The Relationship Between Point of Use Water Purification and Household Welfare:

A Case Study in Sras with Bio-Sand filters

Jenna Knobloch

Intern, The Trailblazer Foundation

March 14, 2011

Although clean water and sanitation constitute the foundation of good health, they continue to be out of reach for many people. Globally, 3.1% of annual deaths and 3.7% of the annual health burden can be attributed to unsafe water and poor sanitation. In Cambodia these figures are much larger, poor water access and sanitation cause 13.1% of deaths and 14.8% of the health burden (Ashbolt 2004). It is not surprising then that this problem remains a serious detriment to economic development. One estimate found that poor sanitation and water access costs the Cambodian economy $448 million dollars every year, $187 million dollars of which are health costs ("Water and Sanitation Program" 2008). During the last two decades there has been much work done to transform the economy and improve the lives of the people. There are a myriad of ways people and institutions are working to reduce poverty, and in this context it is important to consider the impact of water sanitation, specifically point of use water filtration, on a household's well being.

In this study, a village receiving highly subsidized bio-sand water filters is surveyed for various assets that correlate with wealth to investigate whether or not those with filtered water are better off than those without. On average those who purchased a water filter possessed greater than or equal to amounts of almost every asset examined, with significantly larger quantities for several of the categories. Among the assets, this trend was most significant with housing and transport. Improved housing is an especially strong signal of economic well being, and improved transportation further improves rural livelihood. As the water filters are priced within reach of all village households, this could indicate that access to clean water has a positive impact on a households' economic well being. More long term studies are needed to tease out a cause and effect relationship more conclusively.

A strategy that has been promising in recent years to be cost effective and efficient is point of use water purification. Multiple studies have found that diarrhea incidence as well as diarrheal death was substantially reduced even for users with water sources heavily contaminated with pathogens and had no access to latrines (Quick et al 1999; Tiwari et al. 2009). It is an important technology because

even those with “improved” water sources, such as piped water, are still exposed to water borne disease. Of all the point of use technologies, bio-sand filters have been found to be the most sustainable based on quantity needed, quality, ease of use, cost, and deployability (Sobsey et al.). Field studies in different areas have found that bio-sand filters continue to be used by households for years after initial purchase (Sobsey et al 2008, Quick et al. 1999).

Hutton, Haller, and Bartram's 2007 cost benefit analysis of investment in water and sanitation found that all investment in improving water supply and sanitation in developing areas is beneficial, no matter what region of the world. The return on every dollar invested ranges from $5 to $46, depending on the intervention. This held true even under the most pessimistic assumptions.

The costs included the upfront investment, as well as the ongoing upkeep costs of improved wells, latrines, and water filtration. The benefits were avoided time spent recovering from sickness, traveling large distances for water, medical expenses, and death in the family. Of these avoided expenses, 80% of the economic gain was from time saved. On a global scale they estimate that universal point of use water purification would increase the number of work days gained from other water and sanitation improvements from 550 million to 1.5 billion . The total benefit to cost ratio for point of use water purification was estimated to be between 5 and 41 (provided that those with water purifying capabilities have some source of water to purify). By comparison, the cost benefit ratio for access to piped water is between 2 and 12. While this study suggests water sanitation have a significant impact on economic development, their figures are underestimations. The study was limited to productivity gains in time gained from reduction in infectious diarrheal disease and only included benefits that were readily quantifiable. There are many other benefits from improvements in water that are harder to quantify, or just weren't included.

For instance childhood diarrhea, especially early in life, can have impact much longer then just the time lost recovering from a single incident. Children with diarrheal burdens early in life were more

likely to be less physically fit and have poorer cognitive function at ages 6-9 then their burden free peers, even if diarrhea is no longer a problem (Guerrant et al. 1999). Many other health problems are exacerbated by diarrhea. There is much evidence indicating a close tie between malnutrition and diarrhea, as diarrhea handicaps the intestines' ability to absorb nutrients, and decreased nutritional intake handicaps the body's ability to cope with diarrhea (Guerrant et al. 1992). This is supported by one study which found point of use water purification improved users nutritional intake in addition to decreasing incidents of diarrhea (Mahfouz et al. 1995). The implications of this mean benefits of improved nutrition can be also connected with improvements in water access and sanitation. Boosts in nutritional intake lead in a significant increase in number of years spent in school, as well as earlier enrollment rates, and higher IQ's (Alderman, Hoddinott and Kinsey 2003).

