# WORLD BANK DEVELOPMENT MARKETPLACE – PROJECT 407
# ARSENIC BIOSAND FILTER PROJECT FOR RURAL NEPAL

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## PROGRESS REPORT

## 31 MAY 2004

**Submitted to:**

**The World Bank**
**Kathmandu, Nepal**


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## Executive Summary

The objective of this project is to promote the Arsenic Biosand Filter (ABF) as a sustainable and appropriate water treatment alternative in rural Terai. This project has been launched since January 2004. This project is on schedule despite the unstable political and security situation. All required outputs for Milestone 3 have been successfully achieved, including training to local entrepreneurs, training of local VDC members and health post staff, village level education workshops on water-borne diseases and health, website setup, and health survey. We have partnered with several organizations to promote and monitor ABF in the Terai. The goals for the next months include project evaluation, database update and analysis, as well as presentation in conferences to disseminate project information.

## Project Description

The "Arsenic Biosand Filter Project in Nepal", led by Massachusetts Institute of Technology, is one of the winners at the World Bank Development Marketplace Competition 2003. The objective of this project is to promote the Arsenic Biosand Filter (ABF) as a sustainable and appropriate water treatment alternative in rural Terai. An award amount of US$115,000 was granted by the World Bank to implement this project from February 2004 to October 2004.

Currently, many villagers in the rural Terai lack access to safe drinking water because of arsenic and pathogens contamination. To combat this problem, MIT, ENPHO and RWSSSP have developed an innovative household water filter for simultaneous arsenic and pathogen removal, using locally available materials, and constructed by local labor. The design is optimized based on the socio-economic conditions in rural Terai. Pilot studies have shown high user acceptance and excellent arsenic and pathogens removal. In addition, the filter can effectively remove iron, turbidity, and odor. The filter has a high flow rate sufficient for a large family.

The Development Marketplace funding will provide capital to promote ABF in Nepal. An in-country technology dissemination and implementation center is being setup. Local capacity will be built among the poor towards long-term, self-reliant, user-participatory safe water provision, involving training of local women, entrepreneurs, trainers, teachers, and authorities in 25 VDCs. Beside health benefits to the users, this project stimulates village development, and contributes to the World Bank's country-specific goal of poverty-alleviation.

## Work Accomplished to Date

**April 2004**

- Conducted training for local entrepreneurs about the Arsenic Biosand Filter (Kanchan Filter), including technical details, construction methods, trouble-shooting, entrepreneurship techniques, promotion activities, financial sustainability issues, etc. on April 15-16 at Nepal Red Cross Society, Birgunj.
- 26 participants representing 10 arsenic-affected districts received training.
- Provided each participant a demonstration ABF, construction and trouble-shooting manual, posters, brochures, and other promotional materials.

- Prepared new information, education, communication (IEC) materials for the new Gem505 filter design, including posters and brochures.
- Supervised an undergraduate Environmental Science student from Kathmandu University to study the effect of air space on arsenic removal efficiency of the ABF.
- Oriented a group of secondary school students on the ABF. These students presented details of the ABF at the City Hall on Earth Day (April 22).
- Presented "State of Arsenic in Nepal 2003" report at the American Center on Earth Day (April 22). Details on ENPHO's arsenic research and about the ABF were communicated to about 30 participants who are actively involved in arsenic activities in Nepal.
- Presented and displayed ABF information at the South & East Asian Workshop on Arsenic Contamination Conference, a World Bank supported conference, from May 26-27, 2004. Participants from Pakistan, Mongolia, and Japan were very interested in the ABF technology.
- Met Dr. Linda Smith of the University of Texas at Dallas to discuss possible collaboration between her arsenic activities and our project.
- Continued discussion with Nepal Red Cross Society (NRCS) on partnership to promote the ABF in NRCS operated districts.
- Traveled to Bara, Parsa, and Rautahat to research on the accuracy of ENPHO's arsenic field test kit. Experiment results showed the ENPHO kit is the most accurate and easy to use among three field test kit tested.
- Began health survey in Rupendehi and Kapilvastu districts, with particular focus on arsenic-affected patients.

**May 2004**

- Collaborated with Dr. Linda Smith and the Asia Arsenic Network (AAN) to conduct a village awareness program on health, water, sanitation, arsenic, and ABF on May 3, 2004. More than 70 participants from the village of Thulo and Saano Kunwar of Nawalparasi District attended.
- Participants expressed great interest in the filter. Twenty-five filters were installed by May 31, and an additional 50 filters will be installed in June and July.
- Partnered with Research Group for Applied Geology (RGAG) of Japan for arsenic monitoring activities in Kunwar.
- Distributed 6 filters in Sukrauli VDC of Nawalparasi for promotional purpose. After 3 weeks of operation, many villagers from neighbor households expressed interest in obtaining a filter.
- Continue to supervise the Kathmandu Univeristy student on his thesis research.
- Held a staff meeting in Butwal on May 9 to provide training to conduct VDC-level and Ward-level workshops in 6 districts, including 30 VDCs and 180 wards. A total of 15 staff from ENPHO, RWSSSP, and NRCS attended.
- Conducted a workshop at ENPHO, Kathmandu on May 25 on the Information Dissemination on Arsenic Biosand Filter (ABF) Project for Rural Nepal. About 30 participants from prominent NGOs, water supply implementers, and government agencies involved in arsenic activities, as well as newspaper, radio, and TV reporters attended.
- Responses from the participants were very positive. Several agencies expressed interest in the ABF technology. One M.Sc. student from Tribhuvan University was interested in conducting ABF research for his thesis.
- Presented about the ABF at the AGU conference in Montreal, Canada on May 21, 04.
- Attended the Inter-country workshop on Capacity Building in the use of WHO Field Guide for the detection and Management of Arsenicosis in Dhaka, Bangladesh on May

23-28. Information about the ABF was disseminated. Participants expressed interest in the technology.

- Prepared a website for the dissemination of project activities and ABF information. The website will be online by June 15. The URL is http://ceemeng.mit.edu/~water/index.html Project related information such as progress reports and construction manuals can be downloaded.
- Final report on the implementation strategy of the ABF was completed by 4 MIT Sloan Business School students (MBA and PhD).

