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Promoting Community Health and Preventing Waterborne Diseases with TheJalkalp Water Filter

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Abstract:*The biggest challenge for access to safe drinking water is presence of water contaminants in groundwater. Microbes, iron, arsenic and turbidity is encountered in drinking water across numerous states in India. These contaminants could either coexist or may be present individually in water. Population from base of pyramid particularly living in rural villages are the most sufferer. Thus, there is a daunting need to facilitate removal of these frequently occurring contaminants simultaneously as well as individually through a low cost sustainable technology. A technological solution at point of use is preferred particularly in rural settings to eliminate the risk of secondary contamination. The technology needs to be replicable, effective and sustainable against all these contaminants.*

This paper presents an innovative model of BiosandFilter, 'JalKalp', fabricated in stainless steel so as to overcome the limitations experienced with conventional technologies; and innovations adopted in approach and process of promotion.

Keywords: Safe drinking water, Biosand filter, JalKalp, household water treatment, Arsenic, Iron, Water contamination

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I. Introduction

Myriad efforts aimed at achieving the millennium development goal of providing safe drinking water to half of the world's population have not proved to be adequate, as a large bracket of the world's population continues tolack sufficient availability of good quality water. Microbes, iron, arsenic, and turbidity are present individually or coexisting drinking water across numerous states in India.

The World Health Organization noted (WHO 2007)that "Lack of safe water perpetuates a cycle whereby poor populations become further disadvantaged, and poverty becomes entrenched. "The lack of safe drinking water contributes to poor household economy due to loss of livelihood income during illness and increased financial stress from treatment costs.

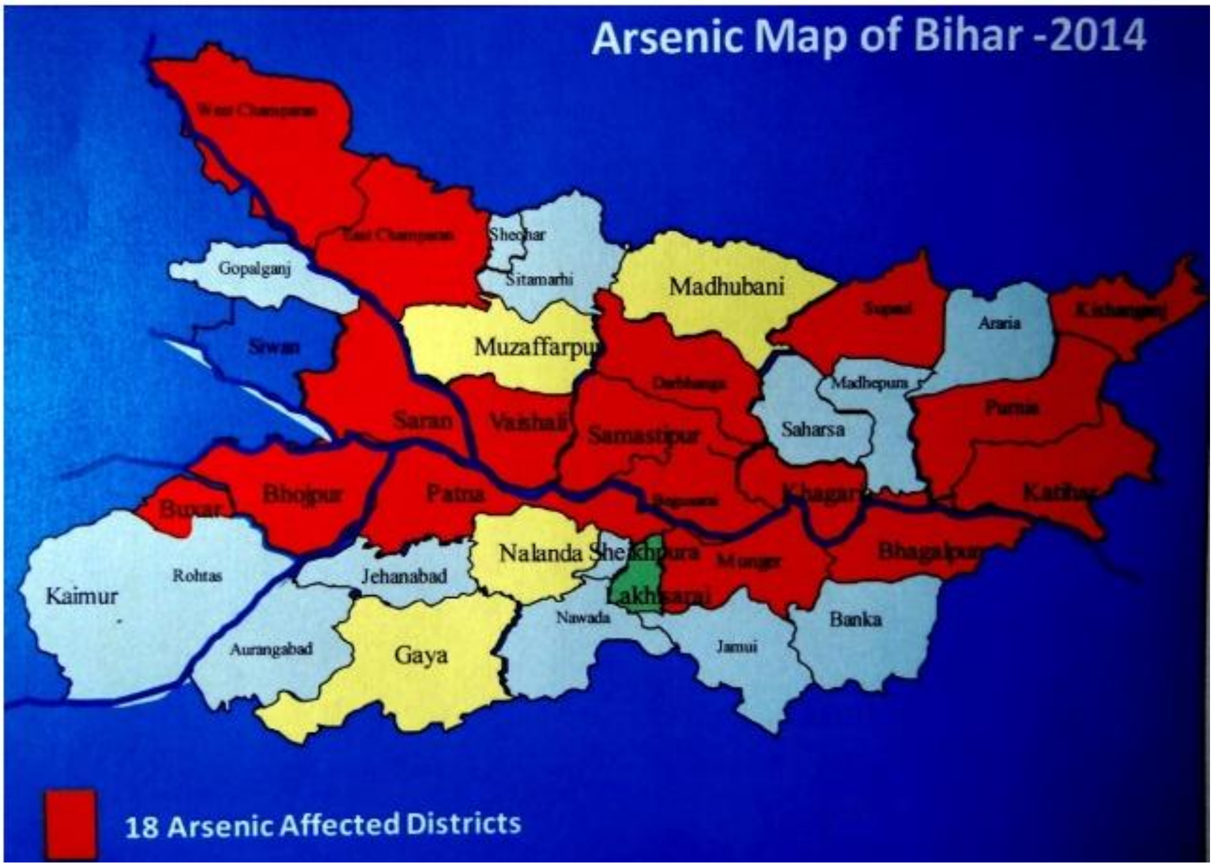
Physical, chemical, and biological forms of contamination make the water unfit for drinking.Diarrhoeal and other waterborne diseases are caused by pathogens present in water. The geographical spread of such biological contamination is observed throughout India, with no estimates available on the number of districts affected (Shankar et al. 2011).

