenditures are borne by Govt. and community volunteers take care of routine maintenance = Rs.8.34

E. Cost per 100 litres of supply = Rs.3.75

F. Capital Investment per head = Rs.200

TABLE – 2 : PAL TROCKNER

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	2000.00	8	402.60
2	Plant	84,000.00	10	15,270.60
B	O&M Expenditures			
3	Replenishment & Chemicals (MnO2)	15,000.00	1	15,000
4	Maintenance of Platform	500.00	1	471.00
5	Price of Recharging	-	-	-
6	Quality Control Inspection	250.00	1/12	2813.78
7	Preventive Maintenance	1000.00	1	942.00
8	Salary and Wages of Staff	800.00	1/12	9004.00
9	Waste Disposal	1250.00	1	1250.00
10	Chemicals & Consumables	-	-	-
11	Costs Stoppage of Supply	-	2/3 days in a year	-
12	Total			29,480.78
				44,751.38

Annual expenditure

	Rs.
Towards Capital component	15,270.60
Towards O&M component	29,480.78
Total:	44,751.38

A. Monthly charges a family has to pay towards covering full costs of drawing @ 40 litres per day when a Unit is allotted to serve 50 families only

Towards Capital Expenditure	25.45
Towards O&M Expenditure	51.31
	76.76

B. Monthly charges a family has to pay to meet O & M Expenditure, when the capital replenishment expenditure is borne by the government = Rs.24.13

C. Monthly charges a family has to pay to meet O & M Expenses when capital and replenishment expenditures are borne by Govt. and community volunteers take care of routine maintenance = Rs.9.13

E. Cost per 100 litres of supply = Rs.6.22

F. Capital Investment per head = Rs.344

TABLE - 3 : WSI

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years0	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	4000.00	8	805.20
2	Plant	83,000.00	10	14,691.00
B	O&M Expenditures			
3	Replenishment	20,000.00	½	38,840.00
4	Maintenance of civil Works	1200.00	1	1130.40
5	Recharging	-	-	
6	Quality Control Inspection	250.00	1/24	5310.85
7	Preventive Maintenance	1000.00	1	942.00
8	Salary and Wages of Staff	1000.00	1/12	11,255.10
9	Waste Disposal	1000.00	½	1970.40
10	Chemicals & Consumables	-	-	-
11	Costs Stoppage of Supply	-	2/3 DAYS IN A YEAR	
12	O & M Exp.			59448.75
	Total			74,944.95

A. Annual expenditure

	Rs.
Towards Capital component	15,496.20
Towards O&M component	59,448.75
Total:	74,944.95

B. Monthly charges a family has to pay towards covering Full costs of drawing @ 40 litres per day when a Unit is allotted to serve 50 families only

Towards Capital Expenditure	25.83
Towards O&M Expenditure	99.08
	124.91

C. Monthly charges a family has to pay to meet O & M Expenditure, when capital and replenishment expenditure is Borne by the government = Rs.34.35

D. Monthly charges a family has to pay to meet O & M Expenses when capital and replenishment expenditure are borne by Govt. and community volunteers take care routine maintenance = Rs.15.59

E. Cost per 100 litres of supply = Rs.10.41

F. Capital Investment per head = Rs.348

TABLE – 4 : APYRON

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	3000.00	8	603.90
2	Plant	79,000.00	5	21,914.60
B	O&M Expenditures			
3	Replenishment	20,000.00	½	38,840.00
4	Maintenance of civil Works	500.00	1	471.00
5	Recharging	-	-	-
6	Quality Control Inspection	250.00	1/24	5310.85
7	Preventive Maintenance	2000.00	1	1884.00
8	Salary and Wages of Staff	3000.00	1/12	33,765.30
9	Waste Disposal	1000.00	½	1970.40
10	Chemicals & Consumables	-	-	-
11	Costs Stoppage of Supply		2/3 days in a year	
12	O & M Expenditure			82,241.55
	Total			1,04,760.05

A. Annual expenditure

	Rs.
Towards Capital component	22,518.50
Towards O&M component	82,241.55
Total:	1,04,760.05

B. Monthly charges a family has to pay towards covering Full costs of drawing @ 40 litres per day when a Family of 50 is being served.

	Rs.
Towards Capital Expenditure	75.06
Towards O&M Expenditure	275.88
Total:	350.94

C. Monthly charges a family has to pay to meet O & M Expenditure, when capital and replenishment expenditure is Borne by the government = Rs.72.34

D. Monthly charges a family has to pay to meet O & M Expenses when capital replenishment expenditures are borne by Govt. and community volunteers take care routine maintenance = Rs.16.06

E. Cost per 100 litres of supply = Rs.14,55

F. Capital Investment per head = Rs.324

TABLE – 5 : ION EXCHANGE

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	5000.00	8	1006.50
2	Plant	67,000.00	8	13,487.10
B	O&M Expenditures			
3	Replenishment	10,000.00	3	4,164.00
4	Maintenance of civil Works	500.00	1	471.00
5	Recharging	500.00	1/12	5,627.55
6	Quality Control Inspection	250.00	1/12	2813.78
7	Preventive Maintenance	1000.00	1/12	11,255.10
8	Salary and Wages of Staff	1500.00	1/12	16,882.65
9	Waste Disposal	3000.00	3	1,249.20
10	Chemicals & Consumables	200.00	1/12	2251.02
11	Costs Stoppage of Supply	-	2/3 days in a year	-
12	O & M Exp.			44,714.30
	Total			59,207.90

A. Annual expenditure

	Rs.
Towards Capital component	14,493.60
Towards O&M component	44,714.30
Total:	59,207.90

