Kitchen Performance Test and Stove Usage Results

Prepared for Winrock International by:

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Executive Summary

This study applied technical field testing methods to explore questions about adoption and fuel efficiency for a group of improved cookstoves in Nepal 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. The assessment focused on six stoves: a traditional modified three-stone fire, and five improved stoves, including the Prakti Double Burner Wood Stove with Chimney, Eco-Chula XXL, locally promoted mud-chimney stove, Xunda Field Dragon, and the Greenway Jumbo. This study used the Kitchen Performance Test (KPT) to assess the real-world impacts of improved stoves on fuel use by measuring fuelwood consumption in 150 representative households over four consecutive days. The study's primary output metric is mass of wood consumed per standard adult[1] per day (kg/SA/day). Stove use monitors (SUMs) were used to track stove temperature as a proxy for usage for several months before and during the KPT to determine the relative adoption levels of the five improved stoves.

The study was implemented in the rural districts of Nawalparasi and Dang during two seasons, end of summer and winter respectively. Due to political unrest in Dang, field visits were delayed for several months, resulting in a gap in SUMs data from August to December, 2015.

In some areas of Nepal, outdoor stoves are commonly used for cooking animal feed and brewing alcohol, which occurred in 77 percent of participant homes in Nawalparasi and 16 percent of homes in Dang. These outdoor stoves are also sometimes used to supplement family cooking. To account for these highly fuel-intensive tasks, location-specific fuel piles were made in these homes during the KPT; one for the outside "animal feed and brewing stoves" and one for the "inside family-cooking stoves," although the tasks for which these different fuel inventories were used were not restricted in any way.

Data from each location was analyzed separately due to distinctly different cooking behaviors and dramatic differences in the season between the two KPT study periods. For example, participants in Nawalparasi did substantially more animal feed cooking and alcohol brewing, while participants in Dang reported far more instances of using their cookstove for household heating.

The main findings for Nawalparasi are presented below.

- Based on SUMs data, improved stove use in Nawalparasi during the KPT was higher than traditional stove use in terms of events per day in all study groups, although the traditional stoves did continue to be used in all groups. Improved stove use in Nawalparasi was relatively consistent over the four month study period, other than for the Eco Chula group, where usage decreased with time, from an average of 2.25 events per day to 0.5 events per day, and the Local Chimney, which increased in popularity with time, from about 0 events per day to 1 event per day.
- Less fuel was used by all improved stove groups in terms of kg/SA/day when compared to the traditional group. On average, the Greenway group used the least fuel (1.1 kg/SA/day),

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[1] The "standard adult" (SA) metric is used in the KPT to normalize the caloric energy needs across gender and age with the following weights: child 0–14 years = 0.5; female over 14 years = 0.8; male 15–59 years = 1; and male over 59 years = 0.8 (FAO, 1983).

followed by the Eco Chula (1.3 kg/SA/day), Xunda (1.3 kg/SA/day), Prakti (1.4 kg/SA/day), and Local Chimney (1.5 kg/SA/day), compared to the traditional group (2.2 kg/SA/day).

- Both groups of improved stove users experienced fuel savings in both the indoor and outdoor fuel inventories, which correlates to the reduced number of reported events completed on outdoor stoves by the improved stove user groups.
- In general, participants with an outdoor stove appeared to use their improved stoves more frequently than those with only an indoor stove. It is hypothesized that these households may have a greater need for cooking capacity due to the additional animal feed and brewing tasks they need to complete.

In Dang, the primary findings were as follows:

- In Dang, a consistent trend of improved stove use was observed over the first three months of stove ownership, other than for the Local Chimney group, which went from 2.5 events per day in June to about 0.8 events per day in August.
- After a fourth month gap in data due to an inability to make field visits, a substantial decrease in all improved stove types was observed. By December 2015, when the KPT was conducted, usage had dropped from between 0.5 to 2 events per day down to between 0 and 0.75 events per day, other than the Local Chimney, which continued to be used at about 1.5 times per day.
- Traditional stove use in the improved groups was similar to the baseline traditional stove user group, meaning that use of the improved stoves was in addition to typical traditional stove cooking.
- None of the improved user groups demonstrated significant fuel savings during the KPT period, as expected given their lack of use.

The difference in usage and fuel savings in Nawalparasi and Dang seem related to the prevalence of heating and the lower incidence of animal feed and brewing in Dang. It is possible that the improved stoves do not provide the same amount of latent heat as the traditional stove, so during cold winter months, the improved stoves are used less frequently. The lower incidence of animal feed and brewing in Dang may mean there is a suppressed demand for increased cooking capacity, compared to Nawalparasi. Markedly dissimilar findings from the KPTs in Nawalparasi and Dang demonstrate the importance of accounting for cultural, climatological, seasonal, and behavioral variability in target communities, even within the same country.

1. Introduction

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 strategic combination of stoves, pricing, distribution and promotional approaches, or "marketing mix," are most likely to result in Nepali households adopting and consistently using high performing cookstoves. This study used field methods, including stove-use monitoring and fuel weighing, to measure whether the stoves being evaluated for the larger study are being used and are providing fuel and possibly time savings to families, under typical Nepali cooking conditions. For the fuel weighing portion of this study, The Kitchen Performance Test (KPT) protocol was used,

which provides real-world fuel consumption estimates. There are two main goals of the KPT: (1) to assess stove usage of improved and traditional stoves through stove usage monitoring measurements and (2) to compare the impact of improved stove(s) on fuel consumption in the kitchens of real households. To meet these aims, the KPT includes quantitative measurements of fuel consumption and stove use.

2.   Study Design and Methods

A total of 150 KPTs were completed during the study, 77 households in Nawalparasi (13 traditional users and 64 improved stove users) and 73 (14 traditional users and 59 improved stove users) in Dang. Technicians from Winrock Nepal were trained by Berkeley Air staff to conduct KPTs, including fuel weighing techniques, data entry, and quality assurance/control procedures. Additional intensive training and a full practice test was conducted with these same enumerators before the formal testing started.