Consumption of contaminated water has particularly adverse health impacts on children and women.In India, the single largest cause of ill health and death among children is diarrhea, which kills nearly half-million children(Pacific Institute 2010). Exposure towaterborne diseases is the foremost causal link behind inequalities in child mortality and poor nutritional status (Khurana & Sen 2006). The duration of illness due to diarrhoeal diseases and its severity arefound to be higher among malnourished children where repeated exposure to diarrhoea results in weight loss, stunted growth, and vitamin deficiency. Morbidity due to waterborne diseasesincreases the chances of children performing poorly or dropping out of school, andthe prevalence of bacterial contamination in water increases the health risks for women especially during pregnancy.

Evidence suggests that prolonged consumption of water contaminated with arsenic is associated with development of cancer, particularly skin, lung, and bladder cancer(WHO 2004). Arsenic contamination above permissible limits is found across alluvial plainsof Ganges, and is more recently been detected in northeastern regions of India (Saurav et al. 2015).

Excess iron in the body leads to health hazards like haemochromatosis. Drinking water withhigh iron content gives rise to iron bacteria—tiny creatures that feed off iron and leave behind iron waste deposits. They cause unpleasant stains, tastes, and odors; leave behind slime that sticks to pipes and fixtures, and can introduce other harmful bacteria.

Arsenic contamination, so far considered endemic to northeastern parts of India, has now spread to a large part of the Bihar state. With nearly twentydistricts in Bihar in the grip of arsenic contamination, the situation has worsened for masses exposed to this slow and consistent toxin.The presence of arsenic in the region was first noticed in Bangladesh in 1991, and in Nepal, adjoining Bihar, in 2001. Arsenic was first found in Bihar in 2002, and extensive testing has since been carried out. The map below shows that eighteendistricts of Bihar had arsenic pollution in the groundwater in2014. In most of these areas, the groundwater also contains high levels of iron and biological contamination. In these mostly flood prone areas, drinking water remains thebiggest challenge during flood periods. But contamination in the drinking water and associated risks remain a big challenge even beyond flood periods.