B. Monthly charges a family has to pay towards covering Full costs of drawing @ 40 litres per day when a Unit is allotted to serve 50 families only

Towards Capital Expenditure	24.16
Towards O&M Expenditure	74.52
	98.68

C. Monthly charges a family has to pay to meet O & M Expenditure, when capital and replenishment expenditure is Borne by the government = Rs.67.58

D. Monthly charges a family has to pay to meet O & M Expenses when capital and replenishment expenditure are borne by Govt. and community volunteers take care routine maintenance = Rs.39.45

E. Cost per 100 litres of supply = Rs.8.22

F. Capital Investment per head = Rs.288

TABLE – 6 : AIIH&PH

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	3000.00	8	603.90
2	Plant	27,000.00	8	5435.10
B	O&M Expenditures			
3	Replenishment	-	-	-
4	Maintenance of civil Works	2000.00	1	1,884.00
5	Recharging	-	-	-
6	Quality Control Inspection	250.00	1/12	2813.78
7	Preventive Maintenance	1000.00	1	942.00
8	Salary and Wages of Staff	500.00	1/12	7878.57
9	Waste Disposal	1000.00	1	942.00
10	Chemicals & Consumables	30.00	1/24	637.30
11	Costs Stoppage of Supply	-	2/3 days in a year	-
12	O & M Expen.			15,097.65
	Total			

A. Annual expenditure

	Rs.
Towards Capital component	6039.00
Towards O&M component	15097.65
Total:	21,136.65

B. Monthly charges a family has to pay towards covering Full costs of drawing @ 40 litres per day when a Unit is allotted to serve 25 families only (becayse the Daily capacity of Plant is only 1000 litres

Towards Capital Expenditure	20.13
Towards O&M Expenditure	50.33
Total:	70.46

C. Monthly expenditure a family has to pay when capital Expenditure is borne by Government Rs. 25.41

D. Monthly charges a family has to pay to meet O & M Expenditure, when capital expenditure is Borne by the government and community volunteers Take care of routine operations = Rs.24.06

E. Cost per 100 litres of supply = Rs.5.87

F. Capital Investment per head = Rs.120

TABLE – 7 : PHED

	EXPENDITURE	AMOUNT (RS.)	LIFE/PERIOD (years)	ANNUAL EXPENDITURE (Rs.)
1	2	3	4	5
A	Capital Expenditure			
1	Civil works	6750.00	8	1,358.78
2	Plant	29,375.00	5	10,922.63
	Total capital			12,281.41
B	O&M Expenditures			
3	Replenishment	7,312.50	1	7,312.50
4	Maintenance of civil Works	500.00	1	471.00
5	Recharging	-	-	-
6	Quality Control Inspection	250.00	1/12	2813.78
7	Preventive Maintenance	1000.00	1	942.00
8	Salary and Wages of Staff	4000.00	1/12	45,020.40
9	Waste Disposal	1000.00	1	942.00
10	Chemicals & Consumables	350.00	1/52	13,718.64
11	Costs Stoppage of Supply	-	2/3 days in a year	-
12	Total			71,220.32
				83,501.73

A. Annual expenditure

	Rs.
Towards Capital component	12,281.41
Towards O&M component	71,220.32
Total:	83,501.73

B. Monthly charges a family has to pay towards covering Full costs of drawing @ 40 litres per day when a Unit is allotted to serve 50 families only

	Rs.
Towards Capital Expenditure	20.45
Towards O&M Expenditure	118.70
	139.15

C. Monthly charges a family has to pay to meet O & M Expenditure, when capital and replenishment expenditure is Borne by the government = Rs.106.51

D. Monthly charges a family has to pay to meet O & M Expenses when capital and replenishment expenditure are borne by Govt. and community volunteers take care routine maintenance = Rs.31.48

E. Cost per 100 litres of supply = Rs.11.60

F. Capital Investment per head = Rs.144.50

APPENDIX – C

TABLE – 8 : Comparative Analysis of Costs of Water Supply under different ARP technologies

S. No.	Technology	Daily capacity	Daily withdrawals	No. of families drawing water	Monthly charges paid (Rs.)	Assumed effective withdrawal from the Plant	Assumed No. of households served
1	2	3	4	5	6	7	8
1	Amal	5000	2500	300	15.00	2000	50
2	Paltrocknor	3000	2000	100	Nil	2000	50
3	WSI	2000	1500	100	Nil	2000	50
4	Apyron	1200	1200	60	Nil	1000	25
5	Ion Exchange	2000	2000	60	Nil	2000	50
6	AIIH & PH	1000	500	24	Nil	1000	25
7	PHD	2000	500	20	Nil	2000	50

Monthly charges a household has to pay to draw water @ 40L per day (Rs.)					Cost for 100 litres of supply (Rs.)	Capital Investment per client (Rs.)
Capital	O&M	Total	To cover O&M Expenditure minus Replenishment	To cover O&M Expenditure Minus replnishment & salaries		
9	10	11	12	13	14	15
16.77	28.28	45.05	23.35	8.34	3.75	200
25.45	51.31	76.76	24.13	9.13	6.22	344
25.83	99.08	124.91	34.35	15.59	10.41	348
37.53	137.94	175.47	72.34	16.06	14.55	324
24.16	74.52	98.68	67.58	39.45	8.22	288
10.06	25.17	35.23	25.41	24.06	5.87	120
20.45	118.70	139.15	106.51	31.48	11.60	144.50