**Milestone #3 US$28,750 (25% of total fund)**

Deadline May 31, 2004.

| Required Output May 31, 2004 | Accomplishment as of May 31, 2004 | Successfully Completed? |
|---|---|---|
| Train local entrepreneurs and local masons in 11 districts | • Conducted a successful training in Birgunj to a group of entrepreneurs on April 15-16, 2004.<br>• 26 participants from 10 districts were trained on ABF construction, troubleshooting, entrepreneurship, and management techniques | YES |
| Select 25 model VDC and provide orientation and awareness | • Selected 30 VDC from Kapilvastu, Rupendehi, Nawalparasi, Bara, Parsa, and Rautahat for intensive orientation and capacity-building programs<br>• Selected all arsenic-affected wards (180 in total) from the above 30 VDCs for village-level education and awareness activities<br>• Arsenic awareness activities was conducted in the village of Kunwar in Nawalparasi District in collaboration with Nepal Red Cross Society, Asia Arsenic Network of Japan and Filters for Families of USA | YES |
| Start health survey | • Health workers have completed one round of health monitoring in Kapilvastu and Rupendehi Districts<br>• Three rounds of health monitoring will be conducted in collaboration with NRCS starting in June 2004 | YES |
| Setup website | • A website containing information about this DM2003 project has been setup.<br>• This website will be located on the MIT server, and will be available online on June 15, 2004 | YES |

| | | |
|---|---|---|
| Continue to monitor installed ABF (1000+) in all districts | • Over 800 existing ABFs have been monitored for arsenic, iron, phosphorus, flow rate, and pH.<br>• Information about GPS location, number of users, users' comments, etc has been collected as well.<br>• All data have been compiled into an ACCESS database | YES |
| Distribution of ABF to poorest households | • Began to distribute of ABF to the poorest households in Kunwar and Sukrauli.<br>• Additional ABFs (about 400) will be distributed as part of the VDC and Ward-level awareness programs | YES |
| Provide services to other water supply implementers | • We are in constant contact with major water supply implementers, such as NRCS, NEWAH, UNICEF, etc to communicate about the progress of this World Bank project.<br>• We also learned about the progress of their own water supply programs, and we provided technical information and expertise to support their programs.<br>• At the request of a number of water supply implementers, we conducted an experiment to evaluate the accuracy of the ENPHO arsenic test kit to be used to test ABF filtered water. The results showed the ENPHO arsenic test kit is the most accurate among 3 different test kits. | YES |
| Submit a progress report of activities carried out during this period to the Project Liaison | • This is the progress report | YES |

## Problems

The U.S. dollar have fallen in value to as low as $1 to 70 NRs in April, as compared to $1 to 74 NRs at the start of the project. The reduced exchange rate causes insufficient funds to perform all activities as originally planned. ENPHO have to revise their original budget allocated to each activity to compensate for the reduced exchange rate. Currently ENPHO has allocated adequate reserve to cover an exchange rate shortfall of up to $1 to 71 NRs.

The unstable political and security situation continues to cause unexpected delay and changed in scheduled activities. Some meetings and travel plans have to be postponed and cancelled. Therefore, We have to closely monitor the current political and security situation, and to plan our daily activities according to the situation.

The extension for a visa for Tommy Ngai has proven to be more difficult than originally thought. Without visa extension, he, who will be in Boston in June and July, cannot return to Nepal in August. An immediate solution must be found in order for him to return to Nepal to complete this project. We are requesting the World Bank to help us.

## Future Steps

The next milestone (last milestone) deadline is on October 31, 2004. Within this period, we will conduct about 30 VDC-level trainings and about 150 Ward-level trainings. We expect to reach 750 participants in the VDC-level trainings. These participants will be village leaders, health post workers, teachers, VDC officials, and/or other interested agencies. In the Ward-level training, we expect to reach 7500 participants (50 participants in each training). These will be mostly villagers, including women and children. In addition, we will conduct more research into the ABF technology, as well as to conduct one full round of monitoring of all ABFs in the country. Furthermore, health survey and project evaluation will be performed. The next progress report will be submitted on October 31, 2004.

## Appendix A
## Local Entrepreneurs' Training on the Promotion of Arsenic Biosand Filter (Kanchan Filter) Training Report

### Introduction
A Local Entrepreneur Training on the Arsenic Biosand Filter (Kanchan Filter) was conducted at the Nepal Red Cross Society Birgunj office on April 15-16, 2004. This training were provided by representatives from Environment & Public Health Organization (ENPHO), Nepal Red Cross Society (NRCS), Rural Water Supply and Sanitation Support Programme (RWSSSP), and Massachusetts Institute of Technology (MIT). Entrepreneurs from 11 arsenic districts attended the training. They were taught about water quality, arsenic health effects, filter construction and operation, entrepreneur techniques, etc.

### Objectives
*Long term objectives*
- To provide arsenic free/ potable water to those people who are at the risk of arsenic so that arsenicosis can be prevented.
- To develop a local lead agency to supply arsenic removal filters.
- To strengthening the capacity of local NGOs and CBOs for arsenic mitigation.

*Immediate objectives*
- To develop a sustainable mechanism to supply filters at the local level
- To orient the participants about the arsenic problem and different types of household filter
- To train the participants to properly assemble filters

### Expected Outcome
- After this training participants will be able to understand about the arsenic problem and its effect in peoples' health.
- Participants will be able to assemble the Kanchan filter
- Mechanism for the filter distribution will be developed
- One demo ABF unit will be setup at the office of each entrepreneur
- Construction, promotion, and selling of filter will begin

**Duration:** 2 days
**Date:** April 15-16, 2004
**Location:** Nepal Red Cross Society Office, Bigunj

**Participants:**

| S. N. | Name | Organization | VDC/ Municipality | District | Contact Tel. |
|---|---|---|---|---|---|
| 1 | Shiv Prasad Lamichhane | Nepal Water for Health (NEWAH) | Dhangadi | Kailali | 091-523142 |
| 2 | Mohan Prasad Sharma | Bal Kalyan Sewa | Tikapur | Kailali | 091-523142 |
| 3 | Umakanta Phuyal | NEWAH | Dhangadi | Kailali | 091-523142 |
| 4 | Binod Prasad Bhatta | Jana Chetana Samaj | Mahendranagar | Kanchanpur | 099-522357 |
| 5 | Parsuram Tharu | Jana Kendrit Bikas Manch | Gulariya | Bardiya | 084-420324 |
| 6 | Govinda Raj Poudel | Nepal Red Cross Society (NRCS) | Gulariya | Bardiya | 084-520125 |

| | | | | | |
|---|---|---|---|---|---|
| 7 | Yadav Pd. Bhusal | Siddharth Social Development Center | Gajehada-7 Siddhipur | Kapilvastu | 076-560312 |
| 8 | Raju Shah | Indreni Rural Development center | Butwal-4, Jitgadhi | Rupandehi | 071-541882 |
| 9 | Kapila K.C. | Pragatisil Women Development Multipurpose co-operative Ltd. | Makrahar | Rupandehi | 071-562356 |
| 10 | Murari Prasad Gupta | NRCS | Parasi | Nawalparasi | 078-520526 |
| 11 | Tirtha Raj Sharma | NRCS | Parasi | Nawalparasi | 078-520526 |
| 12 | Draupadi Rijal | Community Learning Center | Pithauli | Nawalparasi | 078-540419 |
| 13 | Raju Bishwa | SCAD | Panchanagar | Nawalparasi | 078-590035 |
| 14 | Sanjit Adhikari | Kalaiya Municipality | Kalaiya | Bara | 053-550030<br>053-550260 |
| 15 | Uday Nepal | NRCS | Kalaiya | Bara | 053-551081 |
| 16 | Umashankar Yadav | Social Development and Empowerment Center | Madhuban | Bara | 053-550468 |
| 17 | Binod Prasad Yadav | NGOCC | Birgunj | Parsa | 051-522281 |
| 18 | Uday Raj Sharma | NRCS | Birgunj | Parsa | 051-522525 |
| 19 | Ramananda Thakur | Mudali Club | Mudali | Parsa | No number |
| 20 | Bhagwan Saran Shrestha | YCC | Birgunj | Parsa | 051-522281 |
| 21 | Kedar Thapa | Save The Environment of Nepal (STEN) | Chandraniga hapur | Rautahat | 055-520587 |
| 22 | Hemanta Ray Yadav | NRCS | Gaur | Rautahat | 055-520141 |
| 23 | Prithivi Narayan Chaudhary | NRCS | Gaur | Rautahat | 055-520141 |
| 24 | Nandalal Yadav | Gaur Municipality | Gaur | Rautahat | 055-520298 |
| 25 | Ashok Kumar Yadav | NRCS | Siraha | Siraha | 033-520095 |
| 26 | Govinda Pd. Chaudhary | Bhawani Integrated Development Center | Lahan | Siraha | 033-561789 |