Looking at the direct costs of lost labor neglects the additional burden these costs pose because often families don't have the money in hand. A study of debt in rural Cambodia found that because of inadequate and expensive health care access, many went into debt to cover medical costs and often stayed in debt for years, even when the medical costs were modest (Van Damme et al 2004). In this light medical costs are not just a detriment to development, but are also a debilitating poverty trap. Seasonality also changes the costs of lost labor, as water borne disease becomes more prevalent during the rainy season, which is also the most labor intensive time of year for rice growers (Russell 2004). In areas where a family's finances are managed on a day by day basis, money for medical expenses that they could have available after a harvest often isn't saved in time for when they need it.

In the long run the water sanitation can have an even more profound effect on demographic change. Children bare most of the health burden of bad sanitation, as 90% of all deaths from diarrheal disease are children. Decreases in child mortality and the accompanying increase in life expectancy changes a household's decision making. In the face of uncertainty about a child's survival, a household has a “precautionary demand” for larger families. Over long term falling fertility rates more then offset

the increase in family size from the lower morality rate (Kalemli-Ozcan 2002). For individuals who live longer there is more incentive to invest in an education; the benefits of investing in human capital often take many years to compensate for the educational costs. It is no wonder then that when there is a substantial drop in mortality, there is also a significant increase in completed years of school (Kalemli-Ozcan, Ryder, Weil 2000). On an individual level, high educational attainment means more opportunities and better productivity. On a community level, it means better functioning governance, which also leads to economic growth and upward mobility.

The Trailblazer Foundation has been working distributing water filters to numerous villages in the larger Siem Reap area for many years. For a villager the price is (USD) $2.65 for water filter that cost around $50 to build[1]. The bio-sand water filters are comprised of a cement encasement filled with layered gravel and sand. It requires little maintenance and upkeep. Testing by the Center for Sustainable Water and Technology found that the filters reduce viral contamination by 90%, bacterial contamination by between 90-99% and protozoan parasite by greater then 99% ("Biosand Filter"). Testing by the Trailblazer Foundation found similar figures (Hurd 2009). In addition to this with every water filter delivery there is a workshop with the recipients explaining the proper use and maintenance of the bio-sand water filter, the life cycle of water borne disease and hygienic practices. Recipients also receive a large sealable storage container to help keep the filtered water from becoming recontaminated.

It is in this context Sras is examined. Sras is a remote village located in the Svay Chek

1 The money the villagers pay for the water filters go the the Village Fund, not back to the Trailblazer Foundation. For more information about the village fund visit http://www.thetrailblazerfoundation.org/develop_smallbusiness.html

commune of the Angkor Thom district of the Siem Reap province in Cambodia. Almost all of its inhabitants are farmers who grow mainly rice, but also some vegetables and livestock. It was formed 25 years ago by people displaced by the Khmer Rouge, and was one of the last refuges for the Khmer Rouge regime. When the Trailblazer Foundation started working there Sras was one of the poorest villages out of 25 in Angkor Thom district, although it has been growing rapidly over the last few years. Trailblazer has distributed 80 water filters since they began work there 6 years ago. The Trailblazer Foundation also has many other projects in Sras, including the building of 2 school buildings, 72 pull pumps, 19 cement pit wells, well drilling team, sewing projects, drip irrigation, fish farms, bicycles, school supplies, as well as medical checkups[2].

The Trailblazer Foundation's subsidization makes Sras village an excellent candidate for a case study. While there is much evidence that those with access to clean water are wealthier, its harder to determine if they have access to clean water because they are wealthier, or if they are wealthier because they have access to clean water. In reality, it is probably more of a virtuous circle. In Sras, water filtration is affordable for most households, making it easier to attribute wealth to clean water access and not the other way around. While it can be argued that charging anything at all excludes some households, charging a modest amount provides a way of "screening" out households who would get a water filter if it were free, but not use it (Ashraf et al. 2007). Therefore, subsidization rather than not charging increases the likelihood of a household using and maintaining bio-sand water filters. Latrines are also an important aspect of water sanitation, but are not as relevant for this case study because many households paid the full price of the latrine, which makes it difficult to argue cause and effect.

