The application of drip chlorination, tablet chlorinators, solar disinfection technology and ceramic filter in Honduras

Technologies applied for drinking water treatment in rural communities

This report documents some of the most appropriate technologies and methodologies for drinking water disinfection used by rural communities and families in Honduras, and presents the challenges they face in securing sustainable access to safe water.

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Executive Summary

Honduras has gathered interesting and promising experiences on disinfection of rural public water supplies. Government agencies have been responsible for introducing and developing community level technologies in an effort to significantly reduce infant deaths originated by water borne diseases. Different from its neighboring countries, decentralization of water supply services has began, giving local governments greater responsibilities for provision of drinking water. Municipalities and rural communities must take charge of delivering services that meet stringent national quality standards.

There are several treatment systems applied in rural and urban poor communities in Honduras. In this brief report, the four most common methods for disinfecting rural drinking water being applied in Honduras are presented:

- **Drip Chlorination**
- **Tablet Chlorinators**
- **Solar Disinfection-SODIS**
- **Colloidal Silver-Impregnated Ceramic Filtering-el Filtrón**

This report addresses as well some of the advantages that make these technologies accessible to rural communities and the scenarios where they are most applicable. Two of the methods, the drip and tablet chlorinators, are used at the public level, disinfecting water at a distribution tank for delivery through a piped network to each home. The other two methods, SODIS and el Filtrón, are for point-of-use disinfection and are implemented by each household. Obviously, the differing service levels will require a different mix of government, municipal, community, private sector and individual responsibilities.

Introduction

Guaranteeing that more than 3 million rural Hondurans have access to safe water for their daily drinking and cooking needs has been a challenge difficult to meet. At least a million of them depend upon open wells, streams and other unprotected sources. Service and infrastructure deficiencies can mean that even existing wells, hand pumps and water supply systems deliver contaminated water –and even clean water can easily be contaminated after it is handled, brought to the kitchen and stored. Of course, it is the youngest children that are always most vulnerable; water-related illness is the second leading cause of death in children under 5 years old in Honduras.

Disinfection of drinking water has not been an easy habit to create in rural families. It requires consciousness of the dangers and of correct practices and resources involved in boiling, filtering or chlorinating. A reliable access to facilitators, spare parts, distributors, and financial mechanisms -a supply chain- is also necessary to make it feasible to make chlorination a daily custom. The recent Honduras Water and Sanitation Sector Analysis indicates that even though rural infrastructure coverage is nearly 70%, it estimates that only 14% of rural Hondurans drinks treated water, this is still a major improvement over previous decades. The National Water and Sewer Service (SANAA) estimated that since the year 2000, the number of rural water supply systems that regularly chlorinate has tripled, from 567 that year to 1,500 in 2003. Still, this represents only a third of the country's 4500 rural piped systems.

While the specific economic and social impacts of disinfecting drinking water have not been separated from the benefits of access to safe water and sanitation in rural Honduras, it is known that gastro-intestinal diseases are still the second leading cause of infant mortality in the country, killing 17 of every 1,000 children under five each year. Some estimates state that the costs of health care and days lost to water-related illnesses are 6 times the costs of building reliable infrastructure for the same population.

New water sector laws and health codes stipulate that every Honduran has the right of access to reliable services that deliver clean water. Drinking water must present no coliforms and in public systems should also have residual chlorine to protect against secondary contamination. Unfortunately, there are few technicians in the municipalities, and fewer still in rural villages, with the required training to ensure this level of quality of water. Options for various technologies and training must be made available so that rural users can actually receive the clean water to which they are now entitled.

1. Disinfection Methods at the Public Level

1.1. Drip Chlorination

Origin and Operation

Honduran standards stipulate that all public systems must disinfect their water with chlorine, and establish minimum levels of residual chlorine at the tank and at the first and last houses (1.0mg/l, 0.6mg/l and 0.5mg/l, respectively). To achieve these standards, the drip chlorinator has been the standard disinfection device for rural water supply systems in Honduras since the 1980´s, implemented in public systems with household networks by SANAA, the Ministry of Health, NGOs and private contractors implementing state-funding programs. Originally designed and funded with support from the United States Agency for International Development (USAID), it has changed very little from that period. A simple $1m^3$ cement box is built on top of the distribution tank and is filled by hand with a hypochlorite solution from granulated chlorine, normally every five to seven days. The solution steadily drips through a small-perforated tube into the main water storage, where it has sufficient contact time to kill most microorganisms and bacteria. Theoretically, the drip chlorinator requires little supervision beyond regular refilling.

