Thinking rationally on arsenic mitigation

Technical measures as well as institutional design to cope with the arsenic problem should comply with the cultural and social conditions of the communities concerned, writes **Stijn Hoorens**

EVEN in the Netherlands, arsenic has been found in alluvial aquifer sediments of the river Rhine. With regard to geology, Bangladesh and the Nether-lands are quite similar. The Netherlands, too, is a flat country and forms the delta of two major European rivers. It has a long history of dealing with its most dangerous natural enemy, water, posing threats to the Dutch population both from the rivers and the see, for an extensive part of the country is seated below sea level. Hence, floods aren't rare phenomenon, either. However, it should be mentioned that the annual discharge of Bangladesh's delta is several times bigger. Unlike Bangladesh, arsenic contamination of the alluvial sediments is not at all an issue in the Netherlands. The extent of contamination in Bangladesh is far greater than anywhere else in the world. But, besides this, are there any 'magic forces' blocking several measures from successful implementation?

Proper drinking water supply has always been problematic in Bangladesh. During the Monsoon season melting water from the Himalayas and rainwater from all over the Indian sub-continent accumulates in the low-lying parts of Bangladesh, before it finally reaches the Bay of Bengal. Yearly floods, therefore, are a familiar phenomenon. The rainwater from the monsoon rains cannot be effectively harvested for want of required technology to collect and store it. During dry period, however, lack of precipitation causes water scarcity. Besides rainwater a second water resource cannot be used without any doubts, either. Surface water in ponds, rivers and shallow hand-dug wells may cause epidemic of cholera and diarrhoeal diseases. Therefore, international organisations convinced local communities that those surface water resources were unsafe.

Elimination of these two resources for potable water left use of groundwater as the remaining alternative. Two decades ago, the UNICEF and World Bank started installing shallow tubewells to meet the daily drinking water supply in local communities. Within a few years western aid agencies spent billions of takas digging shallow tubewells (TWs) in almost every part of the country, resulting in approximately four million TWs from which 116 million Bangladeshis extract their daily water needs. But, as luck would have it, this solution proved short-lived. Many TWs turned out to be contaminated with arsenic, poisoning millions.

The extent of the problem

In 1983 scientists from the Jadavpur University in Calcutta detected presence of arsenic in some tubewells in West Bengal. In Bangladesh, detection of arsenic in aquifers was made a decade later. However, relevant government agencies were slow to react. Only recently, they have undertaken the process of identifying contaminated TWs and affected patients.

The arsenic problem has already taken ominous proportions, with water from TWs in 59 districts containing arsenic above permissible level, i. e. 0.05 mg/1 in Bangladesh. The World Health Organisation, however, changed their limit a few years ago to 0.01 mg/l, presumably in the context of systematic accumulative effect of arsenic poisoning. Strangely, the government still goes by the old WHO guideline; this standard was developed, just considering the maximum permissible limit in drinking water with respect to the acute poisoning property of arsenic.

Until now approximately 35,000 TWs of the total amount of four million, has been tested and 51 per cent of them has been found contaminated in the GoB standard. This means that still a vast majority of the existing TWs in this country remain untested, resulting in the ongoing poisoning of millions of Bangladeshis. Moreover, according to the Dhaka Community Hospital 7,000 are suffering from arsenicosis, which in fact is fairly underestimated, because only a small part of the potential patients has been diagnosed. Thus, it could be possible that thousands of Bangladeshi already died, due to the effects of arsenicosis, although their actual death cause would never be uncovered.

Presence of arsenic in aquifer sediment has been observed in many countries. Arsenic contamination was already known as a result of leaching from mine tailings in Canada, Japan, United States, United Kingdom, Thailand, Australia and Mexico, but later on in aquifers used for drinking water supply in India, Hungary, Chile, China, United States, New Zealand, Philippines, Taiwan, Inner-Mongolia and recently Bangladesh. Measures to remove the arsenic or alternative ways of drinking water supply are generally known to those whom it may concern. Therefore, the mitigation of arsenic contamination in the above listed countries has been more or less completed, except for Bangladesh. One should notice the difference between a solution and a mitigation measure: mitigation measures are just part of the overall strategy to a solution. Social, cultural, economic, geographic, hydrological and other differences between regions and communities within Bangladesh as well as between Bangladesh and those other countries have made the assessment of strategies difficult.