The study sites selected for the KPT study were within the districts of Nawalparasi and Dang, low land regions in rural Nepal, where the primary economic activity is agriculture (Figure 1).

Figure 1. Districts of Nawalparasi (left) and Dang (right), highlighted in red.

Although wood was the dominant fuel source, multiple cooking fuels were used in nearly all households. Most households had a small traditional stove and an additional traditional open fire for cooking food for domestic animals. Crop residue supplemented wood use in many households. Electricity and biogas were used in some clusters, and LPG was present but rarely used. Plastic, generally in the form of bags and bottles, was used for lighting but not for cooking.

2.1   Study Timeline

Stove usage and fuel measurements were made between June 2015 and January 2016 in both Nawalparasi and Dang after the 2015 earthquake, which greatly impacted the nation. The study sites were left relatively unaffected, although a third site that was supposed to be included was too impacted to participate.

The Nawalparasi KPT was done in late September after slight delays related to the release of the nation's constitution on September 19th. Due to political unrest also related to the constitution, return visits to Dang were not possible between August and December of 2015. After the political situation had settled, the KPT was implemented and SUMs were downloaded and relaunched in

December. However, due to finite iButton memory, no SUMs data was collected in Dang September through November 2015, when visits were not possible. After the Dang KPT, SUMs data was downloaded in early January. This timeline is illustrated in Figure 2.
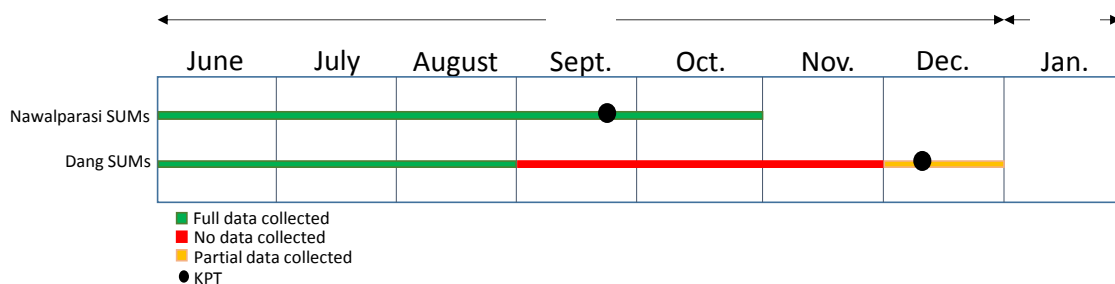
Figure 2. Timeline of stove use monitoring (SUMs) and KPT testing at the two Nepal study sites. Green indicates a full data set, red indicates missing data, and yellow indicates a partial data set.

2.2   Kitchen Performance Testing

The Kitchen Performance Test (KPT) is an uncontrolled, household-level test that measures real-world fuel consumption (Bailis, 2007), for which all household fuels are weighed daily for four continuous days, providing three days of fuel consumption estimates. Fuel was weighed with calibrated, digital, hand-held scales (maximum 50 kg; resolution 0.01 kg), and wood moisture was measured daily. Household fuel consumption estimates are presented as fuel mass per "standard adult" (SA) per day and fuel energy per SA per day. The SA metric is used in the KPT to normalize the caloric energy needs across gender and age with the following weights: child 0–14 years = 0.5; female over 14 years = 0.8; male 15–59 years = 1; and male over 59 years = 0.8 (FAO, 1983). The fuel consumption estimates are at a household level, which subsumes fuel use from different stoves, although each fuel type is estimated separately. In situations where multiple stoves and fuels are used to meet household energy demands, known as stove/fuel stacking (Ruiz-Mercado et al., 2011), the estimates represent the fuel use for a given fuel type regardless of whether that fuel was combusted in one or many stoves. The technical KPT methods used here are the same as those described in Johnson et al. (2013), in which more detailed descriptions of the approach can be found.

In the study group, both outdoor and indoor cooking was observed. Enumerators organized the family's fuel into outdoor and indoor stove piles (Figure 3). These location specific fuel piles were assessed separately. The fuel piles were marked and stored separately, and the participants were

instructed to consistently use one fuel pile for indoor cooking and the other for outdoor cooking. Outdoor cooking consisted mainly of cooking animal feed and alcohol. The fuel was analyzed separately so the fuel used for these tasks did not mask fuel savings achieved by the use of an improved stove for cooking the family's food.

A short survey was administered daily over the course of the four-day study to record information about stove and fuel usage, the number and type of meals prepared, the number and type of stoves used, and the number and age of people for whom the meals were prepared.

Stove usage measurement sensors (SUMs) were manufactured by Maxim Integrated. The iButton is small (the size of a watch battery), relatively robust, and easy to use. It contains a data-logger, real time clock, and solid-state temperature sensor. In this study, we utilized the DS1922T, with a maximum temperature of 120 Celsius – as stove use monitors. Usage measurements took place from June through December of 2015, including during the 3-day KPT, to assess long-term stove use and acceptability, as well as to link fuel consumption with stove use. Measurements were taken on all traditional and improved stoves inside the participating homes, but monitoring did not extend to the outdoor stove, which was used primarily for cooking animal feed and brewing alcohol.

2.3   Quality Control and Assurance

Daily and weekly checks of instrumentation were done to ensure accurate data collection. This includes the daily testing of fuel scale accuracy against a pre-weighed standard weight. A quality assurance checklist and a data entry sheet were filled out weekly with specifications about

instrument functionality to record performance over time.

To ensure a high level of reliability in the sampling form data, the database was reviewed for transcription errors and illogical entries. Subsequent cross-checks of the hard-copy survey form and the electronic database were performed to correct errors as needed, and a final data review was done during the reporting phase.

Figure 4. An enumerator conducting a participant survey.

2.4   Description of Cookstoves

The five improved stove models and the traditional stove tested in the study are described in Table 1 below. The traditional stove was a three-stone-fire, which the local technical team reported to be the most common baseline stove for Nawalparasi and Dang. Other common traditional stove types in the region include metal tripods and simple open stoves constructed of mud.

