An Assessment of the Performance of the Kanchan Arsenic Filter (KAF) in Nawalparasi

FINAL REPORT

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GLOSSARY AND ABBREVIATIONS

AAS	-	Atomic Adsorption Spectrophotometer
ABF	-	Arsenic Biosand Filter
DDC	-	District Development Committee
DWQIP	-	Drinking Water Quality Improvement Program
DWSS	-	Department of Water Supply and Sewerage
E Coli.	-	Escherichia coli
ENPHO	-	Environment and Public Health Organization
GoN	-	Government of Nepal
HCl	-	Hydrochloric Acid
HH	-	Household
HWT	-	Household Water Treatment
JICA	-	Japan International Cooperation Agency
JRCS	-	Japan Red Cross Society
KAF	-	Kanchan Arsenic Filter
mg/L	-	Milligram per Liter
MIT	-	Massachusetts Institute of Technology
NDQWS	-	National Drinking Water Quality Standard
NRCS	-	Nepal Red Cross Society
PPB	-	Parts Per Billion
RWSSSP	-	Rural Water Supply and Sanitation Support Programme
VDC	-	Village Development Committee
WASH	-	Water, Sanitation and Hygiene

EXECUTIVE SUMMARY

Background

Elevated arsenic levels in drinking water from groundwater sources in the Terai region of Nepal is a big public health concern. The state of arsenic in Nepal 2011 report showed that 1.73% of the tested tube wells contained more than 50 ppb, the national drinking water standard in Nepal, and 7.1% of tube wells contained more than 10 ppb, the WHO guideline value for safe drinking water. Out of 20 districts in Terai, Nawalparasi is the most arsenic affected area in Nepal as 11.69% of tested tube wells contained an arsenic concentration above 50 ppb.

With aim to providing arsenic-free safe drinking water, several agencies have provided arsenic mitigation options such as the Kanchan Arsenic Filter (KAF), improved dug well, Arsenic Iron Removal Plants (AIRP), deep tube wells and extension of gravity flow water supply schemes at the arsenic affected communities. It is estimated that more than 5,000 KAFs have been distributed in Nawalparasi district by different agencies. However, the current status of the distributed KAFs is unknown. This study has been designed to assess the current status of KAFs in Nawalparasi district and evaluate their performance.

Methodology

The study was designed upon the completion of a desk study and a household study carried out through the use of a questionnaire. The survey was completed at 2833 households in two phases: detailed survey at 989 households (phase I) and rapid survey at 1844 households (phase II). The water quality testing at the field level was completed using ENPHO field test kits for pH, Iron, hardness and phosphate. For arsenic analysis, the field staff carried out sampling of raw water and treated water for functional KAFs and these samples were dispatched to the ENPHO laboratory for analysis using the Atomic Adsorption Spectrophotometer (AAS). The microbiological analysis was completed for Faecal Coliforms using the Del Aqua test kit at the field level.

KAF Functionality

The household survey was performed in 2,833 households from 21 VDCs/municipalities in Nawalparasi district. Out of 2,833 households, only 792 (28%) of households (HH) were using the KAF on a regular basis and 58 HHs (2%) were using the KAF irregularly. Approximately 70% of HHs were not using the KAF out of which, 45% of HHs responded that they are directly drinking from arsenic contaminated water while approximately 25% of HHs are drinking water from alternative safe water sources.

Around 30.5% of KAFs were not in use due to a leakage problem, while 25.4% filters were found broken. Approximately 15.5% of KAFs have both breakage and leakage problems. Therefore, almost 71% of KAFs were not in operation due to either breakage and/or leakage problems. Nearly 82% of the plastic round (GEM505) version of the KAFs have breakage and/or leakage problems, while almost 10% of the plastic square version have such problems. The concrete versions of KAFs have less breakage and leakage problems compared to the plastic versions; only 1.5% of concrete round KAFs and 6% of concrete square KAFs have reported leakage and/or breakage problems.

The majority of the KAFs were 8-10 years old (27.3%) followed by over 10 years (20.7%) and 4-6 years old (20.3%). This shows that most of the provided filters are more than 4 years old. There are some KAFs (approximately 3%) which are less than 6 months, recently provided by NGOs and local entrepreneurs. Less than 1% HHs did not know the age of the filters.

Altogether 1,818 HHs were provided with the GEM505 version while 501 households were provided with the concrete square version of the KAF. Altogether 269 and 242 HHs were provided with concrete round and plastic hilltake versions of the KAF respectively. Only 3 households were provided with the fiberglass version of the KAF. It was found that 80% of the distributed concrete square version were in use, the highest percentage in comparison to other versions of the KAF. Approximately 47%, 29% and 36% of concrete round, GEM505 and Plastic Hilltake versions of KAF respectively were in use at the time of the survey. Approximately 81% of the KAFs that were distributed more than 10 years ago were not found to be functional whereas only 4% of the KAFs that were distributed 6 months ago or less were not functioning. The dropout rate for the concrete square version is low whereas the plastic round (GEM505) version is high compared to other versions.

Based on the observations by the field team, it was found that 408 filters were in good condition, while 56 filters were found in bad condition. It was found that 34 HHs are still using their KAF even though some parts of the KAF were broken. Almost 77% (382) of filters have clean sanitary condition, whereas 20% (101) KAFs have fair sanitary condition around the KAF. The field team observed dirty and very dirty sanitary conditions around 12 and 3 KAF respectively. These filters may have high risk of microbial contamination.

KAF Water Quality

Table I shows the summary result of water quality tests of all physico-chemical parameters in raw (tube wells) and filtered water of the 497 operational KAFs. The total number of samples for fecal coliform is 30. Arsenic and fecal coliform are considered as the most important parameters. Both the mean and median recorded values of arsenic in raw water are above the Nepal drinking water standard of 50 ppb. The KAF showed good performance of removing arsenic: 83% removal for median value and 75% removal for mean value. Fecal coliform is also high in raw water with 24cfu/100mL as median and 72.86cfu/100mL as mean value. The KAF showed good performance for bacterial removal in this study as 97% in median and 85% in mean value after filtration. KAF showed iron removal capacity as 100% removal for median and 97% removal for mean.

Table I: Overall water quality test result and removal % of KAF *(n=497), fecal coliform (n=30)*

Water Quality Parameters	Raw (tube wells) water			Filtered water			Removal %		
	Range	Median	Mean	Range	Median	Mean	Range	Median	Mean
Arsenic (ppb)	0-1320	60	91.57	0-590	10	25.72	0-100	83	75
Fecal Coliform (cfu/100ml)	0-TNTC	24	72.86	0-170	1	12.53	0-100	97	85
Iron (mg/L)	0-10	3	3.22	0-5	0	0.13	0-100	100	97
Hardness (mg/L)	36-3687	272	280.12	19-664	240	248.6	0-91	7	11
pH	6-7.5	6.5	6.3	6-7.5	6.5	6.5	-	-	-
Phosphate (mg/L)	0-1	0.05	0.15	0-2	0.05	0.04	0-100	75	61

Table II shows percentage of KAFs which exceed water quality parameters. Arsenic test result shows 38% exceeding WHO Guideline Value (GV) and 13% exceeding Nepal drinking water quality standard. Fecal coliform test result shows 57% exceeding both WHO GV and Nepal drinking water quality standard.

Table II: Raw and filtered water exceeding WHO GV and NDWQS

Water Quality Parameters	% Raw (tube well) water Exceeding		% Filtered water Exceeding	
	WHO GV	NDWQS	WHO GV	NDWQS
Arsenic	80%	54%	38%	13%
Fecal Coliform	90%	90%	57%	57%
Iron	-	79%	-	3%
Hardness	-	1%	-	1%
pH	-	40%	-	1%

Arsenic

It was found that nearly 46% of raw water has arsenic below 50 ppb and 54% of raw water samples have arsenic more than 50 ppb. Most of the raw water samples (27.7%) contained arsenic between 51-100 ppb, while 25.3% of raw water samples have arsenic between 101-500 ppb. Altogether 5 raw water samples contained an arsenic concentration above 500 ppb. Approximately 41.4% of raw water samples have arsenic below detection level (less than 0.05 ppb). 86.3% of filtered water has arsenic concentration below 50 ppb (National drinking water quality standard for arsenic), therefore the filtered water from these KAF are safe for drinking in terms of arsenic. Approximately 13.7% (68 KAF) of the filtered water exceeded arsenic concentration of 50 ppb and is therefore unsafe for drinking. Out of these 68 KAFs, approximately 13.3% (66 KAFs) of samples have arsenic between 51-300 ppb and 0.4% (2 KAFs) of samples contained arsenic concentrations between 501-1000 ppb. It was found that 150 (30.3%) KAFs have removed arsenic by 100%. Approximately 44.6% of filters removed 50 to 99% of arsenic, while 6.9% filters removed less than 50% of the arsenic. Overall, the average arsenic removal of KAF was found to be 85%. In terms of arsenic removal by different KAF versions, nearly 47.8% of concrete square KAFs have 100% arsenic removal rate, while only 5.3% of concrete square have 0% arsenic removal rate. Similarly, 29.3% of concrete round, 24.8% of plastic round and 20% of plastic square versions of KAF have 100% arsenic removal rate.

Fecal coliform

The microbiological analysis for fecal coliforms was completed for 30 different randomly selected KAFs. Out of 30 tested filters, 10 filters had 100% removal, while 13 filters were found in the range of 70-99% removal. Two filters were found in the removal range of 50-59% and two filters removed less than 50% of fecal coliforms. A fecal coliform count was not identified in the raw and treated water samples in 3 filters. The average fecal coliform removal for the tested filters is 84.5% which is similar to the previous studies.

Iron

This study exhibited good iron removal performance; approximately 67% of KAFs removed 100% of the iron from the drinking water and approximately 24% of filters removed between 70-99% of the iron concentration. Only 2.8% of filters have iron concentration more 3 ppm which is above the national drinking water quality standard for iron. The average iron removal was found to be 95%.

KAF Improvement Activity

The KAF improvement activities such as cleaning, adding and replacing the iron nails were done in 40 KAF that were not removing arsenic below 50ppb. After the improvement activities, the water samples were taken from the filters after 4 days. The water analysis showed that 15 KAFs performed well in which the filtered water arsenic was detected below 50 ppb and improved from previous results. In 8 KAFs, even though the filtered water was detected below 50 ppb, arsenic removal performance did not improve compared to previous results. Similarly, in 7 KAFs, the arsenic removal performance improved although the concentration of arsenic in the filtered water remained above 50 ppb. In 10 KAF, the arsenic removal performance of the KAFs did not improve and the filtered water also showed arsenic above 50 ppb.

Recommendations

Based on the findings of this study, the following key recommendations have been made:

- The Kanchan Arsenic Filter (KAF) has been promoted as short term arsenic mitigation option at the household level. Since less than 30% of KAF are functioning during this survey, it is very important to provide the households with long-term arsenic mitigation options;
- The robustness of KAF is very crucial for continued use of the filter. It is, therefore, recommended that the concrete version of KAF is promoted;
- Regular monitoring and user's awareness is very important in case of KAF promotion as arsenic mitigation options;
- This study showed that some improvement activities can enhance the arsenic removal performance of KAF. However, more in-depth research is needed to state explicitly what improvement activities can enhance the performance and by how much;

- it is recommended to disseminate the results of this study at central and district levels;
- It is recommended that a national strategy is developed for the mitigation of the arsenic problem, especially focusing on long term safe water options and a system to monitor the progress of mitigation activities.

1. INTRODUCTION

1.1 Status of arsenic in Nepal and Nawalparasi

Elevated arsenic levels in drinking water from groundwater sources in the Terai region of Nepal is a big public health concern. Continued use of arsenic contaminated water for drinking and cooking purposes can cause arsenic poisoning which can result in skin related conditions, cancers of various organs and other severe health consequences.

In Nepal, the Department of Water Supply and Sewerage (DWSS), with assistance from the WHO, conducted the first systematic study on possible arsenic contamination of groundwater in the Jhapa, Morang and Sunsari districts of the eastern Terai of Nepal bordering to Indian State of West Bengal in 1999. The results of the study showed the presence of arsenic at a concentration higher than 50 ppb in limited samples. In early 2000, NRCS, under the financial assistance of JRCS and technical collaboration with Environment and Public Health Organization (ENPHO), conducted the first preliminary study for arsenic investigation in 11 Terai districts. The program was then extended for three years for comprehensive investigation on arsenic contamination, health examination for arsenicosis and mitigation approaches in its program areas in 17 Terai districts under the Drinking Water Quality Improvement Program (DWQIP).

In 2001, DWSS with assistance from UNICEF and various other organizations, carried out blanket testing for arsenic in 20 districts of Terai, Nepal and completed the testing in 2007. The results of the blanket tube well screening showed that 1.73% of the tested tube wells contained more than 50 ppb, the national drinking water standard in Nepal, and 7.1% of tube wells contained more than 10 ppb, the WHO guideline value for safe drinking water. Currently, 321,415 members of the population are exposed to arsenic contaminated water above the Nepal drinking water standard (50ppb) and approximately 974,858 people are exposed to concentrations above the WHO drinking water guidelines (10ppb).

The survey found that tube wells in Nawalparasi district were the most arsenic contaminated among the 20 districts, 11.7% out of an examined 31,676 tube wells were found to have an arsenic concentration of more than 50 ppb. The second highest contaminated district was Bardiya with 5% of the tested tube wells recording an arsenic concentration of more than 50 ppb. The population exposed to arsenic in Nawalparasi district is 63,692 people, 14% of the examined population of 448,023 according to the database (AIMS: Arsenic Information Management System) established by GoN and UNICEF. Approximately 80% of the population was covered by the survey: the total population of Nawalparasi district is approximately 562,870. Therefore, it can be assumed that approximately 80,000 people may use arsenic contaminated water for daily drinking purpose in Nawalparasi.

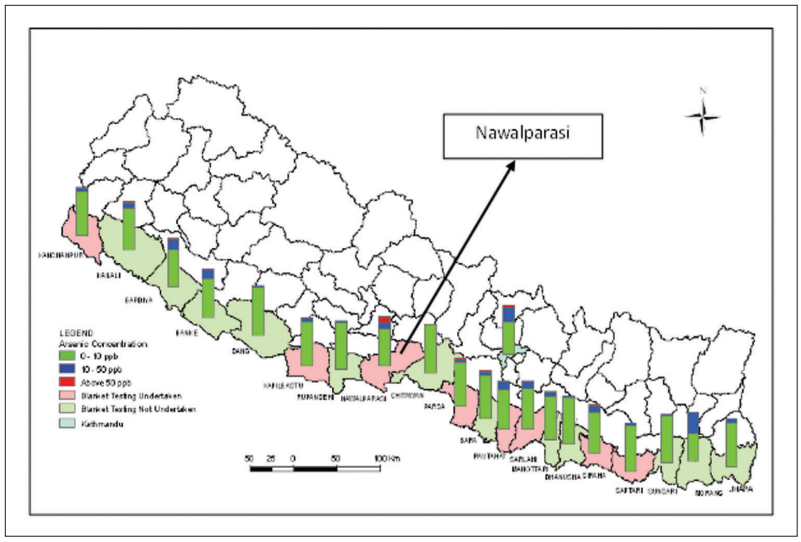

FIGURE 1: DISTRIBUTION OF ARSENIC CONTAMINATION IN NEPAL (SOURCE: THE STATE OF ARSENIC IN NEPAL, 2005)

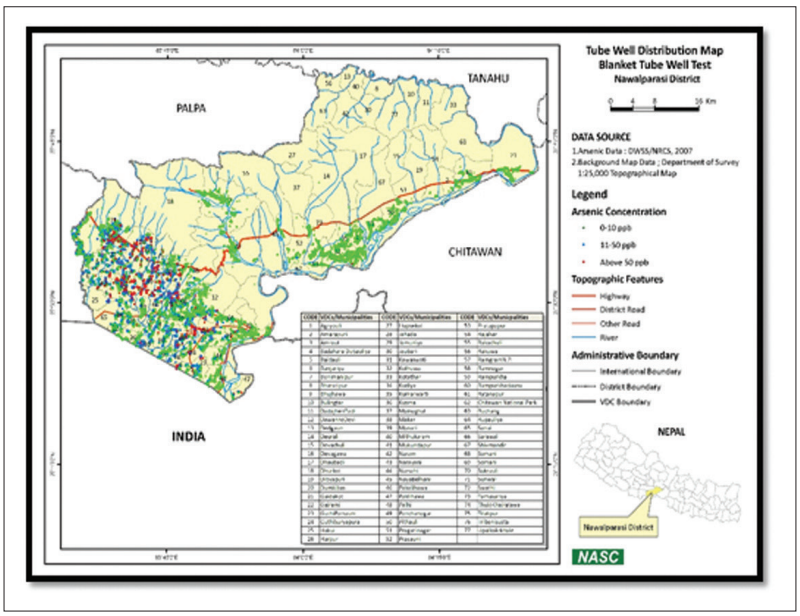

FIGURE 2: ARSENIC CONTAMINATION MAP FOR NAWALPARASI (SOURCE: THE STATE OF ARSENIC IN NEPAL, 2011)

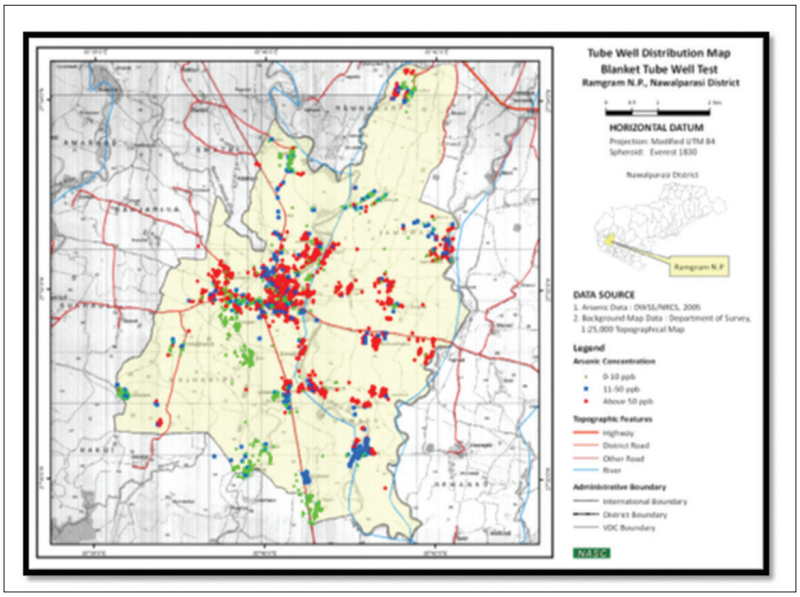

FIGURE 3: ARSENIC CONTAMINATION MAP FOR RAMGRAM MUNICIPALITY (SOURCE: THE STATE OF ARSENIC IN NEPAL, 2011)

1.2 Alternative options for arsenic

Several agencies working in the WASH sector have provided alternative arsenic safe options in affected communities in Nepal. In general, these alternative options include HH level and community level options. The HH level alternative options provided to the arsenic contaminated tube wells were the Kanchan Arsenic Filter, identification of arsenic free tube wells and installation of new arsenic free tube wells. Arsenic Iron Removal Plants (AIRP), Improved Dug wells and Gravity flow spring water supply schemes were provided as community level alternative arsenic safe options. According to the State of Arsenic in Nepal report, about 33,000 KAF, 345 shallow tube wells, 17 AIRPs and 59 dug wells were provided as alternative safe water options for arsenic in Nepal. Out of which 7089 KAF, 15 shallow tube wells, 11 AIRPs and 9 dug wells were provided in Nawalparasi district.

1.3 Description of KAF and promotion in Nepal

The Kanchan Arsenic Filter (KAF) is an innovative household drinking water treatment (HWT) device for removing arsenic, pathogens, iron, turbidity, and some other contaminants in drinking water. The design of this filter is unique as it combines slow sand filtration and iron hydroxide adsorption principles to remove biological, physical, and chemical contaminants in one simple process. This filter was developed by researchers at Massachusetts Institute of Technology (MIT), Environment and Public Health Organization (ENPHO) of Nepal, and Rural Water Supply and Sanitation Support Programme (RWSSSP) of Nepal. This technology is a result of five years of multi-disciplinary research and is optimized by taking into account the socio-economic conditions in rural Terai region of Nepal. Two versions of the KAF have been promoted in Nepal: plastic and concrete. The plastic version is lightweight and cheap, suitable as an introductory filter or as a short- to medium-term option. The concrete version is more durable, suitable for a longer-term deployment. Both filters operate on the same scientific principles and offer the same level of technical performance. Implementers and users can choose either version according to their needs.

In the KAF, non-galvanized iron nails rust quickly, forming ferric hydroxide on the iron nails' surface, which is an excellent adsorbent of arsenic. As ferric hydroxide particles exfoliate from the iron nails, new iron surfaces are created, providing additional arsenic adsorption capacity. Pathogen removal follows the same principle as a slow sand filter or bio-sand filter, consisting principally of four removal mechanisms: physical straining, attachment, biological predation, and natural die-off. In addition, the rusty iron nails can remove viruses through inactivation and irreversible adsorption.

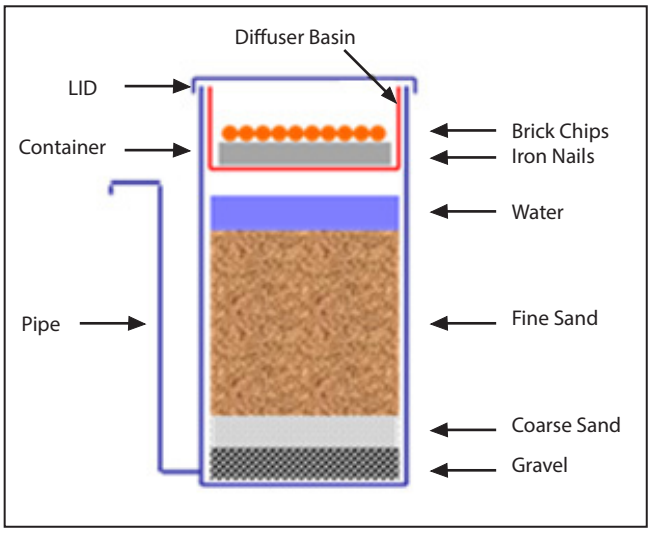

FIGURE 4: CROSS SECTION OF KAF

FIGURE 5: KAF IN USE

Typically, the KAF can reduce arsenic by 85-90%, iron by 90-95%, turbidity by 80-95% and total coliform by 85-99%. To obtain these results, the following water quality characteristics should be met: total arsenic <= 0.5 mg/L, phosphate <= 2 mg/L, pH <= 8 (Ngai, T.; et. al, 2006).

This filter won prestigious awards at the MIT IDEAS Design Competition 2002, the World Bank Development Marketplace Global Competition 2003, the U.S. Environmental Protection Agency P3 Design Competition 2005, and the environment category of the Wall Street Journal Technical Innovation Award 2005. The current Gem505 version is the 4th generation design, promoted since March 2004.

In 2003, MIT and ENPHO, with support from local partners, successfully demonstrated a KAF implementation model in arsenic affected areas. Since then more than 33,000 KAF have been installed in Nepal by several agencies such as DWSS, NRCS, Filters for Families, Rural Water Supply and Sanitation Support Programme, DDC and VDCs.

1.4. Rationale of the study

Since 2000, several studies on KAFs have been conducted at a laboratory and field scale including assessing technical performance, social acceptability and promotional strategy of KAF. The latest study was completed in 2010 by ENPHO and MIT within Nawalparasi district to identify the parameters that affect arsenic removal in the KAF. The study on social acceptability and functionality of the KAF was completed in 2009 by CEMAT lab with support from DWSS, UNICEF and UN Habitat. The current status of functionality and use of the KAF is unknown. Therefore, this study has been designed to determine the current status of the KAF in Nawalparasi district.

2. OBJECTIVE OF THE STUDY

The main objective of this study is to evaluate performance of the KAFs distributed in Nawalparasi district. Following are specific objectives:

- Review arsenic mitigation activities initiated by different organizations to date within Nepal;
- To understand the performance of the KAF and determine how KAF performance declines with respect to time of operation;
- To assess the functionality of the KAF and determine and understand key reasons behind its success or failure;
- To identify simple ways to improve arsenic removal performance of the KAF.

3. METHODOLOGY

The general overview of methodology for this assessment study is presented in figure 6 below:

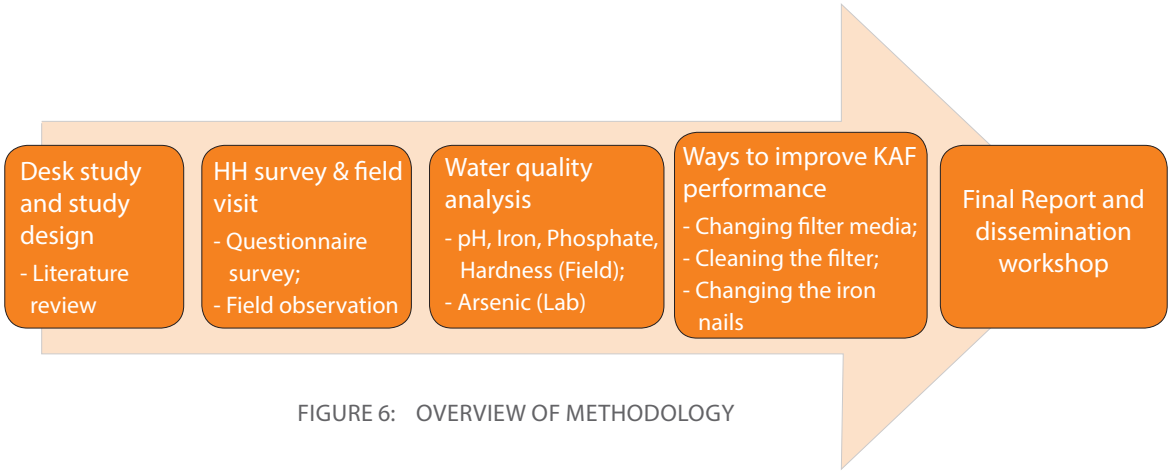

FIGURE 6: OVERVIEW OF METHODOLOGY

Step 1: Desk study and study design

The initial stage of the assessment included the completion of a desk study which included obtaining a complete list of KAFs distributed in Nawalparasi. The list of distributed KAF were obtained from the KAF database maintained at ENPHO. The database consisted of about 3,000 KAFs distributed by various agencies such as ENPHO, NRCS, FFF, RWSSSP/FINNIDA, and DWSS in Nawalparasi. A literature review was completed to understand the study methodology and performance of the KAF in past studies and research works.

Step 2: Finalization of household survey form

After the desk study, a structured questionnaire form was been developed (Annex 1). The form has been categorized into three sections: A, B and C. Section A is for collecting basic household information and the information for KAFs in use, section B to collect information for KAFs that are not in use and section C is for recording water quality test results. The survey form was finalized after getting suggestions and comments from a water advisor at JICA office and water quality chief at DWSS. After the finalization of the survey form it was translated into Nepali.

Step 3: Staff orientation

A one-day orientation session was organized for the selected field staff. During the orientation, the details of the HH survey were described to the staff and a practical session was dedicated to water quality testing using ENPHOs field test kit. Staff were trained to perform testing on pH, Iron, hardness and phosphate. In addition, the staff were trained on correct water sample preservation methods for arsenic and record keeping.