Responsibilities

Although arsenic contamination of groundwater has been a major issue for several years now after being detected in many parts of the world, very little is known about the underlying processes behind such contamination. For this reason it is fairly impossible to depend on TWs that are now considered safe; both for the shallow as well as the deep ones. Let us not forget that in a world where most of the environmental and health problems, some way or the other, are linked to human behaviour, human being could well be excused from this particular issue, as they have little role to play in causing this havoc. The alluvial Ganges aquifers used for public supply are polluted with naturally occurring arsenic. The probable cause lies in the arsenic derivation from the reductive dissolution of arsenic-rich iron oxihydroxides, which in turn are derived from weathering of base-metal sulphides.

Naturally, it is easy to blame nature, or as the DPHE formulated it: "the circumstances are to be blamed for the consequences." Despite the unfortunate combination of natural factors, there are, of course, less natural causes for the biggest mass poisoning ever, which could have been avoided if the institutions concerned would have been sincere in discharging their responsibilities.

Why has no one ever tested the groundwater before installing the tubewells? Even, if there were even the slightest suspicion of presence of any toxic element, it should have been investigated. Possibility of arsenic presence in Bangladesh and West Bengal has been predicted as early as in the eighties. Neither UNICEF nor the World Bank nor any other western donor agency did ever decide to do serious research on the quality of the groundwater before installing these TWs. In comparison, even the slightest of increase in arsenic level sets the alarm bell ringing in the Netherlands. Production of drinking water will then be stopped immediately. In Bangladesh, however, donor agencies were able to supply millions of people with water that exceeds the WHO standard several times. Now, these same organisations have to convince local communities, contrary to what they did two decades ago, to revert back to surface water (e.g. with sand filters) or rainwater harvesting. It wouldn't be surprising if the rural population stops trusting the western aid agencies. Therefore, it is no wonder that a newly formed organisation, the Forum for Arsenic Patients, is threatening to sue UNICEF for compensation of the millions of unsuspecting victims. Moreover, as if it couldn't get any worse, in *The Daily Purbanchal*, November 18, 1998, UNICEF proclaims 16,000 more shallow tubewells will be installed soon. What objectives do these aid agencies have in installing so many more tubewells again? Does this organisation want to help thousands of poor Bangladeshis with provision of poisonous water or perhaps there are more important economical and commercial reasons?

Strangely, it had to be a hospital—Dhaka Community Hospital—to make effort into identifying patients and providing information on the issue. The government department responsible for ensuring supply of drinking water in areas without sufficient facilities, the Department of Public Health and Engineering (DPHE), claims it wasn't heir responsibility to check presence of arsenic and warn people; they don't deal with any aspect other than health. It is the Department of Environment that is supposed to deal with such warnings, the chief engineer of the DPHE told *The Daily Star* (December 11, 1998). Apparently, precaution and mitigation of mass poisoning is not part of public health? Even though, the DPHE eventually took the effort to start testing TWs and developing mitigation strategies, it unfortunately doesn't have the capacity to cope with the problem on its own.

The DPHE has the capacity to test 800 water samples a month against a demand for approximately 6,000 tests. For this reason, perhaps millions of people are still drinking water from untested and probably contaminated wells.

Bottom-up approach

It is of extreme importance, and both government and non-government organisations do agree, that all wells should be tested as soon as possible and will be frequently monitored as well. Thereby, all patients should be diagnosed and mitigation strategies should be developed. Although several government and western aid agencies are involved in various kinds of projects, there has not been much of little tangible and foreseeable outcome. Accordingly, NGOs started criticising the government departments for their top-down approach. They are fairly right, a top-down approach will only be successful with the help of an appropriate institutional infrastructure. In the Netherlands for example water management of regional concern (e. g. drinking water quality and wastewater treatment) is dealt with under the responsibility of specific water boards. These elected institutions work completely independent from the provincial and local governments. In this way, national policy objectives on water management, which are of major concern in the country, could easily be realised according to regional properties and standards.

