BERKELEY AIR
MONITORING GROUP

Assessment of Nepal Consumer Needs, Preferences and Willingness to Controlled Cooking Test Results

Prepared for Winrock International by:

Berkeley Air Monitoring Group

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Supportive Environments for Healthy Communities

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Executive Summary

This study aimed to determine the relative fuel efficiency of cookstoves that are being evaluated as part of the United States Agency for International Development-funded WASHplus project: Assessment of Nepal Consumer Needs, Preferences and Willingness to Pay for Improved Cookstoves. This study used the Controlled Cooking Test (CCT), which involves preparing a standardized regional meal to determine the relative fuel efficiency and time demands of different stoves. The primary output metrics are specific fuel consumption (grams wood/kilogram cooked food) and cooking time.

Testing was conducted over seven days at The Renewable Energy Test Station (RETS) in Lalitpur, Nepal, with technicians from RETS, the Alternative Energy Promotion Center (AEPC), Center for Renewable Energy / Nepal (CRT/N), Winrock International, and Berkeley Air Monitoring Group (BA). A total of 168 CCTs were completed by eight cooks recruited from villages outside of Kathmandu. The baseline technology was a three-stone fire and the five new stoves were the Prakti Double Burner Wood Stove with Chimney, Eco-Chula XXL, AEPC-promoted local mud-chimney stove, Xunda Field Dragon, and the Greenway Jumbo. The main findings are presented below:

- All five of the manufactured stoves had significantly lower specific fuel consumption than the traditional chulho, with savings ranging from 29 to 47%.
- The Eco-Chulha and the Xunda demonstrated the highest fuel efficiency, saving 47 and 45%, respectively, while the local chimney stove had the lowest fuel savings (29%).
- Time savings were also significant, with mean cooking times ranging from 15 to 33% less time than traditional chulho, which required 64 minutes on average.
- The local chimney stove and Prakti stove, the only two pot stoves, required the least amount of time to prepare a meal at 43 and 50 minutes, respectively.

Table 1 summarizes the quantitative stove performance results for each of the six stoves. The table shows the averages (means) and the standard deviations, along with the percent differences compared to the traditional chulho. All differences in fuel consumption and cooking time were significant ($p<0.01$) using an unpaired Student's t-test.

Table 1. Summary of CCT fuel consumption and cooking time results, showing the means (± 1 standard deviation) and percentage differences versus the traditional chulho.

	Trad Chulho	Greenway	Prakti	Xunda	Eco-Chulha	Local chimney stove
Number of tests	28	28	28	28	28	28
Specific consumption (g wood / kg food)	328±56	197±36	197±26	179±37	173±22	234±30
% difference from traditional chulho	NA	40	40	46	47	29
Cooking time (minutes)	64±8	55±7	50±9	54±6	55±9	43±7
% difference from traditional chulho	NA	15	23	16	15	33

1. Introduction

1.1 Background and Purpose

This study was conducted as part of the United States Agency for International Development (USAID) –funded WASHplus project: Assessment of Nepal Consumer Needs, Preferences and Willingness to Pay for Improved Cookstoves. The larger WASHplus cookstoves project in Nepal is seeking to determine what "marketing mix", the strategic combination of stoves, pricing, distribution and promotion approaches are most likely to result in Nepalese households adopting and consistently using high performing stoves. This study specifically assessed stoves with the Controlled Cooking Test (CCT) to ensure that the stoves being evaluated for the larger study can provide fuel, and potentially, time savings benefits under typical Nepalese cooking conditions.

The CCT is a standardized, commonly used protocol in the household energy field for assessing stove performance (Bailis, 2007). The CCT yields two main quantitative outputs: the amount of fuel and time it takes to complete the task of cooking a standardized meal. The CCT was chosen as the performance test for this study because it can be completed in a relatively short timeframe, and it provides a standardized comparison using parameters of local fuel, food, and cooking practices. The performance outcomes from the CCTs provide an indication of the potential these stoves have when used in homes participating in the larger study. The larger study will include assessments of daily household fuel consumption and stove usage to verify which stoves have the greatest impacts in homes.

1.2 Study Location

The Renewable Energy Test Station (RETS) in Lalitpur, Nepal hosted the stove performance testing and associated training from March 2nd to March 12th of 2015. RETS is overseen by the Nepal Academy of Science and Technology, and conducts the certification tests for products and components, including household stoves, being disseminated by the Alternative Energy Promotion Center (AEPC). AEPC, which manages government efforts for improving rural household energy access, provided logistical support along with Winrock. The tests were conducted in the courtyard of RETS, with stations set up for each cook, as well as for food preparation, food serving, and dishwashing (Figure 1).

Figure 1. RETS outdoor courtyard, where CCTs were conducted.