Step 4: Household survey and field visit

After the orientation, the field staff were provided with the list of KAFs distributed in Nawalparasi and were mobilized to the field for the survey. The HH survey was performed in the two phases. Table 1 shows key specifications of the two phases conducted within the survey:

TABLE 1: DESCRIPTION OF HOUSEHOLD SURVEY

Phase	Type of survey	Data collected on	WQ parameters
Phase I	Detailed survey	• General information on KAF; • Users' knowledge, attitude and perception towards KAF; • Functionality of KAF and reasons for using or not using KAF; • Users' willingness to pay for re-operating KAF	• pH, Hardness, Iron, Phos phate by ENPHO field test kit; • Arsenic by ASS at ENPHO laboratory
Phase II	Rapid survey	• General information on KAF; • Functionality of KAF and reasons for using or not using KAF;	Water quality testing not being conducted

Originally, the household survey was designed for detailed survey only and was targeted for 1,000 households. However, after completing the survey it was found that the field staff had deliberately chosen 50% of households with a functional KAF. Following a discussion with DWSS and JICA it was concluded that a more realistic survey had to be conducted as the results from the phase I survey could be biased. Therefore, a rapid survey was designed to collect data and samples from around 2000 additional HHs. The field team was divided into two groups to conduct the additional HH visits. The rapid survey was conducted in the VDCs where the detailed survey was not being conducted. The field coordinator performed supervision and monitoring of the field activities. The field coordinator was also responsible for dispatching the collected water samples and prepared and sent the reports based on the field activities.

Step 5: Water quality testing

In addition to completing the HH surveys, the field team performed water quality analysis of 497 functional KAFs in phase I for pH, Iron, hardness and phosphate by using ENPHO's field test kit. All parameters are based on the colorimetric methods. For arsenic analysis, samples of raw water and treated water were collected for the 497 functional KAFs. Samples were preserved by adding 8 drops of concentrated hydrochloric acid (HCl) in each 250 ml sample. These samples were analyzed using the Atomic Adsorption Spectrophotometer (AAS) at ENPHO's laboratory. For microbiological analysis, 30 randomly selected water samples were collected in sterilized glass bottles from functional KAFs in phase I and were analyzed within 8 hours of sampling. Faecal coliforms were tested using the Del Aqua test kit following the membrane filtration technique.

Step 6: KAF performance improvement activities

Upon completion of the arsenic testing, 50 KAFs that did not remove arsenic to below 50 ppb were selected for further improvement activities. The following activities were carried out on the filters and any changes in performance were recorded;

- Replacing the iron nails;
- Cleaning the iron nails and filter;
- Cleaning the iron nails with concentrated HCl;
- Adding 2-3 kg of iron nails;

Step 7: Data analysis and report preparation

After data entry, necessary data cleaning, processing and analysis were done in MS Excel. The draft report will be prepared and shared with JICA and DWSS to receive the comments for finalizing the report. The final report will be prepared and submitted to JICA and DWSS. At the end of the project, a final workshop will be conducted to disseminate the study findings and to discuss future steps with relevant stakeholders.

4. PREVIOUS STUDIES ON KAF

As mentioned earlier, several laboratory and field based studies and research on KAFs have been completed by various researchers and agencies. Some of the prominent studies done for KAFs are presented in the list below:

Ngai, T., Walewijk, S. (2003). Arsenic Biosand Filter (ABF) Project: Design of an Appropriate Household Drinking Water Filter for Rural Nepal. Final Report. Massachusetts Institute of Technology.

- 16 concrete filters were installed in 4 villages in Nawalparasi and Rupendehi districts of Nepal, with varying amount of nails, and monitored for 3 months. Those with 5 kg of nails had the best arsenic removal, averaging 93%. Average removal of iron was >93%, total coliforms was 58%, and E.coli was 64%.

Odell, N. (2004). Report on a Four-Month Performance Evaluation of the Cement Arsenic Biosand Filter (ABF) for Mitigation of Arsenic Contamination. US Peace Corp Volunteer.

- Two concrete filters (2.5 kg nails and 5.0 kg nails) were installed in Parasi, Nepal. 40L of groundwater was poured into the filters daily. The filter with 5 kg nails consistently removed over 95% arsenic throughout the 4-month testing period.

Pandey, S. (2004). Arsenic Biosand Filter: Study on the Effect of Air Space between the Resting Water and the Diffuser Basin on Arsenic Removal and Determination of General Flow Curve. BSc Thesis. Kathmandu University.

- Four "hilltake" filters (an old version of KAF) in Nawalparasi district of Nepal were continuously tested for arsenic. No fluctuation of arsenic concentration in the effluent throughout a filter run was observed. It was concluded that arsenic removal takes place through two methods: adsorption on iron nails in the diffuser box, and adsorption on iron particles accumulated on top of the fine sand.

Shrestha, P. (2004). Arsenic, Iron and Coliforms Removal Efficiency of Household Level Biosand Filters. MSc Thesis. Tribhuvan University, Nepal.

- A laboratory study in which 1800L of arsenic water was poured into a plastic KAF; arsenic removal was 85%, and total coliform removal was 94%. A field study in which 1600L of actual groundwater from Nawalparasi district of Nepal was poured into the same filter; arsenic removal was 91%.

Sharma, D. (2005). KanchanTM Arsenic Filter: Removal of Bacteria (Total Coliforms) of Gem505 Model, 4-weeks Daily Study. BSc Thesis. Kathmandu University.

- A 4-weeks daily testing of 5 plastic KAFs installed in Nawalparasi district of Nepal found that the average total coliform removal was 85-99%, with an initial biofilm ripening period of as little as 9 days. Proper storage practice and hygiene were found to affect microbial removal efficiency.

Ghimire, B. (2005). KanchanTM Arsenic Filter: Can Iron and Arsenic Particles Migrate through the Sand Layer? MSc research project. Kathmandu University.

- Vertical sand samples from 2 old concrete KAFs and 2 newer concrete KAFs were tested for arsenic and iron; no difference in the concentration profiles was found. It concluded that arsenic and iron particles do not migrate down the sand layer over time.

Yildizbayrak, B., Moschos, N., Tamer, T., LeTellac, Y. (2004) Distribution of KanchanTM Arsenic Filter in Rural Nepal. G-Lab Project Report. MIT Sloan School of Management.

- This study provided guidance to streamline the World Bank funded KAF implementation project, with respect to filter design improvement, target population segmentation, filter subsidy, and distribution network.

Frey, S., Kang, C.;,Lucchino, D., Ueno, D. (2006) KanchanTM Arsenic Filter implementation and enhancement. G-Lab project report, MIT Sloan School of Management

- This study evaluates the KAF implementation process, and identifies opportunities in awareness and education, sales and marketing, pricing and supply chain, and micro-financing to scale-up the project. The study recommended establishing more local entrepreneurs to strengthen the sustainable KAF supply chain at local level.

Ngai, T.K.K., Murcott, S., Shrestha, R.R., Dangol, B., Maharjan, M. (2006) Development and Dissemination of KanchanTM Arsenic Filter in Rural Nepal. Water Science & Technology: Water Supply Vol 6 No 3 pp 137–146 © IWA Publishing

- The paper explains the implementation model of the KAF in Nepal, with detailed discussion on barriers and opportunities to scale-up the technology.

Ngai, T., Shrestha, R., Dangol, B., Maharjan, M., and Murcott, S. (2007) Design for Sustainable Development – Household Drinking Water Filter for Arsenic and Pathogen Treatment in Nepal. Journal of Environmental Science and Health, Part A. Vol A42 No 12 pp 1879-1888 © Taylor and Frances Group

- This paper provides a detailed explanation of the research and development process of the KAF and an extensive discussion on the filter performance. Based on two blanket monitoring rounds of about 1000 functioning KAFs in Nepal, conducted at one year apart, it was found that the average arsenic removal is 90%, with over 95% of the filters meeting the Nepali guidelines. Iron removal is 95%, phosphate removal is 84%, and pH increases by an average of 0.37 after filtration. Sustained use after 1 year is 83%. This paper recommends that the KAF can be effectively deployed in areas where the total arsenic <= 0.5 mg/L, phosphate <= 2 mg/L, and pH <= 8.

DWSS, UNICEF and UNHABITAT (2009) FINAL REPORT ON Performance Evaluation of Kanchan Arsenic Filter (KAF) Volume 1 (Final Draft)

- CEMAT Lab with support from DWSS, UNICEF and UNHABITAT jointly conducted a study on 700 KAFs in 2009. It was found that 88.9% of the filters were maintained in good condition and 95% of the filters removed arsenic to below Nepal drinking water standard quality (50ppb) though 17% of samples were contaminated by E-coli.

A summary of the performance of the KAFs, regarding the removal of arsenic, total coliforms and E.Coli, as identified in the above previous studies is shown in table 2 below;.

TABLE 2: SUMMARY OF ARSENIC AND BACTERIAL REMOVAL BY KAF:

SN	Study	Arsenic removal	Removal of Total Coliforms	Removal of E. Coli.
1	*Ngai, T., Walewijk, S. (2003).*	93%	58%	64%
2	*Odell, N. (2004).*	95%	-	-
3	*Shrestha, P. (2004).*	85%	94%	-
4	*Sharma, D. (2005).*	-	85-99%	-
5	*Ngai, T., Shrestha, R., Dangol, B., Maharjan, M., and Murcott, S. (2007)*	90%	-	-

5. FINDINGS AND DISCUSSIONS

This section describes key findings and discussions of the KAF assessment study.

5.1. Number and distribution of surveyed households

The household survey was performed in 2833 households from 21 VDCs/municipalities in Nawalparasi district. The detailed survey (phase I) was performed in 989 households whereas the rapid survey (phase II) was completed in 1844 households (Figure 7).

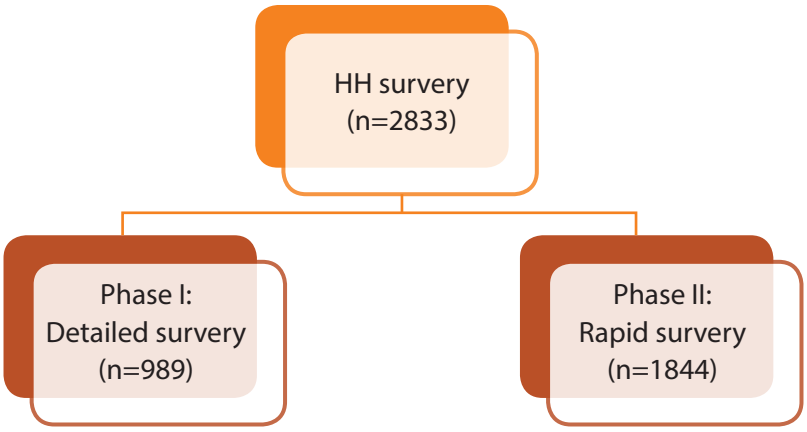

FIGURE 7: NUMBER OF SURVEYED HOUSEHOLDS

Out of 21 VDCs/municipalities, Ramgram municipality consists of the highest number of survey samples with 555 households, followed by Suwal (504 HHs), Manari (353 HHs) and Pratapur (289 HHs). The VDCs with the least number of samples were Badahara Dubauliya (18 HHs), Swathi (6 HHs) and Bhanjhariya (2 HHs). Figures 8 and 9 below presents VDC wise distribution of surveyed households in phase I and II.

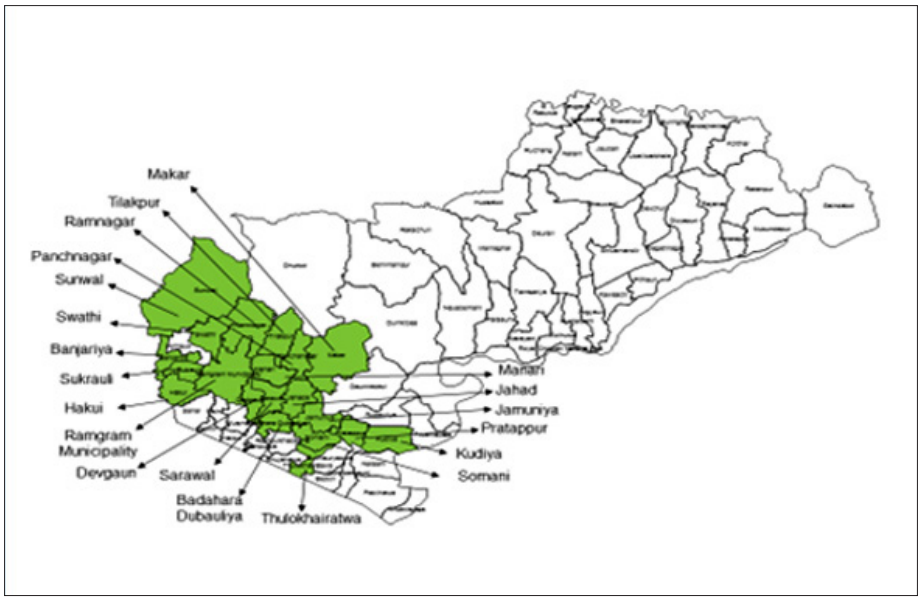

FIGURE 8: MAP SHOWING VDCS VISITED FOR THE KAF SURVEY

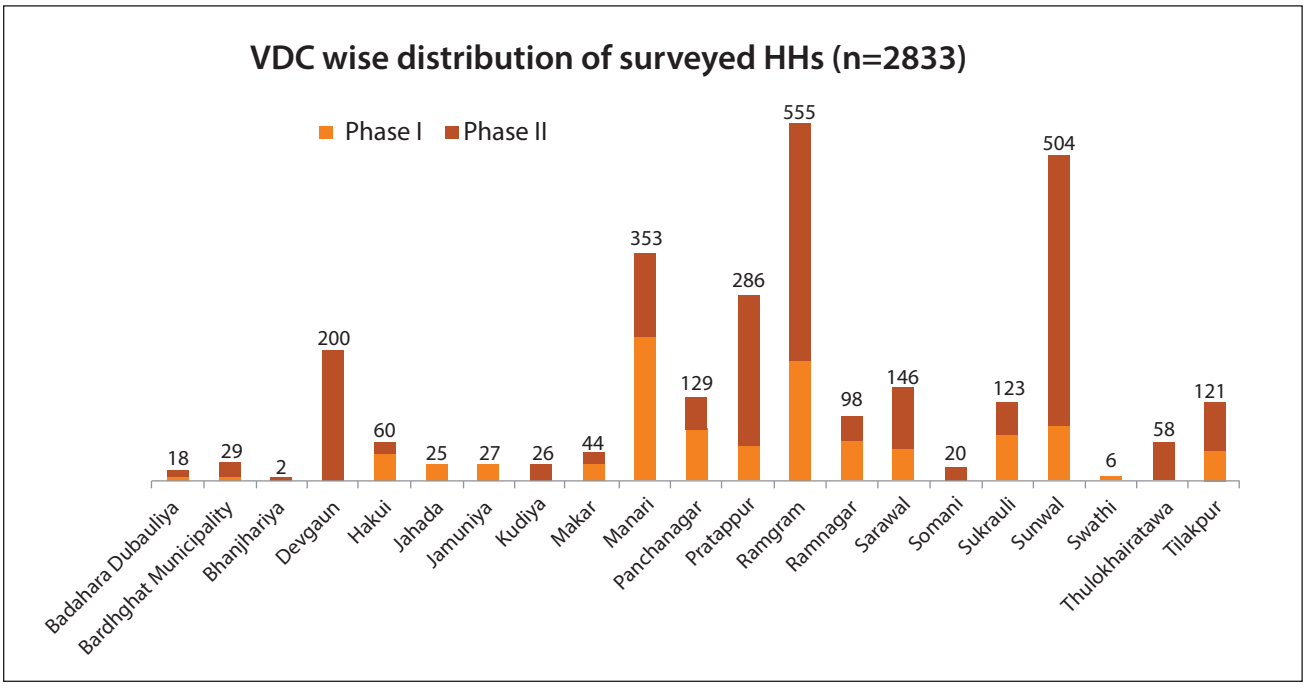

FIGURE 9: VDC WISE DISTRIBUTION OF SURVEYED HHS

5.2. Functionality of KAF

Out of 2,833 households, only 792 (28%) of households (HH) were using the KAF on a regular basis and 58 HHs (2%) were using the KAF irregularly. Approximately 70% of HHs were not using the KAF out of which, 45% of HHs responded that they are directly drinking from arsenic contaminated water while approximately 25% of HHs are drinking water from alternative safe water sources such as other arsenic removal filters, gravity-flow water supply schemes and deep tube wells among others. Further analysis showed that out of 700 HHs using an alternative source, 424 households faced problems in KAF operation and maintenance (O&M) while 276 households did not face any problems. Therefore, KAFs distributed in 1,126 households (39.7%) did not have any reported problems with their KAF. Figure 10 shows the categorization of functionality of KAF.

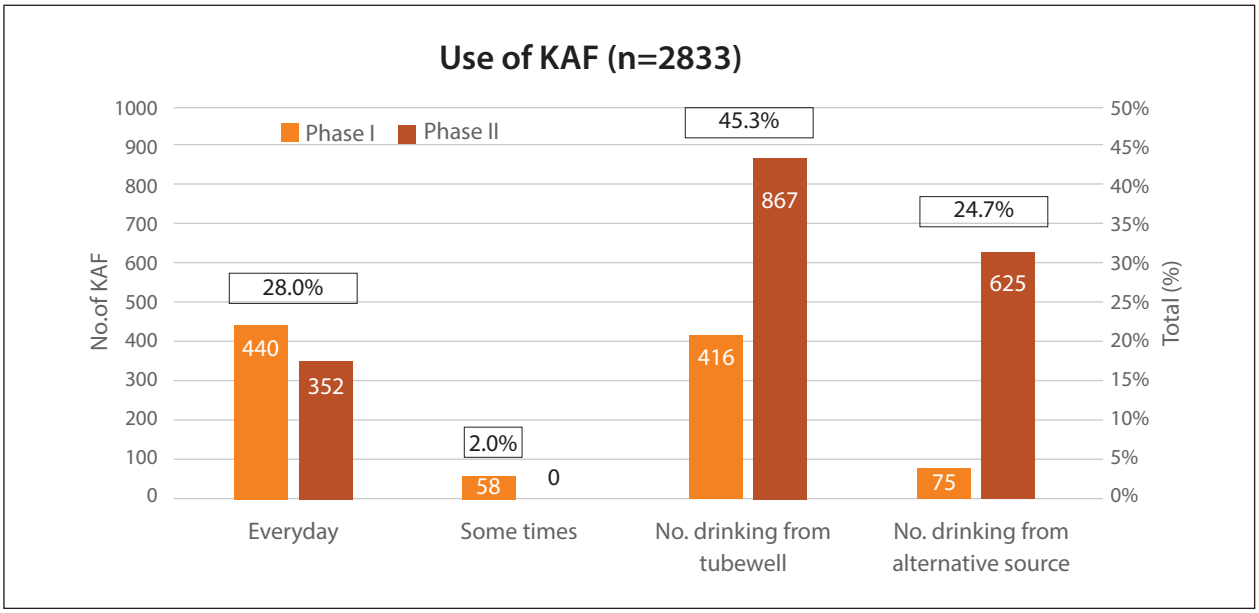

FIGURE 10: FUNCTIONALITY OF KAF

5.3. Sources of drinking water

Almost 80% of surveyed households with KAF are using tube wells as their primary source of drinking water (raw water for the KAF) followed by other sources (13.7%), dug well (3.8%) and spring (1.8%). Almost 0.6% households were getting drinking water from multiple sources such as tube well, dug well and spring.

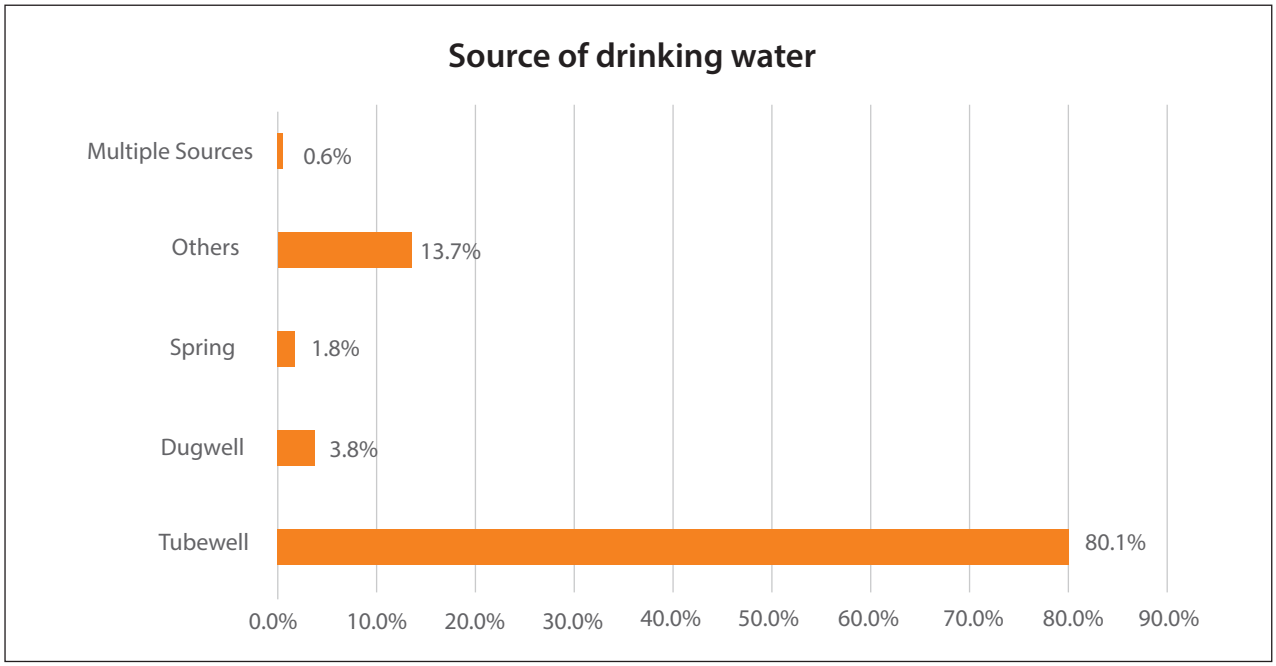

FIGURE 11: SOURCE OF DRINKING WATER

5.4. KAF providers

Approximately 22.2% of households responded that they received their KAF from agencies such as VDCs, local entrepreneurs, DDC and self-made. In 21.6% of households, Filter for Families (INGO based in USA) provided the KAF while 16.4% and 11.9% of households were using KAFs provided by Nepal Red Cross Society (NRCS) and Department of Water Supply and Sewerage (DWSS) respectively. Around 9% of filters were provided by FINNIDA (previously RWSSSP) and 6% of filters were provided by ENPHO. Approximately 13.5% households did not know the name of their KAF provider. The distribution of filter providers is shown in Figure 12.

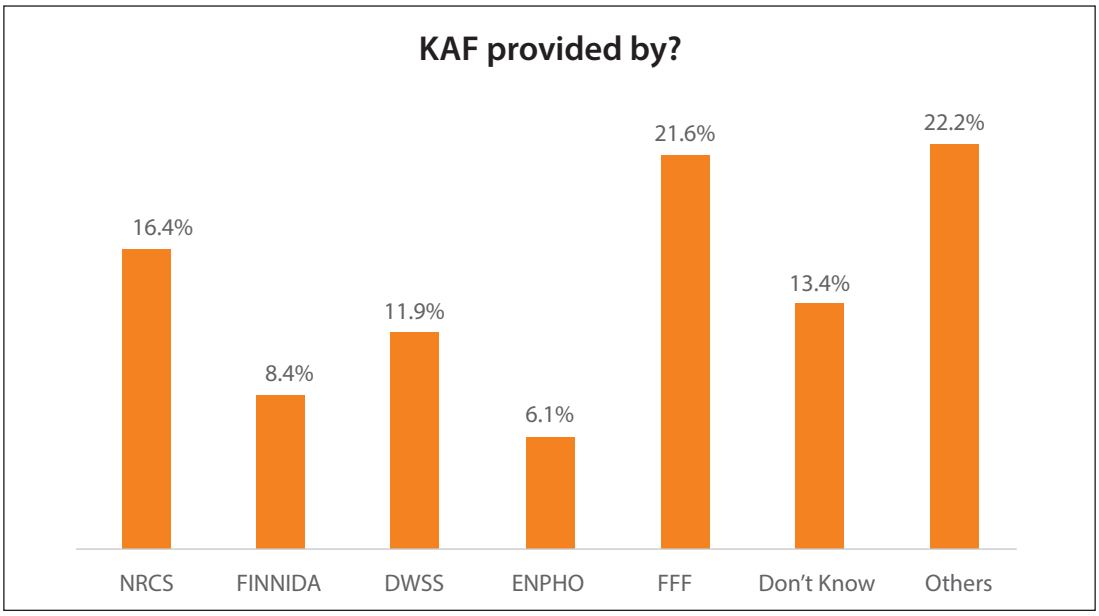

FIGURE 12: KAF PROVIDERS

5.5. Age and types of KAF

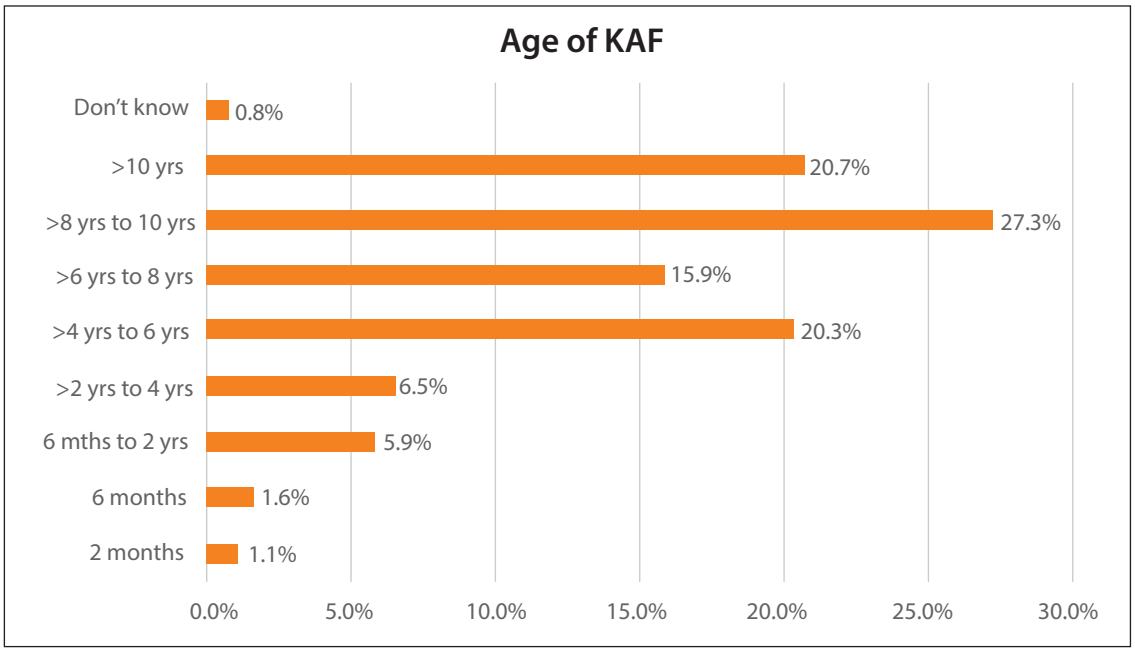

FIGURE 13: AGE OF KAF

As shown in figure 13, most of the KAF (27.3%) were 8-10 years old followed by over 10 years (20.7%) and 4-6 years old (20.3%). This shows that most of the provided filters are more than 4 years old. There are some filters (approximately 3%) which are less than 6 months old, recently provided by Lumanti and local entrepreneurs. Less than 1% households did not know the age of the filters.