APPENDIX – D

TABLE – 1 : DOMESTIC ARSENIC FILTERS

A. AMAL	CAPACITY 24 Litres	AMOUNT
		Rs.
1. Initial price		1650.00
2. Annual Replenishment for five years @ Rs.150 p.a.		540.72
3. Replacement at the end of 5 years Rs.600		340.44
		2541.16

B. PATROCKNER	10 Litres	30 Litres
	Rs.	Rs.
1. Initial Price	3,500	4,500
2. Replacement at the end of the fifth year Rs.1000	567.40	567.40
	4,067.40	5,067.40

C. AIIPH&H 10 litres	
	Rs.
1. Initial Price	.200
2. Cost of chemicals @ Rs.10 p.m. for 5 years i.e For 60 months	377.70
	Rs.577.70

D. Jadavpur University (20litres)#	
	Rs.
1. Initial Price	600.00
2. Cost of chemicals @ Rs0 .75 per day i.e. 68.25 for 91 days (Unit's life is3years)	679.36
	1279.36

#Note: The filter is reported to be still in the development stage. Costs taken in the exercise, therefore, are tentative. A small number of filters were produced and supplied free of cost to a sample of households. Those households are also given regularly free supplies of the chemical (tablet) for daily use. Information is not readily forth coming from the project team as to when these filters are going to be produced on large scale and at what price they are going to be made available in the market and how the distribution network for the supply of chemicals will be established.

APPENDIX - D

TABLE – 2: Comparative Analysis of Water Supply under different DARF technologies.

Sl.No.	Technology	Per capita Investment (Rs.)	Cost per 100 litres of water drawn (Rs.)
1	2	3	4
1	Amal	330	5,80
2	Palrockner (30 litres)	900	9.26
3	AIIH & PH	40	3.17
4	Jadavpur	120	3.50

TABLE – 3: Socio-Economic Profile of the users of Domestic Arsenic Filters

Sl.No.	Technology	Number with high school and above education	Number in Non Agri./Labour occupation	Religion and Average Family size				Average monthly Income (Rs.)	Total
				Hindu	Family size	Muslim	Family size		
1	2	3	4	5	6	7	8	9	10
1	Amal	16	16	8(5)	4.3	8	7.7	1046.7	16
2	Paltrockner	12	9	12(6)	6.2	3	7.7	7566.7	15
3	AIIH & PH	15	14	15	5.5	-	-	4166.7	15
4	Jadavpur	3	10	4 (2)	5.5	11	6.1	1046.7	15

Source: Socio-Economic sample surveys conducted as part of the Present Project (Figures in the bracket in Col.5 are scheduled caste families).

APPENDIX – D

TABLE – 4 : Ownership of Deurables by population below Poverty line as estimated from MISH 1997-98 (per `000 hhs)

Durables	Number of households in 1000 owning the item		
	Urban	Rural	Total
1	2	3	4
Tansistor Radio	423	309	319
Casette Recorders	202	150	156
Pressure Cooker/Pan	260	76	92
Bicycle	419	410	411
Electric Iron	153	47	56
Electric Fans	582	220	252
Wrist Watches	1024	706	734
TV-B&W	312	79	100
Sewing Machine	98	54	58
Colour T.V.	43	7	10
Two Wheelers (motorized)	49	14	17
Washing Machine	12	0	1
Refrigerator	35	4	7

Source: Deepak Lal Et.al, Economic Reforms and Poverty Alleviation – A Tale of two Surveys, Economic and Political Weekly March 24, 2001, page 1027.

APPENDIX – E

TABLE – 1 :Per thousand distribution of households according to the per capita monthly expenditure classifications, in rural West Bengal and in rural India.

Sl.No.	State/India (Rural)	Number of households in the Percapita expenditure classification of (Rs.) in 1000													
		000 120	120 140	140 165	165 190	190 210	210 235	235 265	265 300	000 300	300 355	355 455	455 560	560 & above	All classes
1	West Bengal	6	6	27	27	27	78	93	119	383	196	209	111	100	1000
2	All India	5	12	27	44	48	71	84	106	397	154	182	108	159	1000

Source: Sarvekshana, Volume XXIII No.2, 81st Oct.-Dec.1999, National Sample Survey Organisation,
Ministry Statistics & Programme Implementation, Government of India (NSS 54th Round January 1998 – June 1998) page

APPENDIX – E

TABLE – 2: Value (Rs.) of Consumption of broad groups of food and non-food items per person for a period of 30 days for each monthly expenditure classes/All India Rural

S.No.	Item of consumption	Value of (Rs.) Per capita monthly consumption according to the per capita monthly expenditure classificatin of the households						
		000 120	120 140	140 165	165 190	190 210	210 235	235 265
1	2	3	4	5	6	7	8	9
1	All Food items	78.33	96.10	113.10	130.08	143.72	158.70	176.77
	Non-Food items							
	i)Pan	0.46	0.37	0.45	0.61	0.64	0.87	1.03
	ii)tabacco	2.32	2.17	3.10	3.42	3.96	4.62	4.70
	iii)Intoxicants	0.76	0.61	1.05	1.14	1.77	1.62	1.82
	iv)Durables	0.05	0.75	0.68	0.96	1.33	1.82	2.04
	All Non-food items	30.27	35.09	41.12	48.60	57.02	64.27	73.40
	Total Exp.	108.61	131.1131.19	154.23	178.67	200.74	222.97	250.17