2. Methods

2.1 Study Overview

Figure 2. The cooks take a break from the CCTs for tea.

A total of 168 CCTs (28 tests per stove) were completed during the study. The CCTs were conducted by eight cooks who were recruited from rural communities outside of Kathmandu (Figure 2). The cooks were trained how to use the new stoves by the Winrock technical team and were given ten days to practice cooking with each stove in their home before the CCTs were conducted. Technicians from RETS, AEPC, Winrock, and CRT/N were trained by Berkeley Air staff on conducting CCTs, including food and fuel weighing techniques, data entry, and quality assurance/control procedures. A full practice test was also conducted with the cooks before the formal testing started.

In addition to the technicians and cooks, the team included several other assistants from the local community and RETS, who helped with critical activities such as cutting the vegetables, washing dishes between tests, shopping for food in the local markets, and chopping the wood.

The sampling schedule was structured to rotate stoves, cooks, and technicians over time to minimize potential bias in stove performance results. Specifically, the cooks alternated individual CCTs between the stoves, mitigating against the potential effect of stove/fuel practices changing as cooks became more comfortable with the CCT procedures. This sampling structure also helped guard against changes in weather and fuel moisture content, which also varied on a daily basis. Finally, the technicians and cooks were also rotated to ensure that any effect from specific cook-technician interactions would be spread out evenly among the different stoves. The sampling schedule for day two is provided in Table 2 and the full schedule can be found in Appendix 6.1.

2.2 Food and Pots

The standard meal was decided by consulting with the Nepalese technical team on what food would be representative of the region, which was determined to be rice, daal (lentils), and a vegetable dish consisting of cauliflower, potatoes, onions, tomatoes, and spices (Figure 3). The rice, daal, and vegetables were pre-weighed and prepared in quantities that represented a typical meal for a family of four. Cooks used water, oil, ghee, and spices as desired to complete the dishes. The details of the ingredients and quantities are shown in Appendix 6.2.

Table 2. Sampling schedule for day 2 of the CCTs.

DAY 2 (Friday, 2015/03/06)				
Station	**Cook**	**Stove (replicate)**		
BP	AS	GW 1	EC 1	LC 1
	PD	XU 2	GW 2	EC 2
NJ	NG	PR 3	XU 3	GW 3
	ST	TC 4	PR 4	XU 4
BK	UT	LC 5	TC 5	PR 5
	SM	EC 6	LC 6	TC 6
SM	LP	GW 7	EC 7	LC 7
	DG	XU 8	GW 8	EC 8

Note: “Station” denotes the technician’s initials and “Cook” denotes the cook’s initials

Figure 3. Vegetables and spices on aluminum plates (left), a field technician pre-weighing daal (right).

Food was cooked in three vessels: an aluminum flat-bottom pot with a lid for rice, an aluminum round-bottom pot for vegetables (kadhai), and an aluminum pressure cooker (2 liter capacity) for daal (Figure 4). All stoves were able to accommodate all cooking pots with the caveat that the local chimney stove required a piece of wood to fill a small gap between the pressure cooker and pot-hole wall. The only specific instruction the cooks were provided with for meal preparation was to use the lid for cooking rice, which is typical practice in the region. The total food cooked was determined at the end of the meal by weighing each of the prepared dishes (pot weights were subtracted) and summing the masses. The mean amount of food cooked per meal was 4181 g with a standard deviation of 274 g.

Figure 4. Aluminum wok for vegetables (far left), aluminum pot with lid for rice (middle), and pressure cooker for daal (right).

2.3 Fuel

All tests were conducted using wood sourced from a local merchant and consisted of two hard-woods commonly used in Nepal: Gogan (*Saurauia napaulensis*), a shallow-rooted fruiting tree, and wild Himalayan cherry tree (*Prunus cerasoides*).

The wood was cut into pieces with circumferences of approximately 12-18 cm and differing lengths of 15 to 60 cm, as appropriate for each stove. For the top-loading Eco-Chulha, wood was cut into smaller pieces, approximately 5-10 cm long and 8-12 cm in circumference. Cooks were provided with kerosene and shredded paper to aid in starting the stoves. These fuels helped provide relatively consistent fire starting during the CCTs and are used in rural Nepal, although small twigs, crop residues, and other materials are also commonly used to aid in fire-starting.

Before each test, the field staff formed pre-weighed bundles of wood fuel that were approximately 3 kg. After the food was cooked, the leftover wood, charcoal, and ash were collected and weighed. The weights of the cooked foods in their receptacles were also recorded. The time the fire was lit, the start and end times for each dish cooked, and the time the fire was extinguished were recorded. All data was recorded by field technicians on the field sampling form (Appendix 6.5).