During the KAF development, five different versions of KAFs have been provided by various agencies: concrete round, concrete square, GEM505 (plastic round), Hilltake (Plastic Square) and Fiberglass. 269 HHs have been provided with the concrete round version while 501 HHs have been provided with the concrete square version. 1818 HHs were provided with the GEM505 version and 242 HHs were provided with the hilltake version. Only 3 households were provided with fiberglass version of KAF. Figure 14 shows some of the different versions of KAFs available and Figure 15 shows the distribution of the different versions.

FIGURE 14: DIFFERENT VERSIONS OF KAF

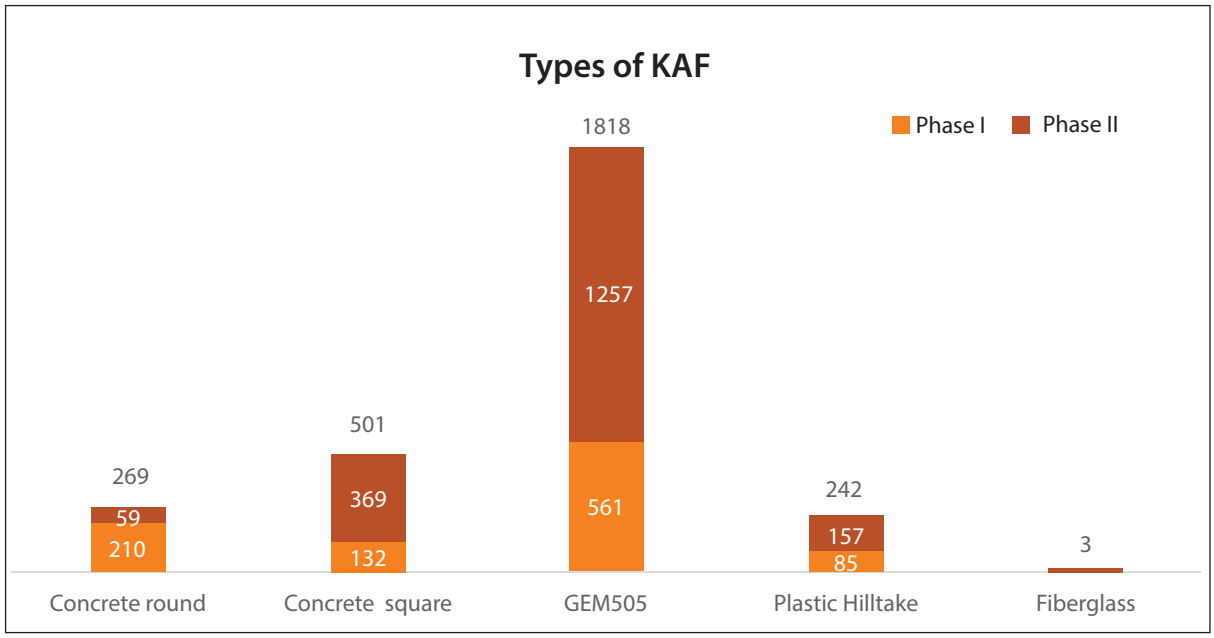

FIGURE 15: TYPES OF KAF

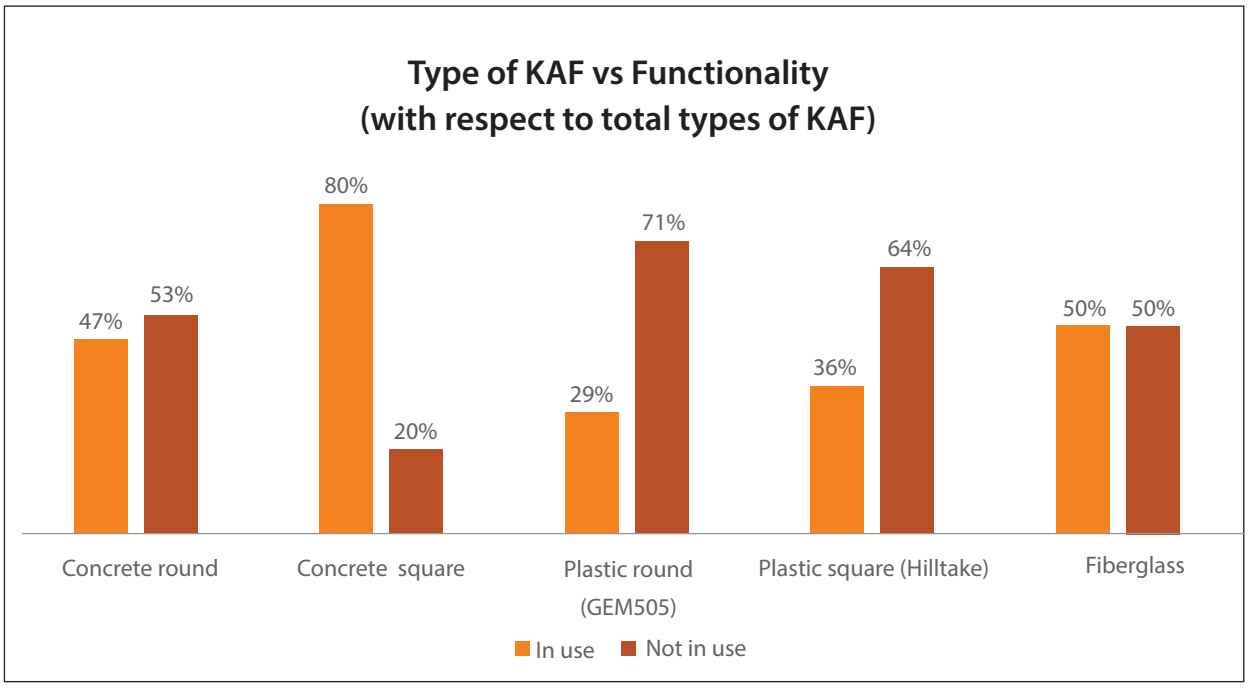

FIGURE 16: TYPES OF KAF VS. FUNCTIONALITY

Figure 16 above shows the percentage of use with respect to the different versions of KAFs. The HHs currently using or treating drinking water from alternative sources were not included in this analysis. It was found that 80% of the concrete square version are in use; this is the highest percentage of use in comparison to the other KAF versions. The main reason for the high percentage of use of this version of KAF is durability as the plastic version is fragile. The reasons for HHs not using their KAFs are discussed later. Approximately 47%, 29%, 36% and 50% of concrete round, plastic round (GEM505), plastic square (Hilltake) and fiberglass versions of KAF were in use respectively during the time of survey.

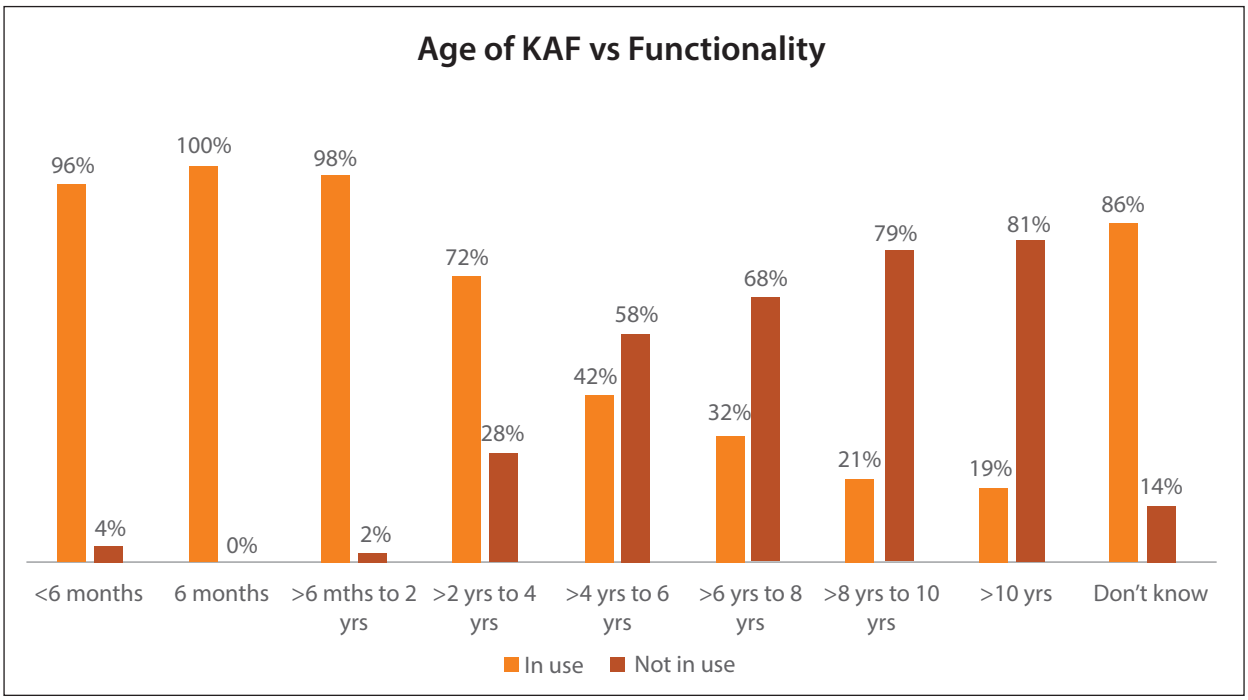

FIGURE 17: AGE OF KAF VS. FUNCTIONALITY

Figure 17 above illustrates, the percentage of use of the KAFs with respect to age. Most of the KAFs distributed within 6 months to 4 years were found to be functional in comparison to the KAFs distributed more than 4 years ago. Approximately 81% of KAFs that were distributed more than 10 years ago were not found to be functional whereas only 4% of KAFs that were distributed up to 6 months ago were not functioning.

The table 3 shows the age of KAF with respect to the type of KAF. Only Concrete Square and GEM505 versions of KAF were distributed less than 6 months ago. Over 27% of KAFs (772) were distributed between 8-10 years and over 21% of KAFs (600) were distributed more 10 years ago. Only 8.6% of KAF were distributed between 6 months and 2 years. Altogether 8 households did not know the age of their KAF. Most of the GEM505 version (525) and plastic square version (123) were distributed before 8-10 years. The majority of concrete square KAFs (151) were distributed more than 10 years ago while the majority of concrete round KAFs (202) were distributed between 4-6 years ago. Most of KAFs (85%) were distributed 4 or more years ago.

TABLE 3: TYPE OF KAF VS. AGE OF KAF

Age of KAF	Type of KAF					Total	(%)
	Concrete Round	Concrete Square	Plastic Round (GEM505)	Plastic Square (Hilltake)	Fiberglass		
< 6m	0	43	3	0	0	46	1.6%
6m	0	29	1	0	1	31	1.1%
>6m - 2y	3	77	85	1	0	166	5.9%
>2y - 4y	4	46	130	1	0	181	6.4%
>4y - 6y	202	38	325	11	0	576	20.4%
>6y - 8y	5	28	404	13	0	450	15.9%
>8y - 10y	39	84	525	123	1	772	27.3%
10y	16	151	340	92	1	600	21.2%
Don't Know	0	5	2	1	0	8	0.3%
Total	**269**	**501**	**1815**	**242**	**3**	**2830**	**100.0%**

TABLE 4: TYPES OF KAF VS. KAF PROVIDERS

Agencies	Concrete round	Concrete round	GEM505	Plastic Hilltake	Fiberglass	Grand Total
NRCS	3	23	207	231	-	464
FINNIDA	58	162	16	1	-	237
DWSS	1	27	309	-	-	337
ENPHO	1	4	167	-	1	173
FFF	1	6	605	-	-	612
Don't Know	15	54	309	2	1	381
VDC	150	75	113	2	1	341
Others	40	150	92	6	-	288
Grand Total	**269**	**501**	**1818**	**242**	**3**	**2833**

Table 4 shows the distribution of types of KAFs with respect to the KAF providers. The plastic round version (GEM505) has been provided by all agencies out of which 605 filters were provided by Filter for Families followed by DWSS (309), NRCS (207), ENPHO (167) and VDC (113). Altogether 501 concrete square KAFs were provided by different agencies such as FINNIDA (162), other agencies (150) such as Lumanti, local entrepreneurs and VDC (75). A total of 150 concrete round KAFs were provided by VDC, followed by FINNIDA (58) and other agencies (40). Most of the Plastic Hilltake version (231) filters were provided by NRCS.

5.6 KAFs not in use

The survey of 2833 HHs in two phases found that almost 70% (1983) of HHs were not using their KAF at the time of the survey. The reasons for not using the KAF are displayed in Figure 18 below.

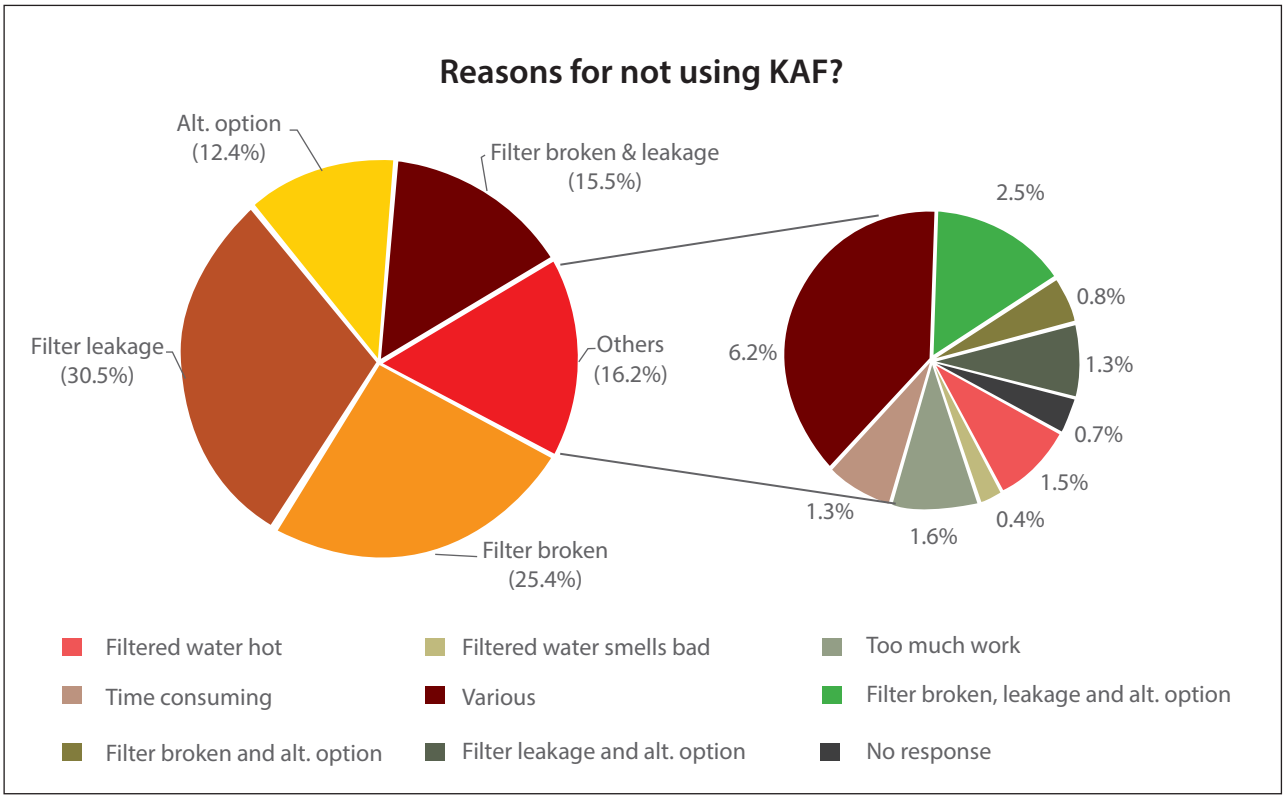

FIGURE 18: REASONS FOR NOT USING KAF

Around 30.5% KAF were not in use due to a leakage problem, while 25% filters were found broken. Approximately 15.5% KAF have reported both breakage and leakage problems. Therefore, almost 71% of KAFs were not in operation due to breakage and/or leakage problems. About 12.4% households responded that they stopped using KAF as they were provided with alternative options. Some of the other reasons for not using the filters are filtered water is too hot, filtered water smell is not good, too much work and time consuming.

TABLE 5: TYPES OF KAF WITH BREAKAGE AND LEAKAGE PROBLEMS

Types of KAF	Broken	Leakage	Total	(%)	Total no. KAF
Concrete Round	21	7	28	1.5%	269
Concrete Square	39	73	112	6.0%	501
Plastic Round (GEM505)	736	795	1531	82.3%	1818
Plastic Square (Hilltake)	80	109	189	10.2%	242
Fiberglass	0	1	1	0.1%	3
Total	**876**	**985**	**1861**	**100.0%**	**2833**

Table 5 shows the types of KAF with respect to the breakage and leakage problems. Nearly 82% of the plastic round (GEM505) version of KAFs have breakage and leakage problems, while almost 10% of the plastic square version have such problems. The concrete versions of KAF have less breakage and leakage problems in comparison to the plastic versions. Only 1.5% of the concrete round KAFs and 6% of the concrete square KAFs have reported leakage or breakage problems.

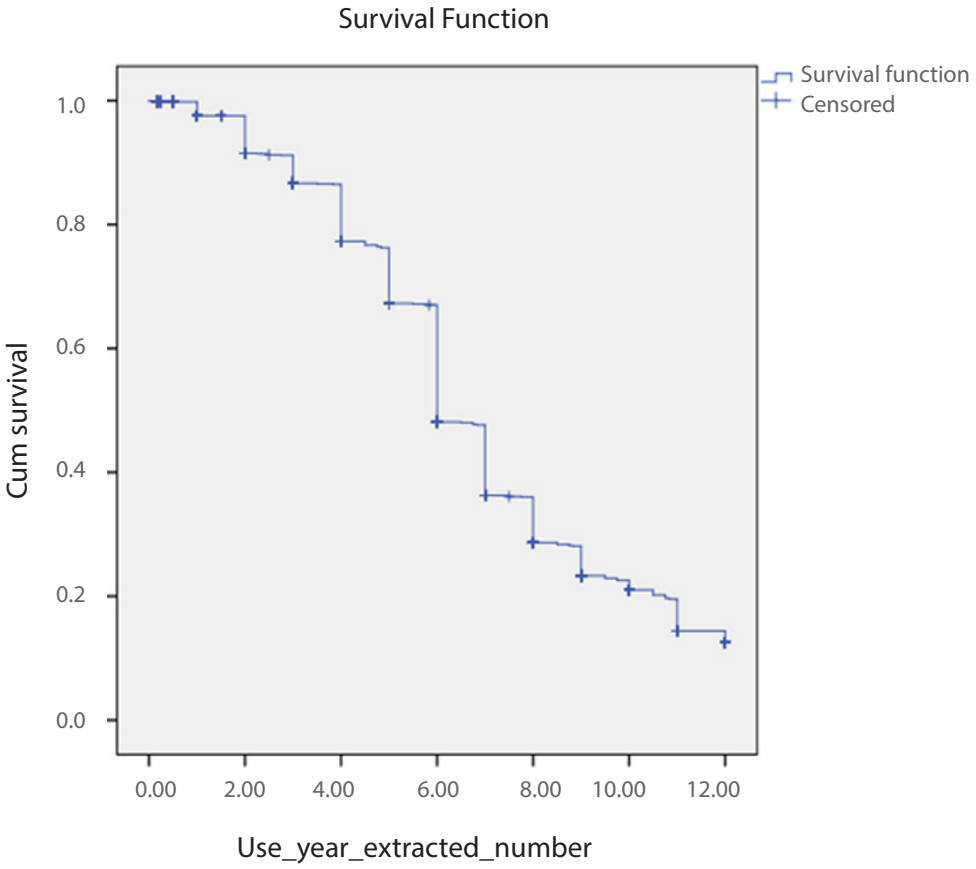

FIGURE 19: DROPOUT RATE OF ALL KAF

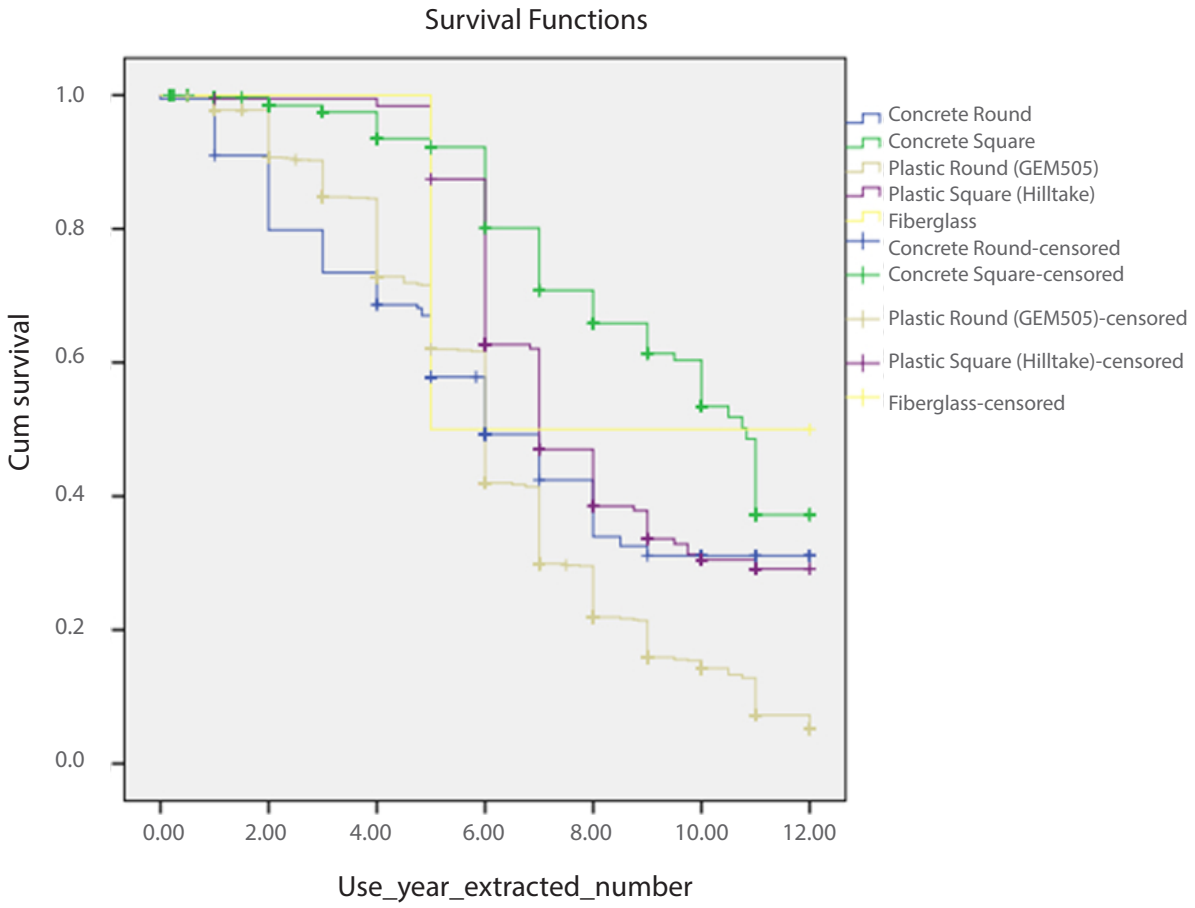

FIGURE 20: TYPE WISE DROPOUT RATE OF KAF

Figure 19 shows the dropout rate for all KAFs. It was observed that most of the KAFs remain in use for up to one year of operation. The dropout rate is then steady up to 5 years of operation. A sudden increase of dropout rate can be seen after 5 years of filter operation. Almost 70% of KAFs were still functioning after 5 years, this decreases to 40% in the 6th year of operation. The significant dropout rate can be seen between 5 and 8 years of KAF operation. After the 8th year, the rate was again steady up to 12 years of operation.

Figure 20 shows the dropout rate of the different versions of KAFs. It shows that the overall dropout rate for the concrete square version is low compared to other types of KAF. Up to the 5th year, the continued use of the plastic square (Hilltake) version was found to be better than other types, but after the 5th year, a sudden increase in dropout rate can be seen for the plastic square version. Overall dropout rate for the plastic round (GEM505) version is high compared to other types of KAF. As mentioned earlier, the breakage and leakage problems with the plastic round (GEM505) version are significantly higher than other versions. Therefore, it is expected that the dropout rate will be high for the plastic round (GEM505) version.

Approximately 15% of HHs stated that they tried to fix the problems. When attempting to fix the problems, 25 HHs called the filter technicians while 45 HHs tried to fix the problems by themselves by applying glue to stop leakage or replacing the broken pipes.

