

**38th WEDC International Conference, Loughborough University, UK, 2015**

**WATER, SANITATION AND HYGIENE SERVICES BEYOND 2015:  
IMPROVING ACCESS AND SUSTAINABILITY**

## **Water treatment with Chulli improved cooking stove in rural areas of Pakistan**

*P. Shaban Daud, R. Kanaganathan & N. Villemint (Pakistan)*

**BRIEFING PAPER 2215**

---

*This case study introduces tests completed in the province of Sindh in Southern Pakistan on improved cooking stoves known as Chulli. The Chulli enables water treatment through the use of a water heating mechanism. It is a cost-effective method for the households as the system is fitted into a stove meaning that water can be treated at the same time as cooking activities are completed. This reduces the need for firewood, itself an inhibitory cost of these poverty stricken communities that results in many not treating their water in any way. The trial was done for 5.000 households in Sindh with a focus on water quality, flow, fuel consumption, time and a cost analysis. The study in general found positive initial results in the water quality, as well as savings for fuel and time. However, the study needs to be followed up by a further study of ongoing usage.*

---

### **Context**

Sindh Province, in Southern Pakistan, was heavily affected by monsoon floods in 2010, 2011 and 2012. The humanitarian situation caused by the loss of houses, livelihoods and assets aggravated further a silent crisis of undernutrition and poor public health. The National Nutrition Survey Pakistan 2011 found that half of the children in Sindh are stunted, making them more vulnerable to diseases, impaired growth, and ultimately cognitive development and economical chances during their adult life.

In 2012, Action Against Hunger completed a nutrition causal analysis in Sindh that identified a number of causes of this undernutrition emergency. Among the main factors was drinking water contaminated with fecal bacteria and unsafe for consumption. In the districts of Badin and Tando Mohammad Khan of Sindh Province, among the worst districts affected by the floods, the main water sources are open irrigation canals or shallow aquifers. Further to this, unhygienic handling and storage of the water result in further contamination. Communities lack the awareness and resources to then treat or filter their water, meaning that they are using contaminated water resulting in water borne diseases and undernutrition.

As part of a humanitarian project supported by European Union's Humanitarian Aid department (ECHO), Action Against Hunger implemented various activities to improve the water access and the water quality for the population of the districts. Additional water points were built and protected, hygiene practices and knowledge were improved for water management, and a water treatment option was introduced. This was specifically targeted at households with high rates of undernutrition as well as contaminated water.

Following trials of various options and consultation with local communities, the choice was made to scale up the introduction of the Chulli, a water treatment solution combined with an improved cooking stove. Action Against Hunger provided 5.000 families with a Chulli in rural areas of Tando Muhammad Khan district, Sindh Province. Chulli stoves have been piloted in other parts of South Asia and can be found in Bangladesh and Myanmar. It was not known in Tando Muhammad Khan district prior to its introduction by Action Against Hunger.

This case study introduces the concept of the Chulli and proposes initial results and discussions on its effectiveness against biological contamination and on its adoption by local communities.

### **The Chulli improved cooking stove**

The Chulli combines a mud stove, traditionally used in rural South Asia, with a piping system heating the water while cooking, therefore treating the water. A copper pipe is built in the mud wall of the round shape stove, as a spiral coil. It is connected to a water storage reservoir. The water is then collected through an outlet pipe with a tap. The water is simply moved by gravity between the storage and the collection tap. The circulation of water in the heated copper pipe reaches temperatures sufficient to disinfect water from pathogens, and in particular faecal bacteria, considered the most common threat in the area.

A valve is integrated in the inlet of the system to ensure that the flow of the water will correspond to reach an adequate temperature of minimum 70°C. The valve is manually set during the test phase to regulate the gravity flow from the reservoir, so that the outlet water will reach the minimum temperature thanks to a sufficient contact time in the copper pipe. Action Against Hunger ensured monitoring of the water quality and the flow of the system to make sure the systems were functional. The valve is then not supposed to be adjusted by the family for normal operation.

The photograph 1 below represents a Chulli ready for usage, with its water reservoir and collection tap. The photograph 2 illustrates the steps of construction, with the coil of copper pipe and the mud plastering. The step under the stove is important to keep the outlet of the water pipe at a level where water can be collected in a bucket or jerry can. Users can then keep their usual cooking habits by squatting on the step, as traditional stoves are usually on the ground. The decorations seen in the pictures are uniquely the result of the enthusiasm and pride of the person building the Chulli, they are not part of the design.