Wood moisture was measured twice daily, once before the CCTs and once after, using a dual pin Extech MO120 moisture meter at three points on seven randomly selected sticks in the woodpile. The moisture readings were recorded on a sampling form (Appendix 6.3) and then transcribed into the database. The average moisture content during the CCTs was 17.6±3.1%, with daily means ranging from 20.7% on the first day to 15.2% on the final day.

Specific fuel consumption was used as a normalized measure of fuel use, defined as the equivalent dry wood used divided by the final amount of food cooked. The "equivalent dry wood consumed" normalizes the amount of wood used to complete the CCT for two factors: the amount of moisture in the wood and the amount of charcoal that remains unburned after the cooking task is complete. The standard units of specific consumption are grams of equivalent dry wood used per kilogram of food cooked (g/kg).

Specific fuel consumption (SC) was calculated as follows:

$$SC = f_d/W_f$$

where W_f is the weight of the cooked food (kg), and f_d is the equivalent dry wood consumed (g). f_d adjusts for the energy used to vaporize moisture in the wood as well as the amount of charcoal left in the stove when cooking is finished with the following equation:

$$f_d = (f_i - f_f)(1-[1.12m]) - 1.5\Delta c_c$$

where f_i is the initial wood weight, f_f is the final wood weight, m is the moisture content on a wet basis, and Δc_c is the weight of the remaining char (CCT 2.0 Protocol).

Firepower was calculated by converting the wood mass to its energy equivalent[1] and dividing by the amount of time it took to complete a given test.

2.4 Description of Cookstoves

The five new stove models and the traditional chulho tested in the study are described in Table 3 below. The traditional chulho was a three-stone-fire, which the local technical team reported to be the most common baseline stove for the WASHplus study area. Other common traditional stove types in the region include metal tripods and simple open stoves constructed of mud.

[1] 18.130 MJ/kg was assumed as the energy density of the dry wood equivalent, based on WBT 4.2.3 protocol.

Table 3. Specifications and photos of stove types.

	Stove Image
Traditional chulho Local modification of the three stone fire • Materials: Clay bricks • Weight: 22.6 kg • Height: 15.6 cm Other features/descriptors: Constructed out of 6 clay bricks, 2 stacked bricks composed each 'stone.'	
Eco-Chulha XXL Single pot, portable, fan gasifier stove • Weight (with stand): 5.8 kg • Materials: Stainless steel • Height: 33 cm • Combustion chamber diameter: 16 cm Website: http://www.ecochula.co.in/	
Local chimney stove Two pot, built-in, clay and clay brick chimney stove • Materials: Iron rod, chimney outlet, chimney blocks, mud bricks	

Stove Model and Specifications	Stove Image
Xunda Field Dragon Single pot, portable, rocket design stove • Weight: 5.94 kg • Materials: Surface - 0.4mm stainless steel, cylinder - 1.5 mm stainless steel • Height: 31 cm • Combustion chamber diameter: 9.0 cm • Model number: Field Dragon, Model No. C1.5-SW-IZ Website: http://www.xundaco.com/	
Greenway Jumbo Single pot, portable, natural draft, gasifier stove • Steel and aluminum with Bakelite handles • Weight: 3.8 kg • Height: 29 cm • Combustion chamber diameter: 11 cm • Model number: JS1 Website: http://www.greenwayappliances.com/	

Stove Model and Specifications	Stove Image
Prakti Double Burner Wood Stove with Chimney Two pot, portable, metal chimney stove. • Materials: Stainless steel, seamless steel, iron sheet • Weight: 7.12 kg (stove), 8.92 kg (stove and chimney) • Height: 27 cm (stove), 193 cm (stove and chimney) • Chimney diameter: 7 cm • Combustion chamber diameter: 12 cm • Other features/descriptors: Flexible pot rest, chimney adaptor Website: http://praktidesign.com/	 

All of the new stoves except the local chimney stove have metal combustion chambers where the fire is contained. The local chimney stove's combustion chamber is formed from clay and mud-bricks. All stoves burn wood and can accommodate other biomass fuels such as twigs and leaves to varying degrees. All stoves except the Eco-Chulha are fueled through an opening at the base of the stove. The Eco-Chulha is fueled from the top, can be loaded with a batch of fuel before lighting the stove, and, as needed, additional pieces of fuel can be slid into the opening between the pot and the stove body, or the stove can be slid out from under the pot stand to add larger amounts of fuel.

The Prakti, Greenway, Xunda, local chimney stove, and traditional chulho are all designed to burn fuel in a single combustion stage. The Eco-Chulha, a forced-air gasifier, is designed to employ a two-stage process where the wood undergoes pyrolysis in the lower part of the combustion chamber and then a second influx of air towards the top of the stove mixes and burns the gases released in the first stage.