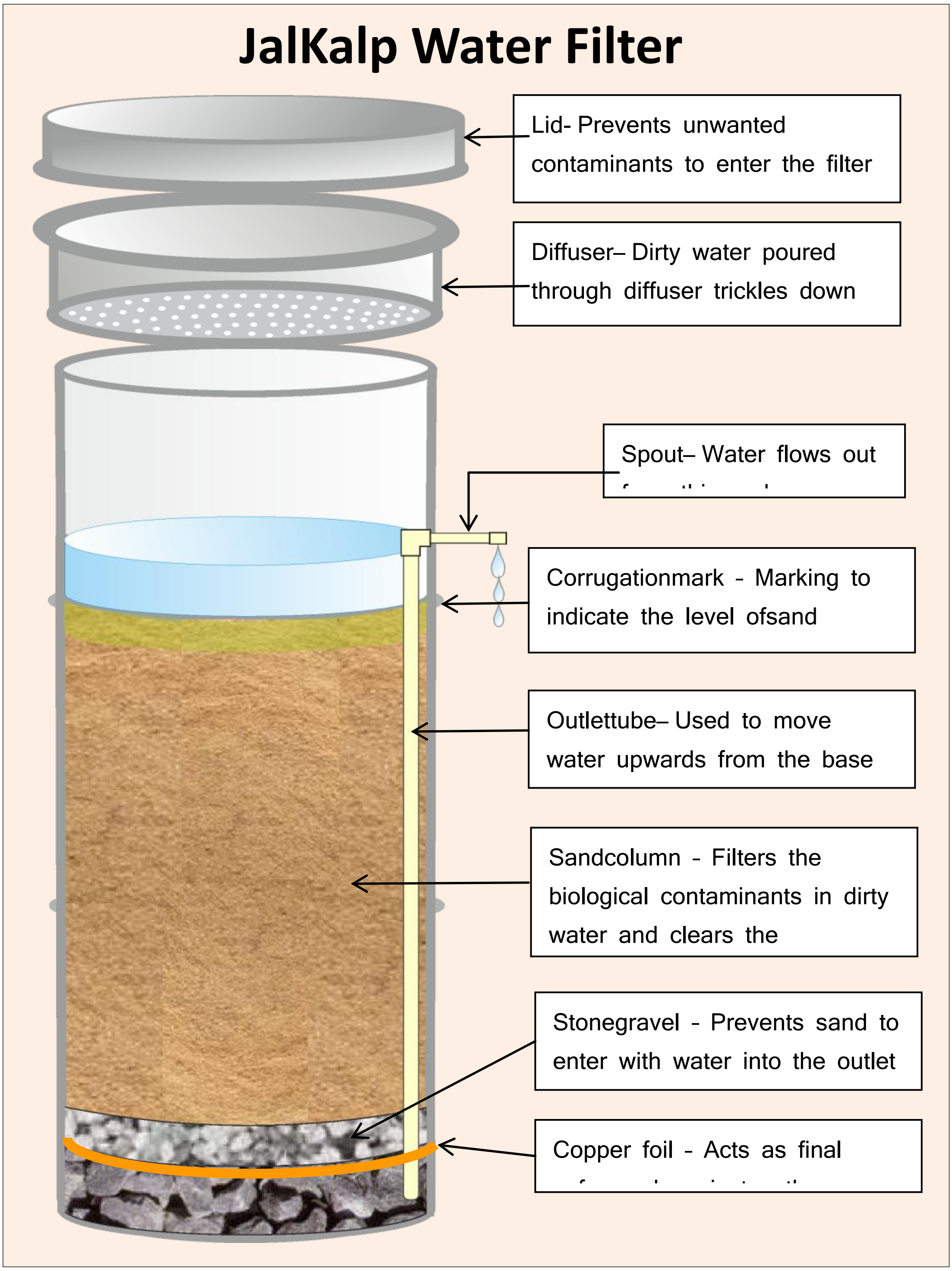
Source: DR A K Ghosh, professor-in-charge, Department of environment and water management, A N College, Patna

Most of the rural population does not currently use any method for purifying water, or have any other adequatesolution. Widespread occurrence of these contaminants and the lack of awareness have created a public health crisisthatcalls for immediate attention. A solution that canfacilitate the elimination of these frequently occurring contaminants simultaneously is an urgent requirement.

Though there have been efforts toput water treatment plants to addressarsenic and iron in some villages, most were not sustainedfor various reasons such as:

- Technological limitations of the plants
- Plants not serviced and maintained timely and/or properly
- Communities not trained, mobilized, and motivated to undertake the maintenance
- Lack of community participation
- Lack of education and awareness among communities
- Poor community dynamics and socioeconomic conditions

Household water treatment technologies have the potential to avoid 122.2 million DALYs (disability adjusted life years) throughout the world (Pacific Institute 2010). JalKalp water filter is one such technology that removes biological contaminants, iron, arsenic, and turbidity from water,making it suitable for drinking. JalKalp works under the force of gravity without using any form of energy or on-line pressure.



