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WATER, SANITATION AND HYGIENE: CHALLENGES OF THE MILLENNIUM

Integration of irrigation and rural drinking water

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THE FACT THAT irrigation water is used for domestic purposes like washing and bathing is common knowledge. That irrigation water can be the only source for all domestic uses, including drinking is less known. The Southern Punjab in Pakistan is an area where irrigation water is the only source for all non-agricultural uses. This paper presents the results of a baseline study on drinking water quality in an irrigation setting in the southern Punjab and preliminary results of the second phase in which methods were tested to improve drinking water quality.

Background

Most of Pakistan depends on irrigation systems for its agricultural production particularly where groundwater is brackish and rainfall is limited. In these areas irrigation water is the only source of water for all domestic uses, including drinking (van der Hoek et.al, 1999). Within the irrigation systems water is formally allocated for domestic uses. Village water tanks and water supply schemes receive water from the irrigation channels on the same rotation, two water turns in every three weeks, as agricultural lands. The rotation schedule and anual period of canal closure makes the delivery of water insecure, as many sources run dry during these periods. To overcome this insecure water supply, bores and wells have been installed next to irrigation canals and close to village water tanks to capture freshwater seepage losses (figure 1).

Study area

This study was undertaken in the command area of the Hakra-6/R irrigation distributary in the Bahawal Nagar district, Southern Punjab, Pakistan. The distributary is the sixth largest in Pakistan, comprising an area of 50,000 ha of which 42,000 ha are irrigated. There are 94 villages in Hakra-6/R with an estimated population of 160,000.

The irrigated area is land reclaimed from the Cholistan Desert and has an arid climate with temperatures ranging from 2 °°C in January to 48 °°C in May. Rain is mainly