**Facilitators:**

- Roshan Shrestha, Project co-ordinator, ENPHO
- Binod Dahal, Trainer, ENPHO
- Bipin Dangol, Researcher, ENPHO
- Hari Budathoki, Supervisor, ENPHO
- Tommy Ngai, Lecturer & Researcher, MIT
- Uday Raj Sharma, NRCS
- Umesh Sharma, RWSSSP

**Other attendance:**

- Jeebendra Ghimire, Program support officer, ENPHO
- Rajendra Mahato, Health Worker, ENPHO
- Gauri Budathoki, Health Worker, ENPHO
- Shyam Pokharel, Chairman, NRCS
- Balram Khanal, Motivator, NRCS

- Upendra Poudel, DWSS

**Activities carried out during training:**

- Opening remarks by Roshan Shrestha and Shyam Pokharel, chairman of NRCS.
- Presentation by Binod Dahal on water quality and its importance, arsenic health effects
- Presentation by Roshan Shrestha on arsenic contamination in Nepal, and mitigation options
- Presentation by Tommy Ngai and Bipin Dangol on filter performance, construction, installation, operation, maintenance, and troubleshooting.
- Experience sharing on Kanchan Filter by Umesh Sharma (RWSSSP) and Jeebendra Ghimire (ENPHO).
- Discussion led by Roshan Shrestha on entrepreneurs concept, market size, pricing, long-term sustainability, filter promotion, etc.
- Demonstration by Hari Budathoki on ABF construction
- Demonstration by Tommy Ngai and Bipin Dangol on ABF installation
- Practice filter construction by all participants. A total of 10 ABF were constructed.
- Distributed IEC (information, education, communication) materials to all participants including Kanchan Filter general brochure, Kanchan Filter posters, and NASC arsenic posters.
- Provided 10 participants one demo ABF construction materials, including one Gem505 bucket (or Bagmati equivalent), one Gem1700 basin, one Gem016 jug, 5 kg of iron nails, one set of piping system, two wrenches, sample bags of fine sand, coarse sand, and gravel, and two bottles of Piyush. The rest of these participants will receive these materials in a later date.
- Feedbacks from participants were collected
- A copy of all presentations and other relevant information was send to all participants

**Discussion results and feedbacks from participants:**

- Local NGOs can only do social marketing of filters.
- Certificate is needed for local entrepreneurs to make authorized distribution and quality assurance of filters.
- To promote the filters people should make aware about the arsenic at first.
- Provision of subsidy for poor people of arsenic affected areas is necessary.
- Provision of installment basis payment system should be developed for poor people.
- Testing of water quality was given less attention so that people are suffering from various types of water born diseases.
- Due to poor sanitary condition around the house, chance of bacterial contamination in drinking water is high even though water is found good at source.
- Provision of arsenic test kit to all local entrepreneurs is necessary.
- Local entrepreneurs need regular technical support for monitoring of filters.
- The price of should be fixed in district wise basis.
- The local entrepreneurs should not take profit more than 10% of total investment of filter. Out of 10% profit, 5% budget should be allocated for maintenance and monitoring of installed filters.
- Participants agreed on our proposed filter distribution and monitoring mechanism.

**Strength:**

- Participants were given one demo filter will tools and sample sand & gravel so that they can begin setting up the demo filter at their office immediately.

**Weakness:**

- Insufficient preparation. List of proper sand sources were not given to participants. Stickers were not ready. Also, there were only 10 buckets available. Therefore some participants were not given the demo filter.
- Hotel condition was poor. Participants expressed dissatisfaction because of the heat and mosquito. Participants were transferred to another hotel for the second night.
- Participants were informed about the training less than one week before the start date. As a result, some participants were unable to attend.

**Recommendations:**

- Visit each of the entrepreneurs to discuss about their interest and capacity in filter production.
- Check each of the entrepreneurs' filter quality.
- Discuss with each entrepreneur on certification and responsibility.

**Training Cost**

| *Item* | *Total (NRs)* |
|---|---|
| Per diem and travel allowance for participants | 31,650 |
| Lodging for participants | 4,550 |
| Hall Rental | 1,500 |
| Stationaries | 1,778 |
| Meals | 16,785 |
| Tea and Refreshments | 4,519 |
| NRCS helpers | 250 |
| Donation to NRCS | 3,000 |
| Plastic Gem505 with lid, 30 sets | 11,580 |
| Plastic Gem1700 basin, 30 sets | 2,190 |
| Plastic Gem016 mug, 30 sets | 330 |
| Iron nails, 150 kg | 9,300 |
| Wrenchs, 60 pieces | 12,300 |
| Pipe and fittings | 3,975 |
| Print copies of presentation and send to participants | 7,317 |
| Total Training Expense | 111,024 |
| Expense per participant (26 in total) | 4,270 |

## Appendix B

# Arsenic Biosand Filter (Kanchan Filter) Promotion Entrepreneur Guidelines & Draft Contract

**Between**

**Environment and Public Health Organization (ENPHO), Kathmandu, Nepal**

**And**

**Entrepreneur: _____**

**General:**

- Both parties (ENPHO and Entrepreneur) agree to abide the rules and regulations contained in this Contract Agreement

**Specifications:**

- The Entrepreneur must use only materials approved by ENPHO. These materials include:
- Container – Gem Plastic model 505, 50 L capacity, including lid
- Basin – Gem Plastic model 1700, 17 inches diameter
- Iron nails – 5 kg, not more than 25 mm (1 inches) long, non-galvanized nails.
- Piping System – 1.25 cm (1/2 inch) inside diameter PVC and HDP pipe, and G.I. pipe fittings
- Fine Sand – 20 L, from verified source, or similar to samples provided. See attached list for approved source.
- Coarse Sand – 4 L, from verified source, or similar to samples provided. See attached list for approved source.
- Gravel – 6 L, from verified source, or similar to samples provided. See attached list for approved source.
- Piyush – 2 bottles obtain from ENPHO
- Filter Installation Guide – obtain from ENPHO
- Operation Procedure Sticker – obtain from ENPHO
- Kanchan Filter Brochure – obtain from ENPHO
- Appropriate amount of Fine sand, coarse sand, gravel, and iron nails must be measured and kept in separate bags. These materials must be installed inside the filter at the customer's location only.
- Entrepreneurs must only produce the filter according to procedures taught during the training provided by ENPHO.