Target Population

It is estimated that a drip chlorinator exists in every one of the 4,500 rural water supply systems in Honduras, each serving population from 700 to 2,500 people on average. The drip chlorinator is suited for rural articulated drinking water systems, allowing centralized disinfection that can be more reliable and effective and less expensive than point-of-use disinfection, where every family must implement their own solution. The moderate cost makes drip chlorination accessible to most communities. Because it is simple to “scale-up” and increase the number of beneficiaries by using a stronger solution, the chlorinator is suitable for larger towns and municipalities. In Honduras, drip chlorinators serve municipalities for even more than 10,000 people.

The drip chlorinator is not applicable for wells with handpumps. This chlorinator also presents a problem in communities that use groundwater. Wells are rarely pumped continuously but are usually subject to rationing because of the high cost of electricity and/or because of low production of the source. Because a drip chlorinator cannot be shut off it continues discharging even when there is no more inflow into the tank, which can cause overdosing and change taste to the point users might reject it. This also incurs greater costs for a community. There is another option discussed in this report for wells and systems that are forced to ration inflow.

Sustainability

There are three basic conditions for sustainable disinfection of rural drinking water:

- Demand for disinfected drinking water, arising from a community informed of the dangers of impure water
- Training to create local capacity for effective use of the selected technology
- A supply chain sufficiently robust to ensure availability of chemicals and needed parts.

Regarding demand, it is important to remember that the drip chlorinator is “standard issue” in every water piped system, whether or not the community that receives one has reached a level of consciousness about the dangers of drinking contaminated water that will ensure they want and will use chlorine. This is evident when government statistics show that only one third (1,500) of rural communities with a water supply system report regularly chlorinating their system. However, this is still three times the number of communities that reported disinfecting their water in year 2000, and all but 90 of these communities are using drip chlorinators. This indeed represents a growing demand for high-quality water and willingness of rural water users to pay for chlorine.

Training is also a core condition for sustaining rural disinfection, and is especially important for the drip chlorinators. After education induces demand in a community for disinfection, the device requires orientation in several areas. Local operators must learn how to safely store and handle the caustic chemical, how to mix it, dose it and measure residual chlorine. Once they understand dosing and measuring residual chlorine then it becomes necessary to vary dosage according to seasonal variations in water quality. Finally, where the physical and chemical characteristics of source water create problems operators must make frequent, even daily,

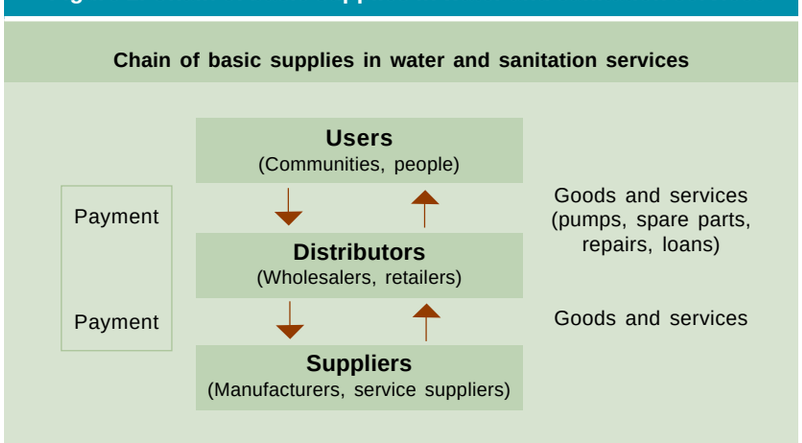
visits up to their tank to unclog the small discharge tube from the chlorinator into the tank.

One of the most important considerations in any of the disinfection methods, independent of any rural water and sanitation technology, is the availability of inputs and spare parts as close and constantly as possible to the communities that use them. The supply chain involved with sustaining a drip chlorinator is somewhat difficult because it involves a chemical that is imported and not sold in every municipality. For many communities local supply is so unreliable that disinfection is an irregular process and users cannot rely on having safe water year-round (see Figure 1). One solution that has made chlorine both less expensive and more available to rural villages has been the existence of chlorine banks in municipalities. Until more chlorine banks are created or the private sector becomes more motivated to widen the distribution of chlorine in more municipalities, disinfecting rural water supply systems will be a challenge.
Notwithstanding this obstacle, the granular chlorine required for drip chlorinators is still far more available than the tablet variety required by the other chlorinator examined below.