Ibid page

265 300	300 355	355 455	455 560	560 & above	All Exp. categories	% in the total Exp.
10	11	12	13	14	15	16
197.06	220.36	257.48	302.25	404.26	232.40	60.48
1.46	1.41	1.92	2.28	2.96	1.58	0.41
5.84	6.06	7.05	7.51	10.85	6.31	1.65
2.30	2.35	3.32	3.87	7.57	3.07	0.80
2.96	3.49	6.68	10.49	75.80	13.46	3.52
85.92	105.65	142.69	197.13	459.76	149.67	39.17
282.97	326.01	400.17	499.38	864.02	382.07	100.00

APPENDIX – E

TABLE – 3: Average monthly Per capita expenditure (Rs.) Rural West Bengal

	Rural	Percentage	All India	Percentage
1	2	3	4	5
Total food items Non-food items	238.80	66.80	232.40	60.83
Pan	1.26	0.35	1.58	0.41
Tobacco	6.26	1.75	6.31	1.65
Intoxicants	1.35	0.38	3.07	0.80
Fuel & Light	26.19	7.33	30.02	7.86
Clothing	19.44	5.44	22.34	5.85
Food Wear	1.74	0.49	3.97	1.04
Misc.consumer goods	14.73	4.12	18.80	4.92
Misc. consumer Services	8.85	2.47	17.95	4.70
Rent	0.09	0.02	1.29	0.34
Taxes & Cesses	0.10	0.03	0.47	0.12
Education	12.58	3.52	9.57	2.50
Medical Institutional	4.65	1.30	6.10	1.60
Medical (Non-Institutional)	13.19	3.69	14.74	3.86
Durable goods	8.29	2.32	13.46	3.52
Total non-food	118.69	33.20	149.67	39.17
Total consumption Exp.	357.50	100.00	382.07	100.00
Sample hhs.	668.00		9986	

Source: Sarveskshana, Volume XXIII, No.2, 81st Issue, Oct.-December 1999, National Sample Survey Organisation, Ministry of Statistics & Programme Implementation, Government of India, (NSS 54th Round January 1998 – June 1998).

APPENDIX – E

TABLE – 4 : Number of households per 1000 willing to contribute money/Labour towards improvement of sanitation in their neighbourhood and in their village/town

	Number of households per 1000 willing to contribute towards improvement of sanitation in our village/town						No. of households (Estd) 000	Sample of households
	Money & labour	Money only	Labour only	Neither	Non Response	All		
Rural West Bengal	106	54	537	277	27	1000	110552	5312
Rural India	153	58	454	323	12	1000	1348695	78990

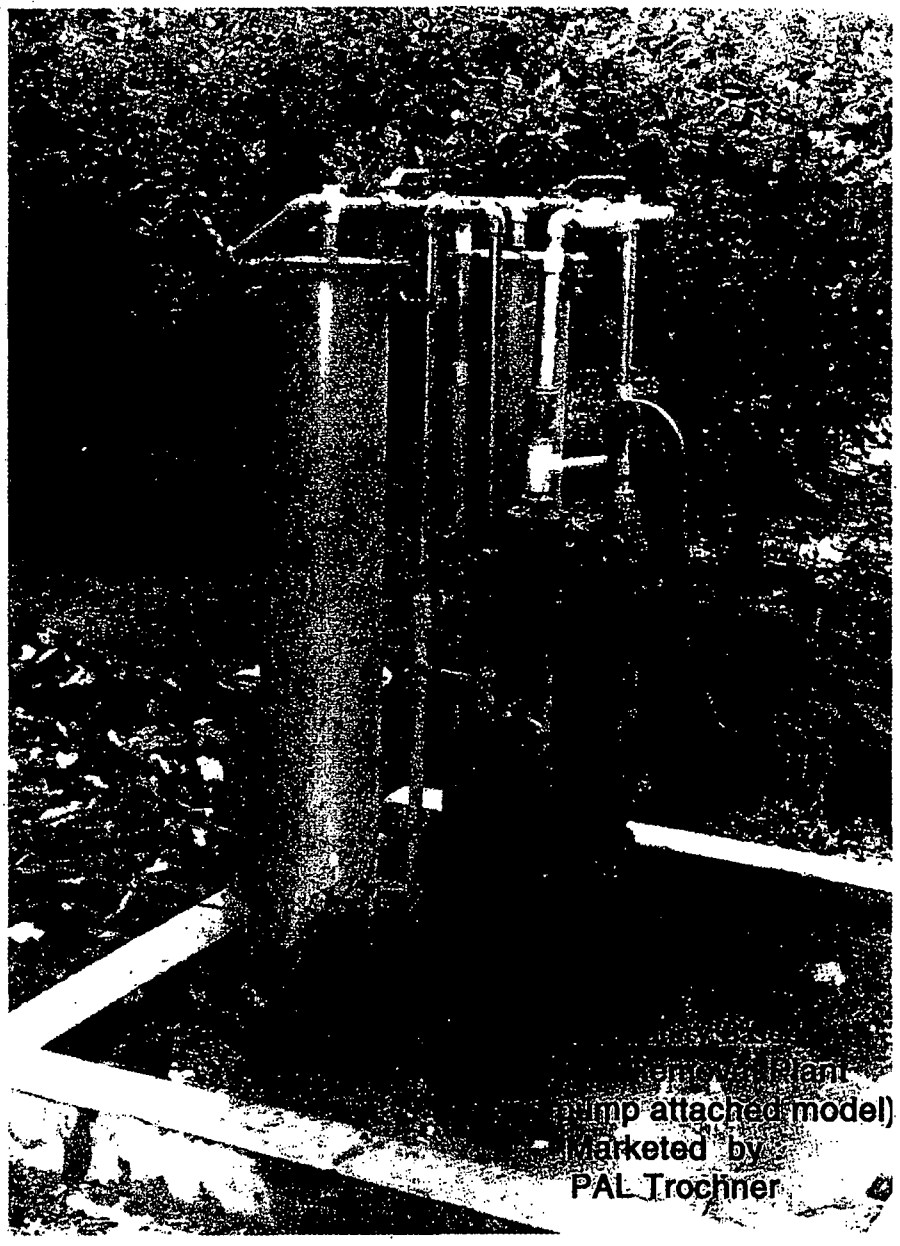
Source: Sarvekshana, Vol.XXVII, No.3, 82nd Issue (Special) January-March, 2000, page S-281.