**Pricing:**

- The selling price for the Kanchan Filter cannot exceed 1500 Rs. This maximum selling cannot be changed unless the Entrepreneur receives approval from ENPHO.
- The cost of all above mentioned materials is included in the 1500 Rs. selling price.
- The maximum price of 1500 Rs. does not include transportation to the customer's location, and does not include on-site installation.

**Responsibilities:**

- The Entrepreneur will gather all necessary materials for the Kanchan Filter.
- The Entrepreneur will clean all necessary materials, to assemble the filter piping system, and to drill holes in the basin.
- The Entrepreneur must explain the final installation procedure and operation & maintenance procedure to customers.
- The Entrepreneur must keep record of all filters sold. The record must be in the format shown in the attached form. There are two forms. The Kanchan Filter Individual Sales Record Form is for individual customers. The Kanchan Filter Bulk Sales Record Form is for institutional customers or large volume sales.
- The Entrepreneur must keep record of customers' feedback/comments when the customers provide it.
- The record must be kept in a legible and organized format, and must be provided to ENPHO when requested.
- The Entrepreneur can only manufacture and/or sell the Kanchan Filter within their certification period. The Entrepreneur is responsible to obtain certification extension from ENPHO before the certification expires. In no event should the Entrepreneur manufacture and/or sell the Kanchan Filter without certification.
- The Entrepreneurs must always maintain a functioning demonstration Kanchan Filter unit at its office.
- The Entrepreneur must always keep a minimum of 5 complete sets of ready-to-be-sold filters in the office.
- The Entrepreneur will provide filter maintenance services such as trouble-shooting and filter installation to customer at a price determined by the Entrepreneur. These costs are in additional to the 1500 Rs. selling price of the Kanchan Filter.
- If the Entrepreneur encountered any problems regarding any aspect of the filter, management, selling, and/or promotion, the Entrepreneur should consult with ENPHO.

**Others:**

- The Entrepreneur will provide arsenic testing services to customer using ENPHO's Arsenic Field Test Kit. Training on the use of the test kit will be provided by ENPHO.
- One ENPHO Arsenic Field Test Kit will be provided by ENPHO to the Entrepreneur. Additional reagents can be obtained from ENPHO.
- The price charged by the Entrepreneur to customers for arsenic testing service will be determined by the Entrepreneur.

- ENPHO will assist the Entrepreneur on the promotion of the Kanchan Filters in arsenic-affected districts through public education, awareness workshops, mass media, and discussion with water supply implementers and other interested parties.
- ENPHO will provide follow-up training on issues related to water, filter, testing, etc. to Entrepreneur at appropriate time.

**Modification and Termination:**

- ENPHO may terminate the Entrepreneur's certification in the event that sufficient evidence has shown that Entrepreneur fails to achieve any of the rules and obligations described in this contract agreement, and fails to provide adequate reasons.
- This Agreement may only be modified in writing, signed by both ENPHO and the Entrepreneur.

| For ENPHO: | For Entrepreneur: |
|---|---|
| _____ | _____ |
| Roshan Shrestha | Chairperson/ Secretary |
| _____ | _____ |
| [print name] | [print name] |
| _____ | _____ |
| [date] | [date] |

**Kanchan Filter Individual Sales Record Form**

| S/N | Date | Customer's Name | District | VDC | Ward No. | Tole | No. of people using filter | Price Paid | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

**Kanchan Filter Bulk Sales Record Form**

| S/N | Date | Implementation Agency | Implementation Area (District, VDC, Ward No., Tole) | No. of Filter Purchased | Total Price Paid | Remarks |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |

Note: After filter distribution by the implementation agency, obtain detail information of all filter users (including Name, district, VDC, Ward No., Tole, Number of users) from the implementation agency.

**List of Verified Sand and Gravel Sources**

| District | Source | Media | Remarks |
|---|---|---|---|
| Kapilvastu | Ram Ghat Khola | Fine sand | |
| Rupandehi | Tinaun Khola Crusher | Coarse sand & Gravel | Sieve their 6-12 mm gravel to obtain coarse sand (smaller) and gravel (larger) |
| Rupandehi | Tinaun Khola | Fine sand | |
| Nawalparasi | Dumkibas Khola | Fine sand | |
| Bara | Dudhaura Khola | Coarse sand & Gravel | Sieve the mixed up coarse sand and gravel |
| Rautahat | Bagmati Khola | Fine sand | Very good quality fine sand found 1 km south of bridge |
| Rautahat | Bagmati Khola | Coarse sand & Gravel | Sieve the mixed up coarse sand and gravel |

Note: Proper Sand and Gravel can be obtained at sources other than those listed above as long as the quality matches with the samples given during the training.

## Appendix C
## Compare Accuracy of Three Arsenic Test Kits

| Sample No. | ENPHO lab (AAS) | regular ENPHO test kit | HCl ENPHO test kit | ITS test kit | RELATIVE PERCENTAGE DIFFERENCE regular ENPHO test kit | HCl ENPHO test kit | ITS test kit |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 101 | 20 | 10 | 15 | 20 | 50.0% | 25.0% | 0.0% |
| 102 | 39 | 40 | 40 | 100 | 2.6% | 2.6% | 156.4% |
| 103 | 13 | 10 | 10 | 10 | 23.1% | 23.1% | 23.1% |
| 4 | 56 | 30 | 40 | 70 | 46.4% | 28.6% | 25.0% |
| 6 | 13 | 30 | 50 | 50 | 130.8% | 284.6% | 284.6% |
| 23 | 25 | 40 | 40 | 30 | 60.0% | 60.0% | 20.0% |
| 15 | 52 | 90 | 70 | 100 | 73.1% | 34.6% | 92.3% |
| 10 | 6 | 10 | 5 | 10 | 66.7% | 16.7% | 66.7% |
| 30 | 25 | 10 | 25 | 10 | 60.0% | 0.0% | 60.0% |
| 77 | 40 | 10 | 10 | 50 | 74.7% | 74.7% | 26.6% |
| 27 | 34 | 20 | 85 | 90 | 40.3% | 153.7% | 168.7% |
| 18 | 0 | 0 | 50 | 100 | | | |
| 8 | 10 | 20 | 30 | 30 | 100.0% | 200.0% | 200.0% |
| 207 | 24 | 0 | 20 | 10 | 100.0% | 16.7% | 58.3% |
| 208 | 19 | 10 | 20 | 20 | 47.4% | 5.3% | 5.3% |
| 209 | 15 | 30 | 10 | 20 | 100.0% | 33.3% | 33.3% |
| 7 | 19 | 20 | 10 | 20 | 8.1% | 45.9% | 8.1% |
| 401 | 0 | 0 | 0 | 0 | | | |
| 402 | 8 | 0 | 0 | 0 | 100.0% | 100.0% | 100.0% |
| 404 | 5 | 0 | 0 | 0 | 100.0% | 100.0% | 100.0% |
| 405 | 10 | 5 | 5 | 5 | 50.0% | 50.0% | 50.0% |
| 406 | 37 | 80 | 40 | 80 | 116.2% | 8.1% | 116.2% |

