

**Extended field trial of Household Iron Removal  
Plants to remove arsenic from groundwater**

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and Environmental Health

**(NIOEH)**

**OBJECTIVES OF THE study**

1. To test arsenic removal efficiency under field conditions; and
2. To investigate user satisfaction with the improved design.

## INTRODUCTION

### Arsenic Situation in Vietnam:

- ❑ Similar geological conditions between Bangladesh and certain parts of Vietnam: *a possibility of arsenic contamination in the groundwater in Red River Delta and Mekong River Delta.*
- ❑ The recent studies: the contamination by arsenic of groundwater to be both *high level and widespread particularly in Red River Delta.*

*A lot of tube wells in the rural areas of Red River Delta have arsenic concentrations in the groundwater in excess 10 ppb, especially in Ha Nam and Ha Tay province.*

### Population exposed to arsenic in drinking water and health impact:

- ❑ World Bank report "**Towards a more effective arsenic response**" quote UNICEF as estimating *the "Population at Risk" to be 10 million.*
- ❑ NIOEH's study in three villages in Ha Nam in 2003 (where As conc. of 94.4% of tested tube wells exceed 10 ppb) found: *eight patients who are the possible arsenicosis.*

*However, there is no official estimate available for exposed population as well as no formal report of the number of possible arsenicosis patients.*

### **Use of household Iron Reduction Plants (IRPs)**

- IRPs have been well accepted and widespread in rural and sub-urban areas since 1990s to remove dissolved iron.
- The potential of IRPs for arsenic removal is not widely known by the majority of the population.

### **National Action Plan for mitigation of arsenic**

- 1) Identifying drilled water with high arsenic content;
- 2) Provision of water filtering devices to households;
- 3) Provision of chemicals for day-to-day use to help the community eliminate arsenic from drinking and domestic use water;
- 4) Utilization of filtered and chloride-processed surface water for drinking and domestic uses;
- 5) Stop using wells with high arsenic level once a temporary water source has been found.

## **Results of the study**

### **Survey for the existing IRPs**

#### **Structure and materials:**

- No standard or even common designs.
- Design and size are not related to the size and water requirements of the household.
- Dimensions and thickness of the sand layer vary between the HHs.
- Constructed with bricks and black sand is used mostly as the filter material.
- 0.35 KW electric pumps are used by almost all HHs to deliver water to IRPs.



*on the ground and  
electric pump*



*on the roof*



*Hand pump*

### **Efficiency of use:**

- Efficiency of iron removal is initially high but decreases rapidly with use.
- Flow rate of filtered water reduced rapidly because of clogging.
- Cleaning of the IRPs is difficult as washing the sand bed requires that the sand is taken out of the filter tank for washing.
- The filtered water has not good transparency and still has iron taste.
- Capacity to reduce arsenic concentration, but still higher than WHO Guideline value (10ppb) in most cases.

**Suggested improvements:**

*(with regarding the community's acceptance).*

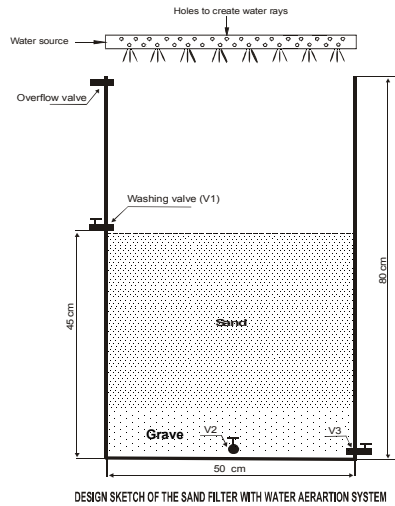
- Increasing filtration capacity;
- Increasing efficiency of both iron and arsenic removals;
- Easier maintenance in washing the sand bed.

**Modifications based on the design of NIOEH's Sand Filter**

***Key features of the NIOEH's design include:***

1. Standards design;
2. Spray system to aerate and disperse incoming water over full area of filter;
3. Use yellow sand;
4. Inclusion of washing valves to improve maintenance.

## Design of Sand Filter System of NIOEH.



### ▪ **Dimensions:**

- Width: 50 cm
- Length: 50 – 60 cm
- High: 80 cm

### ▪ **Materials:**

- Brick and cement
- Yellow sand: 40 – 45 cm
- Gravel : 5 – 10 cm
- PVC pipe
- Valves

**Electric pump**



**Aeration system**

## Testing the improved IRPs in two villages

**The studied villages:** Don Xa village in Ha Nam province and Dung Tien village in Ha Tay province.

### ***In both villages:***

- Groundwater has been used as the main water source for drinking and washing. (*by primary survey*).
- Nearly 100% of HHs use IRPs for removing iron from groundwater (*by primary survey*).
- Groundwater are contaminated with high conc. of arsenic. (*UNICEF's study: max. value of up to 350 ppb*).

### **Installation of the improved IRPs:**

- The installation were conducted at fifty (50) HHs from each village where the arsenic levels in raw water is higher than 10 ppb.
- The IRPs were built by the village workers trained by project for the installation and the operation
- The materials were prepared by the members of the households

## Installation of IRPs



## Performance of the improved IRPs

Efficiency of iron removal - *Percentage Removal*.