APPENDIX – E

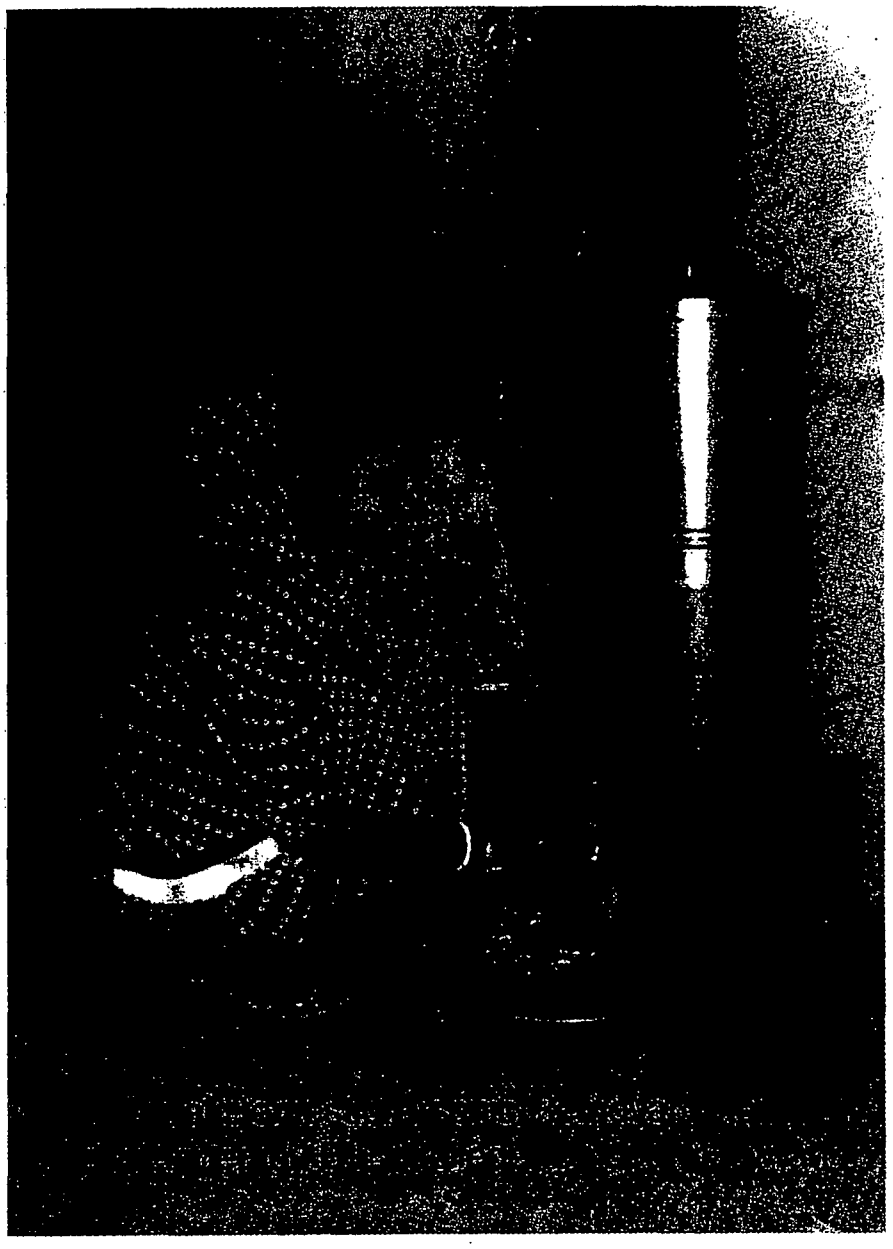
TABLE – 5: Number of households per 1000 willing to contribute money/Labour towards improvement of sanitation in their neighbourhood and in their village/town