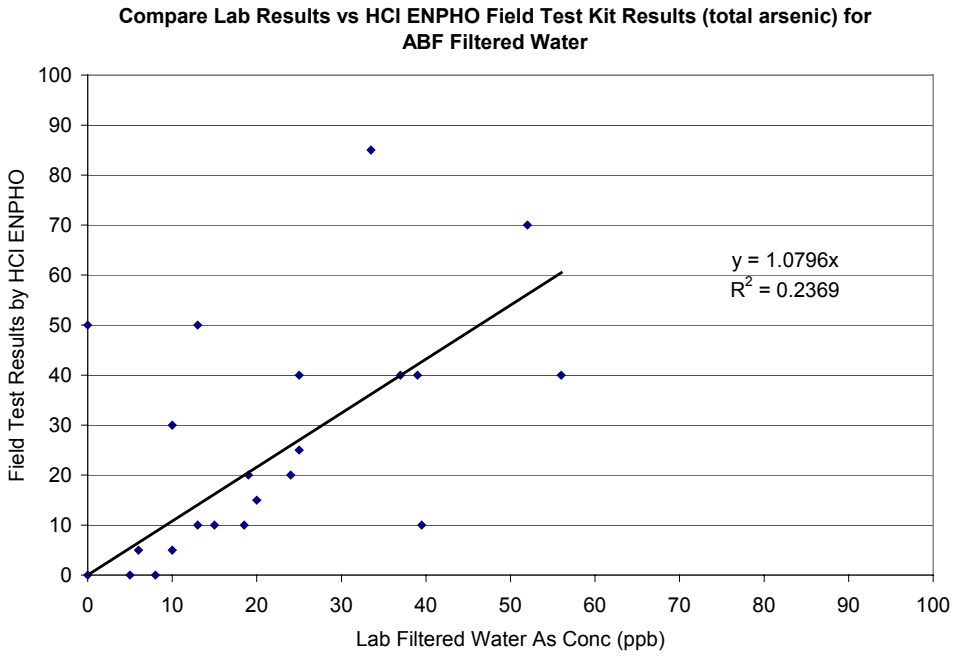
**Note:**

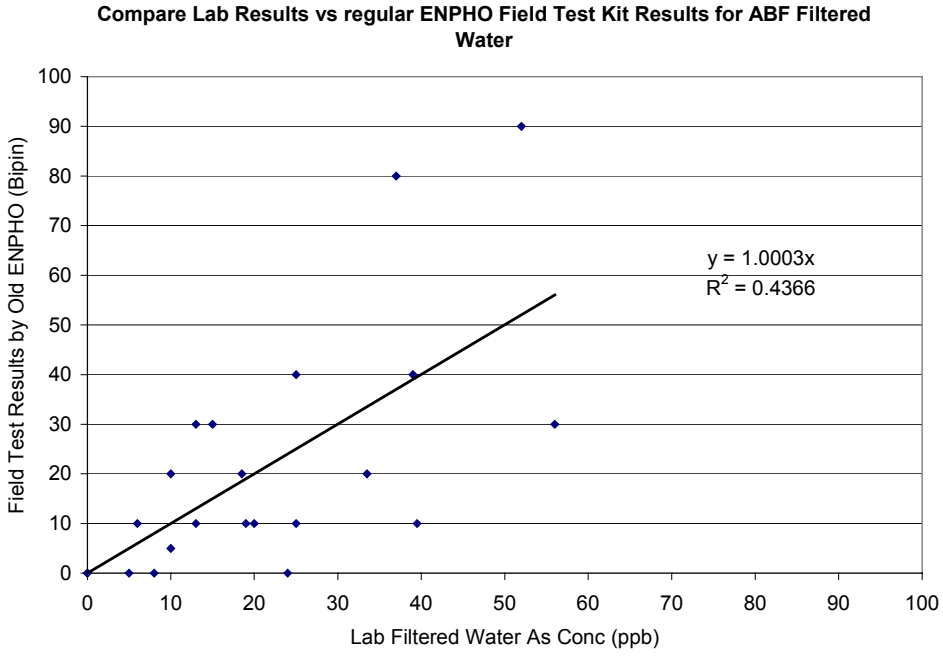
The regular ENPHO kit refers to the existing test kit that consists of ascorbic acid tablet. It is known that this test kit can only detect As(III), but not As(V)

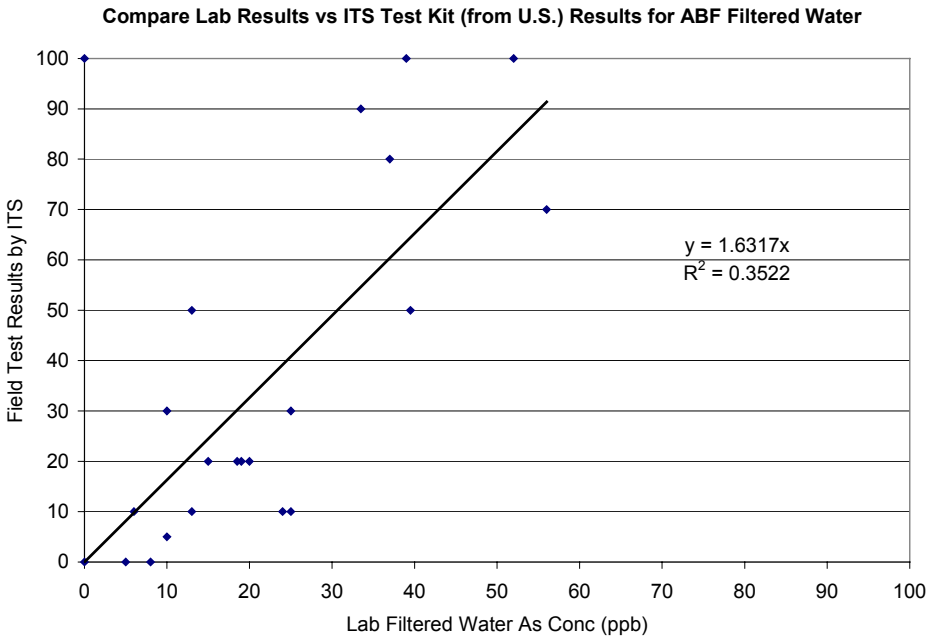
The HCl ENPHO kit uses HCl acid. Because of the lower pH, both As(III) and As(V) can be converted to arsenic gas. Therefore, this HCl ENPHO kit can detect total arsenic.

The ITS test kit is purchased from the U.S. This test kit has been approved by the U.S. Environmental Protection Agency for arsenic testing in the U.S.