WORKING & MAINTENANCE OF JALKALP WATER FILTER

(A) JalKalp water filters remove pathogens with four processes—

- Predation: A bio-layer that forms on top of the sand contains bacteria that consume harmful bacteria and parasites as new water enters the filter.
- Adsorption:Viruses adhere to the surface of specially prepared sand, which has a slight electrostatic charge, and die there.
- Anaerobic Die-off: As there is no oxygen, light, or air further down in the filter, any remaining microbes die off.
- Mechanical Filtration: Fine-grain sand prevents the passage of bacteria, parasites, and worms, which are relatively large.

(B) The technology of arsenic removal in the filter is based on generating Fe^{2+} by contacting water with zero valent iron (ZVI) and efficiently using the iron (Fe^{2+} present in the groundwater and Fe^{2+} produced by corrosion of ZVI) for removal of arsenic. Fe^{2+} forms hydrous ferric oxide (HFO-adsorbent for arsenic) on oxidation of Fe^{2+} during subsequent filtration; HFO is an effective adsorbent for arsenic. The process is so designed that efficient oxidation of As(III) to As(V) is achieved; and As(V), thus formed, is adsorbed on HFO.

(C) The iron-contaminated water passes through the diffuser, drips down in the form of droplets, and the surface area of the water increases. With the increased surface area, the oxygen absorption of the water also increases and thereby iron in the water is oxidized. The compound formed by oxidation is insoluble in water, so it is trapped on the top surface of the sand column and the iron is removed from the water.

As there are no moving parts, JalKalp filter does not require any replacements. With time, the flow rate of filtered water may reduce due to an accumulation of silt (came with water) over the sand top layer. When the flow rate slows down, the maintenance to be conducted is simple: lift off the lid, pour water into the filter, take out the diffuser box, and do a “swirl and dump,” gently swirling the water above the top layer of sand. The deposition is suspended in the water over the sand, and that cloudy water can be removed. This may be repeated once or twice more if the flow rate is not recovered.

S M Sehgal Foundation PromotesSafe Drinking Water

Through a project supported by Water Technology Initiative of **Department of Science and Technology, Government of India,** SM Sehgal Foundation is promoting the adoption of the low-cost sustainable JalKalp water filter in selected villages of Bihar.Sensitizing communities about the presence of contaminants, their impact on health, andneed of safe drinking water is the key component of the project.The project goal is to benefit poor rural communities who are unaware of the importance of safe drinking water and those who cannot access the prevalent high-tech water treatment systems due to lack of affordability or erratic power and/or water supplies.

Innovations at three levels promote adoption of a low-cost, zero-maintenance JalKalp water filter to address arsenic, iron, biological water contaminations, and turbidity:

a) Approach innovation

As discussed above the community based hi-tech failed to reap the intended results. Household water treatment technologies hold an edge over community-level technology as they minimize the chances of secondary infections. S M Sehgal Foundation adopted a sustainable and affordable household safe water solution named “JalKalp” at household-level to address all three commonly encountered contaminations along with turbidity. The “JalKalp” overcomes all these. Over and above the household water treatment technologies hold an edge as they minimize the chances of secondary infections. At the same time being an individual household asset instead of community, households maintain it well. Over and above the operation and maintenance is very easy and simple.

b) Product innovation

JalKalpis a low-tech, low-cost, and easy-to-maintain water filter with a moreinnovative design thanconventional biosand filters. It works under gravity without any external energy/on-line pressure, and has noparts that require replacement. Features include:

- Integration of germicidal properties of copper increases coliform-removal efficiency to 100%.
- Integration of Zero Valent Iron Technology removes arsenic.
- Filtration rate of 0.6 litres per minute is increased over the 0.4 in conventional design.
- Stainless steel cell design weighsonly 4.5 Kg vs. the original concrete design weighing 70 Kg.
- Portability and quality control is better than conventional biosand filters.
- Operation and maintenance do not require any special skills.

c) Process innovation

The key to sustainability is ownership and active participation bybeneficiaries. Therefore, major emphasis is placed on sensitizing communities aboutissues of water quality and waterborne diseases. This process triggers the demand for a solution. When communities are sensitized and demand asolution, JalKalp is offered as a safe andaffordable solution.