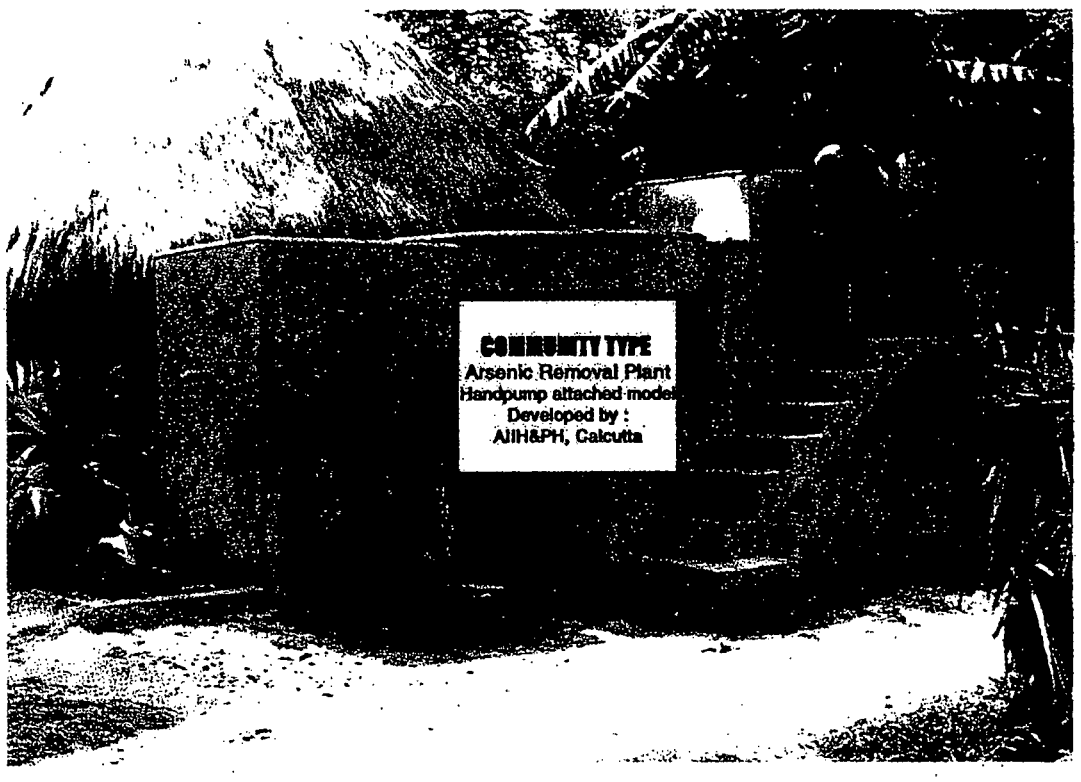
	Number of households per 1000 willing to contribute towards improvement of sanitation in their neighbourhood					
	Money and labour	Money only	Labour only	Neither	Non Response	All
Rural West Bengal	96	56	570	230	47	1000
Rural India	162	66	523	241	8	1000

Source: Ibid p.281.



...ent Unit Plant
...mp attached model)
Marketed by
PAL Trochner




COMMUNITY TYPE
Arsenic Removal Plant
Handpump attached model
Developed by :
AIIH&PH, Calcutta

Moreover, Pal Trockner and Apyron claim to be successful in marketing their ARPs in Bangladesh, which, according to both, offers better potential, primarily due to its government's accordance of priority to the arsenic menace.

Pal Trockner seems to be the only aggressive player as far as the community-based ARPs are concerned. They have tied up with West Bengal Agro Industries Corporation (W.B. Government Undertaking) to market their community-based ARPs. In collaboration with the Zilla Parishad, the latter are in the process of installing 95 ARPs in Murshidabad, all of which are being supplied by Pal Trockner. One such test unit has already been set up in Beldanga, the water quality test results of which have so far been satisfactory. Pal Trockner will provide training facilities to the Corporation's personnel, as well as local beneficiaries. Once a certain number of units are installed, the Corporation plans to appoint a supervisor to provide the necessary services. Since the Corporation has offices and personnel (e.g., mechanics) in every district, this network can be effectively utilized to provide servicing support to the ARPs set up. Pal Trockner also plans to contact individual PHE Departments at the district level, which may be interested to install ARPs in their arsenic-affected blocks.

As part of their promotional exercise, Pal Trockner demonstrates their units (both community and domestic filters) at important fairs, exhibitions and seminars. E.g., it had taken up a stall to demonstrate their units at the Krishi Mela organized by Ramakrishna Mission, Narendrapur. It plans to take up mass media advertising - T.V. / Newspaper / Outdoor / Cinema slides, etc. to spread awareness about its products.

On the domestic filter front, marketing activities are evident for AMAL, the filter developed by B.E. College and whose patent has been handed over to Oxide India (Durgapur), which is solely responsible for its manufacture and marketing. Oxide India has appointed dealers in Malda and Bahrampore (Murshidabad) for selling these domestic filters. These filters are sold at Rs.2, 400/-, of which the dealer gets a commission of Rs.600/- (25%). Dealers' Meets are organised at Durgapur every two months. According to Mr. Gautam Biswas of Oxide India, the Malda dealer has displayed good performance so far.

When contacted, the Malda dealer claimed to have sold around 200 units so far. He is confident of selling 100 units per month, provided he gets adequate support from the company (no supply bottleneck, suitable credit facility, etc.)
He further claimed to get good response from demonstrations given by him at various fairs and workshops, e.g., those of Indian Medical Association and Vigyan Manch. His customers include businessmen (e.g., silk exporters), school teachers and government staff, mostly semi-urban and predominantly of Muslim origin.

At the time of installation, he trains his customers how to backwash the unit, which he advises them to do once a month and dispose the waste water in a sanitary pit. Customers are advised to check the treated water for arsenic after two years and if required, the media is replaced at Rs.350/-. Apart from this, the media is sent for regeneration to Durgapur after every eight months, when a loan media is provided to the customer.

The dealer seemed to share a good rapport with his customers, to whom he provides free service for a period of two years. He provides installment facilities to certain customers at his own risk and discretion. As part of his sales activities, he pays visits to schools, banks, shops, doctors' chambers and homes, gives demos, explains benefits of the filter and then closes the deal.

However, there are no leaflets provided to potential or actual customers.

Promotional Activities

Advertisements in Cable T.V.(urban areas) and participation in fairs and sponsorship of Sports events (rural areas). Oxide India and its dealers share these costs. According to its Malda dealer, awareness about arsenic and its ill-effects are on the rise, people solicit information / make telephonic inquiries.