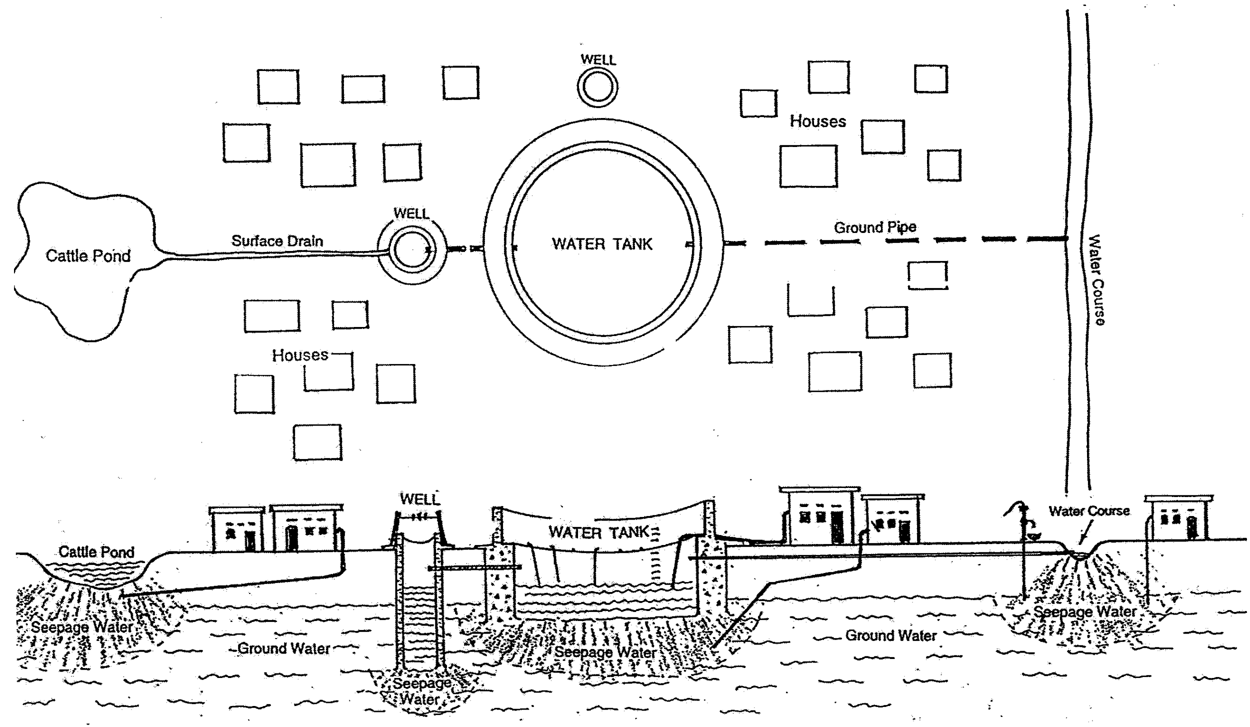

Figure 1. Top view and cross section of a typical village

limited to the monsoon season and is on average 160 mm a year. Groundwater in the entire area is brackish with Total Dissolved Solids values exceeding 2000 mg/l, making the poluation completely dependant on irrigation water for all uses.

Irrigation and drinking water quality

Ten villages along the 6/R distributary were randomly selected, from which 200 households were asked to participate in a year long study. During the period of April 1998 - May 1999, all drinking water sources of the sample households, together with their storage vessels (traditional clay pitchers) were sampled and tested for the presence of E.coli and total coliform. The sources sampled included: the village water tank, deep wells, irrigation water courses, water supply schemes and different seepage sources. Samples were collected in 200 ml sterile bags and within six hours from sampling, filtered using a 0.45mmm Millipore filter under a vacum pressure of 10 cm Hg. Samples were grown in an agar culture.

The outcome of the baseline study is presented in Table 1 (sources) and Table 2 (traditional clay pitchers).

The results show that the surface water sources had consistently high levels of contamination. Seepage water sources showed much lower E. *coli* counts and were of better quality. However water from all sources, once stored in a clay pitcher, in the households was of poor quality. This indicates considerable in-house contamination of drinking water. The target of phase two was, therefore, to improve water quality at household level. Two interventions were executed and more are planned in the ongoing project.

Narrow neck Pitchers versus traditional Pitchers

Since their is no continuous running water supply scheme, villagers must store water within the household. The extreme heat and the absence of elektricity and refrigerators in most households have led to the choice of large clay

Table 1. *E. coli* counts (geometric means per 100 ml) of different drinking water sources

	No. of samples	*E. coli* count	95% CI
Seepage water	2528	1.98	1.80-2.16
Water supply scheme	111	33.08	21.20-51.31
Well connected to water tank	274	96.24	75.97-121.84
Direct from village water tank	333	128.56	107.36-153.92
Direct from canal	30	865.34	499.40-1498.89
Total	3273	5.70	5.21-6.23

Table 2. *E. coli* counts (geometric means per 100 ml) of traditional clay pitchers

	No. of samples	*E. coli* count	95% CI
Traditional clay pitcher	1843	29.66	26.73-32.89

Table 3. *E. coli* counts per 100 ml for traditional and narrow necked pitchers

	No. of samples	*E. coli* count	95% CI
Traditional pitcher	195	98.98	98.56-99.40
Improved pitcher	193	42.82	41.96-43.68

Table 4. *E. coli* counts (geometric means per 100 ml) colonies per 100 ml in the last household of a water supply scheme and in traditional house pitchers

	No. of samples	*E. coli* count	95% CI
Last household			
Chlorinated WSS	30	0.80	0.00-1.69
Non-chlorinated WSS	28	62.94	59.57-66.31
Household pitcher			
Chlorinated WSS	34	18.63	17.85-19.41
Non-chlorinated WSS	33	109.94	108.71-111.17

pitchers for in house storage of drinking water. Clay pitchers keep the water cool and are therefore preferred above allother kinds of plastic containers that could reduce bacterial load through UV light treatment. This prompted us ~~made us~~to modify the existing traditional clay pitcher.

Traditional pitchers with wide necks (figure 2) are vulnerable to contamination as water is easily taken out by (contaminated) hands for drinking. To prevent this contamination the neck of the pitcher was narrowed to 5.5 cm. so that the hands could not contaminate the water any more.