2.5 Quality Control and Assurance

The four digital scales used for fuel mass measurement (My Weigh 7001DX) underwent a 5-point calibration check using NIST certified mass standards in the Berkeley Air laboratory in Berkeley, CA (r^2>0.999). All scales were checked daily and at the end of the field survey to ensure the standard weight measurement was within 1% of the known mass, verifying measurement precision. An additional scale from RETS was used for food mass, and was found to be within 0.2% of the Berkeley Air scales based on the standard weight. An example of the scale check can be found in Appendix 6.4. Moisture meters were checked every morning as per the manufacturer's verification tests.

Data was entered onto survey forms during CCTs (Appendix 6.5) and then transcribed into an online database. The database was reviewed daily for transcription errors and illogical entries. Subsequent cross-checks of the hard-copy survey form and the database were performed to correct errors as needed, and a final data review was done to check for outliers of firepower, cooking time, food weights, and specific consumption.

Figure 5. The CCT team reviewing data entry during the first day of CCTs.

3. Results

3.1 Specific Consumption

All five new stoves significantly reduced fuel use compared to the baseline technology, with savings ranging from 29-47% (Table 4). The Eco-Chulha and Xunda were the most fuel efficient stoves, using 47% and 45% less fuel than the traditional chulho, respectively, while the Greenway and Prakti stoves both used 40% less. The local chimney stove had the greatest specific consumption of the new stoves, but was still 29% more fuel efficient than the baseline technology.

Table 4. Summary statistics of the specific consumption estimates from the CCTs. Bolded differences and p-values indicate statistical significance.

Specific Consumption (g wood / kg food)						
	Trad Chulho	**Greenway**	**Prakti**	**Xunda**	**Eco-Chulha**	**Local Chimney**
Mean	328	197	197	179	173	234
Median	316	192	197	179	171	233
Standard Deviation	56	36	26	37	22	30
Standard Error	11	7	5	7	4	6
CoV	17%	18%	13%	21%	13%	13%
Upper 95% CI	349	211	207	193	181	245
Lower 95% CI	307	184	187	165	165	223
N	28	28	28	28	28	28
Mean Difference	--	**-40%**	**-40%**	**-45%**	**-47%**	**-29%**
P-value	--	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**

Notes: Statistical significance was determined using an unpaired Student's t-test. P-values of less than 0.05 are considered "statistically significant" and indicate that there is greater than 95% likelihood that the difference between the two measured values did not occur by chance.
CoV = coefficient of variation, defined as the standard deviation/mean.
CI = confidence interval.

The box plots of specific consumptions show the differences in fuel efficiency as well as illustrate their performance variability (Figure 6). The traditional chulho's specific consumption had a substantially wider distribution than those for the new stoves, with an interquartile range of 79 g food / kg wood, compared to less than 45 g food / kg wood for all of the new stoves. The tighter distributions for the new stoves are likely due to having enclosed combustion chambers, which help control the fire and limit impacts from wind. There were some specific tests with the new stoves which did show that large variation in performance is possible. The Xunda's 5th and 95th percentiles, for example, ranged from 105 to 240 g food / kg wood, respectively. In general, however, the variability for specific consumption estimates observed in this study was relatively low. The coefficients of variation ranged from 13% to 21%, which are on the lower end compared to those reported for CCTs in Kenya (21%-33%) (Pennise et al., 2010) and Mexico (10-27%) (Berrueta et al., 2008).