Table 1. Specifications and photos of stove types.

Stove Model and Specifications	Stove Image
Traditional stove 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-Chula 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/	

Stove Model and Specifications	Stove Image

Local chimney stove

Two pot, built-in, clay and clay brick chimney stove

- Materials: Iron rod, chimney outlet, chimney blocks, mud bricks
- First pot diameter: 19.5 cm
- Second pot diameter: 15.5 cm
- Height: 22 cm at first pot and 27 cm at second pot, from base.
- Length: 91 cm
- Width: 40 cm
- Chimney heights: 58 cm (version a) and 79 cm (version b), measured from second pot

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/

Stove Model and Specifications	Stove Image

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/

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/

*The photos of stoves were taken from earlier CCT study in Kathmandu, Nepal.

All of the improved 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 crop residues, to

varying degrees. All stoves except the Eco-Chula are fueled through an opening at the base of the stove. The Eco-Chula is fueled by loading it with a batch of fuel from the top before lighting. 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 stove are all designed to burn fuel in a single combustion stage. The Eco-Chula, 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.

3. Results

Nawalparasi and Dang demonstrated dramatically different cooking behavior and so were analyzed and reported separately. For example, participants in Nawalparasi did substantially more animal feed cooking and alcohol brewing, while participants in Dang reported far more instances of using their cookstove for household heating.

3.1 Nawalparasi

Participants were split into two groups for analysis, differentiated by self-reported use of indoor stoves only or use of both indoor and outdoor stoves ("indoor + outdoor"). In Nawalparasi 77 percent (n=57) of homes cooked with an outdoor stove in addition to their indoor stove, in contract to Dang, in which only 16 percent (n=12) of homes did so. When used, the primary function of an outdoor stove was for cooking animal feed and/or brewing alcohol; however, it was also sometimes used for family cooking tasks.

3.1.1 Long term stove use trends
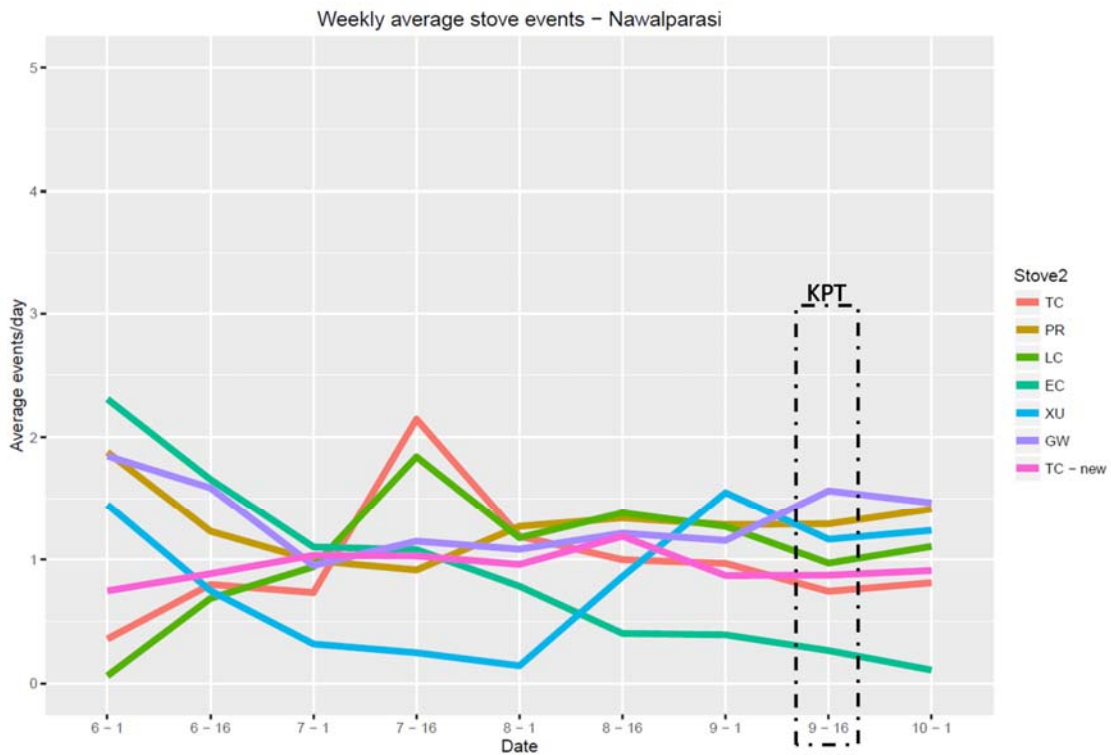
Figure 5 shows the long-term stove use trend in Nawalparasi in participating households over four months for the improved and traditional stove user groups. This plot depicts the usage over time for the different stove user groups and indicates how usage fluctuated between dissemination in June 2015, and the KPT monitoring period in September 2016. The usage metric is cooking events per day and is represented here as binned, twice-monthly averages for each of the stove type groups measured, including the baseline traditional stoves (TC) and the combined traditional stove use by all intervention stove groups (TC- new). Stove usage trends demonstrate generally consistent use of both the improved and traditional stoves in all improved groups, other than the Eco Chula group, where usage decreased over time, and the Local Chimney households, where usage slightly increased slightly over time. The traditional stove use by the improved groups (TC - new) is relatively flat during the four-month monitoring period at around 0.5 to 1 events per day. Importantly, this line is not at 0, demonstrating that the improved stoves are not completely displacing the traditional stove. There seems to be a slight increase in traditional stove use by the non-improved stove group (TC), although this variability is still within the noise of the measurement.
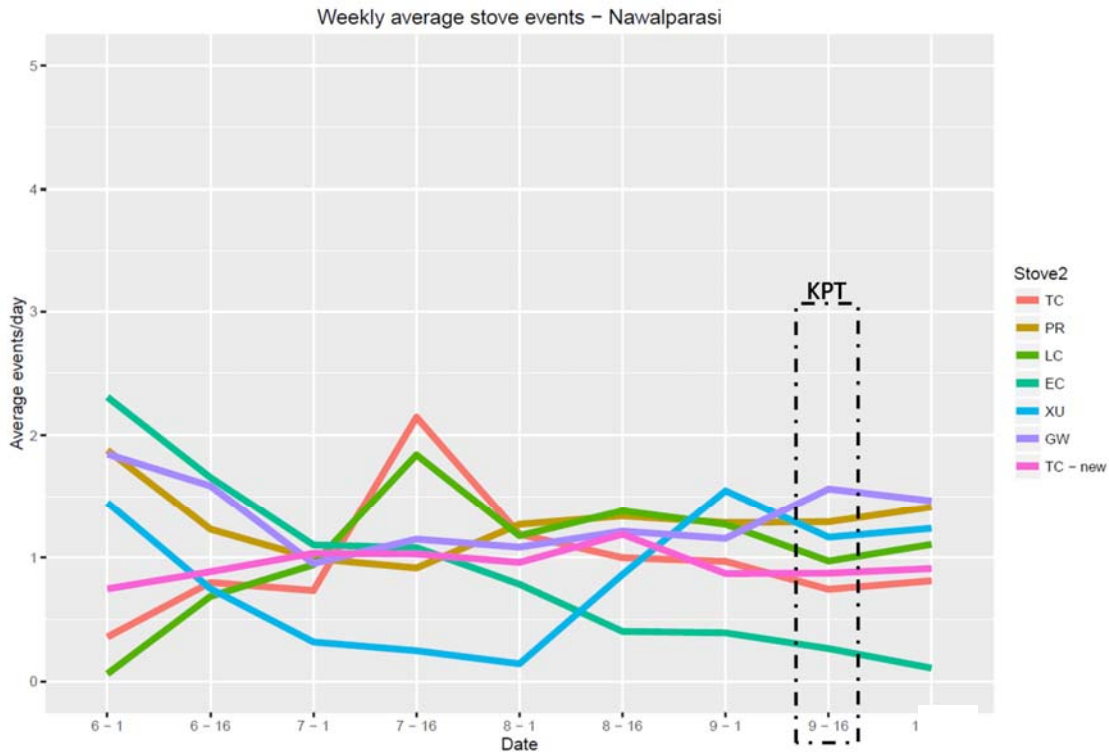
Figure 5. Twice-monthly, binned average cooking events per day for the different stoves used by each stove-specific participant group in Nawalparasi over the five month SUMs sampling period. Traditional stove uses by the improved groups are combined for all improved stove users, for simplification (TC- New). Stove-specific participant groups are Greenway (GW), Eco-Chula (EC), Prakti (PR), Local Chimney (LC), Xunda (XU), Traditional Stove belonging to the improved groups (TC – New), and Traditional Stove in the baseline group (TC). The dashed rectangle designates the KPT monitoring period bin. Error bars are ± 1 standard deviation.