New traditional pitchers were handed out to 33 households while 34 received the narrow necked pitcher. From September to October 1999 source and pitcher samples were taken, twice a week and analysed for the presence of E. *coli*.

The results are presented in Table 3 show that the water quality in the narrowed pitchers was better when compared with the traditional pitchers.

The reason for the geometric mean for both pitcher types being higher than during the baseline study could be explained by the fact that only water from surface sources was used and the study did not include the colder winter months.

The narrow necked pitchers were well received, although some initial problems were faced with cleaning and filling of the pitchers. The fact that the pitchers were locally fabricated and that cost would be close to the traditional pitcher, making the use of a narrow necked pitcher an accepted and sustainable way to improve water quality in the household.

Chlorination of Irrigation water

A few villages have access to an irrigation water based water supply scheme. The baseline study showed that water quality was in general poor and that contamination of drinking water occurred mainly within the household. The aim of the second intervention was to reduce in-house

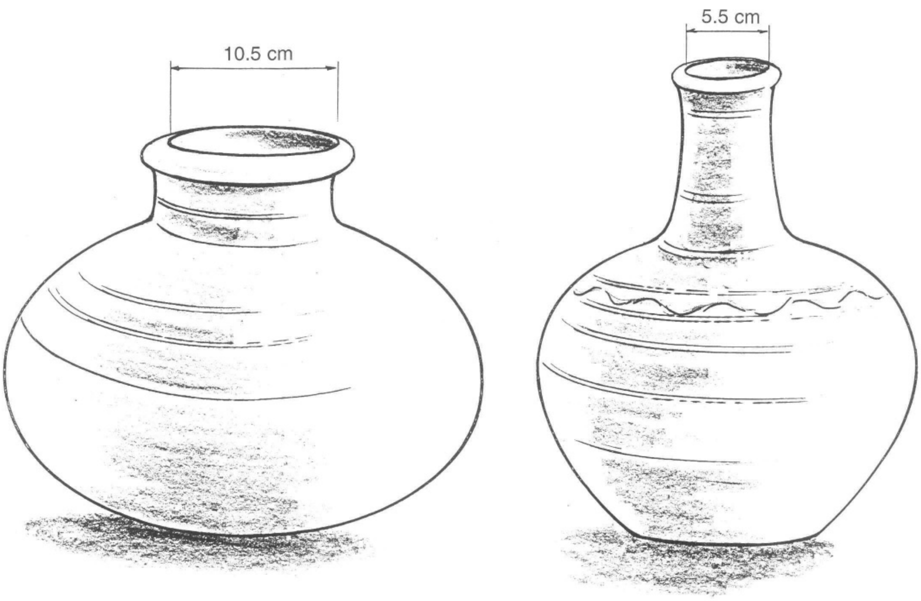

Figure 2. Traditional wide necked and narrow necked pitchet

contamintion of pitchers by chlorinating a village water supply scheme. Free chlorine levels in the system were maintained at 0.1 to 0.5 mg/l to ensure that even water in the last household of the water supply scheme was kept E.*coli* free.

Two villages located by the same irrigation canal and receiving water from similar schemes were selected for this study. One scheme was chlorinated while the other served as a reference. Samples from a household tap were taken, three times a week in the last household of the scheme and from five traditional clay pitchers in each village. The results presented in Table 4 are the preliminary findings of this study that began in May 2000 and will continue until September 2000.

The preliminary results indicate that, overall, chlorination helps to improve the quality of water stored within the households. The data also indicates that E. *coli* counts of water in the last household are kept low because of chlorination.

Conclusion

Our results demonstrate that irrigation water, used directly from canals or indirectly as seepage, does not fulfill the strict requirements set by the World Health Organization of zero E.*coli* per 100 ml of drinking water (WHO, 1995). In water scarce areas such as the Punjab, people have and will continue to rely on irrgation water for their drinking needs. As no other source exist in these areas, treatment of irrigation water at village or household level is imperative. Simple interventions as described above, can improve irrigation water quality considerably and make it fit for human consumption.

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