An extensive survey was done in Sras in 2009 and 2011. In both of these years 149 households were sampled. The survey gathered information about debt, sanitary condition, the ownership of various assets, water access, and basic demographic questions, as well as questions about other NGOs

2 For more information visit http://www.thetrailblazerfoundation.org/

working in the area. Two years were included to decrease the likelihood of data being influenced by an unusual year, and because two years of data are readily available. Further monitoring should continue in the future so that more nuanced long-term trends can be recognized. The survey was conducted by 10 inhabitants of Sras who underwent one day of training.

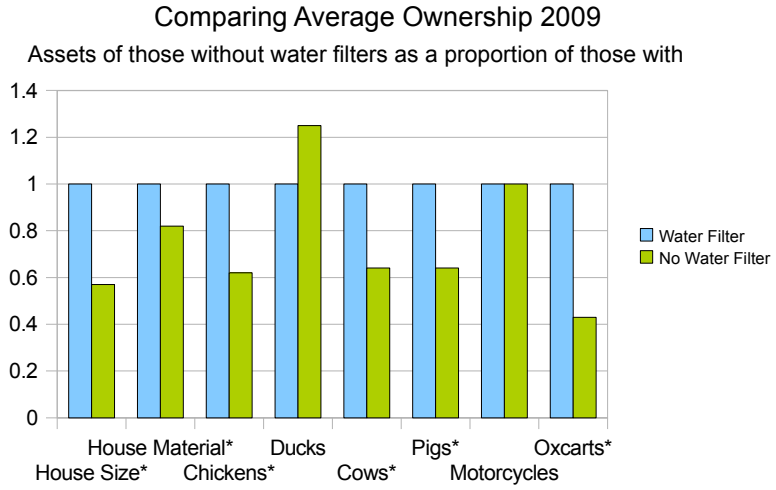
Wealth is very difficult to quantify in developing rural areas. Monetary income fluctuates over time, and often assets are attained though trading or other non-market means. Therefore, the ownership of several different assets will be used as a proxy for wealth. Housing material, house size, the number of chickens, ducks, cows, pigs, motorbikes, and oxcarts are considered. There were many other assets counted by the survey, but they are left out of the analysis because there was little to no variability between households. Bicycles are also left out because the Trailblazer Foundation also provides those at subsidized prices.

In both years, a one way ANOVA test was done to determine if the quality or quantity of an asset owned by a household is influenced by whether or not they also filter their water. For ANOVA the mean ownership of items with normal distributions will be compared between those who have water filters and those who don't to see if the difference is statistically significant. Statistical significance is a less then 5% probability that the difference between the populations in the sample can be attributed to pure chance. Quantity is measured for all except the roofing material, which was measured on an ordinal scale, with 1 being the lowest quality (palm leaf) and 3 being the highest quality (tile). The mean house size is measured in meters squared.

Average Ownership by Asset 2009

Report

Water Filtration		Housesize	RoofMaterial	Chickens	Ducks	Cows	Pigs	Motorbikes	OxCarts
No Water Filter	Mean	25.45	1.38	4.09	.91	1.41	.67	.10	.31
	N	81	81	79	81	81	81	81	81
	Std. Deviation	24.085	.561	3.955	2.087	1.394	1.012	.300	.465
Water Filter	Mean	44.63	1.77	6.75	.78	2.23	1.07	.13	.65
	N	60	60	60	60	60	60	60	60
	Std. Deviation	55.989	.745	9.465	1.814	1.750	.899	.343	.481
Total	Mean	33.61	1.55	5.24	.86	1.76	.84	.11	.45
	N	141	141	139	141	141	141	141	141
	Std. Deviation	41.751	.671	6.992	1.970	1.603	.983	.318	.500