3.1.2   Stove use during the KPT

Stove usage in terms of events per day during the three day KPT in Nawalparasi is shown in Figure 6. Median stove use of the improved stove is greater than the traditional stove in all improved stove groups. The Greenway, Prakti, and Xunda groups demonstrate significantly more use of the improved stove over the traditional stove ($p < 0.05$). The Eco Chula and Local Chimney, while still used regularly, were not used significantly more than the traditional stove based on events per day ($p = 0.3$ and $p = 0.4$, respectively).
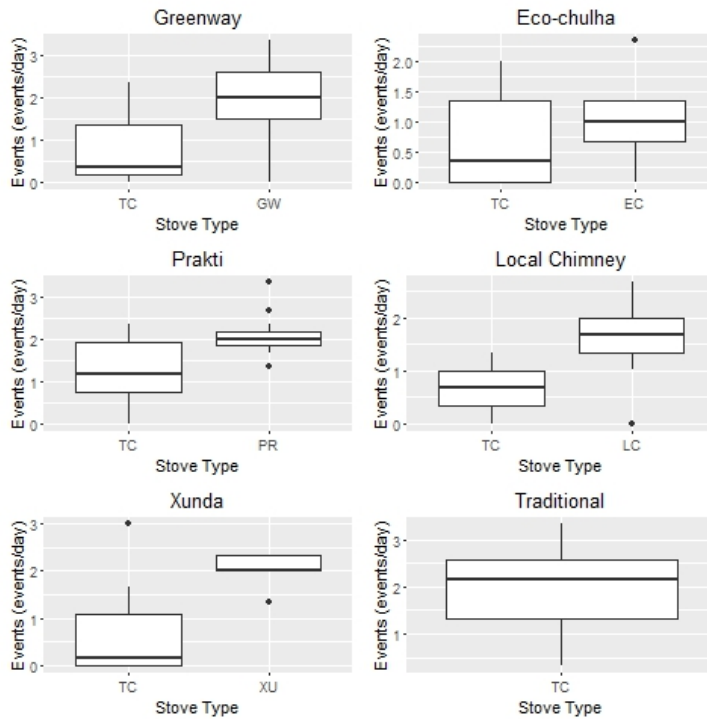
Figure 6. Events per day of the different stove types in each household, grouped by stove-specific study groups, during the four-day KPT monitoring period in Nawalparasi (Greenway (GW): N = 10, Eco-Chula (EC): N = 9, Prakti (PR): N = 11, Local Chimney (LC): N = 9, Xunda (XU): N = 5, Traditional Stove (TC): N = 8). Boxes indicate the 25th and 75th percentile (the lower and upper quartiles (IQR), respectively), and the band near the middle of the box is the 50th percentile (the median). The whiskers represent 1.5*IQR.