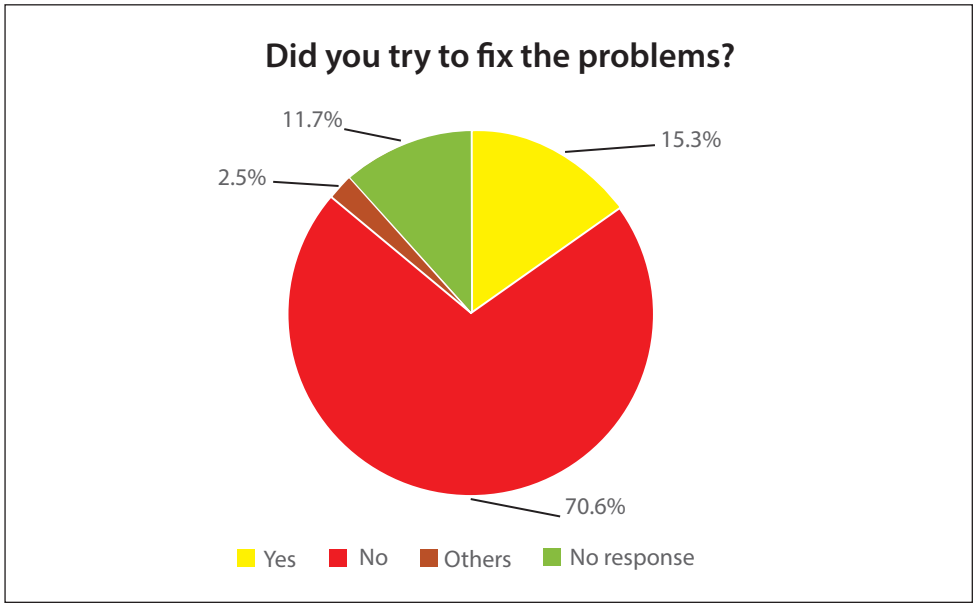

FIGURE 21: TRYING FIX THE KAF PROBLEMS

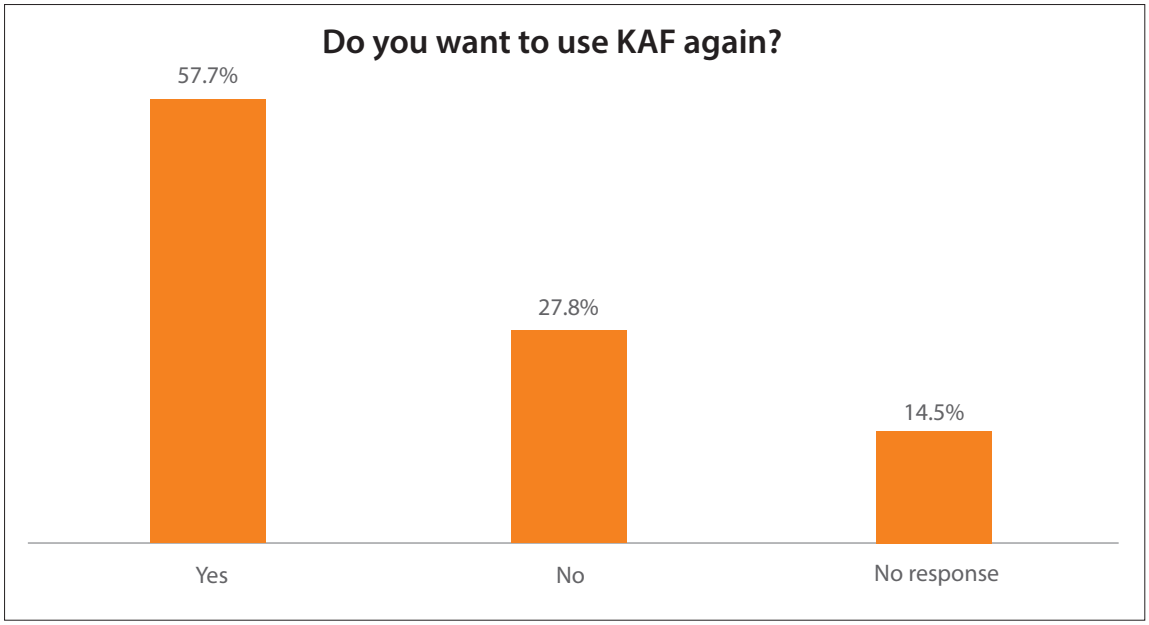

FIGURE 22: WILLINGNESS TO USE KAF AGAIN

As shown in Figure 22, almost 58% of the HHs with non-functional filters responded that they would be willing to use filters again if the problems are fixed. In addition, approximately 68% households deemed that they will not give away their filter even if it is not in use proving the demand for ownership of a filter is very high, shown in Figure 23.

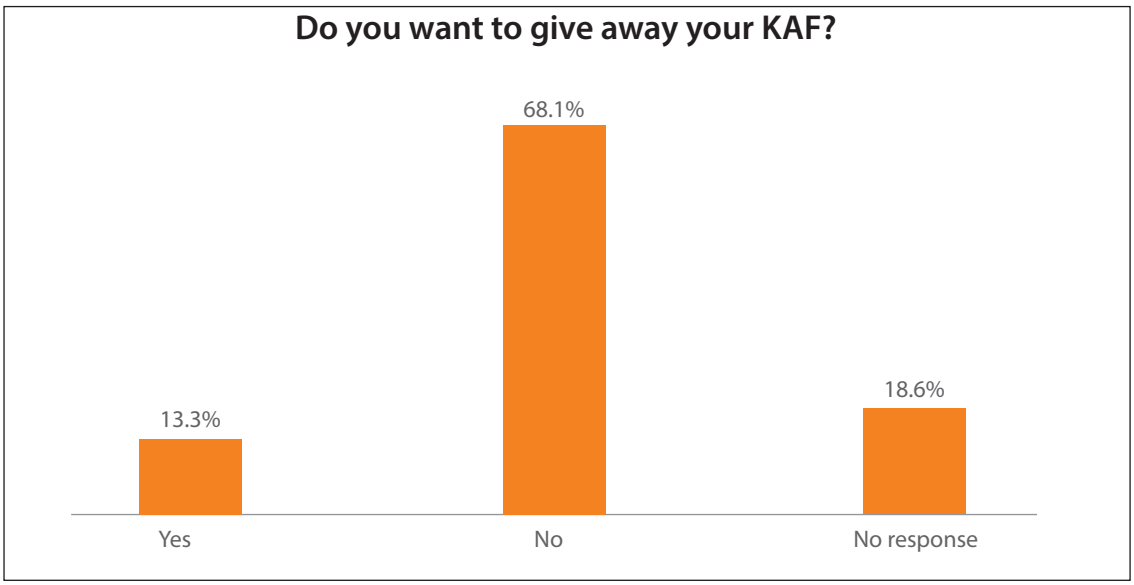

FIGURE 23: RESPONSES ON GIVING AWAY THE KAF

All this information clearly shows that due to breakage and leakage problems, most of the KAFs are not in use. Nevertheless, the KAF users are willing to re-use and retain their filters and even ready to provide contribution to use filter again. Their main demand is the technical support to fix the filter problems or replace the filters if necessary.

5.7 KAF in use from detailed survey

This section presents the findings from the detailed survey (phase I) performed at 498 HHs with functional filters.

Out of 498 HHs, 483 HHs have individual filters, while the number of KAFs shared by 2 and 3 HHs is 10 and 5 respectively. Altogether 3047 people are provided with drinking water from these functional filters.

Figure 24 illustrates the daily volume of filtered water provided by the functional KAFs. According to the technical specifications, the volume of filtered water should not exceed 50 L/day. The overloading of a KAF may comprise its performance. According to the survey findings, approximately 3% of households are filtering more than 50 L/day water and the performance of these filters may be compromised as the recommended volume of water to be filtered out is 40 L/day.

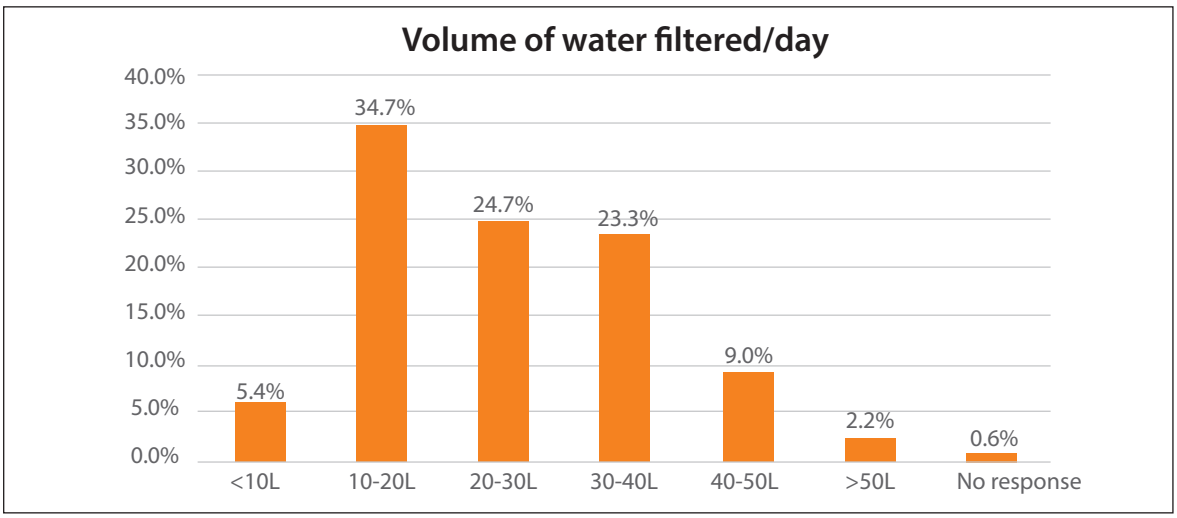

FIGURE 24: VOLUME OF FILTERED WATER PER DAY

As shown in Figure 25, most of the HHs (290) are using a bucket with cover to store their filtered water; this is the best practice and can help to avoid cross contamination. While 114 HHs are using a bucket without any cover and 80 HHs are using gagri to store the filtered water.

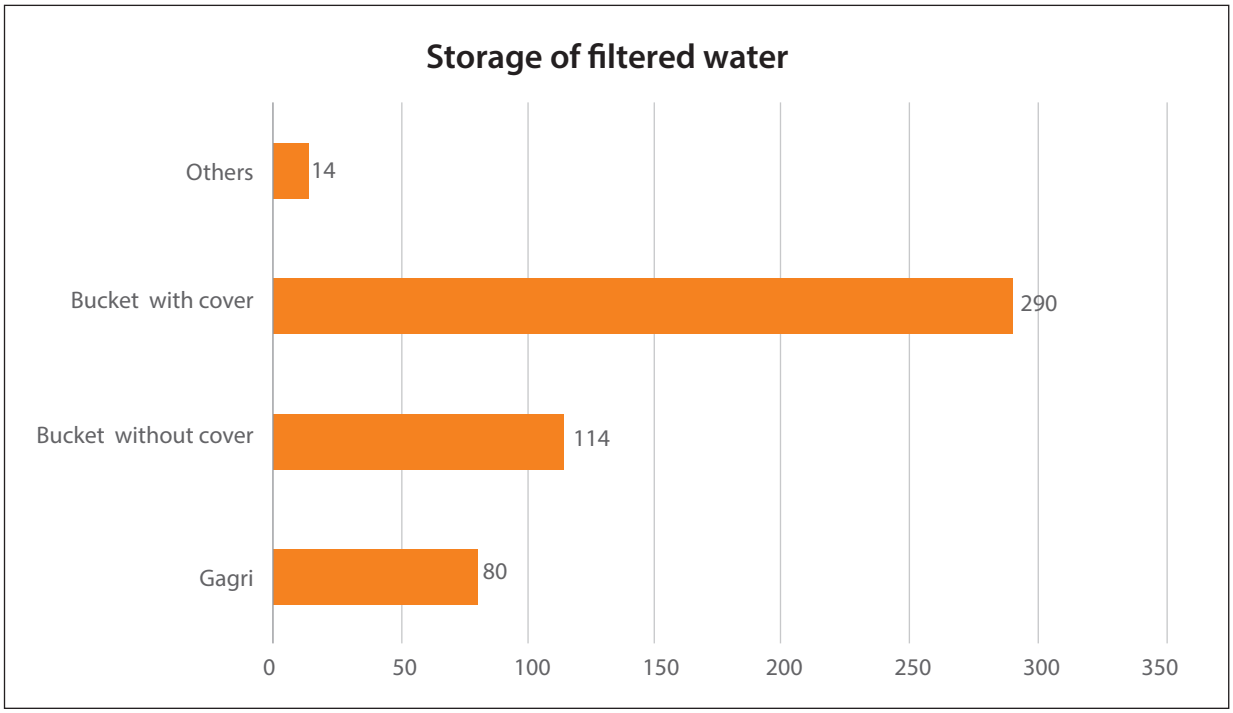

FIGURE 25: STORAGE OF FILTERED WATER

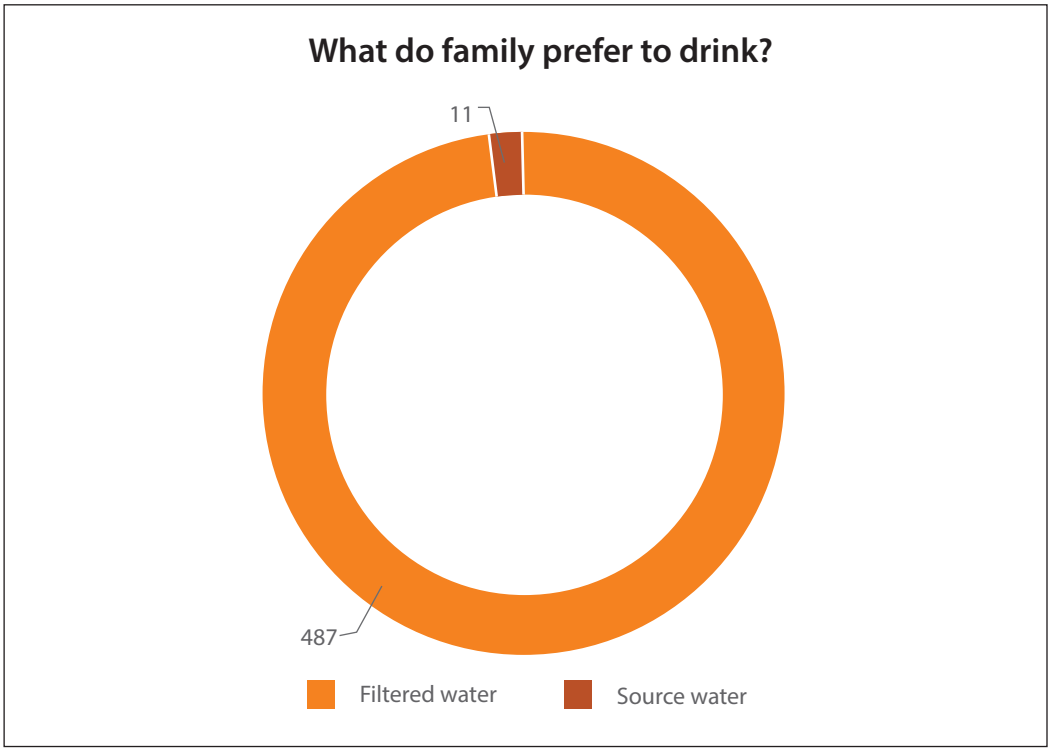

FIGURE 26: PREFERENCE FOR DRINKING WATER

As shown in Figure 26, 487 HHs (98%) responded that their family prefer to drink filtered water. The main reasons for the preference of filtered water are the improved taste, appearance and smell of filtered water in comparison to raw water. Table 6 presents users' preferences for drinking filtered water in terms of appearance, taste and smell. Almost 98% of HHs deemed that the appearance, taste and smell of filtered water is better than tube well water, so they prefer to drink filtered water.

TABLE 6: USERS PREFERENCES FOR DRINKING FILTERED WATER

Attributes	Filtered water is better	Same	Tube well water is better
Appearance	490	8	0
Taste	490	6	2
Smell	492	6	0

	Yes	No	Don't know
Easy to use	494	4	0
Easy to clean	454	41	3

	Feel healthier after using KAF?	Do you recommend KAF to others?
Yes	474	448
No	24	50

Approximately 74% of HHs stated that using their KAF is not too much work for them while the remaining 36% HHs felt that using their KAF was an additional burden to them. Similarly, 99% and 91% of the HHs responded that the KAF is easy to use and maintain respectively. Almost 95% of respondents stated that they felt healthier after drinking filtered water and approximately 90% of HHs would recommend the filter to others. All of this data suggests that the HHs using the KAFs have a sense of ownership towards the filter and are motivated to continue using it.

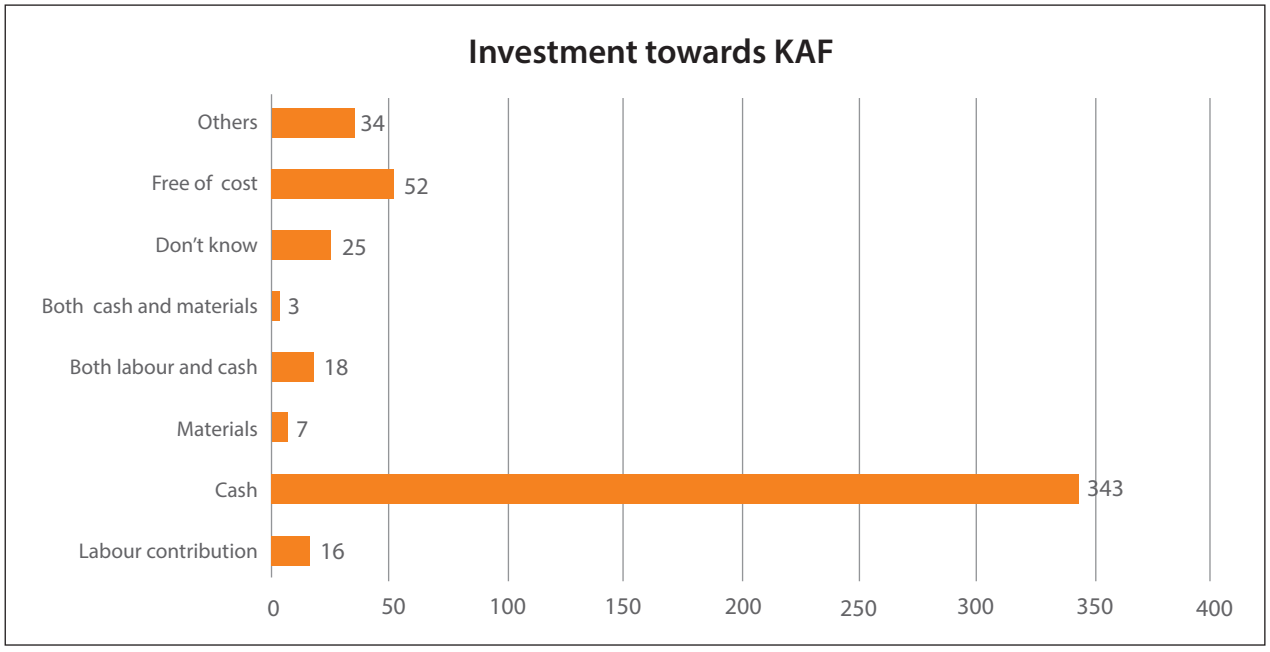

FIGURE 27: INVESTMENT TOWARDS KAF

As most of the filters were distributed by agencies as part of projects, the users were required to contribute something towards the filter. Figure 27 details the contributions that HHs made in order to receive the filter. Most of the HHs (343) contributed partial cash to get the filter, while 52 HHs got the KAF free of cost. Altogether 18 HHs contributed labor and cash and 16 households contributed only labor contribution to receive the KAF.

When cleaning the KAF some sludge will be generated, it is recommended that the sludge is disposed of in the pit along with the cow dung. However, the majority of the HHs (186) are disposing of the sludge directly into an open drain, while 134 HHs are disposing of the sludge with the cow dung as recommended. Altogether 90 HHs are disposing of the sludge haphazardly while 51 HHs are disposing of it in the kitchen garden. Figure 28 below shows the sludge disposal practices of the HHs.

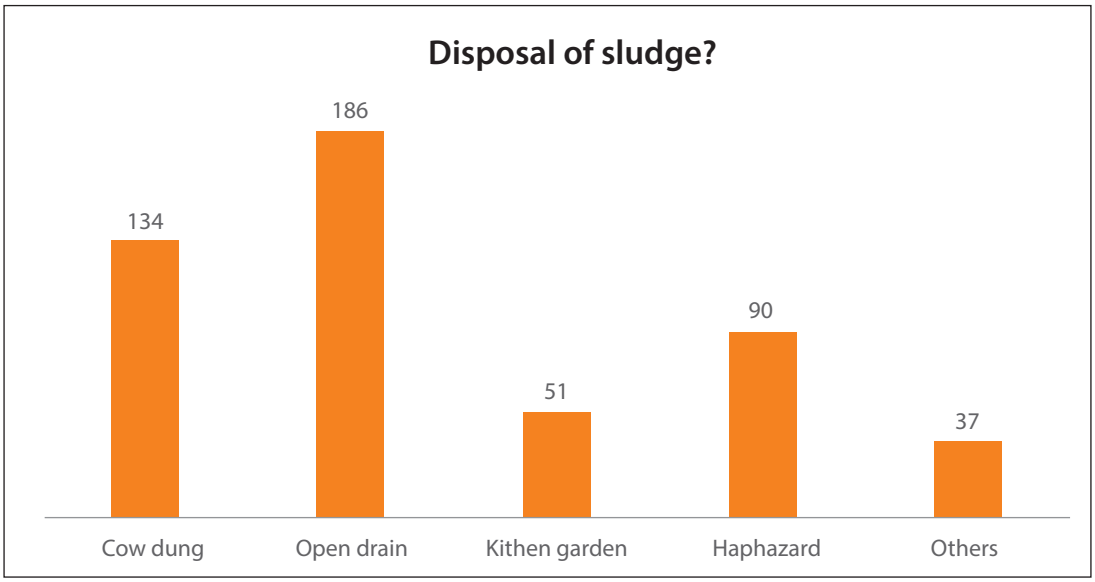

FIGURE 28: SLUDGE DISPOSAL PRACTICES

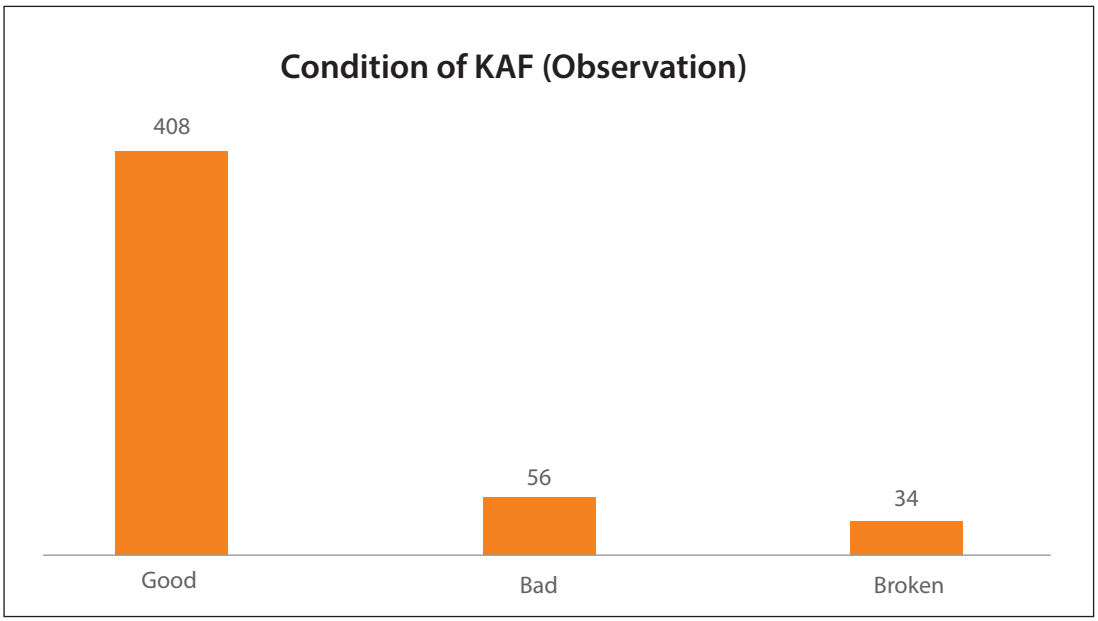

FIGURE 28: CONDITION OF KAF

Figure 29 shows the conditions of the filters surveyed. Based on the observations of the field team, it was found that 408 filters were in good condition, while 56 filters were found in bad condition. It was found that 34 HHs were still using their KAF even though some parts of the KAF were broken.

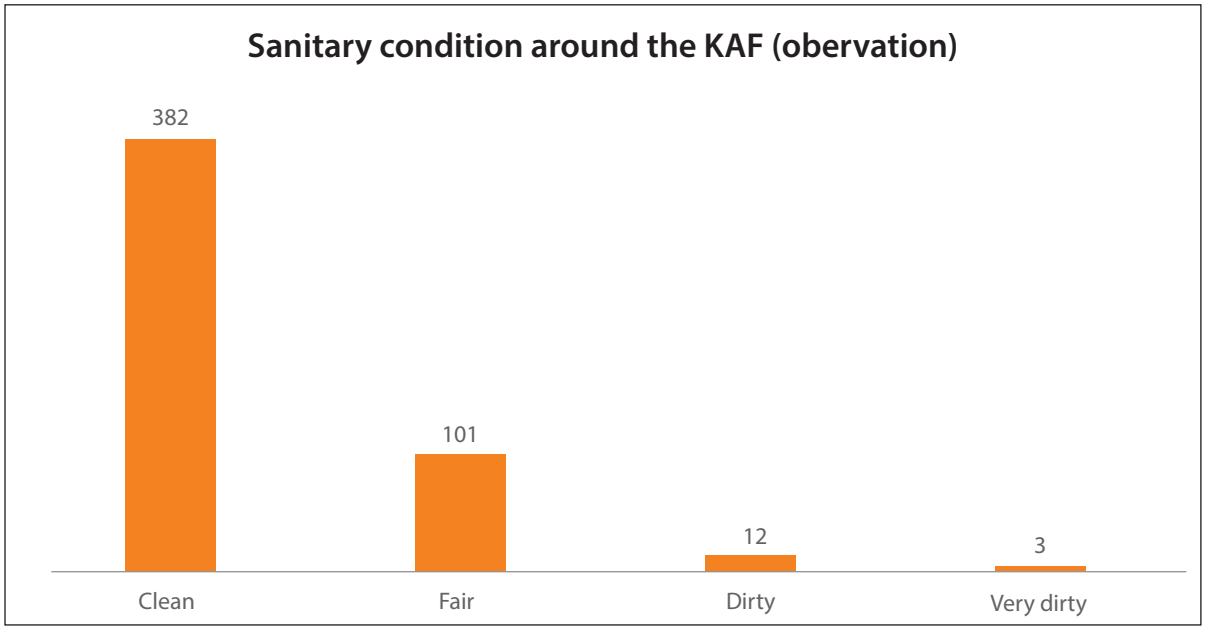

FIGURE 30: SANITARY CONDITION AROUND KAF

Figure 30 illustrates the sanitary conditions surrounding the KAFs observed by field staff during the surveys. Almost 77% (382) of the filters are surrounded by clean sanitary conditions, whereas 20% (101) KAF have fair sanitary conditions surrounding the KAF. The field team observed dirty and very dirty sanitary conditions surrounding 12 and 3 KAFs respectively. These filters are at a much higher risk of microbial contamination, therefore, more awareness on safe hygienic behavior should be provided to these HHs.

5.8. Water quality test result

5.8.1. Summary water quality test result

Table 7 shows a summary of the results of the water quality tests of the physico-chemical parameters in raw (tube wells) and filtered water (n=497) and fecal coliform concentration (n=30). The water quality analysis results from one HH is missing, therefore the data analysis was completed for only 497 out 498 functional KAFs. Arsenic and fecal coliform are considered the most important parameters. The mean and median values of arsenic in raw water are higher than Nepal's drinking water standard (50ppb). The KAFs showed good arsenic removal with 83% median removal and 75% mean removal, with both values falling below the Nepal Drinking Water Quality Standard (NDWQS). Fecal coliform values are also recorded as high in the raw water, median value of 24cfu/100mL and mean value of 72.86cfu/100mL. The KAFs showed good performance for bacterial removal in this study with 97% median removal and 85% mean removal following filtration. The KAF showed a median of 100% and mean of 97% for iron removal.