To overcome the challenge of delivering the filters in remote villages at the earliest, we plan to nurture local social entrepreneurs who can ensure supply and service locally. These local entrepreneurs are being extensively trained on issues of water quality, water-borne diseases, JalKalp technology; and installation and maintenance of “JalKalp”. The presence of local entrepreneurs will ensure easy access and adoption of the “JalKalp” by the communities.

The Foundation is also building capacities of other stakeholders and NGOs on this technology to increase outreach of the product.

Mr. Prince of district Vaishali, a fan of JalKalp

Mr. Prince Singh, age 22 lives with his family (2 males and 4 females) in village Kharikaof blockBidupur,Vaishali district (Bihar). Most hand pumps in his village are marked RED by related departments, forbidding people to use the water from these pumps. Many cases of skin cancer are found in the village, causing many deaths. Mr. Prince's grandmother died of skin cancer after a long medical treatment.

People in the village know how dangerous the water is, so most of them buy water to drink, but for cooking they use the hand pump water, which allows consumption of arsenic through food. So buying water for drinking was not a complete solution. Mr. Prince used to buy water for drinking—before he met Mr. Dharmendra Singh from Sehgal Foundation. Mr. Singh told him about the JalKalp water filter and proposed that he try it. Mr. Prince immediately agreed. Mr. Singh first tested the water from the hand pump using a field kit, which showedarsenic contamination over 250 PPB (parts per billion), iron over 3 PPM (parts per million), and the presence of coliform indicating biological contamination. (Permissible limits are arsenic:10 PPB, iron: 0.3 PPM, and no presence of coliform.)

AJalkalp water filter was installed at Mr. Prince's house and the contamination in water was monitored after a week. The JalKalp water filter had brought down arsenic, iron, and coliform to not-detectable levels.

Mr. Prince was amazed with the results. He said he saw changes in his water. Earlier when we used to prepare tea using hand pump water, its color was almost black; but now theJalkalp filter's water shows the true color of tea. The family no longer purchases water to drink. They use JalKalp for drinking water and for cooking. They not only notice better water color, but also better taste of their food. He said he is also very happy that, since the day he started using the Jalkalp, his digestion problems (acidity, constipation, etc.) have disappeared.

Acknowledgement

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Brief profile of Author

Lalit Mohan Sharma is Director, Adaptive Rural Technologies at SM Sehgal Foundation. He is a graduate civil

engineer and holds a Masters of Technology (Management & Systems) from Indian Institute of Technology, Delhi. He served as an invited member of the panel of experts for the War for Water; and Member of Program Advisory Committee (PAC), Water Technology initiatives under the Technology Mission of the Department of Science & Technology (DST), Government of India; Member of "International Network on Household Water Treatment and Safe Storage"

Working on water issues he has been trying developing innovations in the field of water harvesting structures design, alternative sources of water, low cost water treatment systems. Number of water resource augmenting structure, based on his innovative design, are serving in different settings of Haryana, Rajasthan, and Madhya Pradesh. He innovated a sustainable and low cost water filter named as JalKalp, JalKalp is capable of addressing arsenic, iron, biological contamination and turbidity in water. He has shared this technology with organizations working in different parts of the world to adopt for the communities in need.

Another innovation 'Creating Fresh Water source within Saline Aquifer' was selected by United Nations for showcasing at Solutions Summit – 2015 and I was invited to make a presentation on this innovation at UN Headquarters, New York in Solutions Summit – 2015. Both of these innovations have also been showcased on the web site of Ministry of Drinking Water and Sanitation, Government of India, at innovation page.

Under his leadership SM Sehgal Foundation's water management program has been recognized widely. The organization has won UNESCO-Water Digest 'Best Water NGO' award for 'Revival of Rural Water Resources in 2009 and 2010 and 'Best Water NGO' for 'Rain Water Harvesting' 2008 and 'Ground Water Augmentation Award-2010' from Ministry of Water Resources, Government of India in 2011, FICCI Water Award 2013: first prize under NGO category for excellence in water management and conservation, 'Water Conservation Award-2013' from The Institution of Engineers (India) and FICCI Water Award – 2017 etc. He has written and presented several papers on issues related to integrated and sustainable development of water resources.

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