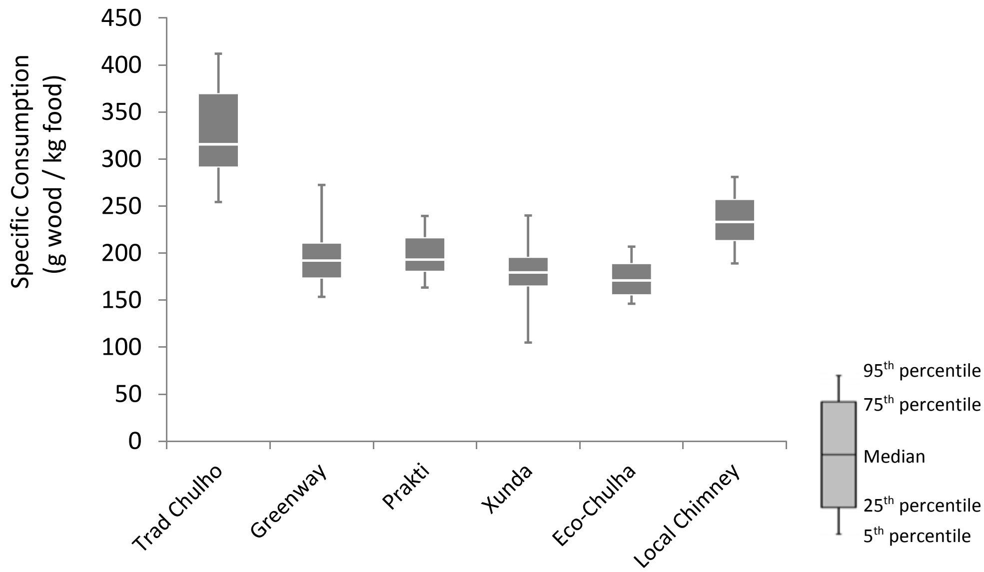

Figure 6. Boxplots showing the distribution of specific consumption for each stove. A guide to the box plot can be found in the lower right hand corner of the figure.

3.2 Cooking Time

All of the stoves significantly reduced cooking times compared to the traditional chulho (Table 5). Mean cooking time for the local chimney stove was the lowest (43 min), a third less than the traditional chulho (64 min). The other two-pot stove, the Prakti, had the second lowest cooking time (50 min, 23% savings), suggesting the ability to simultaneously cook two dishes was a significant factor in reducing the overall cooking time. All of the new, single-pot cooking stoves reduced cooking time by 15%, due solely to their ability to cook single dishes more quickly than the traditional chulho. The distributions of cooking times shown in the boxplots (Figure 7) also illustrate the reduced cooking times achieved by the new stoves. The variability in cooking times, although not large (CoV's of 10-17%), was substantial enough to result in some overlap of cooking time distributions between most of the new stoves and the traditional chulho. This variability was likely due to normal variation in user operation, as well differences in fuel and environmental conditions (e.g. moisture content and wind).

Table 5. Summary statistics of the cooking time estimates from the CCTs. Bolded differences and p-values indicate statistical significance.

Cooking time (minutes)	Trad Chulho	Greenway	Prakti	Xunda	Eco-Chulha	Local Chimney
Mean	64	55	50	54	55	43
Median	64	53	51	54	53	41
Standard Deviation	8	7	9	6	9	7
Standard Error	2	1	2	1	2	1
CoV	13%	14%	18%	10%	17%	16%
Upper 95% CI	67	58	53	56	58	46
Lower 95% CI	61	52	46	52	51	41
N	28	28	28	28	28	28
Mean Difference	--	**-15%**	**-23%**	**-15%**	**-15%**	**-33%**
P-value	--	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**

Notes: Statistical significance was determined using an unpaired Student's t-test. P-values of less than 0.05 are considered "statistically significant" and indicate that there is greater than 95% likelihood that the difference between the two measured values did not occur by chance.
CoV = coefficient of variation, defined as the standard deviation/mean.
CI = confidence interval.

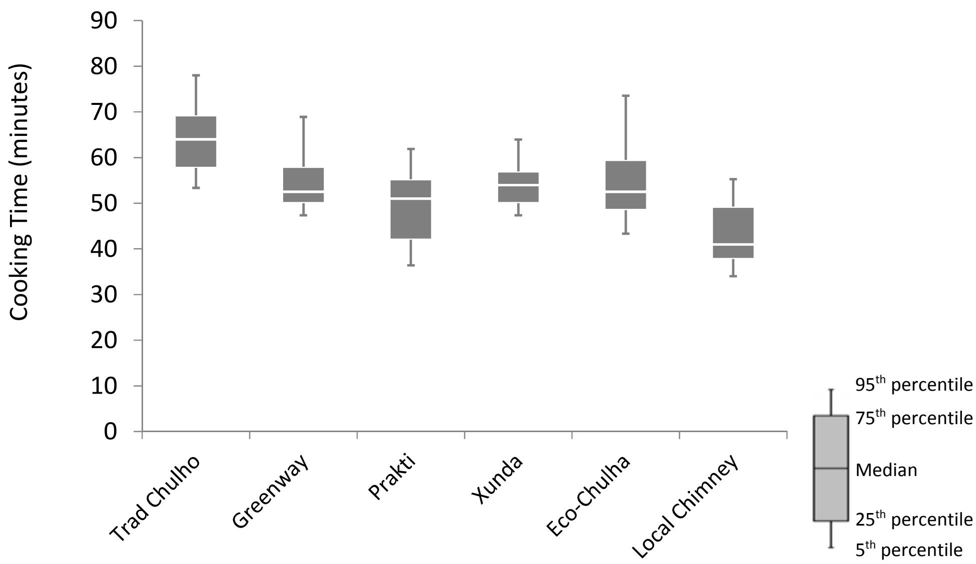

Figure 7. Boxplots showing the distribution of cooking time for each stove. A guide to the box plot can be found in the lower right hand corner of the figure.