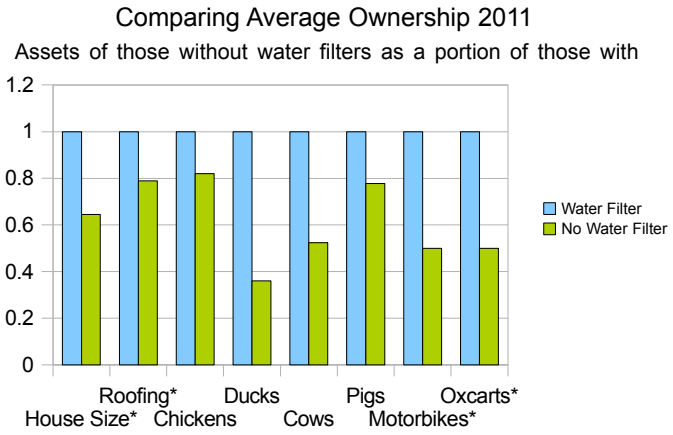


Difference is statistically significant at a level of 5%

Average Ownership by Asset 2011

Waterfiltration		Housesize	Roofmaterial	Chickens	Ducks	Cows	Pigs	Motorbikes	OxCarts
No Water Filter	Mean	24.73	1.50	9.12	.44	1.09	.65	.17	.45
	N	109	108	108	109	109	109	109	109
	Std. Deviation	22.604	.634	11.097	1.250	1.798	1.235	.373	.500
Water Filter	Mean	38.33	1.91	11.06	1.22	2.11	.89	.36	.81
	N	36	34	36	36	36	36	36	36
	Std. Deviation	41.356	.793	11.422	5.388	6.168	1.166	.487	.401
Total	Mean	28.11	1.60	9.60	.63	1.34	.71	.21	.54
	N	145	142	144	145	145	145	145	145
	Std. Deviation	28.873	.695	11.171	2.889	3.445	1.219	.411	.500

* Difference is statistically significant at a level of 5%



In both years and across all assets (with the exception of ducks in 2009) the mean quantity

owned is larger for those with water filters than those without. In 2011 for half of the asset categories this difference is statistically significant at a level of 5%. In 2009 all of the asset categories are statistically significant except pigs and ducks. This is strong evidence that water filtration positively impacts a household's likelihood to own a larger quantity of the various items, and therefore economic well being. There is a noticeable decrease in the number of categories that are statistically significant between 2009 and 2011. There are a number of possible reasons for this. The relative value of owning a motorbike could have increased relative to the value of owning livestock. 2008 could have been an unusually bad year for waterborne illness, widening the difference gap between those with water filters and those without. On the other hand, 2010 could have been a year with less then usual exposure to waterborne illness, allowing the gap to close. In 2011 the sample size of households filtering water is significantly smaller then those not filtering, which makes the data less robust. As a side note, this could be an sign that the Trailblazer Foundation should explore ways of improving communication with villagers about broken water filters, and other possible reasons for the proportion to drop over the course of 2 years.

Structurally improved houses in the form of larger square meter area and improved roofing materials are both out-consumed by those with water filters. In developing countries willingness to pay for improved housing is highly responsive to

income (Follain and Jimenez 1985), suggesting housing quality is a good indicator of wealth. Water filters also raise the value of the house. A functioning water filter, with all the media and the cement casing, weighs around 300 pounds. Moving it increases the chances of it malfunctioning. For these reasons families with water filters may not want to change locations because they would have to sacrifice filtered water. Expecting to stay in the same house for a longer period of time gives households more incentive to make long term investments in their living space. Improvements like installing a tin roof or adding a room further raises their property value.

Motorbikes in 2011 and Oxcarts in both years were more commonly owned by those who filter water, and represent an important investment in transportation. For the farmer, both provide a means of transporting agricultural goods to the markets, which has a large impact on the farmer's productivity, especially the motorbike. Transportation provides the ability to deliver goods faster making them more fresh, and expands which the area in which the farmer can market goods. This not only allows the farmer to pick the market with the highest going price, but can also change the farmer's choice of crops. In one case study of an area in rural Kenya, transportation costs were found to be the determining factor in whether a farmer chose to grow subsistence foods or a more profitable cash crop (Omamo 1998). Motorbikes also create an additional means of income in that they can be rented out to other people. Sras is in an area where schools are few and far between, especially high schools. The ownership of a motorbike could be a key determinate of whether a child continues school by substantially reducing the commute time. Some of the effects of improved transportation have a more ambiguous effect on the overall rural economy. At a local level, while the farmers are able to access more markets for their goods, it also allows more access to the local market for outside competition, as well as increases rural to urban migration (KilKenny 2002).