**Photograph 1. Chulli improved cooking stove**

Source: Riaz Hussain, ACF-Pakistan (2014)



**Photograph 2. Steps of the construction of the Chulli by local families**

Source: Shumaila Noreen @ ACF-Pakistan (2014)

## The study

The objective of Action Against Hunger was to propose an effective water treatment solution easily installed and managed, requiring limited maintenance, and using local materials so that it could be replicated by local communities. More specifically, the study was intended to pilot the Chulli, to test its effectiveness, and to inform any design modifications. In line with this, a series of tests were conducted to analyze the performance for fuel consumption, water quality for both physical and bacteriological contamination, the cost effectiveness, cooking time, the appropriateness compared to local cooking techniques, and the durability of the system. The consumption of fuel used for cooking, usually wood, was also expected to be reduced by the stove.

The initial design imported from other countries used a spiral with 6 rings of copper pipes. It was found during lab tests that the 8 rings of copper pipe in the spiral gave better results than the initial 6, as the water reached high temperatures faster, meaning a higher flow and better fuel efficiency. The 8-ring stove required 25 feet of copper pipe 3/8", and various plumbing fittings.

5,000 households were then selected in consultation with local community leaders. They received the materials for a Chulli, based on various criteria of vulnerability, health score, interest and motivation, and. Technicians were trained to supervise and troubleshoot the construction of the stove, which was then done by the beneficiaries themselves, using the provided materials and traditional mud building techniques. As a note, women are traditionally responsible for the construction of the stove in the house, as it requires regular maintenance or replacement. The women at work can be seen in photograph 2. All the households were trained on how to operate, use and maintain the stove, and on the importance of treating water.

The following results were found through on-site testing, household consultations and a post-distribution survey (Action Against Hunger-Pakistan WASH Post Distribution Monitoring Report-2014).

## Results

### Improved water quality

Every Chulli performed well and eliminated the fecal contamination found in the water before treatment. Tests were performed regularly on a sample of 10 stoves. The water in the inlet reservoir was found

contaminated in 9 out of 10, with the presence of *E-coli* between 3 and 28 counts per 100mL. *E-coli* were systematically absent of the water sample at the outlet of the Chulli when using the same quality testing, at the same time of sampling. All water quality tests were performed directly by Action Against Hunger using a portable DelAgua laboratory.

The treatment of fecal contamination was explained by the temperature reached by the water during its flowing time in the copper pipe. Temperatures at the outlet were measured between 70 and 76°C at the time of sampling. All Chulli had been manually set for a minimum temperature of 70°C, a temperature sufficient to neutralize fecal contamination.

#### ***Decreased cooking time***

Household focus group discussions estimated that women spent an average of 210 minutes (3.5 hours) cooking or using their traditional stove every day. The Chulli stove was expected to shorten that time, a hypothesis confirmed when tests done by Action Against Hunger found that the Chulli required 17% less time to cook than the traditional firewood stove. The tests consisted in cooking 1kg of potatoes, using the traditional cooking utensils and a local recipe. The stoves were lit prior to the cooking trial, and the time was measured from the start of the cooking until the potatoes were fully cooked. The Chulli required an average of 25 minutes to cook 1kg of potato, compared to 30 minutes on average with the traditional stove. This estimation of 17% time saving seems consistent with declarations from users who usually notice a shorter cooking time than they were used to with the traditional stove. Applying the 17% reduction to the average 210 minutes spent by women, the Chulli therefore allows a theoretical reduction of nearly 36 minutes of daily cooking time, slightly under 3 hours (174 minutes).

#### ***Improved fuel consumption***

Similarly, the firewood necessary for the cooking was tested by cooking 1kg of potatoes. The traditional stoves needed an average of 1.115kg of wood to cook the potatoes in 30 minutes, while the Chulli only burnt an average of 0.74kg for the same purpose, thanks to the time reduction (25 minutes) and to better insulation and heat transmission from the fire to the cooking pot. The Chulli saved 34% of wood during these tests. Estimating that 30 minutes of cooking on a traditional stove uses on average 1.115kg of wood, it is estimated that households burn 7.8kg of firewood daily, for 210 minutes of use. This seems consistent with the declarations of respondents during focus group discussions. Applying a 34% reduction to this quantity of wood correspond to 5.15kg of wood, i.e. saving 2.65kg, when using the Chulli for the daily cooking requirements of 174 minutes. The improvement of performances can be explained by the better design of the Chulli concentrating the flame and the heat in the heart of the stove, when traditional stoves have a larger heat loss through their thinner sides.