Costs

Although programs have provided free of costs the building of treatment facilities, the approved design costs US$ 150 to build, without including labor or transporting materials. The cost of chlorine will vary widely depending upon the quality and quantity of water to be disinfected. Annual costs of granular chlorine can be as little as US$ 100 for the smaller villages with clean groundwater to as much as US$ 13,500 (in the case of the municipality of Talanga, in Francisco Morazán department, with 1,700 connections, or approximately US$ 8 per year per connection). Frequently, communities do not include costs for transportation and time spent obtaining chlorine in the total costs of their disinfection. Chlorine banks can create a rural supply chain.

Figure 1. Chain of basic supplies in water and sanitation services



Advantages of Drip Chlorinators

- Drip chlorinators are by far the most common of the rural disinfection methods used by rural communities in Honduras.
- Standardized designs and materials are used nationwide.
- There is a level of familiarity and support available for their proper use.
- Under the right conditions, it can be easy and economical to operate. These conditions include proper construction and use, training in measuring residual chlorine and water quality that does not create precipitation of chlorine and clog the drip tube.
- The granular chlorine (65%) required is the common swimming pool type and is more available than other chlorine options.
- Purchasing chlorine in bulk for an entire community is much more economical than each family buying small amounts for point-of-use disinfection.
- The drip chlorinator is appropriate for the majority of rural water supply systems in Honduras.

Disadvantages

- Chlorine can be difficult to acquire in many rural areas; the supply chain is not assured.
- This design is not appropriate for many systems that rely on well water and pumping, or have sources that are insufficient for 24-hour supply, as the device will overdose drinking water, leading to higher costs and possible rejection of drinking water by users.
- The small-diameter plastic drip tube into the main tank can encrust to clogging. The incrustation-obturation phenomenon occurs because the hypochlorite used is rich in calcium, which saturates the disinfection solution, leading to precipitation of calcium ions in the discharge tube.

- As a result, the time required to maintain a drip chlorinator in some cases is often daily rather than the weekly visits ideally needed only to refill one.
- Where operators do not have simple testers, reactants or training, even when there is demand and diligent application, the effectiveness of the process is in doubt.
- Chlorination affects the taste of water and this is a reason for the consumers' rejection.
- Deciding on the right amount to be applied can be difficult, because it depends on substances present in water and on season.
- This technology is not applicable to wells and hand pumps.

1.2. The Tablet Chlorinator

Origin and Operation
Since 2001, this system is sold in Honduras only by the Honduran Association of Water Boards (AJHASA). Two versions, one imported version from the United States and a second, less expensive national model made by AHJASA from plastic valves, pipe and used chlorine drums are available. In a few areas of the country, AHJASA has aggressively marketed tablet chlorinators and has succeeded in convincing two companies to import the tablets. AHJASA is seeking to import tablets for sale at lower cost. Local users of this chlorinator have proven to be the best "salespeople", often convincing neighboring villages or fellow AHJASA members about the need to treat water and the advantages of the tablet chlorinator.

This device uses chlorine tablets in water by-passed from the main pipe and released into the storage tank. Injection takes place only when water flows from the source. The tablet chlorinator works on articulated systems with household service from surface sources and drilled wells. Each tablet can disinfect 26,000 gallons of water. No electricity is required.

Target Population
The tablet chlorinator is suited for all rural articulated systems providing household service. It is especially appropriate for those systems supplied by pumps or rationed sources where water does not flow 24 hours. The tablet chlorinator works automatically and will not overdose these systems. To date, the largest system served by a tablet chlorinator has 118 connections. Successful experiments have also been done on three hand-dug wells with handpumps.

Sustainability
Quite probably the time spent by AHJASA personnel and members promoting and following-up the devices they have installed results in greater awareness of water quality than in communities that do not receive follow-up after their water systems are implemented. Where there is little exposure to Ministry of Health, SANAA, AHJASA or other NGOs to provide follow-up on treating drinking water it is more difficult to create demand and willingness to pay for chlorine. The effect is sustainable where the same follow-up is coordinated with a local vendor or a municipal chlorine bank with a revolving fund to maintain the local supply. Possibly because the 93 devices that sold in the country to date were actually purchased by member communities of the Honduran Association of Water Boards (AHJASA), and because these receive more frequent follow-up, the tablet chlorinators seem to function more reliably than the 4500 drip chlorinators. AJHASA reports that "at least 80%" of the devices sold in 7 of the country's 18 provinces provide reliable service. In the case of both types of chlorinators, effectiveness appears to be directly related to follow-up provided after a water system is installed, demand of the users, and a reliable supply chain of chlorine.

Some operators reported that where they previously had to provide daily visits to their drip chlorinators (to unstop the drip tube or refill it, for example), using tablet chlorinators they must visit the tank only once a week, and dosing is a much simpler process (a simple twist of a by-pass valve).