Assumed in this study is that clean water is a desire for all those in the village. Culture could be a potential compounding factor that could tip the data in the favor of water filtration. While the

technology is theoretically priced within reach of all the households, more wealthy households may

prioritize sanitation in the first place, and therefore be more inclined to purchase water filters. In many areas in Cambodia superstitions are still being used to explain illness, and some are even skeptical of the existence of microscopic pathogens. Even those who may want water filters may not fully understand the benefits that accrue over time. The Trailblazer Foundation tries to over come this with the training session, but for many, especially the elderly, these are deeply instilled beliefs. Sobsey et al.'s 2008 study of point of use water purification identified cultural and educational barriers as the biggest challenge for large scale deployment of water filtration. Future studies should take this into account by including questions about sanitation beliefs in the survey to see if there is a connection to wealth, or by doing a study involving the same families to compare how individual households' wealth changes over the course of many years.

Outside of Trailblazer, this promising technology's biggest challenge is finance. While the subsidization in Sras allows for many to receive water filters, it is the exception rather then the rule. While the benefits of water filtration are clear, there are few resources for their deployment on a larger scale. The actual cost of $50 is prohibitively expensive for most in the countryside. The benefits of improved water supply, like water filters, accrue mainly to the individual. From the point of view of the already

cash-strapped government its difficult to justify public funding, even for the sake of reducing the burden on the health care system. Although as Hutton, Haller, and Bartram 2007 point out, the government could still have a role to play in educating the populace about the benefits of clean water. Another idea that has been suggested is using price discrimination to subsidize those who can't pay the full price of point of use water filtration. However this has been difficult to implement. Subsidization from outside funding is the only way that has been found to make water filtration adoptable for those who need it most (Harris 2005). Therefore, it would be beneficial for more research into ways of bringing down the cost of this technology.

What does this mean for Trailblazer? While the bio-sand filters have been found to be effective in many parts of the world, it would be highly beneficial to gather more information on the health status of their recipients. Also it would be highly beneficial to survey the same households, so as to see a change in socio-economic status over time. Connecting decrease in water related health issues, especially diarrhea, with upward mobility would allow a much stronger conclusion about the relationship between water purification and economic status. Additionally, as was suggested in Hurd's 2009 report, ways of improving the role of the village steward should be explored. Currently the village steward is paid a very modest sum by the household with the water filter. There was a substantial decrease in the proportion of people filtering water from 2009 to 2011, which suggests that recipients are having difficulties communicating problems they are having with their water filters. A small stipend from the village fund would go a long way in encouraging a more active role for the village steward.

In the village of Sras, the availability of subsidized water filters allows all villagers the option of clean water. Those who purchased subsidized water filters were significantly more likely to own several of the assets surveyed for. While the largest difference was seen in improved housing material, a larger house, and in transportation, in 2009 the ownership of certain livestock was also larger. While these assets may not be directly connected with water filtration, they represent the opportunity cost of

water borne illness. This is a strong indication that subsidizing bio-sand water filters is an effective means of poverty alleviation. The burden of waterborne disease is large, and bio-sand water filters have been found to be an appropriate technology for lifting some of that burden. While few people doubt the essential role water plays in a person's well being, there are few studies quantifying it. The clean water situation is dire in far too many parts of the world. More needs to be done not only to understand new strategies, but implement them. It is costing the world too much not to.

Works Cited

Alderman, Harold, John Hoddinott, and Bill Kinsey. "The Long Term Consequences of Early Childhood Malnutrition." International *Food Policy Research Institute*. IFPRI, Dec 2003. Web. 7 Mar 2011

Ashbolt, Nicolas. "Microbial Contamination of Drinking Water and Disease Outcomes in Developing Countries." *Toxicology* 198. (2004): 229-238. Web. 7 Mar 2011.

Ashraf, Nava, James Berry, and Jesse Shapiro. "Can Higher Prices Stimulate Product Use?." *National Bureau of Economic Research* NBER Working Paper No. W13247 . (2007): n. pag. Web. 7 Mar 2011.

"Biosand filter." *Center for Sustainable Water and Technology*. CAWST, n.d. Web. 7 Mar 2011. <http://www.cawst.org/en/themes/biosand-filter>.

"Economic Impacts of Sanitation in Cambodia." *Water and Sanitation Program*. World Bank, 2008. Web. 7 Mar 2011.

Follain, James, and Emmanuel Jimenez. "The economic benefits of potable water supply projects to households in developing countries." *Urban Studies* 22.5 (1985): 421-432. Web. 7 Mar 2011.