Since a large fraction of users in Nawalparasi brewed alcohol and cooked animal feed on a particular outdoor stove, users who self-identified as having one of these outdoor stoves were analyzed separately from those who did not. Figure 7 shows the stove use during the KPT separated by user groups that self-report as homes with indoor stoves only (I) and those that report to have both an indoor stove and an outdoor stove for cooking animal feed and brewing alcohol (I + O). No stove use measurements were made for outdoor stoves so the results here are only of usage of stoves found within the homes. Households with an outdoor stove appeared to generally use their new stove more times per day than users who did not have an outdoor stove in almost all improved groups, except for the Xunda group. This increase may be due to the homes with an outdoor stove doing more animal feed cooking and alcohol brewing, in addition to family cooking, which results in a greater demand for cooking capacity and hence greater use of the improved stoves (discussed further in section 3.1.3).
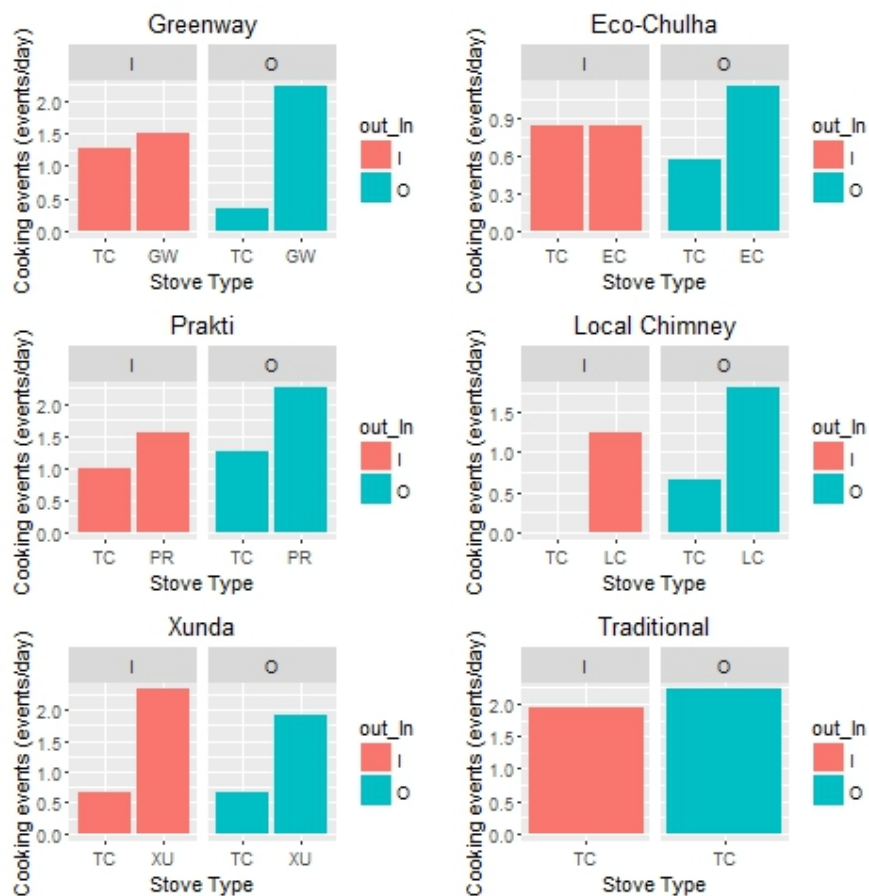
Figure 7. Average cooking events per day completed on indoor stoves only during the KPT, grouped by stove type and indoor stove only households (I) versus households which report to have both and indoor and an outdoor stove (O) in Nawalparasi. Study groups are Greenway (GW), Eco-Chula (EC), Prakti (PR), Local Chimney (LC), Xunda (XU), and Traditional Stove (TC).

3.1.3   Reported stove use

During the KPT survey, participants reported their stove use events over the four-day period, itemized by stove type used and location (indoor stove or outdoor stove). Reported events were separated by traditional (N=13) and improved user groups (N=64), with all improved user groups combined into a single group for simplicity. Figure 8 shows the reported family cooking events by the different user groups that were completed on either indoor or outdoor stoves. The family cooking events on indoor stoves were similar between all of the groups, ranging between 2.14 events/day and 2.79 events/day. However, some family cooking was also completed on outdoor stoves, leading to the outdoor group cooking more family meals, in general, than the indoor group. Slightly more family cooking was done on outdoor stoves in the traditional group than in the improved groups, and conversely, slightly less cooking was done on the indoor stoves in the traditional group than the improved group.

Both the traditional and improved groups reported to cook animal feed and brew on both the indoor and outdoor stoves. Figure 8 shows the reported animal feed and brewing events per day by the different groups and on which stoves the tasks were completed. Overall, the outdoor + indoor improved groups appeared to brew and cook animal feed the most. The indoor traditional and improved groups report to use the stove approximately the same amount for these tasks.

Overall, the groups with an outdoor stove report to cook the greatest number of tasks, on average. This finding supports the theory that the homes with an outdoor stove have a greater cooking need to fulfil, which may increase demand for the improved stove by communities that cook animal feed and brew alcohol frequently.
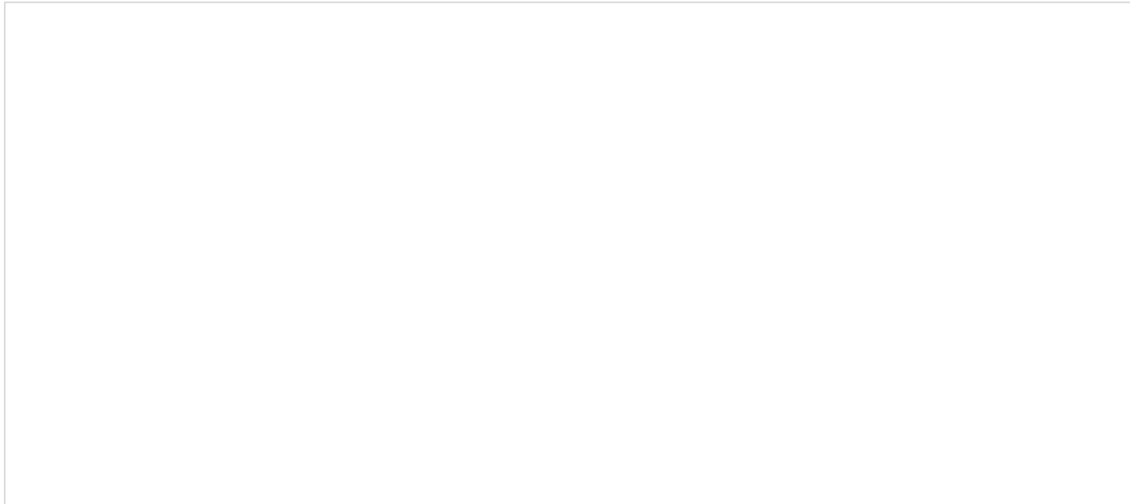
Figure 8. Average reported family cooking and animal feed plus brewing events per household per day in Nawalparasi completed on indoor and outdoor stoves for outdoor + indoor (O + I) traditional group, the outdoor + indoor (O + I) improved group, the indoor traditional group, and the indoor improved group.