Costs
Local water boards always pay for the device. AHJASA frequently provides no-interest credits and delivers tablet chlorinators at no cost. They vary in cost from US$ 166 to US$ 278. Annual operating costs run from US$ 111 – US$ 1,335, the most being spent in the village of Aguacatal, Cedros, Francisco Morazán, with 118 connections (approximately US$ 11.31 per year per household). In more than one village visited during this study, communities reported being satisfied with spending up to 50% or more annually above what their previous drip chlorinator cost them to operate. In the village of La Fuente, La Tigra, Francisco Morazán for example, the water board spends US$ 167 annually on chlorine tablets, half again more than they used to pay for granulated chlorine. Their satisfaction with the tablet chlorinators comes from its effectiveness and ease of operation.

Advantages of the Tablet Chlorinator:

- Uses a pre-measured chlorine tablet that is safer to handle and simplifies dosing.
- Simplicity - it does not require any major training of or intervention by operators.
- It functions automatically with all types of articulated systems, even with pumps and rationed sources where the drip chlorinator is not always appropriate.
- AHJASA provides expert technical support combined with an emphasis on creating and supporting local water boards.
- Purchase by communities means real demand and reduces government subsidies.
- They have created very strong levels of satisfaction among users.

Disadvantages:

- Chlorine tablets are more expensive than granular chlorine.
- Tablets have a weak supply chain and are not available nationwide (only in the two major cities and in the 15 rural chlorine banks operated by AHJASA).
- The device itself is more expensive than the traditional drip chlorinator.
- Where operators do not have simple testers or reactants, the effectiveness of the process is in doubt.

The effectiveness of chlorine desinfection in removing various elements affecting water quality

Treatment effectiveness over various elements affecting water quality									
Bacteria, Amebas	Guinea-worm	Cercaria	Iron Manganese	Fluoride	Arsenic	Salts	Odour Taste	Organic Material	Turbidity
☺☺☺	-	☺☺☺	-	-	-	-	☺	☺☺☺	-

Ref.: Adapted from Brian Skinner and Rod Shaw “household water treatment”,1998.

- : no or poor effectiveness	☺ : little	☺☺ : medium	☺☺☺ : high

2. Other Disinfection Methods used at the Household Level

2.1 Solar Disinfection - SODIS

Origin and Function

There exists at least one additional alternative that does not depend on (imported) chemicals and has practically no cost for disinfecting water. Solar Disinfection –or SODIS– is exceedingly simple, relying on sunlight and plastic bottles. Transparent containers are filled with water and exposed to full sunlight for at least 6 hours. As the micro-organisms are exposed to sunlight and heat, the inactivation process begins. Ultra-violet radiation will destroy most pathogens. Water from almost any source can be used, as long as it is not overly turbid (up to 30 turbidity units). Exposed to direct sunlight from 6 hours to 2 days, depending upon cloud cover, SODIS can kill over 99.9% of microorganisms. SODIS is an excellent option for families without access to safe water, infrastructure or chlorine.

The idea of Solar Disinfection was investigated for the first time by Aftim Acra in 1984. In 1991 a research team at the Swiss Federal Institute of Environmental Science and Technology (EAWAG/SANDEC) started investigating the potential of this method for the inactivation of bacteria and viruses. –For Latin America, a SODIS program called SODIS Foundation– began in Bolivia in 2000. In Central America between 2001 and 2003, the SODIS Foundation financed several small pilot projects of NGOs and government agencies within a strategy to get programs to adopt SODIS as one of their regular tools for disinfecting drinking water. This strategy has proven to be successful in many cases, especially with the government's Center for Study and Control of Contaminants (CESCCO) and the international NGO Acción Contra el Hambre (ACH). Training offered to the programs, and through them to rural villages and families, has resulted in replication beyond original goals. Users themselves have been able to communicate the simplicity, low cost and effectiveness of SODIS to neighbors and nearby villages.

Basic instructions that must be observed when applying SODIS include:

- Use only transparent, plastic bottles of up to 3 liters, those commonly used by soda bottling companies (the "PET" type, with the triangular recycling symbol on the bottom).
- SODIS works reliably under sunny conditions. On cloudy days, exposure time has to be increased to 2 days. On completely rainy days SODIS might not work reliably.
- If water is turbid (>30 turbidity units), it requires filtration to bring it below that level and allow ultraviolet rays to penetrate.
- Bottles must be placed in surfaces exposed to direct sunlight for at least 6 hours.
- Most of the households require from 5 to 20 bottles for the whole family.
- To prevent recontamination, bottles should be washed after each use (including tops and threads).