Guerrant, David, Sean Moore, Aldo Lima, Peter Patrick, John Schorling and Richard Guerrant. "Association of Early Childhood Diarrhea and Crytposporidiosis with Impaired Physical Fitness and Cognitive Function four-seven years later in a Poor Urban Community in Northeast Brazil." *American Journal of Tropical Medicine and Hygiene* 61.5 (1999): 707-713. Web. 7 Mar 2011.

Guerrant, Richard, John Schorling, Jay McAuliffe, and Maria Auxiliadora De Souza . "Diarrhea as a Cause and an Effect of Malnutrition: Diarrhea Prevents Catch-up Growth and Malnutrition Increases Diarrhea Frequency and Duration." *American Journal of Tropical Medicine and Hygiene* 47. (1992): 28-35. Web. 7 Mar 2011.

Harris, John. "Challenges to the Commercial Viability of Point-of-Use Water Treatment Systems in Low Income Settings." *Dissertation submitting MSc Water Science Policy and Management*. Oxford Univserity, 02 Sep 2005. Web. 7 Mar 2011.

Hurd, Brian. "Biosand Filter Monitoring Report." *The Trailblazer Foundation*. The Trailblazer Foundation, Aug 2009. Web. 20 Mar 2011. <www.thetrailblazerfoundation.org/bsf.pdf>.

Hutton, Guy, Laurence Haller, and Bartram Jamie. "Global cost-benefit analysis of water supply and sanitation interventions." *Journal of Water and Health* 5.4 (2007): n. pag. Web. 7 Mar 2011.

Kalemli-Ozcan, Sebnem. "Does the Mortality Decline Promote Economic Growth?." *Journal of Economic Growth* 7. (2002): 441-419. Web. 7 Mar 2011.

Kalemli-Ozcan, Sebnem, Harl Ryder, and David Weil. "Mortality decline, human capital investment, and economic growth ." *Journal of Development Economics* 62.1 (2000): 1-23. Web. 7 Mar 2011.

Kilkenny, Maureen. "Transport Costs and Rural Development." *Journal of Regional Science* 38.2 (2002): 298-312. Web. 7 Mar 2011.

Mahfouz, A. A.; Abdel-Moneim, M.; al-Erain, R. A.; al-Amari, O. M. "Impact of chlorination of water in domestic storage tanks on childhood diarrhoea: A community trial in the rural areas of Saudi Arabia" *Journal of Tropical Medicine and Hygiene* 98.2 (1995) 126– 30. 7 Mar 2011

Omamo, Steve. "Transport Costs and Smallholder Cropping Choice: Applications to Siaya District, Kenya." *American Journal of Agricultural Economics* 80.1 (1998): n. pag. Web. 7 Mar 2011.

Russell, Steven. "The Economic Burden of Illness for Households in Developing Countries: A Review of Studies Focusing on Malaria, Tuberculosis, and HIV/AIDS." *American Journal of Tropical Medicine and Hygiene* 71.2 (2004): 147-155. Web. 7 Mar 2011.

Sobsey, Mark, Christine Stauber, Lisa Casanova, Joseph Brown, and Mark Elliot. "Point of Use Household drinking Water Filtration: A Practical Effective Solution for Providing Sustained Access to Safe Drinking Water in the Developing World." *Environmental Science Technology* 42. (2008): 4261-4267. Web. 7 Mar 2011

Tiwari, Sangya-Sangam, Wolf-Peter Schmidt, Jeannie Darby, Z.G. Kariuki, and Marion Jenkins. "Intermittent slow sand filtration for preventing diarrhoea among children in Kenyan households using unimproved water sources: randomized controled trial." *Tropical Medicine and International Health* 14.11 (2009): 1374-1382. Web. 7 Mar 2011.

Quick, R.E., L.V. Venczel, E.D Mintz, L. Soleto, and J. Aparicio. "Diarrhea prevention in Bolivia through point-of-use water treatment and safe storage: a promising new strategy." *Epidemiology Infect* 122. (1999): 83-90. Web. 7 Mar 2011.

Van Damme, Wim, Luc Van Leemput, Ir Por, Wim Hardeman, and Bruno Meessen. "Out-of-pocket health expenditure and debt in poor households: evidence from Cambodia." *Tropical Medicine and International Health* 9.2 (2004): 173-280. Web. 7 Mar 2011.