TABLE 7: OVERALL WATER QUALITY TEST RESULT AND REMOVAL % OF KAF

Water Quality Parameters	Raw (tube wells) water			Filtered water			Removal %		
	Range	Median	Mean	Range	Median	Mean	Range	Median	Mean
Arsenic (ppb)	0-1320	60	91.57	0-590	10	25.72	0-100	83	75
Fecal Coliform (cfu/100ml)	0-TNTC	24	72.86	0-170	1	12.53	0-100	97	85
Iron (mg/L)	0-10	3	3.22	0-5	0	0.13	0-100	100	97
Hardness (mg/L)	36-3687	272	280.12	19-664	240	248.6	0-91	7	11
pH	6-7.5	6.5	6.3	6-7.5	6.5	6.5	-	-	-
Phosphate (mg/L)	0-1	0.05	0.15	0-2	0.05	0.04	0-100	75	61

Table 8 shows the percentages of raw and filtered water that exceeded water quality parameters. Results show that arsenic concentration in filtered water exceeded WHO GV in 38% of samples and exceeded Nepal drinking water quality standards (NDWQS) in 13% of samples. Fecal coliform test results show both WHO GV and Nepal drinking water quality standards were exceeded in 57% of filtered water samples.

Table 8: RAW AND FILTERED WATER EXCEEDING WHO GV AND NDWQS

Water Quality Parameters	% Raw (tube well) water Exceeding		% Filtered water Exceeding	
	WHO GV	NDWQS	WHO GV	NDWQS
Arsenic	80%	54%	38%	13%
Fecal Coliform	90%	90%	57%	57%
Iron	-	79%	-	3%
Hardness	-	1%	-	1%
pH	-	40%	-	1%

5.8.2. Arsenic removal performance

The distribution of arsenic concentration in raw and filtered water is presented in Figure 31. It was found that 13.5% of raw water samples have arsenic below the detection level (less than 0.05 ppb), 45.9% of raw water has arsenic below 50 ppb and 54.1% of raw water samples have arsenic above 50 ppb. Most of the raw water samples (27.7%) contained arsenic between 51-100 ppb, while 25.4% of the raw water samples have arsenic between 101-500 ppb. Five (1%) of the raw water samples contained an arsenic concentration above 500 ppb.

Approximately 41.4% of filtered water samples have arsenic below the detection level (less than 0.05 ppb). Nearly 86.3% of filtered water has arsenic concentration below 50 ppb (National drinking water quality standard for arsenic), therefore the filtered water from these KAFs are safe for drinking in terms of arsenic. 13.7% (68 KAFs) of the filtered water samples exceeded an arsenic concentration of 50 ppb and are therefore unsafe for drinking. Out of this 13.7%, 13.3% (66 KAFs) of samples have arsenic levels between 51-300 ppb and only 0.4 % (2 KAFs) of samples contained arsenic concentrations between 501-1000 ppb. The main reasons for poor arsenic removal are discussed in a later section.

The maximum arsenic concentrations for the raw water and filtered water were 1046 ppb and 590 ppb respectively, while the minimum arsenic concentrations were below detection level for both raw and filtered water.

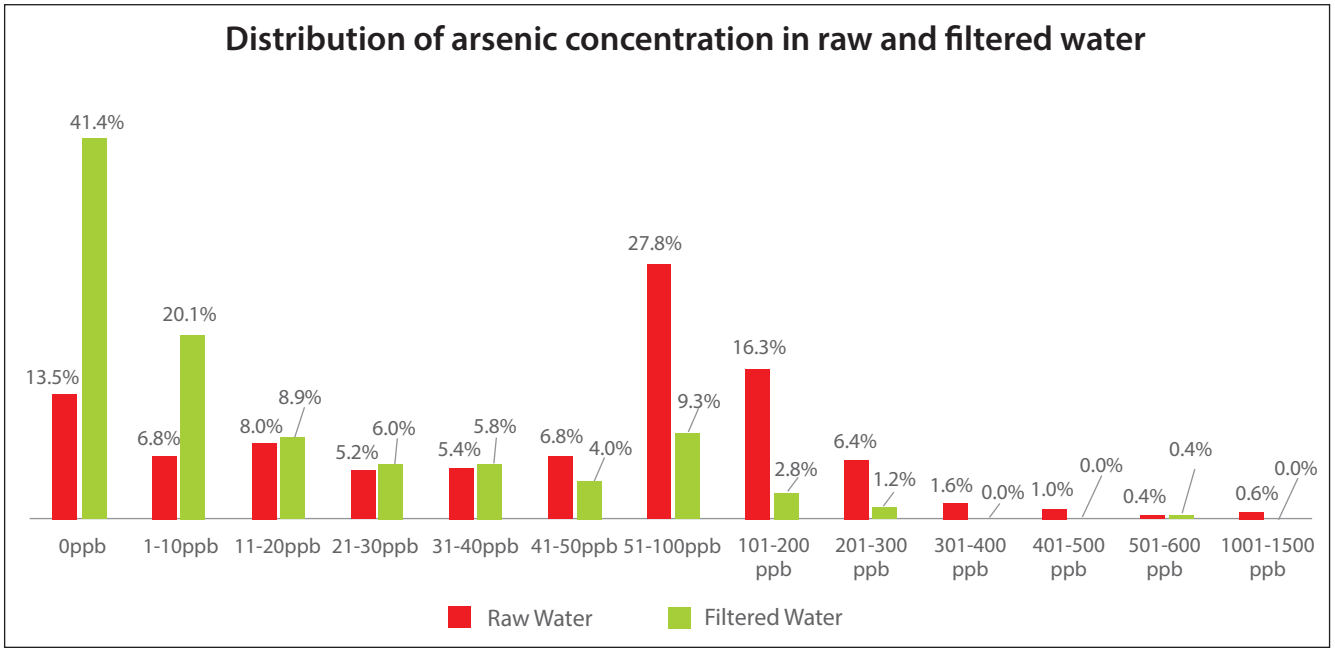

FIGURE 31: DISTRIBUTION OF ARSENIC CONCENTRATION IN SOURCE AND FILTERED WATER

Table 9 shows the number of samples of raw and filtered water that fall within each classification of arsenic concentration: below the WHO guideline of 10 ppb, between the WHO guideline and Nepal Standard and above Nepal Standard of 50 ppb. Approximately 61.6% of filtered water samples were found below the WHO guideline, nearly 24.7% of samples were found between 11-50 ppb and 13.7% were found to have arsenic above the Nepal Standard of 50 ppb.

TABLE 9: CLASSIFICATION OF ARSENIC CONCENTRATION IN RAW AND FILTERED WATER SAMPLES

Range	Raw water		Filtered Water	
	Nos.	(%)	Nos.	(%)
Not detected -10 ppb	101	20.3%	306	61.6%
11-50 ppb	127	25.6%	123	24.7%
Above 50 ppb	269	54.1%	68	13.7%
Total:	**497**	**100%**	**497**	**100%**

Further analysis, detailed in Table 10, showed that only 210 KAFs (42.3%) removed arsenic to below 50 ppb when the raw water concentration was above 50ppb, while in 219 (44.1%) cases both raw water and filtered water samples had arsenic values below 50 ppb. In 59 (11.9%) cases, both raw water and filtered water samples had arsenic concentrations above 50 ppb. In 9 (1.8%) cases, the arsenic concentration in filtered water samples were found to be above 50 ppb even though raw water samples were less than 50 ppb of arsenic. The main reasons are likely to be human error during water sampling or labeling, error during water quality analysis or a higher arsenic concentration in the filtered water due to an over accumulation of arsenic on the top sand layer of the filter.

TABLE 10: DISTRIBUTION OF RAW AND FILTERED WATER SAMPLES WITH ARSENIC ABOVE OR BELOW 50 PPB

Raw water ">50 ppb" and Filtered Water "<=50 ppb"	Raw water ">50 ppb" and Filtered Water ">50 ppb"
210 (42.3%)	**59 (11.9%)**
Raw water "<=50 ppb" and Filtered Water "<=50 ppb"	**Raw water "<=50 ppb" and Filtered Water ">50 ppb"**
219 (44.1%)	**9 (1.8%)**

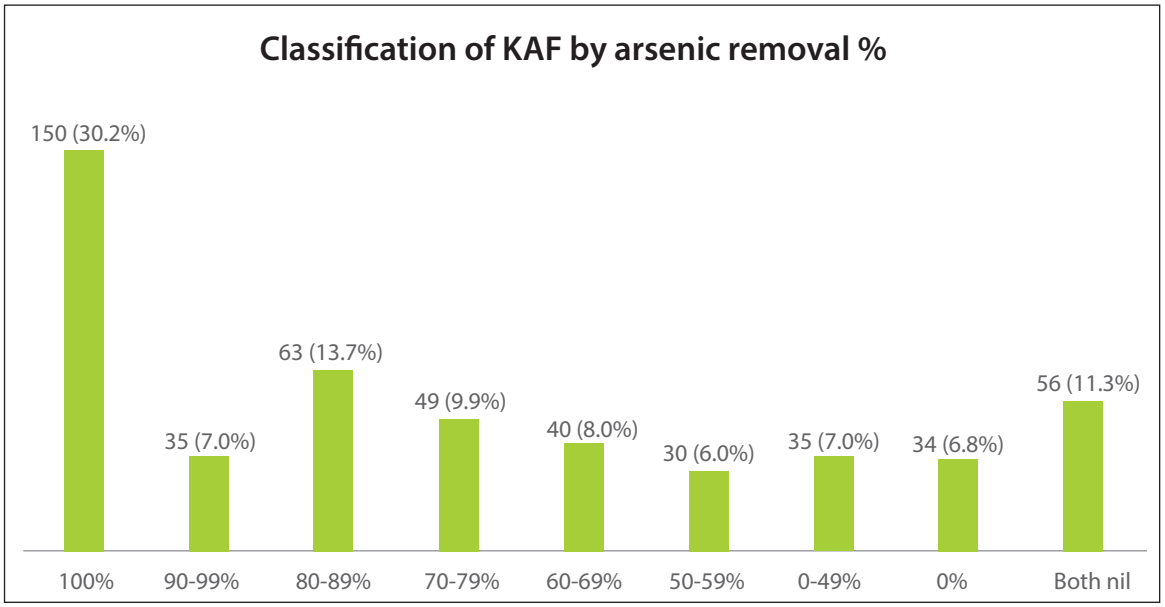

FIGURE 32: CLASSIFICATION OF KAF BY ARSENIC REMOVAL PERCENTAGE

Figure 32 illustrates the classification of KAF by arsenic removal percentage. It was found that 150 (30.3%) KAFs removed 100% of the arsenic. Approximately 44.6% of the filters removed between 50 to 99% of the arsenic, while 6.9% of the filters removed less than 50% of arsenic. Overall, the average arsenic removal of the KAFs was found to be 85%. Table 11 shows the arsenic removal by KAF version.

TABLE 11: CLASSIFICATION OF ARSENIC REMOVAL BY DIFFERENT KAF VERSIONS

% As removal range	Concrete round		Concrete square		Plastic round (GEM505)		Plastic square (Hilltake)		Fiber glass		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
100%	24	28.9%	54	47.8%	63	24.7%	9	20.0%	0	0.0%	150	30.2%
90-99%	9	10.8%	7	6.2%	13	5.1%	6	13.3%	0	0.0%	35	7.0%
80-89%	10	12.0%	7	6.2%	46	18.0%	5	11.1%	0	0.0%	68	13.7%
70-79%	6	7.2%	7	6.2%	27	10.6%	9	20.0%	0	0.0%	49	9.9%
60-69%	7	8.4%	5	4.4%	26	10.2%	2	4.4%	0	0.0%	40	8.0%
50-59%	4	4.8%	6	5.3%	15	5.9%	5	11.1%	0	0.0%	30	6.0%
0-49%	4	4.8%	5	4.4%	21	8.2%	4	8.9%	1	100%	35	7.0%
0%	10	12.0%	6	5.3%	14	5.5%	4	8.9%	0	0.0%	34	6.8%
Both nil	9	10.8%	16	14.2%	30	11.8%	1	2.2%	0	0.0%	56	11.3%
Total:	**83**		**113**		**255**		**45**		**1**		**497**	

In terms of the arsenic removal rates of different KAF versions, nearly 47.8% of concrete square KAFs have a 100% arsenic removal rate and only 5.3% of concrete square KAFs have a 0% arsenic removal rate. Approximately 29.3% of concrete round, 24.8% of plastic round and 20% of plastic square versions have a 100% arsenic removal rate.

The arsenic removal range in terms of age of KAF is shown in Table 12 below. Out of 20 KAF that were distributed less than 6 months ago, 12 filters (90%) were performing well with 100% arsenic removal, while one filter showed 0% arsenic removal. Since these filters have been recently installed, the high arsenic removal is likely to be due to the high arsenic adsorption capacity of the new iron nails, which is better than older nails. However, it should be noted that 100% arsenic removal has also been observed in relatively old KAFs (more than 4 years). Altogether 25% of KAFs that were more than 10 years old had an arsenic removal of 100%. This signifies that if a KAF is properly operated and maintained, arsenic removal can be very effective, regardless of the age of the iron nails.

TABLE 12: AGE OF KAF VS. RANGE OF % ARSENIC REMOVAL

% As removal range	Age of KAF									
	< 6 months	6 months	> 6 mths to 2 yrs	> 2 yrs to 4 yrs	> 4 yrs to 6 yrs	> 6 yrs to 8 yrs	> 8 yrs to 10 yrs	> 10 yrs	Don't know	Total
100%	12	1	42	23	37	7	17	10	1	150
90-99%	3	0	5	3	13	4	5	2	0	35
80-89%	1	0	12	9	15	18	9	4	0	68
70-79%	1	0	7	3	12	9	16	1	0	49
60-69%	0	1	4	3	11	6	8	6	1	40
50-59%	1	0	1	3	13	1	8	3	0	30
0-49%	1	0	5	3	10	7	5	3	1	35
0%	1	0	6	2	9	2	8	6	0	34
Both nil	0	2	20	9	7	5	7	6	0	56
Total:	**20**	**4**	**102**	**58**	**127**	**59**	**83**	**41**	**3**	**497**

5.8.3. Bacterial removal

The distribution of arsenic concentration in raw and filtered water is presented in Figure 31. It was The microbiological analysis was completed by testing for fecal coliforms in 30 randomly selected KAFs. The raw water samples were taken from the tube wells from the respective KAFs. Although the depths of these tube wells were not recorded during this study, the previous study shows that the average depth of a shallow tube well is 5-20 meters in the Terai region (NASC, 2011). Figure 33 shows the removal of fecal coliforms in the 30 samples. Out of 30 tested filters, 10 filters have 100% removal, while 13 filters were found in the range of 70-99% removal. Two filters were found in the removal range of 50-59% and two filters removed fecal coliforms below 50%. The fecal coliforms count was not found both in raw and treated water samples in 3 filters.

The average fecal coliform removal for these filters is 84.5% which is similar in comparison to previous studies.

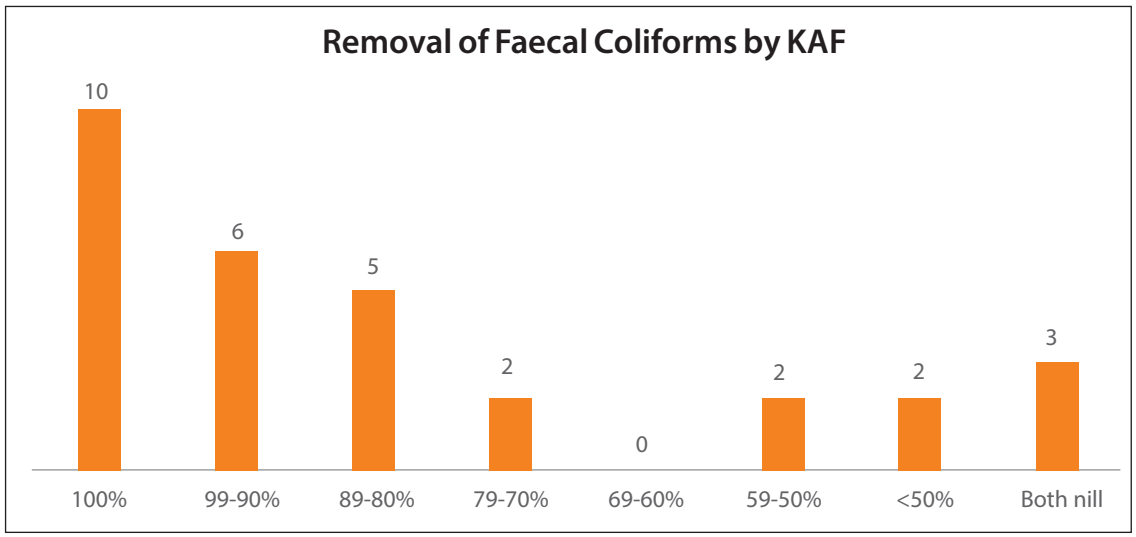

FIGURE 33: REMOVAL OF FAECAL COLIFORMS BY KAF

Figure 34 below illustrates the distribution of fecal coliform removal with respect to types of KAF. Four GEM505 version filters have a 100% removal rate while two filters for each of the other types have a 100% removal. The concrete square version (4 numbers) has removal rate in the range of 80-100%, whereas for GEM505 and concrete round versions the range is 0-100%. The plastic hilltake version has removal range of between 50-100%.

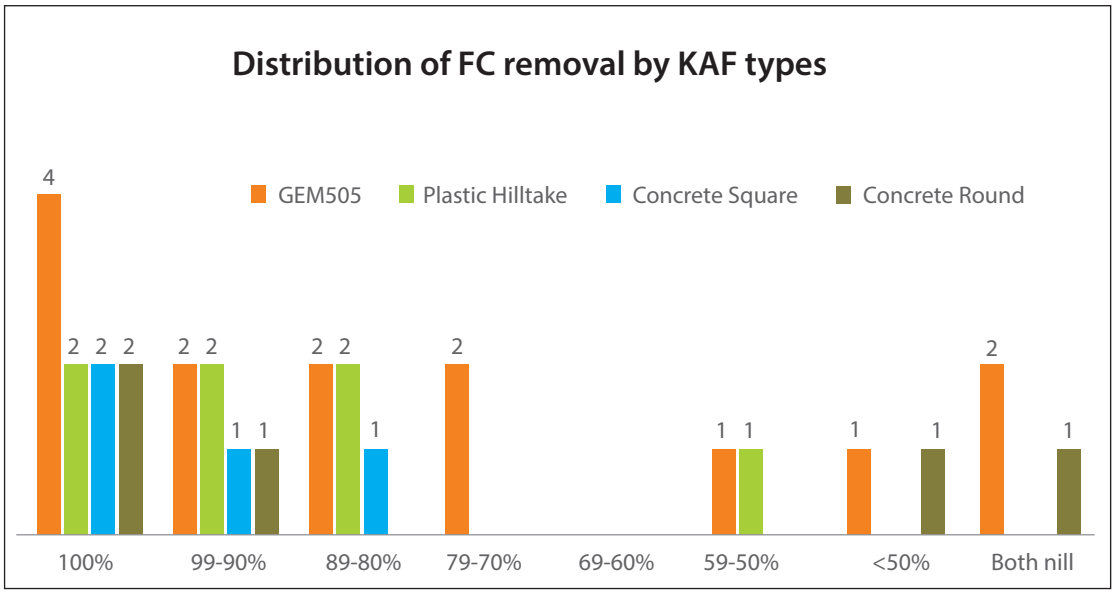

FIGURE 34: RDISTRIBUTION OF FC REMOVAL BY KAF TYPES

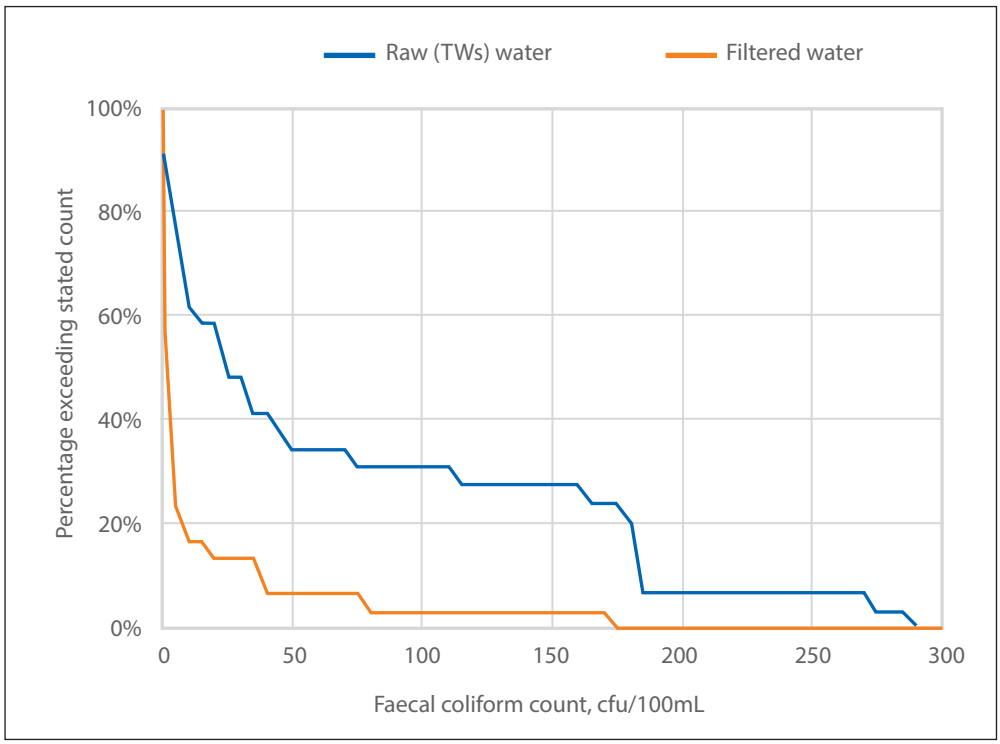

FIGURE 35: CLASSIFICATION OF FECAL COLIFORMS IN RAW AND FILTERED WATER

Figure 35 shows the fecal coliforms concentrations in raw and filtered water. Out of 30 raw water samples tested, 3 samples (10%) did not have coliforms, 8 samples (27%) had fecal coliforms between 1-10 cfu/100 ml, 9 samples (30%) had fecal coliforms between 11-100 cfu/100 ml and 10 samples (33%) contained more than 100 cfu/100ml fecal coliforms. In 13 treated water samples (43%), the fecal coliforms count was 0 cfu/100 ml and safe for drinking in terms of bacterial contamination. Altogether 12 treated water samples (40%) had fecal coliforms between 1-10 cfu/100 ml, 4 samples (13%) had 11- 100 cfu/ 100 ml and one sample (3%) contained more than 100 cfu/100 ml fecal coliforms.

5.8.4. Comparison of results from previous and current studies

Table 13 shows the comparison of results from previous studies and the current study. Overall, this study shows the arsenic removal to be less than that recorded in previous studies. The study conducted by Shrestha, P. (2004) also showed an average arsenic removal of 85%, this study was completed within a laboratory. The remaining studies, which were conducted in field, showed arsenic removal rate above 90%. The current study has found an average arsenic removal of 85% which may illustrate that the performance of the KAFs have decreased with the time. However, more research and analysis would be required to confirm this assumption. In terms of bacterial removal, the current study shows 84.5% faecal coliform removal which is similar to that of previous studies.

TABLE 13: COMPARISON OF THE RESULTS (CURRENT AND PREVIOUS STUDIES)

SN	Study	Arsenic removal	Removal of Total Coliforms	Removal of E. Coli.
1	*Ngai, T., Walewijk, S. (2003).*	93%	58%	64%
2	*Odell, N. (2004).*	95%	-	-
3	*Shrestha, P. (2004).*	85%	94%	-
4	*Sharma, D. (2005).*	-	85-99%	-
5	*Ngai, T., Shrestha, R., Dangol, B., Maharjan, M., and Murcott, S. (2007)*	90%	-	-
6	*Current study*	85%	84.5% (faecal coliforms)	

The results from the previous study on KAFs conducted by DWSS, UNICEF and UNHABITAT in 2009 showed that 89% of 700 KAFs in Rautahat, Bara, Parsa, Nawalparasi, Rupendehi and Kapalbastu districts were found to be functional. The current study shows that only 30% of the KAFs surveyed are functional (25% replaced by alternative option among 70% non-functional KAF). Therefore, it can be concluded that the number of KAFs in the field that are functional has significantly decreased since the previous study in 2009. As mentioned previously, the main issue associated with the non-functionality of KAFs was breakage and leakage problems. Therefore, monitoring and support should be established between the providers and the HHs to identify and resolve problems with the KAFs to allow for sustained use of the filters.

5.8.5. Other parameters (Iron, pH, Hardness, Phosphate)

Previous studies have shown that thr KAF is very efffective at removing iron. This study also exhibited good iron removal performance with approximately 67% of KAFs removing 100% of iron from the drinking water and approximately 24% of filters removing between 70-99% of iron, as shown in Figure 36. The classification of filtered water by iron concentration is shown in Figure 37 below. The results showed that approximately 73% of the filtered water contained an iron concentration of 0 ppm while almost 24% of the filtered water contained an iron concentration between 0-0.3 ppm. Only 2.8% filters had iron concentration more than 0.3 ppm which is the national drinking water quality standard for iron.

As iron is effeciently removed by the KAF, the colour, taste and smell of the filtered water is much more desiareable in comparison to the raw tube well water. This is one of the main reasons that HHs continue to use the KAF.

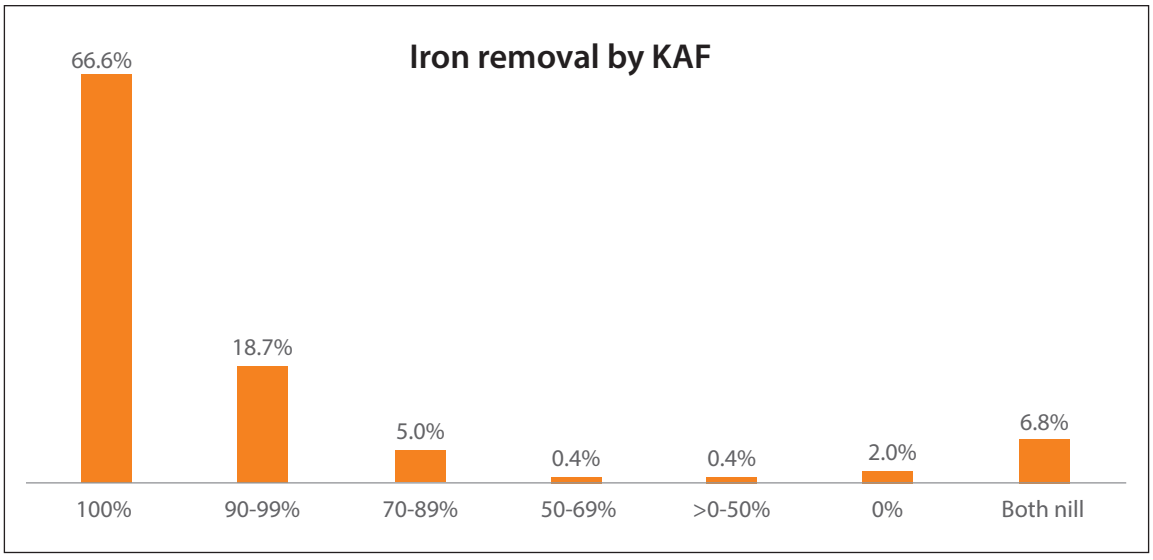

FIGURE 36: IRON REMOVAL BY KAF

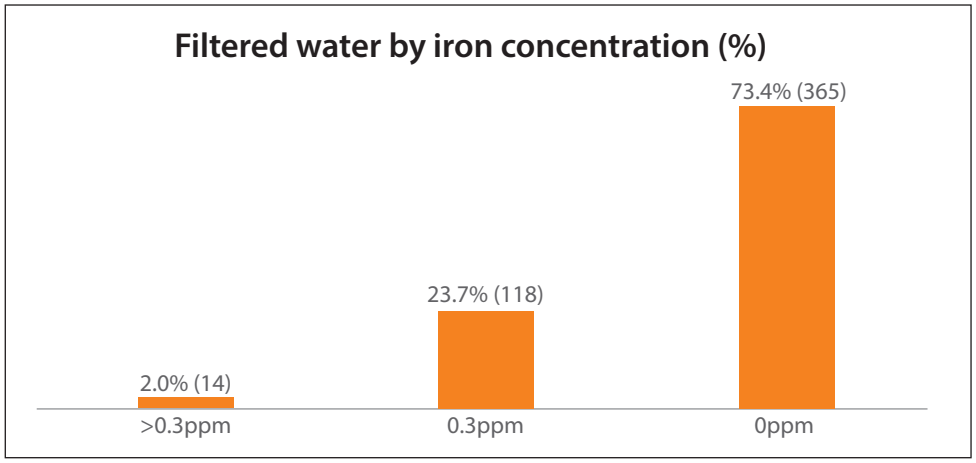

FIGURE 37: CLASSIFICATION OF FILTERED WATER BY IRON CONCENTRATION

This study, water quality testing was completed for other parameters such as pH, hardness and phosphate in the field using ENPHO water testing kits. These tests were completed to determine if such parameters had any influence on arsenic removal performance of KAF. Figures 38, 39, 40 and 41 below show the relationship between arsenic removal percentage and the iron, phosphate, pH and hardness in raw water. The data analysis showed that these parameters do not have any significant influence or correlation with KAF arsenic removal.