Target Population

Most developing countries' rural "potable" water systems are actually "piped" systems. Having sufficient amounts of water in the home affects people's health and standard of living, and running water from a faucet is definitely beneficial. But the actual safeness of the water is often questionable. Sanitary home storage of drinking water is also an issue. SODIS is a point-of-use method, and could finally make safe water within the reach of the following target groups:

- Rural and urban families without access to safe water.
- Families dependent upon unsafe supplies such as open wells, unprotected sources or rainwater collection.
- Rural and urban families using unsafe distribution systems.
- Families with basic service but without resources for or access to chemical disinfection.

SODIS replicates itself

All 7 pilot projects in Honduras were successful and several deserve greater dissemination. The government's Center for Study and Control of Contaminants (CESCCO) implemented promotion and workshops in eleven communities and four villages in rural Ojojona municipality,

involving 203 families (1494 people), including 10 schools with 356 students. By years end, 60% of the participants still used the SODIS method, significantly improving the quality of drinking water.

During 2002, Acción contra el Hambre (ACH) carried out an excellent pilot program in the community of El Cedral, in El Triunfo municipality of Choluteca, south of Honduras. Components that could be replicated in other similar projects included:

- SODIS committees were formed by sectors in the village.
- Three meetings in each sector were held, led by the ACH promoters and each of the sector SODIS committees.
- The members of each sector's SODIS committee made at least two visits to each home to explain SODIS and its benefits.
- Three general village meetings were held, including one with the community water board that maintains wells and handpumps in the village.
- The local elementary school students and their two teachers received special attention as focal points for introducing SODIS.
- ACH got an important donation of plastic soda bottles from a national bottler.

In El Cedral, it is impressive to see how the use of SODIS has been replicated without any additional external intervention. By the end of the project in November 2003, 83% of families (60 households) reported having adopted SODIS. ACH had not revisited the community since the SODIS project ended in 2003. However three months later the following could be observed:

- 100% of the elementary school students uses the SODIS method.
- Leaders reported that 100% of the village's families disinfect their drinking water using SODIS (up from 83% reported at the end of the ACH project).
- Both school teachers reported having, on their own initiative, promoted and organized the adoption of SODIS in five neighboring hamlets, reaching possibly 1,500 more people without additional external support of any kind.

Costs

There is absolutely no recurrent cost for disinfecting water using the Solar Disinfection method – SODIS is free to use. Initial costs to the community in a few cases need to include purchase of plastic bottles, which might cost between US$ 0.06 – US$ 0.15. Often, families can save soda bottles they buy, if they can afford them. Sometimes the NGO or program that promotes SODIS obtains bottles at no charge through campaigns or from manufacturers or bottling companies. Costs for promoting SODIS will of course vary with the program that offers such support, but the SODIS Foundation offered only up to US$ 7,000 for each pilot project they supported, using a rule of US$10 per household as the cost for a good promotion, training and follow-up campaign.

Advantages of SODIS

- SODIS does not depend on chemicals or reactants.
- As it does not require fuel or electricity, SODIS protects the environment.
- SODIS is very low-cost and effective (killing up to 99.9% or more of microorganisms).
- SODIS is a simple, family-based method that does not require a treatment device.
- SODIS can immediately improve water quality; no infrastructure has to be built.
- If unopened, SODIS bottles are safe containers for short-term storage (several days), thus significantly reducing the risk of re-contamination.
- In Switzerland, EAWAG/SANDEC demonstrated the effectiveness of SODIS against virus and bacteria. Other studies in Canada, Brazil, Mexico, Colombia, Lebanon, Bolivia and Honduras confirmed these results. Studies in Colombia and Mexico showed SODIS to be effective in neutralizing the cholera virus.
- In various studies SODIS has proven to significantly reduce diarrhea rates and the risk to contract cholera.

Disadvantages of SODIS

- Disinfection is applied only to low-turbidity water (up to 30 NTU).
- To prevent risks of recontamination once bottles are opened they should not be stored for more than 12 days.
- Effectiveness of SODIS depends upon cloudiness.
- The amount of water produced is limited to the number of bottles available.

The effectiveness of SODIS in removing various elements affecting water quality

Treatment effectiveness over various elements affecting water quality									
Bacteria	Virus	Amebas	Iron Manganese	Fluoride	Arsenic	Salts	Odour Taste	Organic Material	Turbidity
☺☺☺	☺☺-☺☺☺	unknown	-	-	-	-	-	-	-

Ref.: Adapted from Brian Skinner and Rod Shaw “household water treatment”,1998.