However, in Bangladesh during the British rule, all local government institutions were done away with in order to establish a central organisational reigning structure. For this reason local institutional infrastructure, especially in rural areas, is rather ill-developed. Water policy in Bangladesh is divided across several departments: WARPO, for overall long-term planning of water resource allocation; DPHE, for water supply and quality in rural and urban area; LGED, planning designing and implementing rural infrastructure development project; WASA, water supply and sewerage in (metropolitan) urban areas. This causes a confusing situation, where tasks and responsibilities seem rather unclear. Hence, a bottom-up approach to mitigation strategies is required.

This means that projects should directly adapt to the field-level, in which participation of the local community is crucial. Not only technical requirements should be fulfilled, but measures should also comply with cultural, communicational, financial factors and aspects of knowledge and skill of that particular local community.

Fortunately, in government bodies a shift to a more integrated approach can be discerned. The recognition that the standard technical approach has shown a number of disadvantages, especially the inability to cope with social and cultural phenomena, is fuelling a change in a multi-disciplinary direction. The same tendency can be observed for the foreign consultants and constructing companies with their strong technique dominated attitude in the past. Western engineers, technological students, as well as their staff, often tend to approach all kinds of problems with an emphasis on the technical part. Solution to a flooding problem: build a dam; solution to a water contamination problem: treat the water; etc. More recently they are showing their awareness that a more multi-disciplinary approach is needed.

At this point the question arises, whether to adapt the necessary institutional requirements to the technical measures, or the other way around. Traditionally, western engineers should pledge for similar Dutch geographical divisions to meet the institutional needs of installation and maintenance their technical measures. The answer to both questions is no: technical measures as well as institutional design should comply with the cultural and social conditions of the concerned communities.

The author is a research trainee on the arsenic issue under a co-operation programme between Delft University of Technology, Netherlands and Shakti Samannaya and Sampad Unnayan Kendra (SSSUK), an NGO

Severe lesion in the hands

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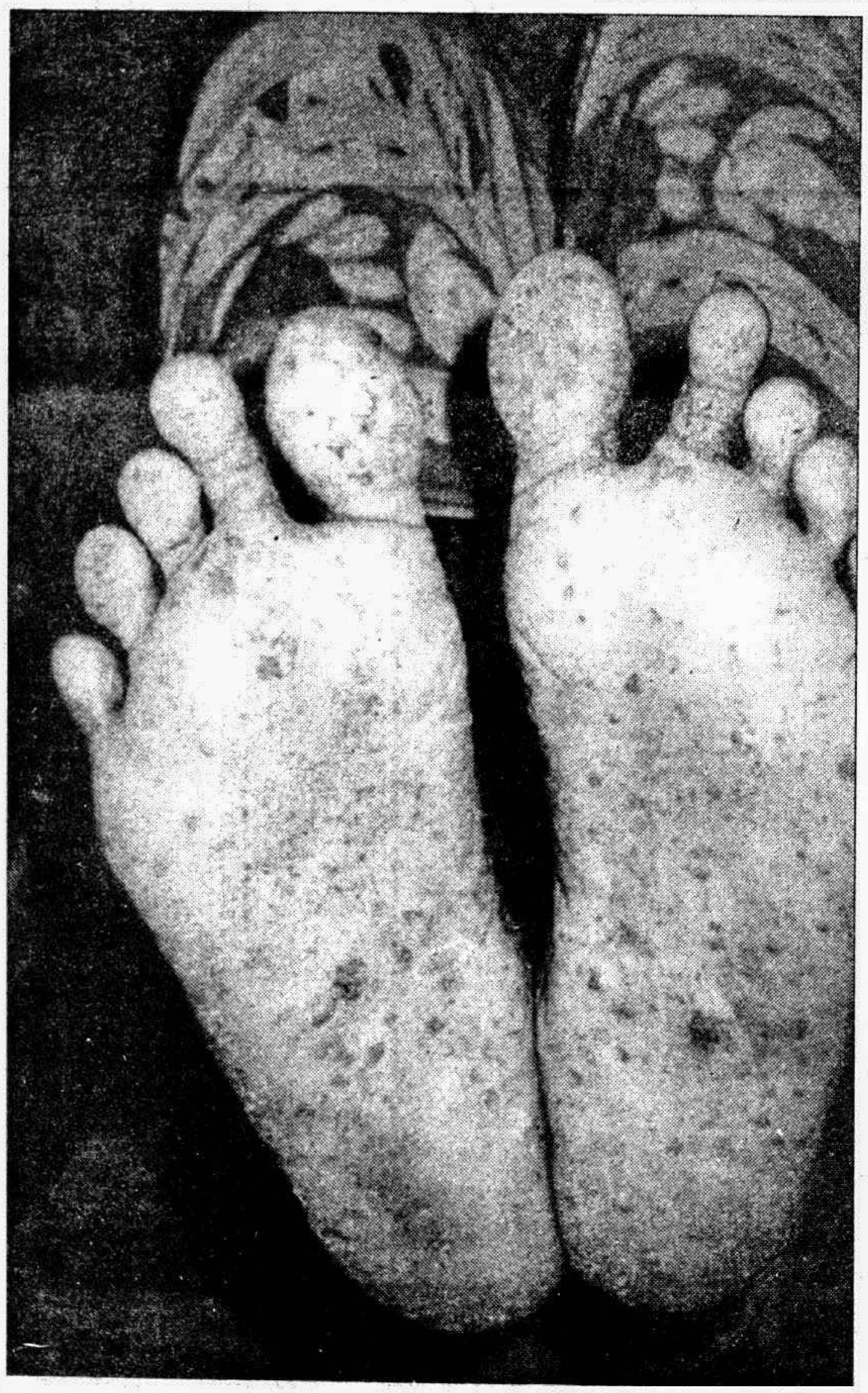