The filtered water arsenic concentration is NOT representative of the filters in general. The above filters have been selected because they were not installed properly and therfore exhibits a higher than normal arsenic concentration in the filtered water.


Compare Lab Results vs HCl ENPHO Field Test Kit Results (total arsenic) for ABF Filtered Water
Field Test Results by HCl ENPHO
Lab Filtered Water As Conc (ppb)
y = 1.0796x
R2 = 0.2369
0
10
20
30
40
50
60
70
80
90
100


Compare Lab Results vs regular ENPHO Field Test Kit Results for ABF Filtered Water
Field Test Results by Old ENPHO (Bipin)
Lab Filtered Water As Conc (ppb)
y = 1.0003x
R2 = 0.4366
0
10
20
30
40
50
60
70
80
90
100


Compare Lab Results vs ITS Test Kit (from U.S.) Results for ABF Filtered Water
Field Test Results by ITS
Lab Filtered Water As Conc (ppb)
y = 1.6317x
R2 = 0.3522
0
10
20
30
40
50
60
70
80
90
100

## Appendix D
## Monitoring Form

### Field Monitoring Form (English version, Page 1)

| | |
|---|---|
| Sampling Date and Time | |
| Your Name | |

| | |
|---|---|
| District | |
| VDC | |
| Ward No. | |
| Tole | |

**ARSENIC BIOSAND FILTER INFORMATION**

| | | |
|---|---|---|
| User's Name | | |
| ABF ID (to be determinated in office) | | |
| Photo Number | | |
| GPS location | Accuracy:<br>Elevation:<br>X-coordinate:<br>Y-coordinate: | |
| Type of ABF | (1) Concrete, round<br>(2) Concrete square | (3) Plastic, round<br>(4) Plastic, square |
| ABF Provided by | (1) NRCS<br>(2) RWSSSP<br>(3) RWSSFDB | (4) Others, specify: |
| ABF Installation Date | | |
| Source of Sand | (1) River<br>(2) Crushed<br>(3) Don't know, supplied by installation agency | (4) Others, specify: |
| Source of Iron Nails | | |
| Quantity of Iron Nails (kg) | | |
| Number of Households | | |
| Number of ABF Users | | |
| Filter Currently in Use? | (1) Yes, everyday<br>(2) Yes, sometimes | (3) No, explain why: |
| Use of Water (check all that applies) | (1) Drinking<br>(2) Cooking<br>(3) Washing | (4) Others, specify: |
| User's Contributions Towards this ABF (check all that applies) | (1) Labour, specify:<br>(2) Cash, how much:<br>(3) Materials, specify:<br>(4) Others, specify: | |
| Sanitary Conditions Around ABF | (1) Clean<br>(2) Moderate | (3) Poor<br>(4) Very dirty |
| Source of Drinking Water | (1) Tube Well<br>(2) Dug Well<br>(3) Spring | (4) Others, specify: |
| Sludge Disposal Location | (1) Cow Dung<br>(2) Ditch<br>(3) Field | (4) Anywhere<br>(5) Others, specify: |
| Owner's household has an arsenic patient? (take picture if yes) | (1) Yes, name:<br>(2) No | |
| Owner knows somebody (non-household member) who is an arsenic patient? | (1) Yes<br>(2) No | |
| When away from home, what do the users drink? | (1) ABF filtered water from home<br>(2) Safe tube wells<br>(3) Any available water source | (4) Others, specify: |

## Field Monitoring Form (English version, Page 2)

| | | |
|---|---|---|
| Filter Cleaning Frequency | (1) once every week<br>(2) once every two weeks<br>(3) once a month | (4) once every 2-4 months<br>(5) never |
| Date of Last Cleaning | | |

**FIELD MONITORING RESULTS**

**pH**

| Influent | Effluent | Test Method/ Instrument | Remarks |
|---|---|---|---|
| | | | |

**Flow rate**

| Time to Fill 100mL Bottle (seconds) | Water Level in Diffuser Box (select one:) | Remarks |
|---|---|---|
| | Full, 3/4, 1/2, 1/4, Empty | |

**Arsenic**

| Influent (ug/L) | Effluent (ug/L) | Test Method/ Instrument | Remarks |
|---|---|---|---|
| | | | |

**Iron**

| Influent (mg/L) | Effluent (mg/L) | Test Method/ Instrument | Remarks |
|---|---|---|---|
| | | | |

**Phosphorus**

| Influent (mg/L) | Effluent (mg/L) | Test Method/ Instrument | Remarks |
|---|---|---|---|
| | | | |

**TUBE WELL INFORMATION**

| | | |
|---|---|---|
| Tube Well Contact Person | | |
| Tube Well Number | | |
| Tube Well Provided by | (1) NRCS<br>(2) RWSSSP<br>(3) DWSS<br>(4) NEWAH<br>(5) RWSSFDB | (6) PLAN Nepal<br>(7) Private<br>(8) Others, specify: |

**USER'S COMMENTS**

| | |
|---|---|
| Comments Category | (1) filter installation and O&M issues<br>(2) water quality issues<br>(3) health and hygiene issues<br>(4) others |
| Detail Comments | |

**YOUR OBSERVATIONS AND COMMENTS**

## Appendix E

**Guidelines on Local Entrepreneurs Training**

**Introduction:**

In the Terai region of Nepal, shallow tube wells represent the main drinking water sources for most people. The water from the tube wells were considered to be safer than the water from dug well and ponds, and were believed to contribute to the reduction of water-borne diseases. In addition, the installation and running cost is generally affordable by communities. Therefore, tube well was an attractive and popular drinking water option, from both water supply implementers' and users' point of view. As a result, about 500,000 tube wells have been installed throughout the Terai, of which about 80% are private and remaining are public. Recently, the detection of arsenic contamination in ground water has raised serious health concern in Nepal. Arsenic is a poison. Long-term consumption of arsenic contaminated water can cause skin diseases and cancer in various human organs. According to national data, approximately 8% of all tube wells in the Terai are found to contain arsenic concentration above 50 ppb, which is the Nepal Interim Standard. There is no appropriate remedy for arsenic-affected patients besides the discontinuation of drinking arsenic contaminated water. Therefore, the consumption of arsenic-free water can help to prevent arsenic-related health concerns for Terai villagers.

To this end, MIT, ENPHO, and RWSSSP have developed a household-level arsenic removal filter after intensive research for 3 years. This Arsenic Biosand Filter (ABF), which is called Kanchan filter in Nepali, is an improve version of Biosand Filter initially developed by a Canadian scientist Dr. David Manz. Currently about 1000 Kanchan filters have been provided to arsenic affected communities by RWSSSP, NRCS, and RWSSFDB with the technical support of ENPHO. However, most people in arsenic affected areas still lack access to this filter. One reason is that only national-level organizations are involved in filter distribution in their operating regions. This raised the issue about how to make the filter easily accessible for most people. There is also the concern about the lack of proper training of the current users about filter operation and maintenance provided by these filter-providing agencies. To fill this information and accessibility gap, the concept of local entrepreneurs was developed. Local NGOs, CBOs and local technicians can act as local entrepreneurs. The local entrepreneurs can play a key role to prepare and supply filters to users. The entrepreneurs will be responsible to control filter quality. The entrepreneurs will also conduct the activities among arsenic-affected community to raise public awareness on arsenic, and to monitor the supplied filters.