Marketing opportunities

- Widespread arsenic contamination in eight districts of West Bengal , fuelling greater awareness about the menace

- Media attention that the arsenic issue is receiving leading to heightened awareness and concern about the issue

- Absence of any worthwhile medical treatment –therefore, drinking arsenic - free water is the only alternative to prevent/check its contamination

- Both governmental agencies, as well as several NGOs, active in this field – hence, need for mitigation all the more felt now

- Pockets of high arsenic contamination, with presence of sizeable number of patients, are demanding mitigation measures with immediate effect

Marketing Constraints

- Awareness of the various ARP options itself is low and confined to pockets where they have been set up, mostly on an experimental basis

- Costs of the ARPs act as a deterrent, particularly of the community – based ones; even in the case of the household filters, its mostly the well – off who can afford them

- Lack of marketing network of the companies in operation - most banking on PHED or Unicef to place orders, hence displaying little initiative to explore alternate options

- Lack of experience in rural marketing often acts as a hindrance

- The technologies being still new, several loose ends need to be addressed -primary among them being the issue of safe sludge disposal, so as not to create any environmental pollution

- Lack of service back-up evident – it's a classic case of chicken and egg, where the companies seem to be waiting for the orders to come in, before they set up their service network in place

However, for long-term sustainability, **the need for community participation,** especially in matters of plant O & M cannot be over – emphasized. Hence, thought needs to be devoted in terms of:

(a) Community mobilization for making them positively disposed towards the ARP options.

(b) Plant selection/installation with the active participation of the community based on their informed choice

(c) Entrusting responsibility for plant O & M to the community, both in terms of carrying out maintenance work, as well as mobilizing them to generate resources for the same.
A comprehensive Training Module needs to be worked out for community members, who can subsequently take on the task of plant maintenance. An Operation Manual is a must for these caretakers, to help them in their day – to – day discharge of duties.

A committee would also have to be formed at each site with full financial responsibilities - it would be its task to mobilize resources for plant O & M keep an account of it and spending on necessary repairs, etc.

Only if the marketing agency is able to instill a sense of ownership among the community members who are benefiting from the installation of an ARP, will it prove to be self – sustaining in the long run.

The companies can also explore the following:

- Establish linkages with key stakeholders, e.g., the Panchayat representatives and various NGOs, who could be potential customers

- Sales promotional activities – e.g., participation in fairs, exhibitions, seminars etc., here they could set up demonstration–cum-sales counters; IEC materials (leaflets, handbills, etc)could also be distributed from these outlets

- Product advertising – mass media options like radio, cable T.V. (where feasible) and outdoor (banner, hoarding etc.) can be thought of to spread product awareness and generate interest in the same; moreover, folk media can also be effectively utilized forwards the same end

- In the case of domestic filters, **the Sanitary Marts** present at the block level can also be roped in to act as 'Retail Outlets'; they can take care of not only sales, but also the service aspect – e.g., they may enter into an **Annual Maintenance Contract** for a year or so with the customer, against a token charge. This charge can not only take care of repairs, etc., but also the cost of conducting periodic water quality tests, which is a strong felt need for the household filter users. They will also have to offer **the facility of media replacement,** once it gets exhausted.

- Tap the corporate sector to sponsor ARP costs- several companies, keen to project a socially positive image, may be interested to fund filters (community or domestic) in arsenic – prone areas and thereby, draw mileage from it as doing their bit for society.

- Innovative marketing schemes tailor made for the rural sector – e.g., easy EMI facility, shared – filter concept (where several adjacent households share water from a particular filter, the costs of which get distributed) and may be, even supplying treated water from community ARPs to remote areas on van, etc. and charge an amount for the same.

Along with all these, one also needs to mention that the companies must engage in continuous R & D in order to make their products:

a) **more user – friendly**
b) **more cost – effective**
c) **more environment-friendly**

TRAINING ISSUES

a) **Training Institute**

The following institutes were contacted which are either already involved in the Arsenic Mitigation Process, or could play a role in it:

- All India Institute of Hygiene and Public Health, Kolkata is an institute of repute. It has both the manpower and the infrastructure to impart training and provide technical assistance. At present, it is collaborating with UNICEF to impart training (technical aspects) on arsenic related aspects. It is also collaborating with India-Canadian Environmental Fund (ICEF) to implement an arsenic mitigation project in West-Bengal.

- The Technical Teachers' Training Institute has been set up by the Ministry of Human Resource Development. It has a network of polytechnics spread across West-Bengal. It conducts various training programs for people working at the grass-root level. At present, the institute is responsible for executing the training aspects of PHED's arsenic Project. As a part of it, it is collecting water samples and sending them for testing at PHED labs.

- Ramakrishna Mission Lokasiksha Parishad, Narendrapur, is a renowned organisation. It has the human resource and infrastructure to conduct training on arsenic related issues. Ramakrishna Mission has also implemented an arsenic mitigation project funded by the World Bank in North and South 24 Parganas. It is also in the process of developing a low-cost domestic arsenic removal filter. It has a wide network of village clubs, who is actively involve in social and cultural activities, throughout the state. At present, one of its branches in Murshidabad is engaged in identifying the handpumps which are delivering arsenic contaminated water.

- Society for Equitable Voluntary Action is an NGO mainly working in North 24 Parganas and Birbhum. It has qualified personnel and infrastructure to organize training on the arsenic issue. It has set up a laboratory at Atghara, North 24 Parganas to conduct water quality test. At present, it has launched an awareness programme on arsenic contamination.

- Mass Education is an NGO, which is correctly working in about five districts. It is also collaborating with Calcutta Municipal Corporation in the disposal of clinical waste from hospitals and garbage clearance. It has the infrastructure to organize training on arsenic related issues. The strength of the organization is that it has a wide network of Self Help Group, which can be harnessed to spread the awareness about arsenic related issues.