3.3 Firepower

Firepower, or the energy consumed per unit time (kilojoules/second [kW]), provides an indication of how stoves are being operated. The range of mean firepowers observed here (4.1-7.0 kW) (see Table 6) are in line with those reported during other laboratory and field studies. Woodfuel cookstoves from Jetter et al.'s (2012) laboratory tests had mean firepowers ranging from ~2.5-7 kW, and Johnson and Garland (2014) presented field based estimates of ~3-8 kW for similar stove types. The similar firepower ranges between this and other studies indicate that the stoves were being operated normally by the CCT cooks.

Table 6. Summary statistics of the firepower estimates from the CCTs. Bolded differences and p-values indicate statistical significance.

Firepower (kW)	Trad Chulho	Greenway	Prakti	Xunda	Eco-Chulha	Local Chimney
Mean	6.6	4.6	5.1	4.1	4.1	7.0
Median	6.5	4.6	5.0	4.1	4.1	6.8
Standard Deviation	1.1	0.8	0.9	0.8	0.6	1.3
Standard Error	0.2	0.1	0.2	0.2	0.1	0.2
CoV	16%	17%	18%	21%	16%	18%
Upper 95% CI	7.0	4.8	5.5	4.4	4.3	7.5
Lower 95% CI	6.2	4.3	4.8	3.8	3.8	6.6
N	28	28	28	28	28	28
Mean Difference	--	**-31%**	**-23%**	**-38%**	**-39%**	6%
P-value	--	**<0.01**	**<0.01**	**<0.01**	**<0.01**	0.20

Notes: Statistical significance was determined using an unpaired Student's t-test. P-values of less than 0.05 are considered "statistically significant" and indicate that there is greater than 95% likelihood that the difference between the two measured values did not occur by chance.
CoV = coefficient of variation, defined as the standard deviation/mean.
CI = confidence interval.

Higher firepowers are generally associated with lower thermal efficiency as more energy needs to be consumed to result in the same energy delivered to the pot (Jetter et al., 2012; Johnson and Garland, 2014). The firepowers observed for this study generally followed this trend (see Figure 6 and Figure 8), with the most fuel efficient stoves (Xunda and Eco-Chulha) having been operated at the lowest mean firepower (4.1 kW). The much less efficient traditional chulho was operated at significantly higher firepower (6.6 kW). The local chimney stove, which was 29% more fuel efficient than the traditional chulho, was an exception, with the highest mean firepower (7.0 kW). The reason for this exception is almost certainly that while the local chimney stove consumed more energy per unit time than the traditional chulho, it was also able to transfer more of that released energy into cooking food due to its two-pot configuration.

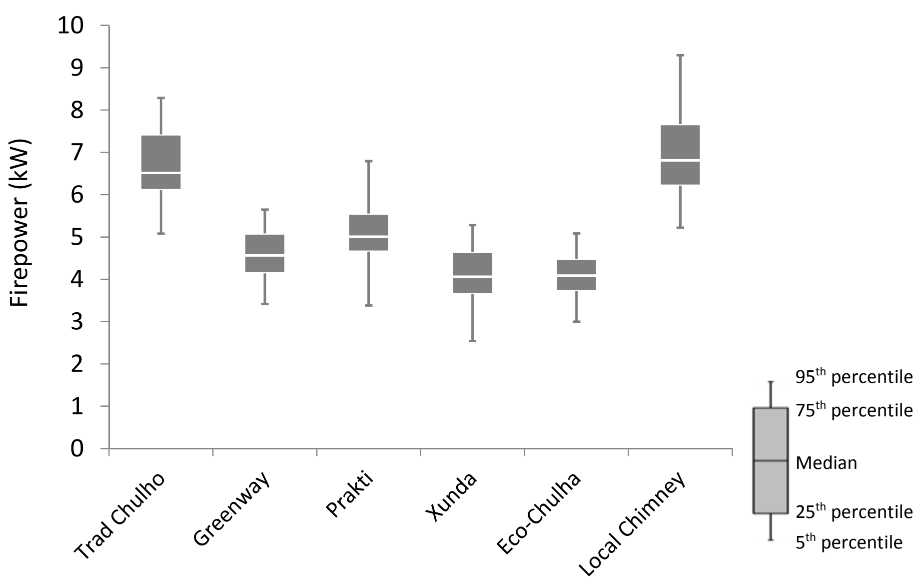

Figure 8. Boxplots showing the distribution of firepower for each stove. A guide to the box plot can be found in the lower right hand corner of the figure.