- : no or poor effectiveness	☺ : little	☺☺ : medium	☺☺☺ : high

2.2 Ceramic Filter (Filtrón)

Origin and Function
Since 1998, Potters for Peace has been developing a low-tech, low-cost, colloidal silver-enhanced ceramic water filter – Filtrón, through the establishment of micro-enterprises of artisans making the filters, and then by partnering with NGOs that distribute the filters to families. The ultimate objective of the Filtrón project is to provide employment for local potters while meeting an urgent demand for safe water in rural and marginalized communities, particularly in the developing countries. After several years of trials and marketing, the Filtrón has found a niche in Nicaragua. In 2003 manufacture began in Honduras.

The ceramic filter itself is 30 cm in diameter, 24 cm high, and holds 7.1 liters of water. The filter sits inside a receptacle. Receptacles are either 20 cm-liter plastic buckets or ceramic pots. A plastic spigot is inserted at the bottom of the receptacle. Lastly, a plastic or ceramic lid is placed on top the filter and receptacle. Colloidal silver-impregnated ceramic filters produce a filter capable of removing most of the bacteria and bacterial indicators of disease-causing organisms.

The Filtrón is designed to address water quality in the home at the point of use, regardless of delivery method. It is well suited for source water that is too turbid for consumption or other disinfection methods. Given the variables involved, an overall gravitational flow rate of 1¾ - 2 liters per hour is possible and should be insisted upon. Clinical analyses of the Filtrón filter have been successfully conducted at laboratories in Honduras and several countries around the world. These results range in time from 1986 to 1999, and include samples from filter projects in Central America, the Caribbean, West Africa and South East Asia. The results from all these examinations indicate an overall success rate of eliminating parasites and harmful bacteria of approximately 99.88%, with no results coming back less than 98% effective.

Target Population
As with the SODIS method, the Filtrón is suited for families that have reason to mistrust the quality of their drinking water. In this study, the Filtrón is especially useful for rural or urban families that rely on water that is untreated by their system operator, or water from handpumps and wells. Water that is too turbid for treatment, either by chlorine or Solar Disinfection, should be filtered first. Filtering drinking water by families that rely on water from unprotected sources is especially important, but as these are usually the poorest families a Filtrón may be too expensive. These families often will rely on locally made stone filters or filtering through a rag or cloth, both of which are far inferior to the Filtrón.

Sustainability
As the Filtrón is purchased by individual families, this presupposes the demand and sense of ownership necessary for sustainability. The three most important issues therefore appear to be maintenance, cost and the supply chain. The cost of the filter element, which should be replaced annually, is US$ 5. These can be “reburned” and recoated with silver for one dollar less. Unfortunately, the Filtrón and its replacements are sold only at the factory outlet in one town 20 miles outside the capital, making for a very weak supply chain that could seriously limit the ability of poor rural families to sustain the filter.

Maintenance of the Filtrón is essential to sustain its capacity to filter water. In 2001, USAID contracted a private US firm to evaluate 24 filters in use in 7 communities. Findings included:

- There is a lack of education about safe water practices, as well as correct usage and maintenance (including cleanliness) of the filter.
- The most common problem seen was breakage of the filter or receptacle.
- The flow rate in 14 of 24 of the homes did not meet basic requirements for drinking water. This is due to the accumulation of turbidity on the filter itself. Scrubbing the filter with a brush can regenerate the flow rate.
- Only 25% of the Filtrons removed H_2S-producing bacteria and 53% removed E. coli when present, due to contamination of the receptacle and inadequate storage of water.
- Latrine ownership, household cleanliness, and plastic receptacles were correlated with microbial removal.
- No household with a filter that removed microbial contaminants had a child with diarrhea in the last month.

Based on these results, the following recommendations should be considered:

- Partner NGOs should be educated on factors that affect the success and failure of the filter. They should also be encouraged to regularly follow-up with and provide education to families. A manual should be developed for NGOs with filter programs.
- A cleaning kit used to scrub the filter to regenerate the flow rate and to disinfect the receptacle to prevent recontamination should be developed and sold with each filter. In addition, families need to be educated about correct filter cleaning methods.

- Plastic receptacles are easier to clean and should be encouraged over ceramic, despite the perceived benefits of ceramic creating more employment and keeping water cooler.
- Include a dose of residual chlorine in the finished water container.
- Pursue government accreditation of the program.