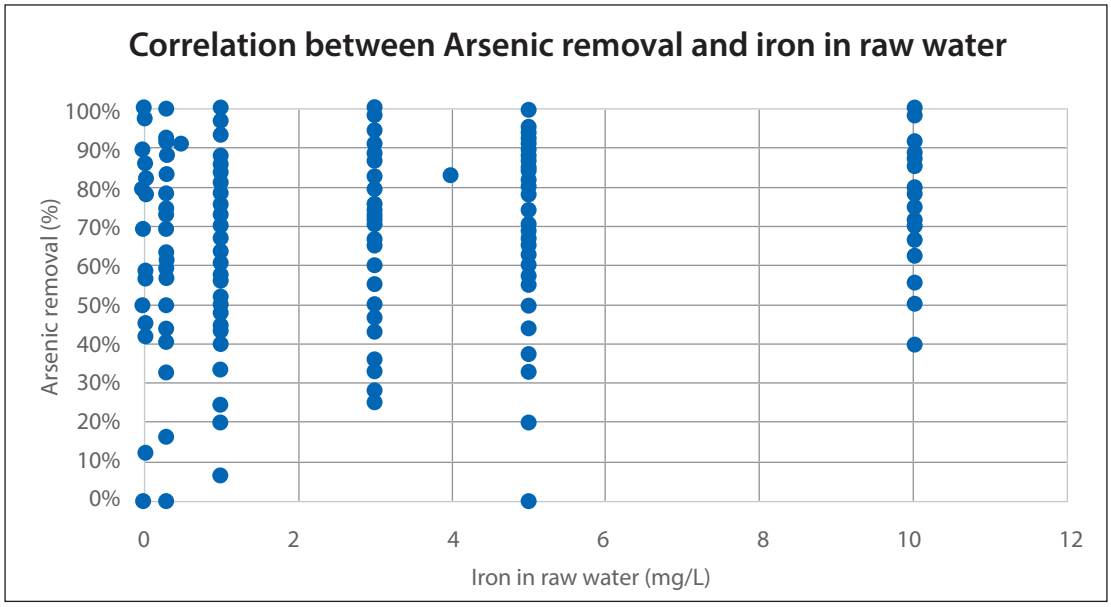

FIGURE 38: CORRELATION BETWEEN ARSENIC REMOVAL AND IRON IN RAW WATER

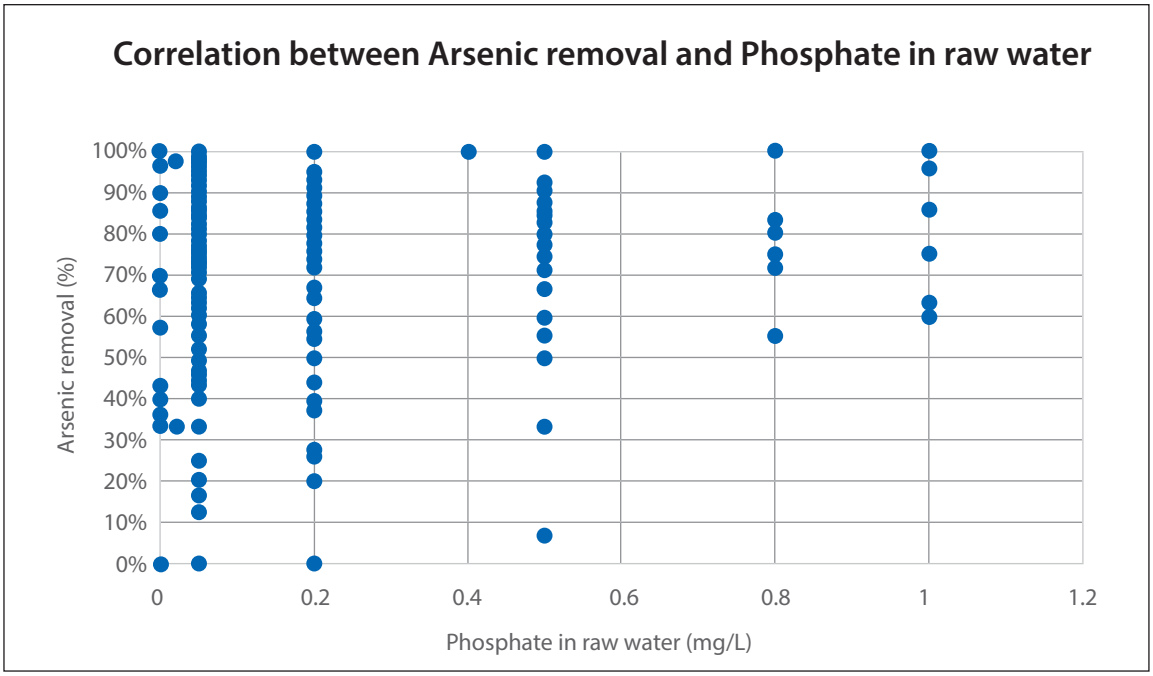

FIGURE 39: CORRELATION BETWEEN ARSENIC REMOVAL AND PHOSPHATE IN RAW WATER

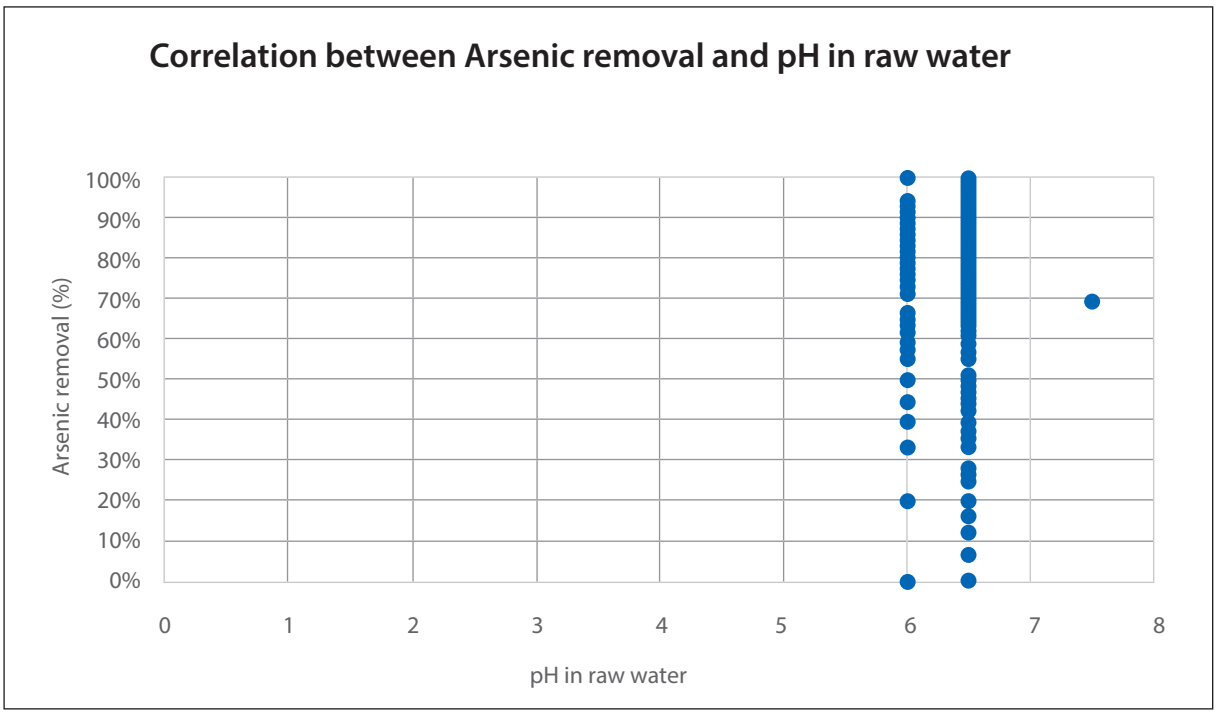

FIGURE 40: CORRELATION BETWEEN ARSENIC REMOVAL AND PH IN RAW WATER

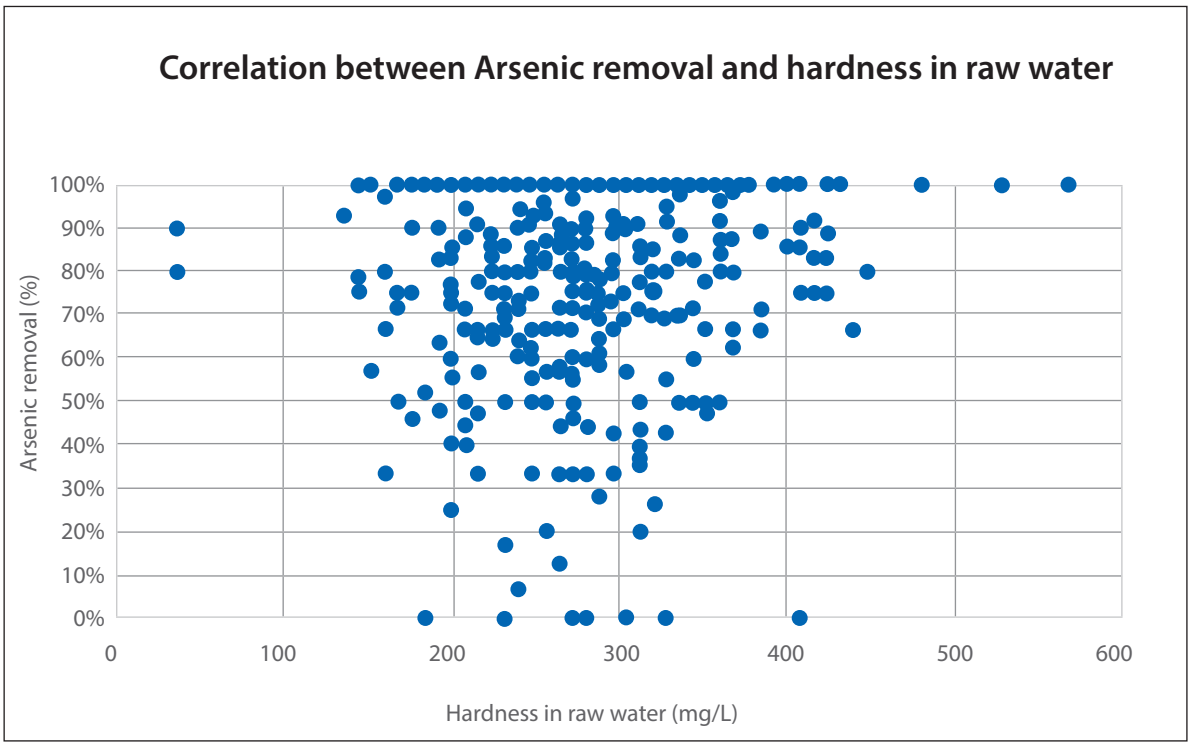

FIGURE 41: CORRELATION BETWEEN ARSENIC REMOVAL AND HARDNESS IN RAW WATER

Figures 42, 43, 44 below show the comparative histograms for pH, hardness and Phosphate in raw and filtered water samples.

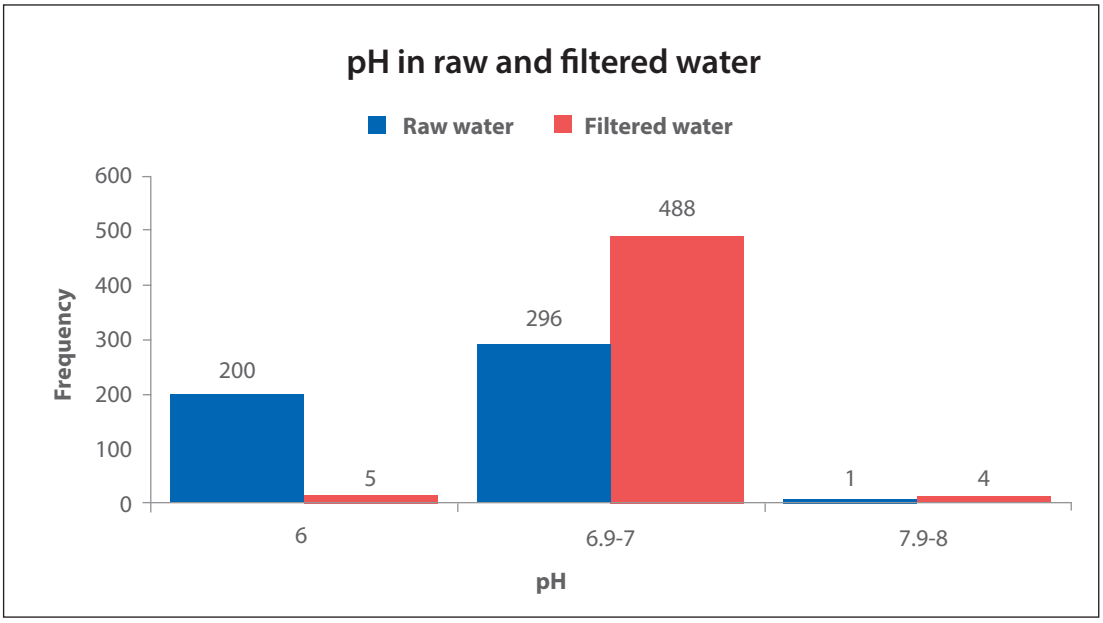

FIGURE 42: HISTOGRAM FOR PH IN RAW AND FILTERED WATER

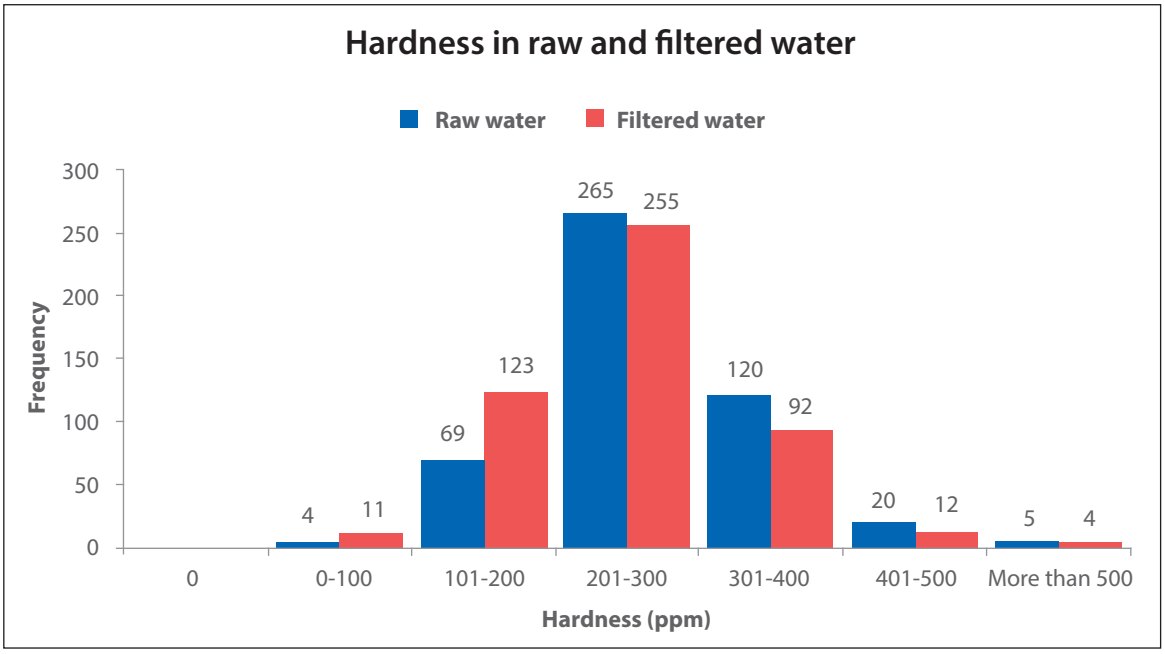

FIGURE 43: HISTOGRAM FOR HARDNESS IN RAW AND FILTERED WATER

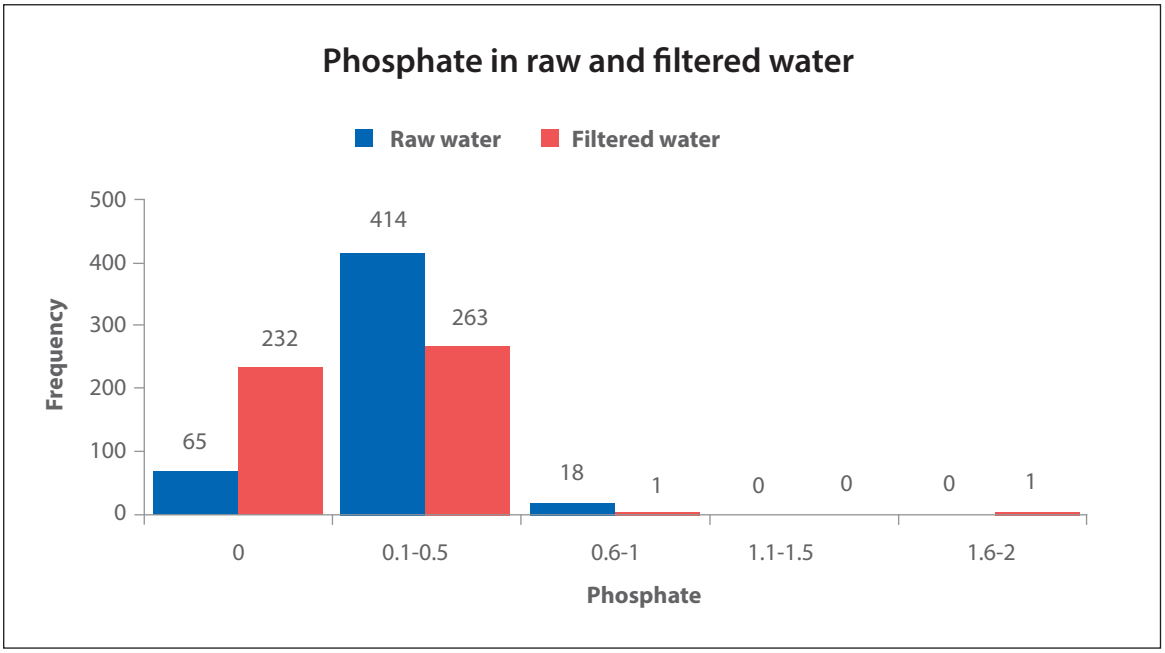

FIGURE 44: HISTOGRAM FOR PHOSPHATE IN RAW AND FILTERED WATER

5.9. KAF improvement activities

As mentioned a previous section, there were 70 filters which did not remove arsenic from drinking water. Out of these 70 KAFs, activities such as increasing the number of iron nails, cleaning the existing nails, washing the iron nails with concentrated acid, replacing the iron nails and combination of these alterations were carried out in 40 selected filters. Table 14 below presents the issues associated with these selected 40 KAF:

TABLE 14: PROBLEMS ASSOCIATED WITH KAF

Problems	Frequency	(%)
Long iron nails	6	15.0%
Less nails	8	20.0%
Scattered nails	19	47.5%
Silt	7	17.5%
Total	**40**	**100.0%**

The field observations at the 40 selected filters have identified four major problems:

- Long iron nails: The recommended size of the iron nails for the KAF is ½ inch, however, longer nails were found in six of the filters. Using longer nails reduces the surface area and resulting in a decrease in the arsenic adsorption capacity of the iron nails. This can significantly lower the arsenic removal efficiency of the KAF.
- Less nails: It is recommended that there is at least 5 kg of iron nails in the KAF. In eight of the filters there was between 2-3 kg of nails.
- Scattered nails: Due to the force of the incoming water and only a small quantity of brick chips, the iron nails in the diffuser basin often get scattered. As a result, the contact time between the iron nails and the arsenic contaminated water is reduced, which effects the arsenic removal efficiency of the filter. This issue was observed in 19 filters.

- Silt in raw water: Raw water containing high quantities of silt was observed in seven locations. When raw water contains high quantities of silt, a layer of silt develops on the surface of the iron nails. As a consequence, the ferric hydroxide on the surface of the rusted iron nails is blocked and is therefore not in contact with the raw water, reducing the filters ability to remove arsenic from the raw water.

Table 15 below details the activities carried out on 40 of the underperforming filters to improve their performance

TABLE 15: ALTERATIONS TO UNDERPERFORMING FILTERS

What was done?	Nos.
Add nails	8
Acid wash	14
Nails Cleaned	10
Replaced nails	4
Add nails & acid wash	1
Add nails & cleaned	3
Total	**40**

Iron nails were added to eight filters that did not have the recommended quantity. The raw water in one of the filters had a very high arsenic content (above 500ppb) therefore 2.5 kg of nails were added to the filter to determine if its performance would improve. The iron nails were cleaned in 10 KAFs, while acid wash was carried out in 14 KAFs. The purpose of the acid wash is to expose new surface area on the iron nails.

After the improvement activities, water samples were collected from the filters after four days. The water analysis showed that 15 KAFs performed well as the arsenic content of the filtered was below 50 ppb and had improved from prior to the improvement activity. In eight filters, even though the filtered water was detected below 50 ppb, the performance did not improve compared to previous results. In seven KAFs, the arsenic removal performance improved but the filtered water contained arsenic above 50 ppb. The performance of the KAF did not improve and the filtered water also showed arsenic above 50 ppb in 10 KAFs. Table 16 below shows the observed improvements upon completion of the improvement activities.

TABLE 16: STATUS OF KAF AFTER IMPROVEMENT ACTIVITIES

Status	No. of KAF	(%)
Below 50 ppb and improved	15	37.5%
Below 50 ppb and Not improved	8	20.0%
Above 50 ppb and improved	7	17.5%
Above 50 ppb and Not improved	10	25.0%

6. CONCLUSIONS

It is estimated that more than 5000 KAFs have been distributed in Nawalparasi district by different agencies. However, the current status of these KAFs is unknown. This study was designed to assess the current status of KAFs in Nawalparasi district. A survey was conducted at 2833 HHs in two phases – detailed survey (phase I) at 989 HHs and rapid survey (phase II) at 1844 HHs.

The HH survey was performed in 2833 HHs from 21 VDCs/municipalities in the Nawalparasi district. Out of the 2833 HHs, only 792 (28%) HHs were using their KAF on a regular basis, and 58 HHs (2%) were using their KAF irregularly. Around 71% of KAFs were not in operation due to breakage and/or leakage problems. Approximately 83% of the plastic round (GEM505) version of the KAF had problems of breakage and leakage. Approximately 81% of KAFs that were distributed more than 10 years ago were not found to be functional whereas only 4% of KAFs that were distributed less than six months ago were not functioning. The dropout rate for the concrete square version is low and for plastic round (GEM505) version is high in comparison to other versions.

The KAF showed effective removal of arsenic with a median removal of 83% and mean removal of 75%. The KAF showed very effective bacterial removal in this study with a median removal of 97% and mean removal of 85% after filtration. The KAF showed very effective iron removal with a median removal of 100% and a mean removal of 97%. It was found that 43% of filtered water samples had arsenic content below detection level (less than 0.5 ppb) and 86% of filtered water samples had arsenic concentration below 50 ppb (National Drinking Water Quality Standard for arsenic).

Improvement activities such as cleaning, adding and replacing the iron nails were carried out in 40 KAFs that were underperforming. Analysis showed that performance was improved in 15 KAFs and the arsenic content in the filtered water was below 50 ppb.

7. RECOMMENDATIONS

Based on the findings of this study, following key recommendations were made:

- The Kanchan Arsenic Filter (KAF) has been promoted as short term arsenic mitigation option at the HH level. As the average arsenic removal capability of the KAF is approximately 85%, it is recommended that this filter is installed in HHs drinking arsenic contaminated water below 330 ppb ensuring the treated water is below 50 ppb.
- Since less than 30% of the surveyed KAFs were functioning during this survey, it is very important that a long-term arsenic mitigation solution is provided.
- The robustness of the KAF is crucial for the continued use of the filter. The survey results concluded that the majority of HHs liked the filter however could not use it due to breakage and/ or leakage problems, particularly with the plastic versions.
- Due to the robustness and efficiency in the removal of arsenic and other pathogens, it is recommended that the concrete versions, particularly the concrete square version, of the filter are promoted.
- Due to some of the operation and maintenance issues observed with the filters including the condition and quantity of nails and characteristics of the sand in the top layer of the filter, it is recommended that regular monitoring of filters is carried out and a focus on user awareness is initiated.
- This study showed that some improvement activities can enhance the arsenic removal performance of the KAFs. However, more in-depth research is needed to state explicitly what improvement activities can enhance the performance and by how much;
- It is recommended to disseminate this results at a central and district level.
- It is recommended that a national strategy is developed for the mitigation of the arsenic problem, especially focusing on long term safe water options and a system to monitor the progress of mitigation activities.

REFERENCES

DWSS, UNICEF and UNHABITAT (2009) FINAL REPORT ON Performance Evaluation of Kanchan Arsenic Filter (KAF) Volume 1 (Final Draft)

Frey, S., Kang, C.;,Lucchino, D., Ueno, D. (2006) KanchanTM Arsenic Filter implementation and enhancement. G-Lab project report, MIT Sloan School of Management

Ghimire, B. (2005). KanchanTM Arsenic Filter: Can Iron and Arsenic Particles Migrate through the Sand Layer? MSc research project. Kathmandu University.

National Arsenic Steering Committee (NASC, 2011) The State of Arsenic in Nepal 2011. Final Report.