4. Implications for field study

Overall, the specific consumption and cooking time results are promising given the reductions relative to the traditional chulho. The results suggest that the best performing stoves could result in nearly 50% fuel savings in homes, which would provide substantial household-level and environmental benefits. It is important to note, however, that these benefits will be a function of performance and usage. A recent paper by Johnson and Chiang (in press) presented a framework which modeled how different stove performance-usage scenarios translate into varying levels of health and environmental impacts. By combining the CCT results found here, with the approach described in Johnson and Chiang (in press), we estimated the fuel consumption savings shown in Figure 9. The modeled fuel savings estimates show, for example, that the extent to which the Eco-Chulha or Xunda displaces the traditional chulho is going to be far more important than the small difference in savings due to their performance. The graph also illustrates that there are scenarios for which the local chimney stove could provide the greatest benefits, should it almost entirely displace the traditional chulho, versus the other higher performing stoves, should they only displace the traditional chulho by ~60% or less. While these are only modeled estimates, they illustrate the importance that user preference, and thereby usage of the new stove and displacement of the traditional chulho, will have on the household-level impacts. This assessment of user preference is a main focus of the WASHplus study.

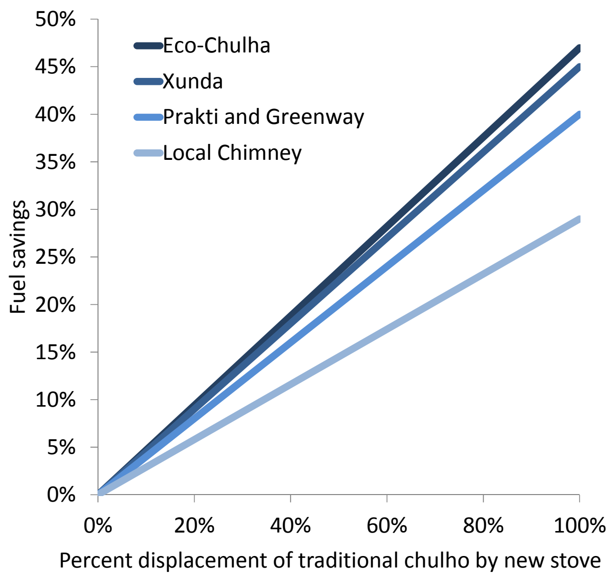

Figure 9. Modeled relationships between three-stone-fire displacement and fuel savings for different performance-usage scenarios, estimated using the CCT specific consumption results and the percent displacement of the traditional chulho.

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6. Appendices

6.1 Daily Scheduling Matrix

Full schedule for the CCTs. The cooks alternated between all 6 stoves to minimize the potential effect of behavioral changes over time.

Technician, Cook, Stove (Test, Replicate ID)

Tech	Cook	Wednesday		
NJ	AS	TC 1	PR 1	XU 1
	PD	LC 2	TC 2	PR 2
BK	NG	EC 3	LC 3	TC 3
	ST	GW 4	EC 4	LC 4
SM	UT	XU 5	GW 5	EC 5
	SM	PR 6	XU 6	GW 6
BP	LP	TC 7	PR 7	XU 7
	DG	LC 8	TC 8	PR 8

Tech	Cook	Friday		
BP	AS	GW 1	EC 1	LC 1
	PD	XU 2	GW 2	EC 2
NJ	NG	PR 3	XU 3	GW 3
	ST	TC 4	PR 4	XU 4
BK	UT	LC 5	TC 5	PR 5
	SM	EC 6	LC 6	TC 6
SM	LP	GW 7	EC 7	LC 7
	DG	XU 8	GW 8	EC 8

Tech	Cook	Sunday		
SM	AS	TC 9	PR 9	XU 9
	PD	LC 10	TC 10	PR 10
BP	NG	EC 11	LC 11	TC 11
	ST	GW 12	EC 12	LC 12
NJ	UT	XU 13	GW 13	EC 13
	SM	PR 14	XU 14	GW 14
BK	LP	TC 15	PR 15	XU 15
	DG	LC 16	TC 16	PR 16

Tech	Cook	Monday		
BK	AS	GW 9	EC 9	LC 9
	PD	XU 10	GW 10	EC 10
SM	NG	PR 11	XU 11	GW 11
	ST	TC 12	PR 12	XU 12
BP	UT	LC 13	TC 13	PR 13
	SM	EC 14	LC 14	TC 14
NJ	LP	GW 15	EC 15	LC 15
	DG	XU 16	GW 16	EC 16

Tech	Cook	Tuesday		
NJ	AS	TC 17	PR 17	XU 17
	PD	LC 18	TC 18	PR 18
BK	NG	EC 19	LC 19	TC 19
	ST	GW 20	EC 20	LC 20
SM	UT	XU 21	GW 21	EC 21
	SM	PR 22	XU 22	GW 22
BP	LP	TC 23	PR 23	XU 23
	DG	LC 24	TC 24	PR 24