3.1.4 Fuel Use

Fuel use statistics for Nawalparasi, by stove, for the indoor stove only users, indoor + outdoor stove users, and all users combined are shown in **Error! Reference source not found.**, Table 4, and Table 2, respectively.

Fuel use results of all stove users, combined indoor only and indoor + outdoor are shown in Table 2. Nearly all improved stove groups showed statistically significant less overall fuel use ($p < 0.05$) when compared to the traditional group, except for the Local Chimney, which showed nearly statistically significant less overall fuel use ($p = 0.07$).

Table 2. Nawalparasi Kitchen Performance Test results in all homes. Results of fuel use per standard adult per day (kg/SA/day) are grouped by stove types, including five improved stoves and one traditional stove.

All Users - All stoves						
Fuel use on all stoves (kg/SA/day)	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
Mean	2.2	1.4	1.3	1.3	1.1	1.5
SD	1.2	0.8	0.7	0.6	0.5	0.6
N	13	12	14	13	13	12
% difference of means		38%	40%	41%	51%	32%
p-value		**0.04**	**0.03**	**0.02**	**0.01**	0.07

Note: 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. Significant p-values are in bold.
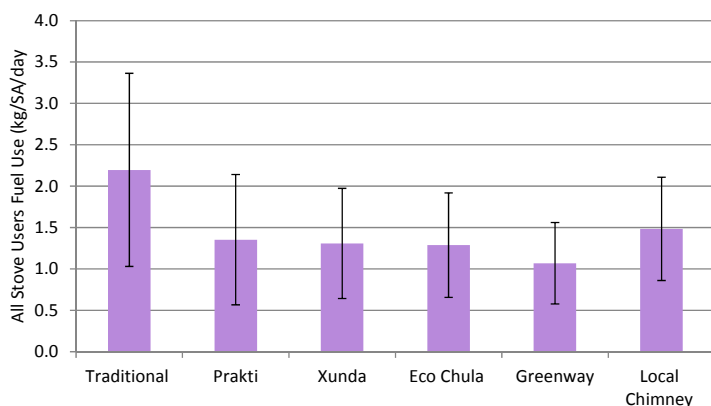
Figure 9. Fuel use in Nawalparasi during the three day KPT, for all stoves in all households. Error bars indicate ± 1 standard deviation.

In the user group that only cooked with an indoor stove, all improved groups used less fuel than the traditional group, but the differences were not statistically significant (**Error! Reference source not found.**).This is likely due to the small sample size for the indoor stove only group (N = 3-6).

Table 3. Nawalparasi Kitchen Performance Test results in homes that do not do outdoor cooking. Results of fuel use per standard adult per day (kg/SA/day) are grouped by stove types, including five improved stoves and one traditional stove.

	Indoor Stove Only Users					
kg/SA/day	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
Mean	1.5	0.96	1.2	1.0	0.72	1.3
SD	0.83	0.52	0.50	0.5	0.3	0.43
N	6	3	5	3	6	4
Improved Stove Users vs. Traditional Users						
% difference of means		35%	22%	33%	52%	11%
p-value		0.29	0.45	0.33	0.07	0.69

In the group that used both indoor + outdoor stoves, all improved stove user groups used significantly less fuel than the traditional stove group. When analyzing the fuel used on the indoor stoves and outdoor stoves separately, significantly less fuel ($p < 0.05$) was used on indoor stoves in nearly all improved stove groups, except for the Xunda and Local Chimney. Interestingly, significantly less fuel ($p < 0.05$) was also used on outdoor stoves in nearly all improved stove groups, except for the Prakti group (Table 4). This resulted in all improved stove groups that used indoor + outdoor stoves having a combined indoor and outdoor fuel use that was significantly lower than the traditional stove group. This is demonstrated in Figure 10, which shows that the traditional stove users consumed more fuel on both stoves than the improved stove groups.

Table 4. Nawalparasi Kitchen Performance Test results in homes that use outdoor stoves for cooking animal feed and/or brew alcohol. Results of fuel use per standard adult per day (kg/SA/day) are grouped by stove types, including five improved stoves and one traditional stove.