Ngai, T., Shrestha, R., Dangol, B., Maharjan, M., and Murcott, S. (2007) Design for Sustainable Development – Household Drinking Water Filter for Arsenic and Pathogen Treatment in Nepal. Journal of Environmental Science and Health, Part A. Vol A42 No 12 pp 1879-1888 © Taylor and Frances Group

Ngai, T., Walewijk, S. (2003). Arsenic Biosand Filter (ABF) Project: Design of an Appropriate Household Drinking Water Filter for Rural Nepal. Final Report. Massachusetts Institute of Technology.

Ngai, T.; Dangol B.; Murcott, S.; Shrestha, R.R. (2006). Kanchan Arsenic Filter. Massachusetts Institute of Technology (MIT) and Environment and Public Health Organization (ENPHO). Kathmandu, Nepal

Ngai, T.K.K., Murcott, S., Shrestha, R.R., Dangol, B., Maharjan, M. (2006) Development and Dissemination of KanchanTM Arsenic Filter in Rural Nepal. Water Science & Technology: Water Supply Vol 6 No 3 pp 137–146 © IWA Publishing

Odell, N. (2004). Report on a Four-Month Performance Evaluation of the Cement Arsenic Biosand Filter (ABF) for Mitigation of Arsenic Contamination. US Peace Corp Volunteer.

Pandey, S. (2004). Arsenic Biosand Filter: Study on the Effect of Air Space between the Resting Water and the Diffuser Basin on Arsenic Removal and Determination of General Flow Curve. BSc Thesis. Kathmandu University.

Sharma, D. (2005). KanchanTM Arsenic Filter: Removal of Bacteria (Total Coliforms) of Gem505 Model, 4-weeks Daily Study. BSc Thesis. Kathmandu University.

Shrestha, P. (2004). Arsenic, Iron and Coliforms Removal Efficiency of Household Level Biosand Filters. MSc Thesis. Tribhuvan University, Nepal.

Yildizbayrak, B., Moschos, N., Tamer, T., LeTellac, Y. (2004) Distribution of KanchanTM Arsenic Filter in Rural Nepal. G-Lab Project Report. MIT Sloan School of Management.

ANNEXES

Annex: 1 Household Survey Form

Annex: 2 Results for arsenic analysis with KAF information that are in use

Annex: 1 Household Survey Form

Form A: KAF information and use

Date and Time	
Your Name	

District	
VDC	
Ward No	
Tole	

Person answering questions	(1) Woman (2) Man
User's Name (household head's name)	
Type of KAF	(1) Concrete, round (4) Plastic, square (2) Concrete square (5) Gem505 (3) Plastic, round (6) Fiberglass (7) Others:
How many filters do you have?	
KAF Provided by	(1) NRCS (5) FFF (2) RWSSSP (6) Don't Know (3) DWSS (7) Others, specify: (4) ENPHO
KAF Installation Date	
Quantity of Iron Nails (kg)	
Filter current in use?	(1) Yes, everyday (2) Yes, sometimes (3) No. I drinking unfiltered water. (4) No. I use another arsenic-free water source, specify:
If KAF is use (every day or sometimes), ask following questions	
If KAF is not in use go to Form B	
Number of Households using KAF	
Number of KAF Users	
How many liters of water do you filter each day?	(1) less than 10 L (4) 30 to 40 L (2) 10 to 20 L (5) 40 to 50 L (3) 20 to 30 L (6) over 50 L
What do you use to store filtered water?	(1) Gagri/Kolshi (2) Plastic/metal container, no lid (3) Plastic/metal container, with lid (4) Others, specify:
Your household members usually prefer to drink	(1) Filtered water (2) Unfiltered water
What do you think about the appearance of filtered water?	(1) Filtered water looks better than unfiltered water (2) Filtered water is about the same as unfiltered water (3) Filtered water is worse

What do you think about the taste of filtered water?	(1) Filtered water tastes better than unfiltered water (2) Filtered water is about the same as unfiltered water (3) Filtered water is worse
What do you think about the smell of filtered water?	(1) Filtered water smells better than unfiltered water (2) Filtered water is about the same as unfiltered water (3) Filtered water is worse
Is the filter simple to operate?	(1) Yes (2) No
Is the filter simple to clean?	(1) Yes (2) No
Filter Cleaning Frequency	(1) once every week (2) once every two weeks (3) once a month (4) once every 2-4 months (5) never
Date of Last Cleaning	
Do you think using the filter is too much work?	(1) Yes (2) No
Do you feel healthier after you start to drink filtered water?	(1) I feel healthier than drinking unfiltered water (2) I feel about the same (3) I feel worse
Would you recommend the filter to your friends and relatives?	(1) Yes (2) No
User's Contributions Towards this KAF (check all that applies)	(1) Labour, specify: (2) Cash, how much: (3) Materials, specify: (4) Others, specify:
Source of Drinking Water	(1) Tube Well (2) Dug Well (3) Spring (4) Others, specify:
Sludge Disposal Location	(1) Cow Dung (2) Ditch (3) Field (4) Anywhere (5) Others, specify:
Owner's household has an arsenic patient?	(1) Yes, name: (2) No
Owner knows somebody (non-household member) who is an arsenic patient?	(1) Yes (2) No
Filter Condition (Observation)	(1) Good (2) Poor (3) Broken, specify:
Sanitary Conditions Around KAF (observation)	(1) Clean (2) Moderate (3) Poor (4) Very dirty

TUBE WELL INFORMATION

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

Form B: Questions for the hosueholds with KAF not in use:

For how many years you have used the filter	(1) 1 year (2) 2 years (3) 3 years (4) 4 years	(5) 5 years (6) over 5 years (7) Others:
Since when you stopped using the filter?	(1) less than 3 months ago (2) 3 months ago (3) 6 months ago (4) One year ago (5) 2 years ago	(6) 3 years ago (7) 4 years ago (8) 5 years ago (9) Others:
Why did you stop using the filter?	(1) Filter broken (2) Filter leakage (3) Got alternative source, what? (4) Did not like filtered water too warm (5) Did not like filtered water smell is not good (6) Too much work (7) Don't have time to use and clean filter (8) Others, please specify:	
In case of filter broken and leakage, Did you try to fix your filter?	(1) Yes (how many times?) (2) No (3) Others:	
Did you contact someone to fix your filter?	(1) Yes (Whom?) (2) No (I fixed myself) (3) Others:	
Do you want to continue the filter?	(1) Yes (2) No	
What support do you need to continue use of the filter?		
Do you want to give the filter to someone else?	(1) Yes (2) No	
Why?		
Any suggestions or comments?		

Form C: Water Quality Testing record form:

Date and Time	
Your Name	

District	
VDC	
Ward No	
Tole	

KANCHAN ARSENIC FILTER INFORMATION

User's Name	

FIELD MONITORING RESULTS

pH

Influent	Effluent	Test Method/ Instrument	Remarks

Flow rate

Time to Fill 100mL Bottle (seconds)	Water Level in Diffuser Box	Remarks

Hardness

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

Iron

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

Phosphate

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

USER'S COMMENTS

Comments Category	(1) filter installation and O&M issues (2) water quality issues (3) health and hygiene issues (4) others
Detail Comments	
YOUR OBSERVATIONS AND COMMENTS	

Annex: 2 Results for arsenic analysis with KAF information that are in use

SN	Form no	VDC	Ward	Tole	Water-source	Filter-type	Who_gave_filter	installed_year_com-bined	In_use	Nail_KG	Arsenic_In	Arsenic_Out	Arsenic_%_Reduction
1	1	Manari	4	Patani	1	3	4	4	1	5	320	230	28.1%
2	2	Tilakpur	1	Tilakpur	1	4	8	7	1	5	210	50	76.2%
3	3	Tilakpur	1	Tilakpur	1	2	8	3	1	4	130	0	100.0%
4	4	Tilakpur	6	Parkhauli	1	2	8	5	1	4	140	20	85.7%
5	5	Tilakpur	6	Parkhauli	1	4	1	8	1	3	10	0	100.0%
6	6	Tilakpur	6	Parkhauli	1	2	8	4	1	5	490	10	98.0%
7	7	Tilakpur	6	Parkhauli	1	2	8	5	1	5	720	10	98.6%
8	8	Tilakpur	6	Parkhauli	1	3	4	4	1	5	1050	590	43.8%
9	9	Tilakpur	6	Khokharpur	1	2	8	6	1	4	270	40	85.2%
10	10	Panchanagar	9	Gaidahawa	1	4	1	8	1	5	270	20	92.6%
11	11	Makar	8	Lagunhawa	1	2	8	4	1	4	10	0	100.0%
12	12	Makar	8	Lagunhawa	1	3	4	5	1	5	1320	550	58.3%
13	13	Makar	8	Lagunhawa	1	3	4	5	1	5	20	10	50.0%
14	14	Makar	8	Lagunhawa	1	3	1	5	1	5	280	60	78.6%
15	15	Manari	4	Patani	1	2	8	8	1	-1	150	40	73.3%
16	16	Tilakpur	1	Tilakpur	1	2	6	3	1	4	160	40	75.0%
17	17	Tilakpur	1	Tilakpur	1	2	8	3	1	4	30	0	100.0%
18	18	Tilakpur	6	Tulshipur	1	4	8	8	1	5	50	10	80.0%
19	19	Tilakpur	6	Parkhauli	1	2	8	3	1	4	50	60	0.0%
20	20	Tilakpur	6	Parkhauli	1	4	1	7	1	5	200	250	0.0%
21	21	Tilakpur	6	Parkhauli	1	2	8	2	1	4	160	60	62.5%
22	22	Tilakpur	9	Khokharpur	1	2	8	4	1	5	210	90	57.1%
23	23	Tilakpur	9	Khokharpur	1	2	8	3	1	5	430	110	74.4%
24	24	Panchanagar	6	Gaidahawa	1	4	1	8	1	5	370	30	91.9%

25	25	Makar	8	Lagunhawa	1	3	4	4	1	0	130	20	84.6%
26	26	Makar	8	Lagunhawa	1	3	4	5	1	5	120	50	58.3%
27	27	Makar	8	Lagunhawa	1	3	1	6	1	5	90	30	66.7%
28	28	Makar	8	Lagunhawa	1	3	4	4	1	5	130	50	61.5%
29	29	Makar	8	Lagunhawa	1	3	4	5	1	0	30	70	0.0%
30	30	Makar	4	Lagunhawa	1	3	4	5	1	5	260	10	96.2%
31	41	Ramgram	4	Suryapura	1	3	5	7	1	5	100	30	70.0%
32	42	Ramgram	3	Suryapura	1	3	5	8	1	2	90	10	88.9%
33	43	Sunwal	3	Bhuputole	1	1	2	8	1	5	50	10	80.0%
34	44	Sunwal	3	Dadatole	1	1	8	8	1	5	30	10	66.7%
35	45	Sunwal	3	Dadatole	1	3	1	5	1	5	100	10	90.0%
36	46	Sunwal	3	Dadatole	4	1	2	8	1	3	0	10	0.0%
37	47	Sunwal	3	Dadatole	1	1	2	8	1	5	30	20	33.3%
38	48	Sunwal	3	Dadatole	3	1	2	8	1	5	0	0	Both nil
39	49	Sunwal	3	Dadatole	1	3	8	2	1	5	30	0	100.0%
40	50	Sunwal	3	Dadatole	1	1	2	3	1	5	50	10	80.0%
41	51	Sunwal	3	Dadatole	3	1	2	8	1	5	0	20	0.0%
42	52	Sunwal	3	Nadawa	1	1	8	5	1	5	40	0	100.0%
43	53	Sunwal	3	Nadawa	1	2	2	8	1	5	80	0	100.0%
44	54	Sunwal	3	Nadawa	1	2	2	8	1	5	70	10	85.7%
45	55	Sunwal	3	Nadawa	1	2	2	8	1	5	120	0	100.0%
46	56	Sunwal	3	Nadawa	3	2	8	2	1	-1	0	0	Both nil
47	57	Sunwal	3	Nadawa	3	2	2	8	2	2	0	0	Both nil
48	58	Sunwal	3	Nadawa	1	2	2	8	1	5	0	0	Both nil
49	59	Sunwal	3	Nadawa	4	2	2	3	1	5	30	0	100.0%
50	60	Sunwal	3	Nadawa	1	2	2	8	1	5	100	0	100.0%
51	61	Sunwal	3	Nadawa	1	2	2	8	1	5	20	0	100.0%
52	62	Sunwal	3	Nadawa	1	1	2	8	1	5	6	80	0.0%
53	63	Sunwal	3	Nadawa	1	2	2	8	1	5	10	0	100.0%
54	64	Sunwal	2	Batraule	1	3	4	4	1	5	9	6	33.3%

55	65	Swathi	8	Swathi	1	3	4	4	1	3	13	0	100.0%
56	66	Swathi	8	Swathi	1	3	4	4	1	3.5	13	0	100.0%
57	67	Swathi	8	Ranipakad	1	3	4	5	1	2.5	13	0	100.0%
58	68	Ramgram	11	Ranipakad	1	3	8	4	2	5	14	0	100.0%
59	69	Ramgram	11	Ranipakad	1	3	8	8	1	-1	179	59	67.0%
60	70	Ramgram	12	Panchagau	1	3	8	7	1	5	83	15	81.9%
61	71	Ramgram	13	Padatikar	1	3	8	7	1	5	156	70	55.1%
62	72	Ramgram	12	Padatikar	1	3	8	6	2	5	156	57	63.5%
63	73	Ramgram	13	Padatikar	1	3	8	8	1	5	30	0	100.0%
64	74	Ramgram	13	kanchanhawa Siwangadh	1	5	8	8	2	5	150	140	6.7%
65	75	Panchanagar	11	Gaidahawa	1	2	8	8	1	1	230	70	69.6%
66	76	Panchanagar	11	Gaidahawa	1	3	1	5	1	5	230	30	87.0%
67	77	Panchanagar	11	Gaidahawa	1	3	1	5	1	5	70	10	85.7%
68	78	Panchanagar	11	Gaidahawa	1	3	1	7	1	4	80	20	75.0%
69	81	Ramgram	12	Kasia	1	3	6	6	1	5	190	100	47.4%
70	82	Bardhghat Municipality	11	Gaidaha	1	3	4	3	1	5	50	10	80.0%
71	83	Bardhghat Municipality	11	Gaidaha	1	4	1	7	1	5	220	20	90.9%
72	84	Bardhghat Municipality	11	Gaidaha	1	4	1	7	2	5	230	40	82.6%
73	85	Ramgram	13	kanchanhawa	1	3	5	5	2	5	230	130	43.5%
74	86	Ramgram	13	kanchanhawa	1	3	6	5	1	5	150	90	40.0%
75	90	Ramgram	13	Paratikar	1	3	5	6	1	5	80	30	62.5%
76	92	Ramgram	12	Panchagau	1	3	5	5	1	5	260	80	69.2%
77	93	Ramgram	12	Panchagau	1	3	5	5	1	5	200	70	65.0%
78	94	Ramgram	12	Panchagau	1	3	5	5	1	5	170	60	64.7%
79	95	Ramgram	12	Panchagau	1	3	5	5	1	5	260	60	76.9%
80	96	Ramgram	12	Panchagau	1	3	4	3	1	5	280	80	71.4%

81	97	Ramgram	12	Panchagau	1	3	4	3	1	5	150	60	60.0%
82	98	Ramgram	11	Ranipakad	1	3	4	4	1	5	60	20	66.7%
83	99	Swathi	8	Swathi	1	3	6	8	1	5	0	0	Both nil
84	100	Sunwal	2	Batraule	1	3	5	5	1	5	1050	40	96.2%
85	102	Sunwal	3	Nadawa	1	1	2	7	1	5	40	10	75.0%
86	103	Sunwal	3	Nadawa	1	2	2	7	2	3	20	10	50.0%
87	104	Sunwal	3	Nadawa	1	3	6	5	1	5	60	10	83.3%
88	105	Sunwal	3	Nadawa	3	2	2	7	1	4	0	10	0.0%
89	106	Sunwal	3	Nadawa	3	2	8	2	1	2	0	0	Both nil
90	107	Sunwal	3	Nadawa	1	2	2	7	1	2	40	0	100.0%
91	108	Sunwal	3	Nadawa	1	2	2	7	1	3	90	0	100.0%
92	109	Sunwal	3	Nadawa	1	2	8	3	1	2	30	0	100.0%
93	112	Sunwal	3	Nadawa	1	2	2	7	1	5	40	0	100.0%
94	113	Sunwal	3	Kirtipur	3	3	4	3	2	2	0	0	Both nil
95	114	Sunwal	3	Kirtipur	1	2	2	7	1	1.5	30	20	33.3%
96	115	Sunwal	3	Kirtipur	1	2	6	7	1	1	40	0	100.0%
97	116	Sunwal	3	Kirtipur	3	2	6	3	1	3	0	0	Both nil
98	117	Sunwal	3	Kirtipur	1	2	6	7	1	3	0	0	Both nil
99	118	Sunwal	3	Kirtipur	3	2	2	7	1	0	0	0	Both nil
100	119	Sunwal	3	Kirtipur	1	3	4	3	1	5	0	0	Both nil
101	120	Sunwal	3	Kirtipur	3	3	4	3	1	5	0	0	Both nil
102	121	Sunwal	3	Kirtipur	1	2	2	7	1	5	100	40	60.0%
103	122	Ramgram	4	Kerabani	1	3	1	6	1	5	140	90	35.7%
104	123	Ramgram	4	Suryapura	1	3	5	8	1	5	100	50	50.0%
105	129	Ramgram	4	Suryapura	1	3	6	8	1	3	130	40	69.2%
106	130	Ramgram	4	Suryapura	1	3	6	8	1	4	0	40	0.0%
107	131	Sunwal	3	Kirtipur 1	4	3	4	3	1	5	50	10	80.0%
108	132	Sunwal	3	Kirtipur 1	1	2	2	7	1	5	30	0	100.0%
109	140	Sunwal	3	Kirtipur 1	1	1	6	7	1	4	120	40	66.7%
110	141	Sunwal	3	Kirtipur 1	4	1	6	7	1	4	100	10	90.0%

111	142	Sunwal	3	Kirtipur 1	4	3	5	3	1	5	0	0	Both nil
112	143	Sunwal	3	Kirtipur 1	1	1	6	5	1	5	10	10	0.0%
113	144	Sunwal	3	Kirtipur 1	3	1	6	7	1	5	0	0	Both nil
114	145	Sunwal	3	Kirtipur 1	1	2	6	7	1	5	70	30	57.1%
115	146	Sunwal	3	Kirtipur 1	1	1	2	7	1	5	60	30	50.0%
116	147	Sunwal	3	Kirtipur 1	1	2	2	7	1	5	70	40	42.9%
117	148	Sunwal	3	Kirtipur 1	3	1	2	7	1	5	0	0	Both nil
118	149	Sunwal	3	Kirtipur 1	1	2	2	7	1	5	0	20	0.0%
119	150	Sunwal	3	Kirtipur 1	1	3	4	3	1	5	40	0	100.0%
120	151	Sunwal	3	Kirtipur 1	1	2	2	7	1	5	40	20	50.0%
121	152	Sunwal	3	Kirtipur 1	3	2	2	7	1	5	0	10	0.0%
122	153	Sunwal	3	Nadawa	4	1	6	7	1	5	0	0	Both nil
123	154	Sunwal	3	Nadawa	4	3	6	6	1	6	0	0	Both nil
124	156	Sunwal	3	Nadawa	4	2	6	7	1	5	6	6	0.0%
125	157	Sunwal	3	Nadawa	4	2	6	7	1	5	0	0	Both nil
126	158	Sunwal	3	Nadawa	4	2	2	7	1	5	60	0	100.0%
127	159	Sunwal	3	Nadawa	1	2	2	7	1	5	60	5	91.7%
128	160	Sunwal	3	Nadawa	1	1	2	7	1	5	0	7	0.0%
129	161	Sunwal	3	Nadawa	1	2	2	7	1	5	80	30	62.5%
130	162	Sunwal	3	Nadawa	3	2	6	3	1	5	0	0	Both nil
131	164	Sunwal	2	Batraule	1	3	1	6	1	5	20	6	70.0%
132	165	Sunwal	2	Batraule	1	3	5	7	1	5	80	0	100.0%
133	166	Sunwal	2	Batraule	1	3	5	7	1	5	90	10	88.9%
134	169	Sunwal	9	Swathi	1	3	4	3	1	5	0	0	Both nil
135	170	Ramgram	11	Ranipakad	1	3	4	4	1	5	60	10	83.3%
136	171	Ramgram	12	Panchagau	1	3	6	5	1	5	140	60	57.1%
137	172	Ramgram	13	Paratikar	1	3	6	5	1	5	300	100	66.7%
138	173	Ramgram	13	Paratikar	1	3	6	7	1	5	50	10	80.0%
139	174	Ramgram	13	Paratikar	1	3	8	7	1	5	60	4	100.0%
140	175	Panchanagar	3	Gaidaha	1	4	1	6	1	4	230	40	82.6%

141	176	Panchanagar	9	Gaidaha	4	3	6	5	1	5	230	70	69.6%
142	178	Ramgram	12	Kasia	1	3	8	5	1	5	190	40	78.9%
143	179	Ramgram	12	Kasia	1	4	1	7	1	-1	40	10	75.0%
144	182	Manari	5	Tilauli	1	1	8	5	1	5	30	0	100.0%
145	183	Manari	5	Tilauli	1	1	8	5	2	5	0	0	Both nil
146	184	Manari	5	Tilauli	1	1	8	5	2	5	30	0	100.0%
147	185	Manari	5	Tilauli	1	1	8	5	2	5	0	0	Both nil
148	186	Manari	5	Tilauli	1	1	8	5	2	5	110	0	100.0%
149	187	Jahada	3	Bargadahi	1	3	6	8	1	4	60	20	66.7%
150	188	Jahada	3	Shivnagar	1	4	1	7	1	4	70	20	71.4%
151	189	Jahada	3	Shivnagar	1	4	1	7	1	4	70	20	71.4%
152	190	Jahada	3	Mareulepa	1	4	1	8	1	5	70	30	57.1%
153	191	Sarawal	5	Janakpur	1	2	1	6	1	4	50	10	80.0%
154	192	Sarawal	6	Sarawol	1	4	1	7	1	4	80	20	75.0%
155	193	Manari	1	Manari	1	1	8	5	1	5	120	30	75.0%
156	194	Sarawal	6	Sarawol	1	3	1	6	1	5	70	10	85.7%
157	195	Manari	5	Tilauli	1	1	8	5	1	5	110	10	90.9%
158	196	Manari	5	Tilauli	2	1	8	5	2	5	20	0	100.0%
159	197	Manari	5	Tilauli	1	1	8	5	1	5	140	0	100.0%
160	198	Manari	5	Tilauli	1	1	8	5	1	5	80	0	100.0%
161	199	Manari	5	Tilauli	1	1	8	5	1	5	90	0	100.0%
162	200	Manari	5	Tilauli	1	1	8	5	1	5	80	0	100.0%
163	201	Manari	5	Tilauli	1	3	6	7	1	5	60	0	100.0%
164	202	Manari	5	Tilauli	1	1	8	5	1	5	90	0	100.0%
165	203	Manari	5	Tilauli	1	3	6	7	1	5	110	0	100.0%
166	204	Manari	5	Tilauli	1	1	8	5	1	5	10	0	100.0%
167	205	Pratappur	3	Pratappur	1	4	1	7	1	5	50	10	80.0%
168	206	Pratappur	3	Pratappur	1	4	1	7	1	5	60	20	66.7%
169	207	Manari	1	Manari	1	1	8	5	1	5	10	20	0.0%
170	208	Manari	6	Aahitauli	1	1	8	7	1	4	20	0	100.0%

171	209	Manari	5	Tilauli	1	1	8	5	2	5	60	0	100.0%
172	210	Manari	5	Tilauli	1	1	8	5	2	5	80	10	87.5%
173	211	Manari	5	Tilauli	1	1	8	5	2	5	100	0	100.0%
174	212	Manari	5	Tilauli	1	1	8	5	1	5	100	0	100.0%
175	213	Manari	5	Tilauli	1	1	8	5	2	5	110	0	100.0%
176	214	Manari	5	Tilauli	1	1	8	5	1	6	120	10	91.7%
177	215	Manari	5	Tilauli	1	1	6	5	1	5	0	110	0.0%
178	216	Manari	5	Tilauli	1	1	8	5	1	5	130	10	92.3%
179	217	Manari	5	Tilauli	1	1	8	5	1	5	140	50	64.3%
180	218	Manari	5	Tilauli	1	3	6	4	1	5	100	10	90.0%
181	219	Manari	5	Tilauli	1	3	8	7	1	5	60	10	83.3%
182	220	Manari	5	Tilauli	1	1	8	5	1	5	90	20	77.8%
183	221	Jamuniya	4	Semaru	1	3	8	3	1	5	0	0	Both nil
184	222	Manari	5	Tilauli	1	1	8	5	1	5	100	10	90.0%
185	223	Jamuniya	4	Semaru	1	2	8	3	1	4	10	0	100.0%
186	224	Jamuniya	4	Semaru	1	3	8	4	1	0	0	0	Both nil
187	225	Jamuniya	4	Semaru	1	3	8	4	1	5	20	0	100.0%
188	226	Jamuniya	4	Semaru	1	3	4	6	1	5	70	10	85.7%
189	227	Pratappur	2	Madavpur	1	3	6	6	1	5	40	10	75.0%
190	228	Pratappur	2	Madavpur	1	3	6	6	1	5	80	10	87.5%
191	229	Pratappur	3	Pratappur	1	4	1	7	1	5	50	0	100.0%
192	230	Tilakpur	7	Padkhauli	1	3	4	5	1	5	110	30	72.7%
193	231	Tilakpur	7	Padkhauli	1	3	6	4	1	5	130	140	0.0%
194	232	Tilakpur	7	Padkhauli	1	3	6	5	1	5	110	40	63.6%
195	233	Tilakpur	7	Padkhauli	1	4	1	6	1	5	100	20	80.0%
196	234	Tilakpur	7	Padkhauli	1	4	1	6	1	5	100	10	90.0%
197	235	Tilakpur	7	Padkhauli	1	4	1	6	1	5	100	10	90.0%
198	236	Panchanagar	8	Bhagjogani	1	2	1	6	1	5	80	70	12.5%
199	237	Panchanagar	8	Bhagjogani	1	3	1	5	1	5	60	50	16.7%
200	238	Panchanagar	6	Bijaypur	1	3	1	6	1	5	152	60	60.5%