Tech	Cook	Wednesday		
BP	AS	GW 17	EC 17	LC 17
	PD	XU 18	GW 18	EC 18
NJ	NG	PR 19	XU 19	GW 19
	ST	TC 20	PR 20	XU 20
BK	UT	LC 21	TC 21	PR 21
	SM	EC 22	LC 22	TC 22
SM	LP	GW 23	EC 23	LC 23
	DG	XU 24	GW 24	EC 24

Tech	Cook	Thurday		
SM	AS	TC 25	PR 25	XU 25
	PD	GW 25	EC 25	LC 25
BP	NG	LC 26	TC 26	PR 26
	ST	XU 26	GW 26	EC 26
NJ	UT	EC 27	LC 27	TC 27
	SM	PR 25	XU 27	GW 27
BK	LP	GW 28	EC 28	LC 28
	DG	TC 28	PR 26	XU 28

6.2 Standard Meal Details

Ingredient	Initial Mass
Rice	800g
Daal	200g
Cauliflower	~Half a head
Potatoes	~1 large or 2 small
Tomatoes	~6 small tomatoes
Onion	~1 small
Turmeric, coriander, cumin, salt, chili powder, garlic, ginger, and ghee	Cook's discretion
Oil	Cook's discretion
Water	Cook's discretion

6.3 Wood Moisture Sampling Form

Day 1 Morning			**Date (YY/MM/DD):**								
stick1	stick1	stick1	stick2	stick2	stick2	stick3	stick3	stick3	stick4	stick4	stick4
stick5	stick5	stick5	stick6	stick6	stick6	stick7	stick7	stick7			
Day 1 Evening											
stick1	stick1	stick1	stick2	stick2	stick2	stick3	stick3	stick3	stick4	stick4	stick4
stick5	stick5	stick5	stick6	stick6	stick6	stick7	stick7	stick7			

6.4 Scale Calibration and Maintenance

Table 7. Example of scale maintenance database (data from day 1 of CCTs shown).

Scale: Daily Check

1. At the beginning of the study each of the technicians need to pick a standard weight that will not change mass and enter into column M
2. Every day, the technician should enter initials, date, scale ID number, and standard mass reading to ensure the scales are not drifting
3. If % difference in column J is red, try re-weighing the standard weight again. If still red, recalibrate scale.

Difference will display red when recalibration is required (>2%)

Tech	Date	ID/Serial number	X kg reading	Standard Mass kg	Slope Adjustment	Intercept Adjustment	Adjusted X kg reading	Difference
RS	3/4/2015	TS_1	2455	2456	1.0002	0.0001	2456	0.0%
RS	3/4/2015	TS_2	2454	2456	0.9997	0.0006	2453	0.1%
RS	3/4/2015	TS_3	2456	2456	1.0001	0.0001	2456	0.0%
RS	3/4/2015	TS_4	2453	2456	0.9998	0.0002	2453	0.1%
RS	3/4/2015	RETS1	2462	2456	1.0000	0.0000	2462	0.2%

6.5 Field Sampling Form

Controlled Cooking Test Form – Nepal, 2015

A. Test Data			Stove Type Codes	
A1	Date (YY/MM/DD)		TC	Traditional chulho
A2	Technician ID	RS / NJ / BK / SM / BP	PR	Prakti
A3	Cook ID	AS / PD / NG / ST / UT / SM / LP / DG	XU	Xunda
A4	Stove	TCa TCb / PRa PRb / XUa XUb GWa GWb / ECa ECb / LCa LCb	GW	Greenway
A5	Raining	Y / N	EC	EcoChulha
A6	Wind Condition	1. calm / 2. light breeze / 3. strong wind	LC	Local chimney

TEST ID:

(STOVEID_COOKID_TECHID_REP#).

Example: TCa_LS_PT_7

The replicate# can be found on the daily sampling plan sheet for each station.

B. Food Weights		Empty container (g)	Container with food (g)	Soaked
B1	Dry daal			Y / N
B2	Cooked daal			
B3	Dry rice			Y / N
B4	Cooked rice			
B5	Uncooked vegetables			
B6	Cooked vegetables			

C. Fuel Weights		Empty container (g)	Container with fuel (g)
C1	Initial weight of wood		
C2	Final weight of remaining wood		
C3	Weight of leftover char		
C4	Weight of leftover ash		
C5	Initial weight of starter paper		
C6	Final weight of starter paper		

D. Times		(HH:MM) 24 hr format	
	Activity	Start	End
D1	CCT		
D2	Daal		
D3	Rice		
D4	Veg		

6.6 Field team