Indoor and Outdoor Stove Users						
Indoor (kg/SA/day)	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
Mean	1.1	0.70	0.91	0.62	0.70	0.84
SD	0.71	0.31	0.56	0.30	0.21	0.34
N	7	9	9	10	7	8
% difference of means		37%	18%	44%	37%	24%
p-value		**0.05**	0.22	**0.03**	**0.05**	0.12
Outdoor (kg/SA/day)						
Mean	1.7	0.79	0.48	0.76	0.67	0.72
SD	0.99	0.85	0.48	0.54	0.39	0.64
N	7	9	9	10	7	8
% difference of means		53%	72%	55%	60%	57%
p-value		0.08	**0.02**	**0.05**	**0.03**	**0.05**
Improved Stove Users vs. Traditional Users (Both Indoor and Outdoor Stove Users) - All stoves						
% difference of means		47%	50%	51%	51%	44%
p-value		**0.02**	**0.02**	**0.01**	**0.03**	**0.03**
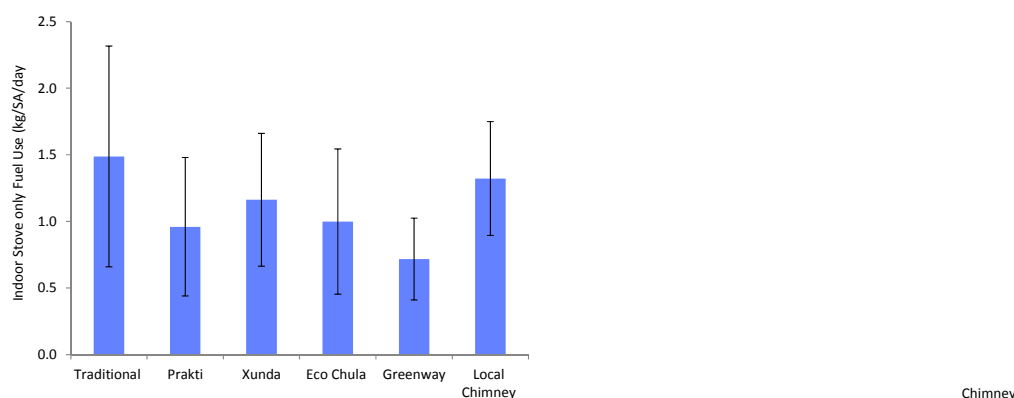
Figure 10. Fuel use in Nawalparasi during the three day KPTs, for all stoves, in households that used indoor stoves only (left panel) and indoor + outdoor stoves (right panel). Error bars indicate ± 1 standard deviation.

3.1.5   Nawalparasi highlights

The main findings from the study in Nawalparasi are:

- Long-term stove use trends starting at improved stove dissemination and ending at KPT monitoring were generally consistent for all stove types, other than the Eco Chula, which decreased substantially.
- During the KPT monitoring period, median improved stove use was higher than traditional stove use, however, traditional stoves continued to be used and stove stacking was common.

- On average, participants that reported to have an outdoor stove for cooking animal feed and brewing alcohol generally used their improved stove more frequently than participants who only had an indoor stove. This may be due to those with an outdoor stove having an increased demand to meet daily cooking needs, including a higher rate of animal feed and alcohol brewing.
- Participants with an outdoor stove report to generally cook more than participants without an outdoor stove. This supports the theory that those homes with an outdoor stove, who hence frequently perform animal feed cooking and alcohol brewing, may find increased cooking capacity more attractive than homes that do not have an outdoor stove or perform these additional non-family cooking tasks.
- Nearly all improved stove groups demonstrated statistically lower fuel use (kg/SA/day) than the traditional stove group, other than the Local Chimney, which was nearly significant (p = 0.07). The Greenway showed the greatest fuel savings (50%) and the local chimney showed the least (32%) when compared to the traditional stove group.

3.2 Dang

3.2.1 Long term stove use

The Dang stove use trends (Figure **11**) includes all SUMs data between June 2015 and January 2016, except for the three month period when the iButton memory was exhausted because visits to the field were delayed. During the initial three months of stove usage monitoring, all stove types showed relatively flat trend-lines, other than the Local Chimney group, which showed a slightly decreasing usage trend, and the Greenway and Eco-Chula, which experienced a spike in use during mid-August. Despite the continued-use trend observed in Figure **11**, it appears that during the four months in which no visits to Dang were possible, between the start of monitoring in June 2015 and the end of monitoring in January 2016, improved stove usage decreased in all groups. Eco Chula and Xunda use declined to close to zero events per day, on average, by mid-December. Prakti use was reduced by approximately two fold, from the beginning of the monitoring period to the end. Greenway use went down by approximately 50 percent and demonstrated substantial variability from month to month. The Local Chimney was used most frequently of all of the improved stoves, but still was used about 40% less frequently than when initially disseminated. The reduced use of the improved stove is accompanied by a 1.5 fold increase in traditional stove use by the improved stove user groups between June 2015 and January 2016.
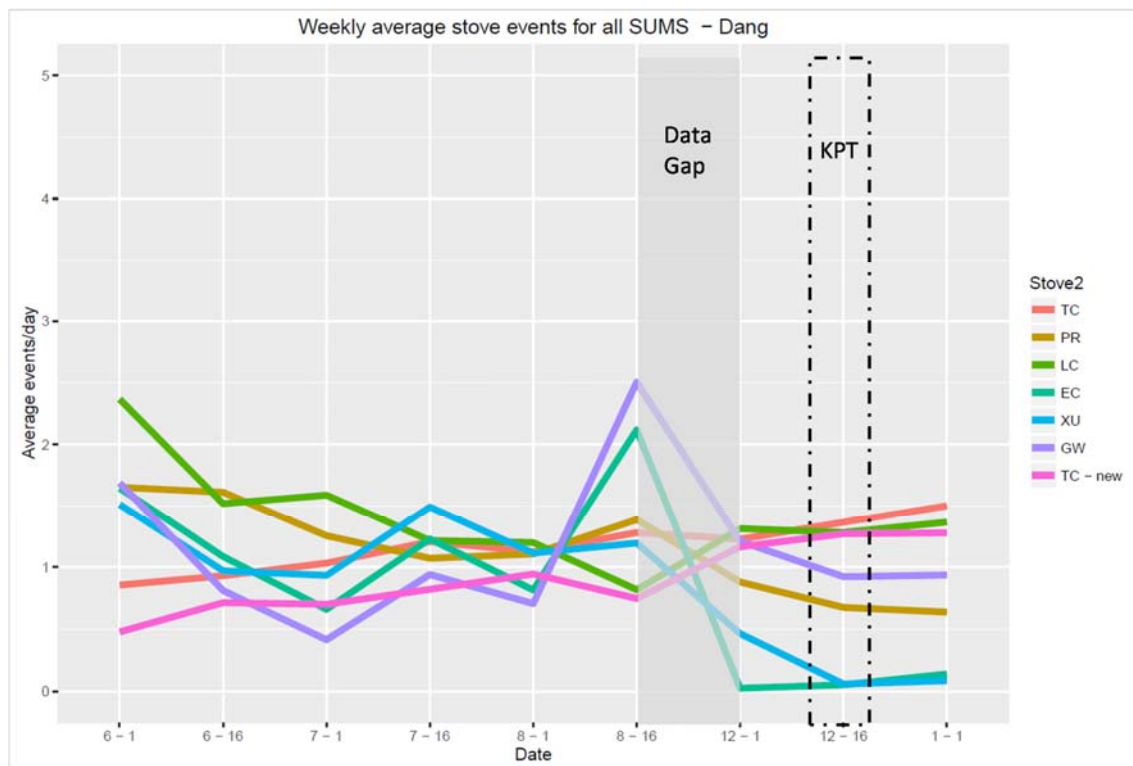
Figure 11**. Twice-monthly binned averages for the different stove-specific participant groups over a four month SUMS sampling period. Months September through November are not represented due to an inability to make field visits during a time of political turbulence. Stove-specific participant groups are Greenway (GW), Eco-Chula (EC), Prakti (PR), Local Chimney (LC), Xunda (XU), Traditional Stove belonging to the improved groups (TC – New), and Traditional Stove in the baseline group (TC). The bin containing the KPT is shown as the dashed box. The data gap when field visits were not possible is grayed out. Error bars represent ±1 standard deviation.**