Therefore, an orientation program for local entrepreneurs is necessary. This program is organized under the Arsenic Biosand Filter Promotion Program.

**Objectives:**

*Long term objectives*

- To provide arsenic free/ potable water to those people who are at the risk of arsenic so that arsenicosis can be prevented.
- To develop a local lead agency to supply arsenic removal filters.
- To strengthening the capacity of local NGOs and CBOs for arsenic mitigation.

*Immediate objectives*

- To develop a sustainable mechanism to supply filters at the local level
- To orient the participants about the arsenic problem and different types of household filter
- To train the participants to properly assemble filters

**Expected Outcome:**

- After this training participants will be able to understand about the arsenic problem and its effect in peoples' health.
- Participants will be able to assemble the Kanchan filter
- Mechanism for the filter distribution will be developed
- One demo ABF unit will be setup at the office of each entrepreneur
- Construction, promotion, and selling of filter will begin

**Duration:** 2 days

**Participants:**

- 30 participants in each orientation (including representative of local NGOs, CBOs and local technicians in arsenic-affected areas)

**Facilitators:**

| | |
|---|---|
| • Engineer | 1 |
| • Water Quality Expert | 1 |
| • Health & Sanitation Expert | 1 |
| • Chemist | 1 |

**Materials Required:**

| | |
|---|---|
| • This training manual | 1 |
| • List of local entrepreneurs and addresses | 1 |
| • Gem 505 plastic bucket | 25 |
| • Gem 1700 plastic basin | 25 |
| • Gravel | 30 L |
| • Coarse sand | 30 L |
| • Fine sand | 150 L |
| • Piyush | 50 bottles |
| • Iron nails | 125 kg |
| • One liter measuring cup (Gem 016) | 25 |
| • Pipe, fittings, Teflon tape, etc. | 25 sets |
| • Tools | 25 sets |
| • ABF Posters (3 per participant) | 90 plus some extra |
| • NASC Poster (3 per participant) | 90 plus some extra |
| • ABF Brochure (10 per participant) | 300 plus some extra |
| • ABF Sticker poster (10 per participant) | 300 plus some extra |
| • My Clear Bag | 30 |
| • Notebook | 30 |
| • Dot-pen | 30 |
| • Certificates for participant | 30 |
| • Meta card | some |
| • Food | 40 people |

**Activities:**

*Pre-training activities (1 week before actual training day)*

- Confirm training location, date, and time
- Inform participants about training location, date, and time
- Purchase and transport all necessary materials (e.g. sand, buckets, tools) to training location

*Schedule /Content of Orientation*

| 1st Day | | | |
|---|---|---|---|
| Time | Contents | Teaching/Learning Activities | Person in charge |
| 9:00-10:00 | Registration of Participants | Self | Hari |
| | Breakfast | | Hari |
| | Participants' expectation collection | Meta card | Hari |
| 10:00-10:15 | Introduction to DM program and training objective | Lecture | Kala |
| 10:15-11:15 | NGOs sharing experience in water supply | Discussions | Binod |
| 11:15-11:45 | Water quality and its importance | Explanation, discussion, demonstration | Binod |
| 11:45-12:00 | Tea Break | | Hari |
| 12:00-12:45 | Arsenic contamination in drinking water, situation of arsenic in Nepal and its health affects | Explanation using IEC materials | Roshan |
| 12:45-13:15 | Arsenic removal techniques | Explanation/ Discussions | Roshan |
| 13:15-14:15 | Lunch Break | | Hari |
| 14:15-14:30 | Participants' experience on ABF | Meta card | Binod |
| 14:30-15:30 | Introduction to ABF, types of ABF Efficiency of ABF regarding physical, chemical and biological parameters | Explanation and discussions | Tommy and Bipin |
| 15:30-16:30 | Construction and Installation process of filters | Explanation by using drawing | Tommy and Bipin |
| 16:30-16:45 | Tea Break | | Hari |
| 16:45-17:30 | Concept of Local entrepreneurs and its importance | Presentation | Roshan |
| 17:30-18:00 | Questions | | Binod |
| 18:00-18:30 | Rest | | Hari |
| 18:30-19:30 | Dinner | | Hari |

| 2nd Day | | | |
|---|---|---|---|
| 8:00-8:30 | Breakfast | | Hari |
| 8:30-9:00 | Review of previous day | Ask participants to explain lessons learned | Binod |
| 9:00-11:00 | Demo filter installation | Practical | Tommy |

| | | | |
|---|---|---|---|
| | | Each participant will construct a filter | and Bipin |
| 11:00-12:00 | Lunch | | Hari |
| 12:00-14:30 | Discussion on how to obtain filter materials, promote and distribute filters, make profit, keep business sustainable, deal with donors, government and general public | Group discussions | Roshan, Kala, Binod, Tommy, Bipin |
| 14:30-15:00 | Commitments from local entrepreneurs | | Binod |
| 15:00-15:30 | Certificate distribution and closing | | Red Cross |
| 15:30-17:00 | Questions | Optional | Binod |

*Post-training activities*

- Each of the entrepreneurs will setup one demo ABF in their office
- Visit each of the entrepreneurs to observe their progress on filter construction, promotion, and selling
- Provide follow up training if necessary
- Provide additional IEC materials if necessary

**Budget:**

| *Item* | *Units* | *Rate (NRs)* | *Total (NRs)* |
|---|---|---|---|
| Per diem allowance for participants (2 ½ days) | 30 | 625 | 18,750 |
| Transportation for participants (return bus ticket) | 30 | 350 | 10,500 |
| Lodging (2 nights) | 40 | 200 | 8,000 |
| Hall Rental | n/a | 1,500 | 1,500 |
| Demo ABF | 25 | 1,300 | 32,500 |
| Tools | 25 | 1,000 | 25,000 |
| Stationaries | 30 | 50 | 1,500 |
| ABF Poster | 100 | 25 | 2,500 |
| ABF Brochure | 300 | 10 | 3,000 |
| ABF Sticker poster | 300 | 20 | 6,000 |
| NASC Poster | 300 | free | 0 |
| Certificates | 40 | 50 | 2,000 |
| Lunches (2 meals) | 40 | 160 | 6,400 |
| Dinners (3 meals) | 40 | 240 | 9,600 |
| Refreshment | 40 | 100 | 4,000 |
| Others | n/a | 3,750 | 3,750 |
| Total Expense | | | 135,000 |
| Expense per participant | | | 4,500 |

## Guidelines on VDC-Level Orientation

### Objectives:

- To increase the awareness among VDC members, health post, teachers about water related diseases, health, hygiene, and sanitation
- To inform about various treatment options for arsenic and bacteria removal
- To demonstrate the installation, operation, and maintenance of ABF
- To orient on how to obtain a filter (local entrepreneurs contact information) and available subsidy
- To build local capacity on safe water provision, promotion, monitoring, and management