Appendix
2009
Descriptive Statistics

Report

Water Filtration		Housesize	RoofMaterial	Chickens	Ducks	Cows	Pigs	Motorbikes	OxCarts
No Water Filter	Mean	25.45	1.38	4.09	.91	1.41	.67	.10	.31
	N	81	81	79	81	81	81	81	81
	Std. Deviation	24.085	.561	3.955	2.087	1.394	1.012	.300	.465
Water Filter	Mean	44.63	1.77	6.75	.78	2.23	1.07	.13	.65
	N	60	60	60	60	60	60	60	60
	Std. Deviation	55.989	.745	9.465	1.814	1.750	.899	.343	.481
Total	Mean	33.61	1.55	5.24	.86	1.76	.84	.11	.45
	N	141	141	139	141	141	141	141	141
	Std. Deviation	41.751	.671	6.992	1.970	1.603	.983	.318	.500

ANOVA output

		Sum of Squares	df	Mean Square	F	Sig.
Housesize	Between Groups	1.268E4	1	12681.816	7.619	.007
	Within Groups	2.314E5	139	1664.447		
	Total	2.440E5	140			
Roof Material	Between Groups	5.081	1	5.081	12.205	.001
	Within Groups	57.869	139	.416		
	Total	62.950	140			
Chickens	Between Groups	241.536	1	241.536	5.086	.026
	Within Groups	6505.630	137	47.486		
	Total	6747.165	138			
Ducks	Between Groups	.585	1	.585	.150	.699
	Within Groups	542.578	139	3.903		
	Total	543.163	140			
Cows	Between Groups	23.513	1	23.513	9.719	.002
	Within Groups	336.289	139	2.419		
	Total	359.801	140			
Pigs	Between Groups	5.515	1	5.515	5.909	.016
	Within Groups	129.733	139	.933		
	Total	135.248	140			
Motorbikes	Between Groups	.041	1	.041	.405	.526
	Within Groups	14.143	139	.102		
	Total	14.184	140			
OxCarts	Between Groups	4.016	1	4.016	18.047	.000
	Within Groups	30.934	139	.223		
	Total	34.950	140			

2011
Descriptive Statistics

Waterfiltration		Housesize	Roofmaterial	Chickens	Ducks	Cows	Pigs	Motorbikes	OxCarts
No Water Filter	Mean	24.73	1.50	9.12	.44	1.09	.65	.17	.45
	N	109	108	108	109	109	109	109	109
	Std. Deviation	22.604	.634	11.097	1.250	1.798	1.235	.373	.500
Water Filter	Mean	38.33	1.91	11.06	1.22	2.11	.89	.36	.81
	N	36	34	36	36	36	36	36	36
	Std. Deviation	41.356	.793	11.422	5.388	6.168	1.166	.487	.401
Total	Mean	28.11	1.60	9.60	.63	1.34	.71	.21	.54
	N	145	142	144	145	145	145	145	145
	Std. Deviation	28.873	.695	11.171	2.889	3.445	1.219	.411	.500

ANOVA output

		Sum of Squares	df	Mean Square	F	Sig.
Housesize	Between Groups	5004.950	1	5004.950	6.221	.014
	Within Groups	115041.284	143	804.485		
	Total	120046.234	144			
Roofmaterial	Between Groups	4.384	1	4.384	9.631	.002
	Within Groups	63.735	140	.455		
	Total	68.120	141			
Chickens	Between Groups	101.113	1	101.113	.809	.370
	Within Groups	17743.324	142	124.953		
	Total	17844.438	143			
Ducks	Between Groups	16.543	1	16.543	1.996	.160
	Within Groups	1185.085	143	8.287		
	Total	1201.628	144			
Cows	Between Groups	28.120	1	28.120	2.393	.124
	Within Groups	1680.638	143	11.753		
	Total	1708.759	144			
Pigs	Between Groups	1.527	1	1.527	1.028	.312
	Within Groups	212.308	143	1.485		
	Total	213.834	144			
Motorbikes	Between Groups	1.039	1	1.039	6.370	.013
	Within Groups	23.333	143	.163		
	Total	24.372	144			
OxCarts	Between Groups	3.430	1	3.430	15.041	.000
	Within Groups	32.611	143	.228		
	Total	36.041	144			