Costs

The two models of the Filtrón are both 5 gallon capacity. The ceramic container model costs US$ 19.44, while the plastic bucket model costs US$ 12.78. The same replaceable ceramic filter insert is used in both and lasts for about a year at a cost of US$ 5 for replacement.

Advantages of the Filtrón :

- The Filtrón is a very effective method for removing water-borne bacteria and organisms.
- The Filtrón is well-liked by families because of ease-of-use and taste of the water.
- Filtered water is stored in the device, limiting handling that can recontaminate it.
- No chemicals, fuels or electricity are needed.
- They can eliminate turbidity, making other disinfection methods feasible.

Disadvantages of the Filtrón:

- Short life of filter elements (1 year or more, depending on use).
- Difficult supply chain, with replacements available in only one place.
- An optimally-working filter supplies barely enough drinking water for one family.
- Many families do not adequately maintain their filter (cleaning, handling the recipient), which can drastically reduce production and cleanliness of filtered water.
- NGO follow-up with families increased continued usage rates.

The effectiveness of Filtron at varying concentrations of colloidal silver

	Bacterial removal rates				
Silver applied	No silver	2 ml 94 ppm	1 ml 3.2%	2 ml 3.2%	5 ml 3.2%
Total coliform	98	76	100	100	100
Fecal coliform	97	63	100	100	100
Fecal streptococcus	82	76	100	100	100

Ref. Investigation of the Potters for Peace Colloidal silver-impregnated Ceramic Filter, 2002.

3. Maintaining Public Disinfection in a Decentralized Environment

Chlorine banks began appearing in Honduras in the mid 1990´s, when the Honduran Association of Water Boards – AHJASA, programs of the Ministry of Health with the European Union and the World Bank, and others concluded that sustaining disinfection of rural drinking water would be impossible without a constant local supply of chlorine. Since they were of relatively short duration, support from many outside programs has ceased. Where NGOs or membership-driven users associations like AHJASA have been able to maintain a supply chain, chlorine banks are still functioning. AHJASA maintains 15 chlorine banks, with plans to triple that number this year. Chlorine purchases by water boards creates a revolving fund, often with the first supply of chlorine provided at no cost. Sustainability depends upon local purchases, motivation of intermediaries (government, NGOs or associations), and ease of transporting chlorine.

If a revolving fund from chlorine sales in the municipality and community can be maintained, supply chain problems can be minimized. Chlorine banks can be managed locally by users associations (AHJASA), health centers or other government programs, and NGOs. Chlorine banks are especially vital for chlorine tablets (for the AHJASA devices), only two national resellers import them. Outside of the country's two major cities the chlorine tablets are sold only by AHJASA and their 15 chlorine banks.

In 1999, the Regional Water and Sanitation Network of Central America, RRAS-CA, and the University of Southampton, England, calculated that if a chlorine bank were independent and paid all of its direct costs, (including transport), a municipal chlorine bank would need to serve some 1,700 households, and sell at least two 45 kg drums of commercial granular chlorine (65%) monthly. A departmental chlorine bank would have to sell at least five drums a month and serve 4,200 connections or more. Today, all chlorine banks receive some level of outside support, at least in organization, purchasing, and/or transport. Some do not quantify or charge for their administration, accounting, and supervision of the chlorine bank or promotion and training in the communities.

The recently passed Water and Sanitation law that reorganizes the water and sanitation sector has two aspects that impact on water quality for rural users. First, it guarantees all Hondurans, whatever their economic status, access to "potable water". The very poor could be entitled to unspecified subsidies to secure that access. Secondly, the operation of potable water services must be decentralized from government agencies to municipalities and local communities. These can establish community water boards, municipal water divisions, mixed enterprises or even concessions with the private sector as service providers. Obviously, this will change the state's role from one of provider charging services to that of a normative, training and control organ assuring that others provide quality water.

To maintain chlorination in rural systems, both Environmental Health Technicians (TSAs) of the Ministry of Health and the Operation and Maintenance Technicians (TOMs) of SANAA are charged with training and on-site monitoring of rural system operators in the use of their drip chlorinator and measuring residual chlorine. Some rural mayors are now trying to supplement the few TOMs available nationwide with their own Municipal Operation and Maintenance Technicians responsible for water systems in their jurisdiction, but the law is clear that at least for the next several years the central government's TOMs will be responsible for providing technical backstopping nationwide. Unfortunately, there are too few of them employed to cover all the 4,500 rural water supply systems in the country, and those that do exist are not yet responsible for supporting the estimated 250,000 users that depend on wells with handpumps. Health and sanitary education is a role that will apparently remain with the Ministry of Health's promoters and TSAs, although a stronger relationship with schools, community water boards and municipalities will be necessary to broaden impact and change unsafe behaviors.