Unmistakable signs of Arsenic poisoning

Proper drinking water supply has always been problematic in Bangladesh. During the Monsoon season melting water from the Himalayas and rainwater from all over the Indian sub-continent accumulates in the low-lying parts of Bangladesh, before it finally reaches the Bay of Bengal. Yearly floods, therefore, are a familiar phenomenon. The rainwater from the monsoon rains cannot be effectively harvested for want of required technology to collect and store it.

Taking solution to poor

Instead of going for expensive and energy requiring gadgets like the Reverse Osmosis or RO, we should focus on traditional remedies that are not technically savvy or require huge investment, writes **Dr. A. H. Jaffor Ullah**

"Some business concern is going to take advantage of the situation to bring some gadgets into the country no doubt, but as a scientist and researcher we have an obligation to forewarn the public. What Bangladesh needs at this time is clear-headed thinking and a long-range plan to solve this monumental problem. The business community should listen carefully to the experts before they import any newfangled technology, which may not work in the rural settings."

AN Internet newspaper (NFB September 25, 1999) blabbered: "New technology to purify water coming in mkt." The Internet newspaper was merely quoting news published in a financial newspaper. The gist of the news is that a private Bangladesh-Taiwan joint venture is going to market two units of water purifier in Bangladesh. The technology to be used is "Reverse Osmosis" (RO). The company press release stated that it would be marketing two RO products in Bangladesh at a cost of about Taka 57,500 and Taka 27,200, respectively.

The company touted the process of RO to be a new technology for Bangladesh. This may be true. However, the bigger question is do we need RO to mitigate arsenic problem that had plagued the rural Bangladesh especially in the south-western districts?

The RO technology is nothing new to this world. To separate contaminating chemicals that are dissolved in brackish water, two techniques are now being utilised in the developed nation. One is "Electrodialysis" and the other is "Reverse Osmosis." In electrodialysis, an electric voltage is applied across the contaminated solution. The dissolved contaminating ions then move to the electrode opposite to their charge. In normal osmosis, a semi-permeable membrane separates two solutions of different concentrations. Water has the tendency to flow from dilute side to the concentrated side. However, when pressure is applied to the concentrated side, the water from concentrated side flows out to the dilute side. This process of forcing water to move to the less dilute side of the osmosis membrane by pressure is called reverse osmosis. This technique is also known as ultrafiltration.

To operate a RO unit one needs supply of electricity. There should be a mechanism to apply pressure into the vessel. Most likely the air will be compressed by some means and then the compressed air will be forced enter the vessel. Next, the membrane filter will be clogged every now and then necessitating its replacement.