#### ***Sufficient daily quantity of treated water***

The water flow to reach the 70°C temperature was on average 7 liters per hour. Based on an average of 174 minutes of usage per day, about 20.3 liters of water can be treated for drinking purposes while cooking. This is enough to meet the daily requirements for drinking water for a household of 7 members, the average number found by Action Against Hunger when surveying the population of the district of Tando Muhammad Khan.

#### ***Cost- benefit considerations***

Considering the gain in time and firewood from the Chulli, an analysis of the cost was undertaken. Households often pay for their firewood, and the Chulli provides a monthly saving of 795 PKR (approx. 7.80USD) on the cost of firewood, based on a daily saving of 2.65kg of wood at 10 PKR per kg on the local market.

The cost for the installation of a Chulli is estimated at 3 900PKR (38.5USD), when the traditional stove would cost no more than one day of casual labour (4.5USD). The savings on the firewood (795 PKR) will meet the cost of the investment in a Chulli (3 900PKR) in about 5 months of daily usage.

18 hours of cooking time can also be saved and used for other activities every month (36 minutes every day for 30.4 days). But this data has not been included in the calculation as it is difficult to link this time with direct income generation for the household, women are rarely directly involved in income generation activities in the cultural norms of the region.

### ***Appropriateness to the local context***

The reception of the Chulli improved cooking stove seemed very positive among the rural population during household consultations and post-distribution monitoring. The savings on the firewood consumption is a strong motivator for families to invest in the Chulli. However, the current price of the Chulli, mainly due to the copper pipe, makes it unaffordable to most households as a onetime investment. Funding mechanism such as micro-loans or revolving funds should be investigated to strengthen a local market.

The calculations used above show very significant cost savings. However, they may overestimate real-life conditions of the most vulnerable households, who usually can't afford to cook 3 meals per day, therefore cooking for less time than the estimated daily duration. The quantity of safe water available for these families will be reduced and may fall under acceptable standards.

On top of the savings, the Chulli improved stove was seen as an easy and cost effective method to treat bacteriological contamination from drinking water in Sindh province. Action Against Hunger was raising the awareness of populations on contamination risks in parallel to the Chulli project. The regulation of the temperature remains one of the key factors to effectively operate the system, as 70°C is required. Users should be able to adjust it using the flow valve, but this setup should not be changed once the temperature and flow have been regulated. More follow-up is required to check this regulation over time, as there may be changes in flow, deposits in the pipes, etc.

Another issue that will need to be verified is the time it may take during the hot season to cool the water to drinkable temperatures. Indeed, Sindh province witnesses episodes of high temperatures reaching 50°C, and this will influence the time it will take for the water to be cooled down from above 70°C. It may also influence the choice of household members to use cooler non-treated water. Recontamination of the water if left unprotected for cooling overnight is also a risk factor.

### **Conclusions**

The introduction of the Chulli improved stove is showing encouraging results in Southern Pakistan, as an affordable option that saves firewood and daily cooking time, and as a water treatment against faecal contamination. It was met with a strong interest and enthusiasm of local communities, and it is expected to provide enough treated water for the drinking usage of an entire family. Further monitoring is necessary to confirm these initial results and confirm that the advantages of the Chulli are sustained for the users.

---

### **Acknowledgements**

Action Against Hunger would like to extend thanks to its partners the EU's Humanitarian Aid Department (ECHO) and Charity: Water for supporting and providing funds to pilot the introduction of the Chulli, respectively in TMK/Badin districts and Dadu district, Pakistan.

The team in Pakistan would also like to thank Mr Zach Watson for his efforts to trigger and develop innovative solutions to Pakistan's water quality issues.

---

### **References**

Aga Khan University-Pakistan, Pakistan Medical Research Council, and Nutrition Wing of the Cabinet Division, Government of Pakistan, supported by UNICEF Pakistan (2011) *National Nutrition Survey Pakistan 2011*

Action Against Hunger - Pakistan (2014) *WASH Post Distribution Monitoring Report-2014: WASH Project in District Tando Muhammad Khan, Sindh Pakistan.*

---

### **Contact details**

P. Shaban Daud  
Address: House No 4, Street 38,  
F8/1, Islamabad, Pakistan  
Tel: +92 301 855 06 83  
Email: [washco.pk@acf-international.org](mailto:washco.pk@acf-international.org)  
[www.actionagainsthunger.org](http://www.actionagainsthunger.org)

Nicolas Villeminot  
Address: 247 West 37th Street, 10th Floor  
New York, NY 10018 - USA  
Tel: +1 212-967-7800  
Email: [nvilleminot@actionagainsthunger.org](mailto:nvilleminot@actionagainsthunger.org)  
[www.actionagainsthunger.org](http://www.actionagainsthunger.org)