201	239	Panchanagar	6	Bijaypur	1	3	1	6	2	5	180	60	66.7%
202	240	Panchanagar	6	Bijaypur	1	2	8	6	1	4	130	40	69.2%
203	241	Panchanagar	6	Bijaypur	1	2	8	6	1	4	100	60	40.0%
204	242	Manari	9	Madubhawa	1	3	8	3	1	5	5	20	0.0%
205	243	Manari	9	Madubhawa	1	3	8	3	1	5	70	20	71.4%
206	244	Manari	9	Madubhawa	1	3	8	3	1	5	70	20	71.4%
207	245	Manari	9	Madubhawa	1	3	4	5	1	5	90	40	55.6%
208	246	Manari	9	Madubhawa	1	3	8	3	1	5	400	70	82.5%
209	247	Manari	9	Madubhawa	1	3	8	3	1	5	420	10	97.6%
210	248	Manari	9	Madubhawa	1	3	8	3	1	5	290	10	96.6%
211	249	Manari	9	Madubhawa	1	3	8	3	1	5	350	60	82.9%
212	250	Manari	9	Madubhawa	1	3	8	3	1	5	590	70	88.1%
213	251	Manari	9	Madubhawa	1	2	8	4	1	5	440	210	52.3%
214	252	Makar	2	Chisapani	1	3	4	3	1	3	70	0	100.0%
215	253	Makar	2	Chisapani	1	3	4	3	1	6	0	0	Both nil
216	254	Bhadar	8	Lagunhawa	1	4	1	5	2	-1	60	0	100.0%
217	255	Bhadar	8	Lagunhawa	1	4	1	5	2	5	50	40	20.0%
218	256	Bhadar	8	Lagunhawa	1	4	1	5	2	5	40	20	50.0%
219	257	Bhadar	8	Lagunhawa	1	3	4	5	1	7	50	30	40.0%
220	258	Panchanagar	9	Gaudahawa	1	4	1	8	1	5	50	30	40.0%
221	259	Panchanagar	9	Gaudahawa	1	3	8	5	1	5	170	50	70.6%
222	260	Panchanagar	9	Gaudahawa	1	4	1	7	1	5	80	7	91.3%
223	261	Panchanagar	9	Gaudahawa	1	4	1	7	1	5	70	20	71.4%
224	262	Panchanagar	9	Gaudahawa	1	3	6	4	1	5	372	100	73.1%
225	263	Panchanagar	9	Gaudahawa	1	3	4	3	2	5	110	10	90.9%
226	264	Panchanagar	9	Gaudahawa	1	3	4	3	1	5	15	132	0.0%
227	308	Manari	9	Bhahuhawa	1	3	8	3	1	5	370	100	73.0%
228	309	Manari	9	Bhahuhawa	1	3	8	3	1	5	330	130	60.6%
229	310	Manari	9	Bhahuhawa	1	3	8	3	1	5	40	10	75.0%
230	311	Manari	9	Bhahuhawa	1	3	8	3	1	5	60	20	66.7%

231	312	Manari	9	Bhahuhawa	1	3	8	3	1	5	290	90	69.0%
232	313	Manari	9	Bhahuhawa	1	3	8	3	1	5	290	40	86.2%
233	314	Manari	9	Bhahuhawa	1	3	8	3	1	5	160	30	81.3%
234	315	Manari	9	Bhahuhawa	1	3	8	3	1	5	300	40	86.7%
235	316	Manari	9	Pipara	1	3	8	3	1	5	50	0	100.0%
236	317	Manari	9	Pipara	1	3	4	5	1	6	480	250	47.9%
237	318	Manari	9	Pipara	1	3	8	3	1	5	270	150	44.4%
238	319	Makar	2	Chisapani	1	3	8	3	1	5	40	0	100.0%
239	320	Makar	2	Chisapani	1	3	4	3	1	4	0	0	Both nil
240	321	Panchanagar	9	Gaudahawa	1	3	4	5	1	5	70	30	57.1%
241	322	Makar	8	Lagunhawa	1	3	1	5	1	5	40	0	100.0%
242	323	Makar	8	Lagunhawa	1	4	1	5	2	5	40	60	0.0%
243	324	Panchanagar	6	Bijaypur	1	3	1	6	1	4	80	50	37.5%
244	325	Panchanagar	9	Gaudahawa	1	3	8	5	1	6	140	60	57.1%
245	326	Panchanagar	9	Gaudahawa	1	3	4	3	1	5	260	50	80.8%
246	327	Panchanagar	9	Gaudahawa	1	3	1	4	1	5	90	10	88.9%
247	328	Panchanagar	9	Gaudahawa	1	3	1	5	1	5	60	10	83.3%
248	329	Panchanagar	9	Gaudahawa	1	4	1	3	1	5	40	20	50.0%
249	330	Panchanagar	9	Gaudahawa	1	3	8	4	2	5	100	40	60.0%
250	331	Panchanagar	9	Gaudahawa	1	3	8	4	2	5	60	0	100.0%
251	332	Panchanagar	9	Gaudahawa	1	3	8	4	2	5	200	50	75.0%
252	333	Manari	8	Aagahari	1	3	4	6	1	4	230	30	87.0%
253	334	Tilakpur	7	Padkhauli	1	3	4	5	1	5	240	130	45.8%
254	335	Tilakpur	7	Padkhauli	1	2	1	4	2	6	170	30	82.4%
255	336	Tilakpur	7	Padkhauli	1	3	8	5	1	6	70	260	0.0%
256	337	Tilakpur	7	Padkhauli	1	3	8	3	1	5	70	40	42.9%
257	338	Tilakpur	7	Padkhauli	1	3	8	3	1	5	110	10	90.9%
258	339	Panchanagar	8	Bargadahi	1	2	8	3	1	4	50	0	100.0%
259	340	Panchanagar	8	Bargadahi	1	3	1	6	1	5	50	50	0.0%
260	341	Panchanagar	6	Bijaypur	3	4	1	6	2	5	90	50	44.4%

261	342	Panchanagar	6	Bijaypur	1	3	1	3	1	5	130	70	46.2%
262	343	Panchanagar	6	Bijaypur	1	2	8	6	1	4	180	10	94.4%
263	344	Panchanagar	6	Bijaypur	1	2	8	5	1	4	140	30	78.6%
264	345	Jamuniya	4	Semari	1	3	4	6	1	5	10	0	100.0%
265	346	Jamuniya	1	Jamunabari	1	2	8	5	1	4	0	0	Both nil
266	347	Jamuniya	1	Jamunabari	1	3	4	3	1	5	0	0	Both nil
267	348	Jamuniya	1	Jamunabari	1	3	4	5	1	5	10	0	100.0%
268	349	Jamuniya	1	Jamunabari	1	3	4	7	1	5	0	0	Both nil
269	350	Pratappur	2	Madavpur	1	3	4	6	1	5	50	10	80.0%
270	351	Pratappur	2	Pratappur	1	2	8	4	1	5	60	10	83.3%
271	352	Pratappur	2	Pratappur	1	3	4	3	1	3	50	0	100.0%
272	353	Pratappur	2	Madavpur	1	3	4	3	1	6	30	0	100.0%
273	354	Pratappur	2	Madavpur	1	4	1	5	2	-1	40	10	75.0%
274	355	Pratappur	2	Madavpur	1	4	1	5	2	5	10	0	100.0%
275	356	Pratappur	2	Madavpur	1	4	1	5	2	5	60	0	100.0%
276	357	Manari	1	Manari	1	3	4	5	1	7	100	10	90.0%
277	358	Manari	1	Manari	1	4	1	8	1	5	0	50	0.0%
278	359	Manari	6	Ahirali	1	3	8	5	1	5	50	0	100.0%
279	360	Pratappur	2	Madavpur	1	4	1	7	1	5	60	30	50.0%
280	361	Manari	6	Ahirali	1	2	8	8	1	4	20	0	100.0%
281	362	Manari	5	Tilauli	1	1	8	5	1	5	130	0	100.0%
282	363	Manari	5	Tilauli	1	1	8	5	2	5	80	0	100.0%
283	364	Manari	5	Tilauli	1	1	8	5	1	6	280	0	100.0%
284	365	Manari	5	Tilauli	1	1	8	5	2	5	30	20	33.3%
285	366	Manari	5	Tilauli	1	1	8	5	1	5	150	20	86.7%
286	367	Manari	5	Tilauli	1	1	8	5	1	5	230	80	65.2%
287	368	Manari	5	Tilauli	1	1	8	5	2	5	140	10	92.9%
288	369	Manari	5	Tilauli	1	1	8	5	1	5	140	0	100.0%
289	370	Pratappur	2	Madavpur	1	3	1	6	1	5	70	10	85.7%
290	371	Manari	5	Tilauli	1	1	8	5	1	5	80	0	100.0%

291	372	Manari	5	Tilauli	1	3	5	7	1	5	140	10	92.9%
292	373	Manari	5	Tilauli	1	1	8	5	1	5	90	0	100.0%
293	374	Manari	5	Tilauli	1	1	8	5	1	5	100	50	50.0%
294	375	Manari	5	Tilauli	1	1	8	5	2	5	70	10	85.7%
295	376	Manari	5	Tilauli	1	3	8	5	1	6	140	0	100.0%
296	377	Manari	5	Tilauli	1	3	8	3	1	5	60	0	100.0%
297	378	Manari	5	Tilauli	1	3	8	3	1	5	80	10	87.5%
298	379	Manari	5	Tilauli	1	2	8	3	1	4	100	0	100.0%
299	380	Manari	5	Tilauli	1	3	1	6	1	5	80	0	100.0%
300	381	Manari	5	Tilauli	3	4	1	6	2	5	40	0	100.0%
301	382	Manari	5	Tilauli	1	3	1	3	1	5	50	0	100.0%
302	383	Manari	5	Tilauli	1	2	8	6	1	4	40	0	100.0%
303	384	Manari	5	Tilauli	1	1	8	5	2	5	0	0	Both nil
304	385	Manari	5	Tilauli	1	1	8	5	2	5	0	0	Both nil
305	386	Manari	5	Tilauli	1	1	8	5	2	5	0	0	Both nil
306	387	Manari	5	Tilauli	1	1	8	5	2	5	90	10	88.9%
307	388	Jahada	3	Shivnagar	1	4	1	7	1	4	80	20	75.0%
308	389	Jahada	3	Shivnagar	1	1	1	7	1	4	80	20	75.0%
309	390	Jahada	3	Katoliya	1	4	1	8	1	4	60	30	50.0%
310	391	Panchanagar	9	Gaudahawa	1	3	6	7	1	4	70	0	100.0%
311	392	Panchanagar	9	Gaudahawa	1	3	8	3	1	3	50	0	100.0%
312	393	Sarawal	6	Sarawol	1	4	6	6	1	5	140	30	78.6%
313	394	Sarawal	6	Sarawol	1	3	4	6	1	4	40	10	75.0%
314	397	Manari	1	Manari	1	1	6	5	1	5	90	60	33.3%
315	406	Ramgram	10	Manjharia	1	4	1	5	2	0	90	90	0.0%
316	407	Ramgram	8	Unaocha	1	4	1	5	2	5	90	50	44.4%
317	408	Ramgram	8	Unaocha	1	4	1	5	2	5	190	0	100.0%
318	409	Jamuniya	4	Semari	1	3	4	5	1	7	8	0	100.0%
319	410	Jamuniya	4	Semari	1	4	1	8	1	5	0	0	Both nil
320	411	Jamuniya	1	Jamunabari	1	3	8	5	1	5	20	0	100.0%

321	412	Jamuniya	1	Jamunabari	1	4	1	7	1	5	20	0	100.0%
322	413	Jamuniya	4	Semari	1	4	1	7	1	5	30	10	66.7%
323	414	Jamuniya	1	Jamunabari	1	3	6	4	1	5	20	0	100.0%
324	415	Jamuniya	1	Jamunabari	1	3	4	3	2	5	70	10	85.7%
325	416	Jamuniya	1	Jamunabari	1	3	4	3	1	5	60	60	0.0%
326	417	Jamuniya	1	Jamunabari	1	3	1	5	2	6	70	20	71.4%
327	418	Pratappur	3	Pratappur	1	3	4	6	1	4	40	0	100.0%
328	419	Pratappur	3	Pratappur	1	3	4	3	1	6	20	0	100.0%
329	420	Pratappur	3	Pratappur	1	3	1	8	1	2	0	0	Both nil
330	421	Pratappur	3	Madavpur	1	3	1	8	1	5	30	0	100.0%
331	422	Pratappur	2	Madavpur	1	3	1	8	1	2	30	10	66.7%
332	423	Pratappur	2	Madavpur	1	3	1	4	1	5	20	0	100.0%
333	424	Manari	1	Manari	1	1	8	5	2	5	20	80	0.0%
334	425	Manari	1	Manari	1	1	8	8	1	-1	10	110	0.0%
335	426	Manari	1	Manari	1	1	8	5	1	5	110	10	90.9%
336	427	Manari	1	Manari	1	1	8	5	2	2	150	10	93.3%
337	428	Manari	1	Manari	1	1	8	5	1	2	150	20	86.7%
338	429	Manari	1	Manari	1	1	8	5	1	5	60	60	0.0%
339	430	Manari	6	Aahiroli	1	1	8	5	1	5	50	20	60.0%
340	431	Manari	6	Aahiroli	1	1	8	5	1	5	70	10	85.7%
341	432	Manari	6	Aahiroli	1	1	8	5	1	5	40	0	100.0%
342	433	Manari	6	Aahiroli	1	1	8	5	2	-1	30	10	66.7%
343	434	Manari	6	Aahiroli	1	1	8	5	1	5	70	20	71.4%
344	435	Manari	6	Aahiroli	1	1	8	5	1	-1	60	40	33.3%
345	436	Ramnagar	4	Santapur	1	3	1	6	1	1.5	70	10	85.7%
346	437	Ramnagar	4	Gheu dalla	1	3	1	6	1	3	10	0	100.0%
347	438	Ramnagar	4	Gheu dalla	1	2	8	3	1	5	0	0	Both nil
348	439	Ramnagar	4	Gheu dalla	1	3	1	6	2	-1	0	0	Both nil
349	440	Ramnagar	4	Gheu dalla	1	3	1	3	1	0	0	0	Both nil
350	441	Ramnagar	4	Gheu dalla	1	3	1	4	1	5	10	0	100.0%

351	442	Ramnagar	4	Gheu dalla	1	2	8	3	1	5	0	0	Both nil
352	443	Ramnagar	4	Gheu dalla	1	3	1	6	1	0	0	0	Both nil
353	444	Ramnagar	4	Gheu dalla	1	3	1	6	1	3	10	0	100.0%
354	445	Ramnagar	4	Gheu dalla	1	3	1	5	1	3	0	0	Both nil
355	446	Ramnagar	4	Gheu dalla	1	3	8	6	1	1.5	0	0	Both nil
356	447	Ramnagar	4	Gheu dalla	1	3	4	6	1	3	0	0	Both nil
357	448	Ramnagar	4	Gheu dalla	1	3	4	4	1	0	0	0	Both nil
358	449	Ramnagar	4	Gheu dalla	1	3	4	4	1	3	0	10	0.0%
359	450	Ramnagar	4	Gheu dalla	1	3	1	5	1	1	50	10	80.0%
360	451	Ramnagar	4	Gheu dalla	1	3	4	5	1	1	50	10	80.0%
361	452	Ramnagar	4	Gheu dalla	1	2	8	3	1	4	60	0	100.0%
362	453	Ramnagar	4	Gheu dalla	1	3	4	5	1	2	50	0	100.0%
363	454	Ramnagar	4	Gheu dalla	1	3	4	3	1	5	50	0	100.0%
364	455	Ramnagar	4	Gheu dalla	1	3	4	5	1	2	80	0	100.0%
365	456	Ramnagar	4	Gheu dalla	1	3	4	4	1	3	20	10	50.0%
366	457	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	20	0	100.0%
367	458	Ramnagar	4	Gheu dalla	1	3	4	4	1	2	60	10	83.3%
368	459	Sukrauli	9	Nadawa	1	3	1	5	1	5	100	40	60.0%
369	460	Sukrauli	9	Nadawa	1	3	1	5	1	5	100	50	50.0%
370	461	Sukrauli	9	Nadawa	1	3	1	5	1	5	100	50	50.0%
371	462	Tilakpur	5	Wasabsahi	1	2	8	3	1	5	30	0	100.0%
372	463	Tilakpur	5	Wasabsahi	1	2	8	3	1	5	10	0	100.0%
373	464	Tilakpur	5	Wasabsahi	1	2	8	3	1	5	10	0	100.0%
374	465	Tilakpur	5	Wasabsahi	1	2	8	5	1	5	20	0	100.0%
375	466	Ramgram	10	Manjhariya	1	3	6	3	1	5	200	0	100.0%
376	467	Ramgram	10	Manjhariya	1	3	4	3	1	5	40	30	25.0%
377	468	Ramgram	8	Unawacha	1	3	5	7	1	5	120	30	75.0%
378	469	Ramgram	8	Unawacha	1	3	8	3	1	5	120	140	0.0%
379	470	Ramgram	8	Unawacha	1	2	8	1	1	5	230	20	91.3%
380	471	Ramgram	8	Unawacha	1	3	5	7	1	5	190	140	26.3%

381	472	Ramgram	8	Unawacha	1	3	5	7	1	5	190	40	78.9%
382	473	Ramgram	8	Unawacha	1	3	5	7	1	5	180	30	83.3%
383	474	Ramgram	8	Unawacha	1	3	8	3	1	5	180	9	95.0%
384	475	Ramgram	8	Unawacha	1	3	5	7	1	5	200	70	65.0%
385	476	Ramgram	8	Unawacha	1	3	5	7	1	5	200	90	55.0%
386	477	Ramgram	8	Unawacha (garden tole)	1	3	5	7	1	5	30	0	100.0%
387	478	Ramgram	8	Garden tole	1	3	5	7	1	5	30	10	66.7%
388	479	Ramgram	8	Garden tole	1	2	8	1	1	2	140	10	92.9%
389	480	Ramgram	8	Garden tole	1	2	8	1	1	2	100	50	50.0%
390	481	Ramgram	8	Garden tole	1	2	8	1	1	2	80	10	87.5%
391	482	Ramgram	8	Garden tole	1	2	8	1	1	2	140	0	100.0%
392	483	Ramgram	8	Garden tole	1	2	8	1	1	2	190	0	100.0%
393	484	Ramgram	8	Unawachha	1	3	5	7	1	5	210	70	66.7%
394	485	Ramgram	8	Unawachha	1	3	5	7	1	5	150	30	80.0%
395	486	Ramgram	8	Unawachha	1	3	5	7	1	5	50	50	0.0%
396	487	Ramgram	8	Unawachha	1	3	5	7	1	5	60	40	33.3%
397	488	Ramgram	8	Unawachha	1	2	8	1	1	5	400	10	97.5%
398	489	Ramgram	8	Unawachha	1	2	8	1	1	5	190	100	47.4%
399	490	Ramgram	8	Unawachha	1	3	5	7	1	5	20	10	50.0%
400	491	Ramgram	8	Unawachha	1	2	8	1	1	3	70	0	100.0%
401	492	Ramgram	8	Unawachha	1	2	8	1	1	6	70	0	100.0%
402	493	Ramgram	8	Unawachha	1	2	8	1	1	2	70	0	100.0%
403	494	Ramgram	8	Unawachha	1	3	5	7	1	5	80	20	75.0%
404	495	Ramgram	8	Unawachha	1	2	8	1	1	3	70	0	100.0%
405	496	Ramgram	8	Unawachha	1	2	8	1	1	3	70	0	100.0%
406	497	Ramgram	8	Unawachha	1	2	8	1	1	3	50	0	100.0%
407	498	Ramgram	8	Unawachha	1	2	8	1	1	4	90	0	100.0%
408	499	Ramgram	8	Unawachha	1	2	8	1	1	5	100	0	100.0%
409	500	Ramgram	8	Unawachha	1	3	5	7	1	5	100	30	70.0%
410	501	Jamuniya	4	Semari	1	3	8	3	1	5	10	0	100.0%

411	502	Jamuniya	1	Jamunabari	1	2	6	3	1	3	0	0	Both nil
412	503	Jamuniya	1	Jamunabari	1	2	6	1	1	3	10	0	100.0%
413	504	Jamuniya	4	Semari	1	3	6	3	1	5	40	0	100.0%
414	505	Pratappur	2	Madhavpur	1	3	6	7	1	5	30	50	0.0%
415	506	Pratappur	2	Madhavpur	1	3	6	7	1	5	60	10	83.3%
416	507	Pratappur	3	Pratappur	1	3	6	4	2	5	60	10	83.3%
417	508	Pratappur	3	Pratappur	1	3	6	6	1	5	10	0	100.0%
418	509	Pratappur	3	Pratappur	1	3	6	5	2	5	40	10	75.0%
419	510	Pratappur	2	Pratappur	1	3	6	6	2	5	40	10	75.0%
420	511	Manari	1	Manari	1	1	2	4	1	4	70	20	71.4%
421	512	Manari	1	Manari	1	1	2	4	1	4	70	10	85.7%
422	513	Manari	6	Ahirauli	1	1	2	5	1	4	70	0	100.0%
423	514	Manari	6	Ahirauli	1	1	2	5	1	5	70	10	85.7%
424	515	Manari	6	Ahirauli	1	1	2	5	1	5	90	5	94.4%
425	516	Ramnagar	4	Santapur	1	3	4	5	1	5	70	10	85.7%
426	517	Ramnagar	4	Santapur	1	3	4	6	1	5	50	10	80.0%
427	518	Ramnagar	4	Santapur	1	2	4	6	1	5	180	40	77.8%
428	519	Ramnagar	4	Gheu dalla	1	3	6	4	1	5	0	0	Both nil
429	520	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	9	0	100.0%
430	521	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	20	0	100.0%
431	522	Ramnagar	4	Gheu dalla	1	3	4		1	2.5	20	0	100.0%
432	523	Ramnagar	4	Gheu dalla	1	3	4	3	1	2.5	20	0	100.0%
433	524	Ramnagar	4	Gheu dalla	1	3	4	3	1	2.5	0	0	Both nil
434	525	Ramnagar	4	Gheu dalla	1	2	4	3	1	2.5	0	0	Both nil
435	526	Ramnagar	4	Gheu dalla	1	3	4	4	1	1	10	0	100.0%
436	527	Ramnagar	4	Gheu dalla	1	3	4	4	1	1.5	0	0	Both nil
437	528	Ramnagar	4	Gheu dalla	1	3	4	4	1	1	0	0	Both nil
438	529	Tilakpur	6	Basabasahi	1	2	8	3	1	5	20	0	100.0%
439	539	Ramgram	10	Manjhariya	1	3	8	3	1	5	250	200	20.0%
440	540	Ramgram	8	Unawachha	1	3	6	6	1	4	240	160	33.3%

441	541	Ramgram	8	Unawachha	1	3	6	6	1	3	160	20	87.5%
442	542	Ramgram	8	Unawachha	1	3	6	6	1	0	190	20	89.5%
443	543	Ramgram	8	Unawachha	1	3	5	6	1	3.5	260	30	88.5%
444	544	Ramgram	8	Unawachha	1	3	5	6	1	4	70	270	0.0%
445	545	Ramgram	8	Unawachha	1	2	8	1	1	5	40	10	75.0%
446	546	Ramgram	8	Unawachha	1	3	5	6	1	4	70	20	71.4%
447	547	Ramgram	8	Unawachha	1	3	5	6	1	4	100	10	90.0%
448	548	Ramgram	8	Unawachha	1	3	5	6	1	5	90	20	77.8%
449	549	Ramgram	8	Unawachha	1	3	5	6	1	4	120	30	75.0%
450	550	Ramgram	8	Unawachha	1	3	5	6	1	4	50	10	80.0%
451	551	Ramgram	8	Unawachha	1	2	8	1	1	5	10	90	0.0%
452	552	Ramgram	8	Unawachha	1	3	5	6	1	4	50	10	80.0%
453	553	Ramgram	8	Unawachha	1	3	5	6	1	5	100	20	80.0%
454	554	Ramgram	8	Unawachha	1	2	8	1	1	2	130	0	100.0%
455	555	Jamuniya	4	Semari	1	3	8	4	1	4	0	0	Both nil
456	556	Jamuniya	4	Semari	1	3	8	3	1	3	10	0	100.0%
457	557	Jamuniya	4	Semari	1	3	8	4	1	5	20	0	100.0%
458	558	Jamuniya	4	Semari	1	3	8	4	1	5	50	10	80.0%
459	559	Pratappur	2	Madhavpur	1	3	3	6	1	5	70	30	57.1%
460	560	Pratappur	2	Madhavpur	1	3	6	8	1	4	10	0	100.0%
461	561	Pratappur	3	Pratappur	1	4	1	7	1	5	20	0	100.0%
462	562	Pratappur	3	Pratappur	1	3	1	7	1	5	60	0	100.0%
463	563	Pratappur	3	Pratappur	1	3	1	7	1	4	50	30	40.0%
464	564	Manari	1	Manari	1	1	8	5	2	5	90	40	55.6%
465	565	Manari	6	Ahirauli	1	1	8	5	2	5	120	40	66.7%
466	566	Manari	6	Ahirauli	1	1	8	5	1	5	90	40	55.6%
467	567	Ramnagar	4	Santapur	1	2	6	7	1	3	170	40	76.5%
468	568	Ramnagar	1	Gheu dalla	1	3	6	4	2	5	100	10	90.0%
469	569	Ramnagar	4	Gheu dalla	1	3	3	4	1	5	0	0	Both nil
470	570	Ramnagar	4	Gheu dalla	1	2	8	3	1	5	10	0	100.0%

471	571	Ramnagar	4	Gheu dalla	1	3	4	3	1	0	0	0	Both nil
472	572	Ramnagar	4	Gheu dalla	1	2	8	3	1	5	20	0	100.0%
473	573	Ramgram	8	Unawachha	1	3	5	4	1	4	0	0	Both nil
474	574	Ramnagar	4	Gheu dalla	1	2	8	4	1	5	10	0	100.0%
475	575	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	20	0	100.0%
476	576	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	10	0	100.0%
477	577	Ramnagar	4	Gheu dalla	1	3	8	4	1	0	20	0	100.0%
478	578	Ramnagar	4	Gheu dalla	1	3	4	4	1	5	10	0	100.0%
479	579	Ramnagar	4	Gheu dalla	1	3	4	3	1	4	20	0	100.0%
480	580	Ramnagar	4	Gheu dalla	1	3	4	4	1	0	20	0	100.0%
481	581	Ramnagar	4	Gheu dalla	1	3	4	4	1	1	0	0	Both nil
482	582	Ramnagar	4	Gheu dalla	1	3	4	3	1	1	10	0	100.0%
483	583	Ramnagar	4	Gheu dalla	1	3	6	3	1	2	0	20	0.0%
484	584	Tilakpur	6	Basabasahi	1	2	8	3	1	5	30	0	100.0%
485	585	Tilakpur	6	Basabasahi	1	2	6	3	1	5	20	0	100.0%
486	586	Tilakpur	6	Basabasahi	1	2	8	4	1	5	50	0	100.0%
487	587	Tilakpur	6	Basabasahi	1	2	8	4	1	3	20	0	100.0%
488	588	Tilakpur	6	Basabasahi	1	2	8	3	1	-1	40	0	100.0%
489	589	Tilakpur	6	Basabasahi	1	2	8	3	1	3	20	0	100.0%
490	590	Tilakpur	6	Basabasahi	1	2	8	3	1	4	30	0	100.0%
491	591	Tilakpur	6	Basabasahi	1	2	8	4	1	5	20	0	100.0%
492	592	Tilakpur	5	Basabasahi	1	2	8	3	1	5	20	0	100.0%
493	593	Tilakpur	5	Basabasahi	1	2	8	3	1	5	0	0	Both nil
494	594	Tilakpur	5	Basabasahi	1	2	8	3	1	5	0	0	Both nil
495	595	Tilakpur	6	Basabasahi	1	2	8	3	1	5	30	0	100.0%
496	596	Tilakpur	6	Basabasahi	1	2	8	3	1	5	20	0	100.0%
497	597	Tilakpur	5	Basabasahi	1	2	8	3	1	5	30	0	100.0%