### Expected Outcome:

- Participants will understand about arsenic and its effect on health
- Participants will understand about various mitigation options
- Participants will know how to obtain, install, operate, and maintain an ABF
- Participants will make informed decision on appropriate safe water options

### Participants:

- 25 participants per VDC, including VDC members, health post workers, doctors (if any), teachers, and other relevant persons. It is desirable to have many women participants.
- Minimum of three staff from NRCS, ENPHO, or RWSSSP.
- One should be a Support Officer/Trainer/Supervisor who is familiar with water management, entrepreneur training, financing and subsidy options, and ABF promotion techniques.
- The other staff can be health workers or motivators who are familiar with arsenic and trained on ABF installation, operation, maintenance, and troubleshooting technique

### Duration:

- 6-7 hours

### Materials Required:

| | |
|---|---|
| • Copy of this training guideline | 1 |
| • Copy of entrepreneurs list for all districts | 1 |
| • Assembled Gem505 Filter | 1 |
| • Gravel (washed) | 4 L |
| • Coarse sand (washed) | 4 L |
| • Fine sand (washed) | 25 L |
| • Piyush | 2 bottles |
| • Iron nails | 5 kg |
| • One liter measuring cup (Gem 016) | 1 |
| • Posters, 1 per participant | 25 plus some extra |
| • Brochures, 5 per participants | 125 plus some extra |
| • Additional educational materials and aids | some |
| • Stationary (pens, notebooks) for participants | 25 |
| • Video projector | 1 |
| • Laptop computer | 1 |
| • Camera | 1 |
| • Lunch and Refreshment | 30 people |

**Activities:**

*Pre-workshop activities (1 week before actual workshop day)*

- Identify location for workshop (e.g. health post, VDC office, meeting hall, school)
- Inform VDC members, health post workers, teachers and other relevant persons about workshop date, time, and location
- Transport assembled filter and prepared & washed media to workshop location

*Detailed workshop activities*

| *Activities* | *Duration (hours)* | *Remarks* |
|---|---|---|
| Registration, opening remarks | 0.25 | Collect names of all participants |
| General information on water quality, health, hygiene, sanitation | 0.5 | Use of video, posters and other visual aids |
| Information on arsenic, testing results, and its health effects | 0.75 | Show pictures of arsenicosis effects<br>Explain health survey results |
| Tea break | 0.25 | |
| Discussion on mitigation options including ABF, dug well, etc<br>Explain advantages and disadvantages of each options | 0.5 | Obtain opinions from VDC members on which options they prefer |
| Distribution of IEC materials | 0.25 | One ABF poster and five brochure for each participants<br>Posters and stickers posted in easy to see places |
| Discussion on water provision, management, user payment, financing, subsidy, monitoring | 1 | Provide entrepreneur list including contact information |
| Lunch | 1 | |
| Demonstration on ABF installation, operation and maintenance, and monitoring | 1.5 | Demo ABF unit |
| Questions | 0.5 | More time if necessary |
| Total | 6.5 | |

*Post-workshop activities*

- Arrange follow-up meeting to clarify any concerns and confusions
- Monitor new filters in August and September 2004

**Budget**

| *Item* | *Units* | *Rate (NRs)* | *Total (NRs)* |
|---|---|---|---|
| Refreshment | 30 | 20 | 600 |
| Lunch | 30 | 50 | 1,500 |
| Stationeries | 25 | 30 | 750 |
| Other logistics | n/a | n/a | 150 |
| Total Expense per VDC | | | 3,000 |

Note: Cost for demo filter, tools and IEC materials are not included above

**Guidelines on Ward-Level Awareness Workshop**

**Objectives:**

- To increase the awareness among villagers about water related diseases, health, hygiene, and sanitation
- To inform villagers of treatment options such as dug well and ABF
- To demonstrate the installation, operation, and maintenance of ABF
- To orient villagers on how to obtain a filter (local entrepreneurs contact information) and available subsidy

**Expected Outcome:**

- Participants will understand about arsenic and its effect on health
- Participants will understand various mitigation options
- Participants will know how to obtain, install, operate, and maintain an ABF

**Participants:**

- 50 villagers per ward. It is desirable to have as many women participants as possible.
- Minimum of two health workers from NRCS, ENPHO, or RWSSSP who are familiar with arsenic and trained on ABF installation, operation, maintenance, and troubleshooting technique

**Duration:**

- 3 to 4 hours

**Materials Required:**

| | |
|---|---|
| • Copy of this training guideline | 1 |
| • Copy of entrepreneurs list for all districts | 1 |
| • Assembled Gem505 Filter | 1 |
| • Gravel (washed) | 4 L |
| • Coarse sand (washed) | 4 L |
| • Fine sand (washed) | 25 L |
| • Piyush | 2 bottles |
| • Iron nails | 5 kg |
| • One liter measuring cup (Gem 016) | 1 |
| • Posters to be posted in the ward | 5 plus some extra |
| • Brochures for participants | 50 plus some extra |
| • Additional educational materials and aids | some |
| • Camera | 1 |
| • Refreshment | 50 people |

**Activities:**

*Pre-workshop activities (1 week before actual workshop day)*

- Identify location for workshop (e.g. open space or at villager's home)
- Inform VDC and villagers about workshop date, time, and location

*Detailed workshop activities*

| *Activities* | *Duration (hours)* | *Remarks* |
|---|---|---|
| Registration, opening remarks | 0.25 | Collect names of all participants |
| General information on water quality, health, hygiene, sanitation | 0.25 | Use of posters and other visual aids |
| Information on arsenic, testing results, and its health effects | 0.5 | Show pictures of arsenicosis effects<br>Explain health survey results |
| Information on mitigation options including ABF, dug well, etc | 0.25 | Explain advantages and disadvantages of each options |
| Distribution of IEC materials | 0.25 | One ABF brochure for each participants<br>Posters and stickers posted in easy to see places |
| Tea break | 0.25 | |
| Demonstration on ABF installation, operation and maintenance | 1 | Demo ABF unit |
| Information on how to obtain a filter, and available subsidy | 0.25 | Entrepreneur list is available at VDC and NRCS offices |
| Questions from villagers and Closing | 0.5 | More time if necessary |
| Total | 3.5 | |

*Post-workshop activities*

- Obtain from local entrepreneurs name and address of users who have obtained a filter from the entrepreneurs. This will assist us to update our ABF database for easy future monitoring
- Obtain from subsidy provider name and address of users who have obtained filter subsidy. This will assist us to update our ABF database
- Monitor new filters in August and September 2004

**Budget**

| *Item* | *Units* | *Rate (NRs)* | *Total (NRs)* |
|---|---|---|---|
| Refreshment | 50 | 15 | 750 |
| Other logistics | n/a | n/a | 50 |
| Total Expense per Ward | | | 800 |

Note: Cost for demo filter, tools and IEC materials are not included above