To run RO, one needs to apply high pressure inside the vessel. The Taiwanese manufacturer may be upbeat about this gadget for obvious reason, but the consumer should be informed about the negative aspects of this technology too. To lure the would-be customers the company in their press release has said that one of the gadgets would also deliver either ice cold or hot water. Needless to say, this icy or hot water dispensing RO gadget would require a huge amount of electricity to produce the much desired icy water in the summer months and hot water in the winter days. Bangladesh has serious problems securing enough electricity to meet up the demand. The introduction of these new RO gadgets may poignantly remind us the Bangla adage "*mora'r upor kharar gha*" (punishing the dead one).

To mitigate arsenic crisis in the nation what we need is not RO gadgets. Instead, what we need is simpler device. Chemists know that blowing air can oxidise arsenic-laced water from tubewells. The air may be blown by mouth with the aid of simple plastic tube or even bamboo cane. If the air-blown water is allowed to stand overnight, a precipitate will come down to settle in the bottom of the earthenware. The precipitate can be easily removed through filter made from discarded sari or lungi materials. This air treatment of contaminated tubewell may not remove all the arsenic from water, but it will remove the bulk of it. Bangladesh's higher institute of learning has chemistry department that can perform the necessary experiments to figure out the details of arsenic removal by simple air oxidation.

The other indigenous method that can help remove toxic arsenic salts from tubewell without having to buying expensive gadgets as "Ultrafiltrator" or "RO" is water treatment with Fitkiri (alum). This is essentially a crystalline solid made up of aluminium potassium sulphate that is used in medicine as an astringent and styptic. This reagent is also capable of changing ionic species of arsenic to render them insoluble. Treating arsenic-laced water with fitkiri overnight can form an insoluble mass that can then be removed through a sieve made out of discarded sari or lungi. Again, the Chemistry department of Rajshahi or Dhaka University may work out the condition for our masses. The arsenic mitigation does not require that we remove all the arsenic from drinking water. If we can remove in excess of 95 per cent of the arsenic present in deep tubewell water by indigenous method, which should work because of the underlying chemical principles, we can save thousands of people from contracting arsenical dermatosis or melanokeratosis.

Scientists who are working at the Southern Regional Research Centre in New Orleans to convert agricultural refuses to useful activated charcoal are of the opinion that activated charcoal has the potential to bind minerals including arsenicals. On top of that any bacteria or microbes will not be able to pass through the activated charcoal filter. This will be blessing to us because our water in general is not safe for drinking because it contains too many microbes, disease causing or not. One can imagine having earthen pot with a hole at the bottom. This hole can be plugged up by using cotton fabric very easily. The holed and plugged up earthenware can now be filled up with activated charcoal. We can easily pass the contaminated water through the home-made activated charcoal filter. We should use the force of gravity rather than any force electrically generated as is the case with Reverse Osmosis. Activated charcoal filter has gained wide acceptance in the US to enhance the taste of water. The contaminating minerals and organic matter in water when removed through activated charcoal enhance the taste of the purified water.

Bangladesh produces an extraordinary amount of rice husks as agricultural by-product every year. If we can set up furnaces in the rural areas to convert say 10-25 per cent of the rice husk or bagasse generated by the sugar mills, we can produce enough activated charcoal in Bangladesh. The demand for activated charcoal is growing all over the world. With excess production Bangladesh can become a reputable supplier of activated charcoal to the world.

In summary, for arsenic mitigation we should not be using expensive and energy requiring gadgets. One such gadget, the Reverse Osmosis or RO, has been touted in the press by a private company. Instead, we should focus on traditional remedies that are not technically savvy or require a huge investment. Our village folks who are primarily affected by arsenic contamination of drinking water are simple folks with limited financial resources. For them to recommend RO or Electro-dialysis for arsenic removal is equivalent to "*mosha marte kaman daga*" (a complex solution for a simple problem). A variety of chemical approaches can be recommended for remedy to arsenic contamination in our drinking water. Those chemical methods should be tested out by the university and government researcher immediately. Some business concern is going to take advantage of the situation to bring some gadgets into the country no doubt. What Bangladesh needs at this time is clearheaded thinking and a long range plan to solve this monumental problem. The business community should listen carefully to the experts before they import any newfangled technology, which may not work in the rural settings.

The writer is a senior research scientist in America. He writes from New Orleans.