- Economic Rural Development Societies is an NGO, working in three districts of West-Bengal - South 24 Parganas, South Dinajpur and Malda. In Malda, it has a very good infrastructure to organize training. It

has also set up Sanitary Marts in three blocks in Malda with the support of UNICEF. It has also organized an awareness campaign on arsenic contamination in Malda with the support from WATERAID. It is also implementing other developmental activities.

b) Training **For Sustainable ARP Management**

ARPS have been installed in many villages in West Bengal. **The Consulting Team during its field visits felt that hardly anything has been done to motivate and educate the communities on sustainable management of the ARPs.** With this as the issue, the training objective would be to:

Ensure long term sustainability in use of ARPs

The proponent of the Plants will have to appoint an experienced and qualified Training Consultant to take on the task of training on their behalf, specifically for the non-technical aspects.

The first step for the proponents would be to constitute a committee of users, which would be handed over the management of the plants. Persons with the following qualities need to be involved in the committee:

- Enthusiasm and motivation
- Leadership
- Demonstrated capabilities and commitment towards community organization
- Willingness to devote time for the project
- Basic literacy

Steps in Training

It is felt that, the following steps would be necessary for a successful training program aiming at sustainability:

1. **Process oriented participatory training** : The committee that would be formed will be trained in this, so as to involve people, specifically the users, again rapport, act as advocates for use of arsenic free water, overall operational aspects of the plants, contribution for operation and maintenance (payment for caretaker will also form a part of this), monitoring of smooth operation of the plant, etc.

2. **Training for overall IEC:** The committee will be responsible for generating awareness among the people that would included issues such as:

    i. dangers of drinking arsenic contaminated water
    ii. benefits of drinking ARP treated water
    iii. proper use of plant to ensure longevity
    iv. need for maintenance & contribution for the same

3. **Technical training:** This will be meant for the caretakers specifically and will include the following:

    i. all processes involved in the functioning of the plant
    ii. parts of the plants, wear & tear of the same, availability of spare parts, costs involved
    iii. operational methods regarding day to day effective running of the plant, for instance chemical dosing where required
    iv. proper maintenance of plant - backwash method, safe disposal of waste water & sludge, minor repairs (e.g. changing washer), networking for major and other repairs for which local support not available
    v. Water quality surveillance - testing of water samples for relevant quality tests with field kits

4. **Financial Management:** Maintain accounts of contributions collected, expenditure on maintenance, banking transactions, etc.

Training Manual and Operational Manual will be prepared in simple language with pictorial representation of the processes.

Overall monitoring the training program and its effectiveness, an external monitoring agency may be appointed. Initially, quarterly reports (first year) and later biannual reports (2nd & 3rd year) and annually (4th , 5th and 6th year). This is in consideration of the fact that a plant needs replacement of the media, after a stipulated period of time, which would involve resource mobilization.

CONTROL VILLAGES

The following villages, known to be in the arsenic –risk zone, but with no mitigation intervention, were chosen for the purpose of the study:

1. Gharamipara (Baruipur block of South 24 Parganas)
2. Mollapara, Surjapur (do)
3. Baikanthapur (Rajpur - Sonarpur Municipality)

While the first and third were predominantly Hindu, the second one had a Muslim majority population. The occupation profile of most of the respondents in the first two villages was small and marginal farmers, daily labour and petty traders, that of the third was mostly a mix of servicemen, business men and traders.

Most of the respondents were aware of arsenic, mainly due to initiatives taken by Jadavpur University and Vigyan Manch to carry out water quality tests in their area. These tests have established the presence of arsenic in several tubewells at the first sites, and some tubewells in the third. Moreover, some educated people of the suburban area of Baikanthapur had actually carried water quality samples of their private tubewells to RKMLSP for arsenic testing (they had come to know of this facility from a staff of the organization residing in their area).

The level of concern was generally high in the first two villages, while it was largely restricted to the educated people in the third. This was mainly because Jadavpur University has carried out extensive water quality tests in the first two, whereas those of Vigyan Manch were not so. Moreover, people are aware of arsenic induced deaths in Gharamipara – they mentioned that about sixteen patients had died in and around their village. At present, they believe there are about a dozen patients in their village, of whom two male patients were present in the FGD. Similarly, in Mollapara, three male patients were present in the FGD.No patients were present at Baikanthapur FGD.

These patients, as well as the other respondents, were quite concerned about their state of health. In Gharamipara, they avail drinking water from a deep tube well, which has been identified as arsenic – free by J.U, as also from the taps of the Piped Water Supply Scheme of the region. Similarly, in Mollapara, they try to avail water from a deep tubewell situated in their market place. However, some women pointed out that it becomes a bit difficult to collect water from this particular tubewell, since it is situated at a distance from their homes. Moreover being in the midst of a market place, women feel uncomfortable to fetch water from here. In Baikanthapur, respondents mainly depend on the Piped Water Supply Scheme for drinking water.

However, most of the respondents at all three sites indicated preference for their private tubewell water for cooking purpose. This was chiefly due to:

(a) "it is difficult to fetch such a large quantity of water from the deep tubewells".
(b) Some respondents are of the opinion that since the water gets boiled during cooking, it gets rid of arsenic, as well.

Some of the patients at both the sites mentioned that they visit SSKM Hospital in Calcutta for treatment purpose. Hair and nail samples were collected to detect arsenicosis. The doctors, thereafter, advised them to drink arsenic – free water. On doing so, they feel that the spots on their bodies have reduced. Besides, a local NGO, Antoday Surya Sangha has been distributing some protein –rich food to these patients, for which they are grateful to it.