4. Conclusions

4.1 Promoting Health, Sanitation and Disinfection of Drinking Water

Boiling is also a recommended water disinfection method. The World Health Organization, WHO, recommends that the water be brought to a vigorous boil. This will kill, or inactivate, most organisms that cause diarrhoea. High turbidity does not affect disinfection by boiling, but if the water has to be filtered, this must be done before boiling. If it is not to be stored in the same pot in which it was boiled, the water should be poured into a clean storage container immediately after boiling, so that the heat of the boiled water will kill most of the bacteria in the storage container. Fuel cost, environmental concerns and the time involved in boiling and cooling the water, limit the usefulness of this method.

Probably the most important impacts were found in communities that adopted either SODIS or chlorinators through external promotion and support after community water systems were built. This would confirm impressions that these villages and families:

- Received promotion, training and follow-up from capable organizations.
- Have access to private vendors or chlorine banks operated by AHJASA or other organizations.
- Directly purchased their tablet chlorinators or Filtrón with their own funds most likely they have an increased awareness about safe water and an ownership stake in its delivery.

Maintaining promoters in the field imply costs that must be born by someone. About 60% of AHJASA's annual budget (including the chlorine banks) comes from membership fees and chlorine sales. The actual direct contribution to training costs alone is much lower, probably around 20-30%. Most AHJASA staff and promoters are paid from external donations from the National Rural Water Association of the USA, the Irish Aid Agency TROCAIRE, and others.

Government employees such as SANAA's TOMs are presently restricted from collecting user funds, and all of their operating costs (approximately US$ 200,000 annually) have come from the USAID. More recently, new sector laws and the trend toward decentralization could create incentives for the central government to absorb this budget and seek partnerships with municipalities and user associations for maintaining or expanding the program. In the case of both associations and government extension programs, user funds as well as support from outside will be needed to expand the culture for hygiene and safe drinking water in rural Honduras, until a point when demand from the users themselves could eventually be more important than external promotion.

4.2 Lessons Learned

- None of the presented methods can improve the physical or chemical quality of drinking water. Thorough laboratory tests should be carried out on any water source before infrastructure is built to determine if any other treatment will be needed, or even if a source should be abandoned for human consumption.

- Disinfection of drinking water has not been an easy habit to create in rural families. Three essential conditions are:
  - Consciousness of the dangers of contaminated drinking water.
  - Awareness of resources and correct practices for disinfecting water.
  - Local abilities in storing, handling and applying caustic chemicals.
  - A reliable supply chain to make treatment and disinfection a daily habit.

- If there is no induction by government or NGO programs, a culture of family and community hygiene and demand for safe water will be difficult to achieve.

- Thanks to two decades of experience, today one third of rural water supply systems in Honduras regularly disinfect their drinking water. The most frequently used method is chlorination, with a standardized drip chlorinator.

- Experiences that emphasize user demand include the Honduran Association of Water Boards with their sale of tablet chlorinators and the Filtrón.

- Solar Disinfection is highly effective and easy to use, while it implies almost no cost. Programs working in water, sanitation, hygiene or health could promote SODIS in their community interventions as a low cost disinfection technology, when there are no others effective alternatives available.

- The Ceramic Filter – Filtrón can be highly effective in reducing turbidity, bacteria and microorganisms for those families that can afford one and its replacements.

- Rural chlorine banks, with revolving funds to bring chlorine as near as possible to rural users, can be vital if an independent supply chain in the private sector is not strong.

- Finally, all programs, governments, municipalities, NGOs, the private sector should dedicate resources to induce a culture of hygiene and inform communities and families about the importance of drinking only safe water. All of the methodologies presented here should be part of the treatment “menu” used by all promoters, institutions and municipalities active in the sector. In the end it is only an informed and demanding populace that will put them into practice.

References:

Linking Technology Choice with Operations and Maintenance, F. Brikké and M. Bredero, WHO, IRC, April 2001.

Household Water Treatment 1, Skinner B, Shaw R, 1998.

Solar Water Disinfection - a guide for the application of SODIS – Meierhofer, R., et al., EAWAG/SANDEC 2002.
URL: http://www.sodis.ch/Text2002/T-Papers.htm

Drip Chlorinators
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El Filtrón
Investigation of the Potters for Peace Colloidal Silver-Impregnated Ceramic Filter, D.S. Lantagne, 2002.
Carretera al Sur, Sabana Grande
Phone: 504-996-3987
Web Site: www.elfiltron.org and www.potpaz.org

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