Village	Percentage Removal (%)					
	Existing IRPs			Improved IRPs		
	Mean	Min	Max	Mean	Min	Max
Don Xa	88.4	48.7	99.8	94.7	50	99.7
Dung Tien	64.6	1.2	99.4	90.7	52	99.7
<i>n</i>	<i>DX = 40; DT = 38</i>			<i>DX = 50; DT = 50</i>		

- The efficiency is increased : 88.4 to 94.7% in DX, and 64.6 to 90.7% in DT.

### Performance of the improved IRPs (cond.)

Efficiency of iron removal – Per. of IRPs reduced Fe levels to within acceptable limit (0.5 mg/l).

Village	Per. of IRPs reducing Fe conc.			
	Existing IRPs		Improved IRPs	
	≤ 0.5 mg/l	> 0.5 mg/l	≤ 0.5 mg/l	> 0.5 mg/l
Don Xa	26 (65%)	14 (35%)	42 (84%)	8 (16%)
Dung Tien	14 (37%)	24(63%)	43 (86%)	7 (14%)
<i>n</i>	<b><i>DX = 40; DT = 38</i></b>		<b><i>DX = 50; DT = 50</i></b>	

- The rate is increased : 65% to 84% in DX, and 37% to 86% in DT

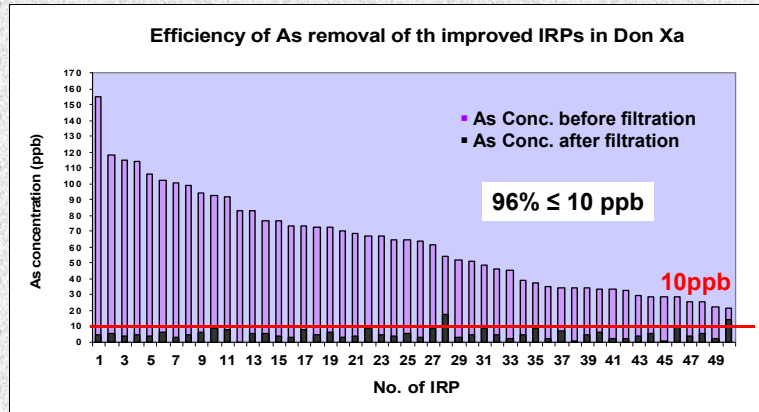
### Performance of the improved IRPs (cond.)

Efficiency of arsenic removal - Percentage Removal.

Village	Percentage Removal (%)					
	Existing IRPs			Improved IRPs		
	Mean	Min	Max	Mean	Min	Max
Don Xa	83.2	30.4	100	89.0	33.6	100
Dung Tien	50.9	4.5	99.1	64.1	20.8	99.2
<i>n</i>	<b><i>DX = 42; DT = 49</i></b>			<b><i>DX = 50; DT = 44</i></b>		

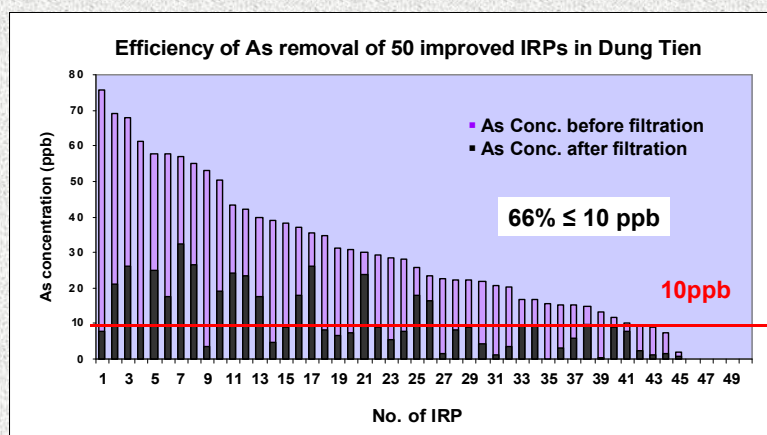
- The efficiency is increased : 83.2 to 89% in DX, and 50.9 to 64.1% in DT.

## Performance of the IRPs of NIOEH *(cond.)*



- Per. of IRPs reduced As levels to within 10ppb increases : 69% to 96%.
- Average Conc. of arsenic is reduced from 62.99 ppb to 5.36 ppb.

## Performance of the IRPs of NIOEH *(cond.)*



- Per. of IRPs reduced As levels to within 10ppb increases : 41% to 66%.
- Average Conc. of arsenic is reduced from 29.68 ppb to 11.39 ppb.

## **User satisfaction survey**

*(after 6 – 8 weeks of construction).*

- Approximately 80% of HHs agreed: the water quality is improved considerably on the transparency and taste;
- 68% of HHs said: easier operation compared with existing IRPs;
- 99% of HHs said: maintenance in washing sand bed is simple and easy.
- 91% of the HHs where the improved IRPs have not been installed wished to assess and learn this technique.

## **CONCLUSIONS**

- The existing iron reduction plants have a potential for the arsenic removal, but it is not widely known as yet in the community.
- The improved design of NIOEH solved the disadvantages of the existing IRPs with:
  - Increasing significantly the efficiency in removal of both arsenic and iron.
  - Making the procedure easier and simpler in maintenance of sand filter.

- The improved IRPs were well accepted by the community.
- ***Recommendations for further studies:***
  - The effect of the groundwater composition on the efficiency of arsenic removal.
  - The possibility of recontamination to the environment by the sludge with arsenic enrichment drained from the IRPs.
  - Expansion of the IEC activities on clean water and sanitation to increase the efficiency of using the IRPs.



Thank you!