3.2.2   Stove use during the KPT

Figure 12 shows stove use data collected during the KPT and reveals that complete traditional stove displacement did not occur in any of the improved stove user groups. On the contrary, traditional stoves continued to be used in all intervention groups at nearly the same rate as the traditional stove was used by the traditional stove group, between 1.5 and 2.0 times per day. This means any use by the improved stoves was in addition to the typical traditional stove cooking frequency. Median use of the improved stove by the Eco Chula, Prakti, and Xunda groups was between 0 and 0.5 times per day. The Local Chimney and Greenway were used slightly more frequently, about 1 and 2 times per day, although there was a lot of variability in use in these groups and the traditional stove was still frequently used. The prevalence of stove stacking and continued traditional stove use in the improved stove user group is also apparent in the substantial decreasing trend of improved stove usage and increasing trend of the traditional stove usage over time shown in Figure **11**.
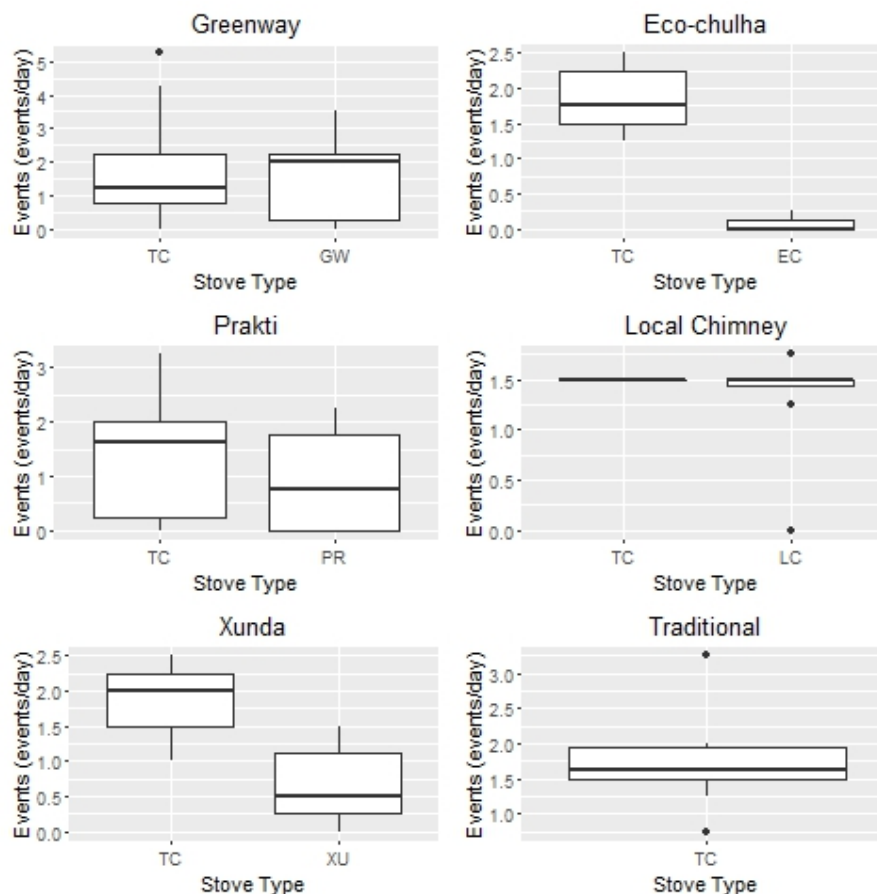
Figure 12. Events per day of the different stove types in each household, grouped by stove-specific study group, during the four-day KPT monitoring period in Dang. Stove-specific participant groups are Greenway (GW): N = 9, Eco-Chula (EC): N = 8, Prakti (PR): N = 12, Local Chimney (LC): N = 8, Xunda (XU): N = 6, Traditional Stove (TC): N = 10. Boxes indicate the 25th and 75th percentile (the lower and upper quartiles (IQR), respectively), and the band near the middle of the box is the 50th percentile (the median). The whiskers represent 1.5*IQR.

3.2.3   Reported stove use

During the KPT survey, participants reported their stove use events over the four day period. These events were separated by traditional (N=14) and improved user groups (N=59), with all improved user groups combined into a single group for simplicity. Indoor and outdoor cooking was not differentiated in Dang due to the small number of outdoor stove users. Figure 13 shows that reported family cooking events in the improved stove user group (10.03 events/day) was 1.96 events/day less than the traditional stove user group (8.07 events/day), meaning that more family cooking was being completed in homes that had a new stove. However, only slightly more (0.32 events/day) animal feed and brewing events were reported by the improved user group (1.75 events/day) than in the traditional group 1.43 events/day).
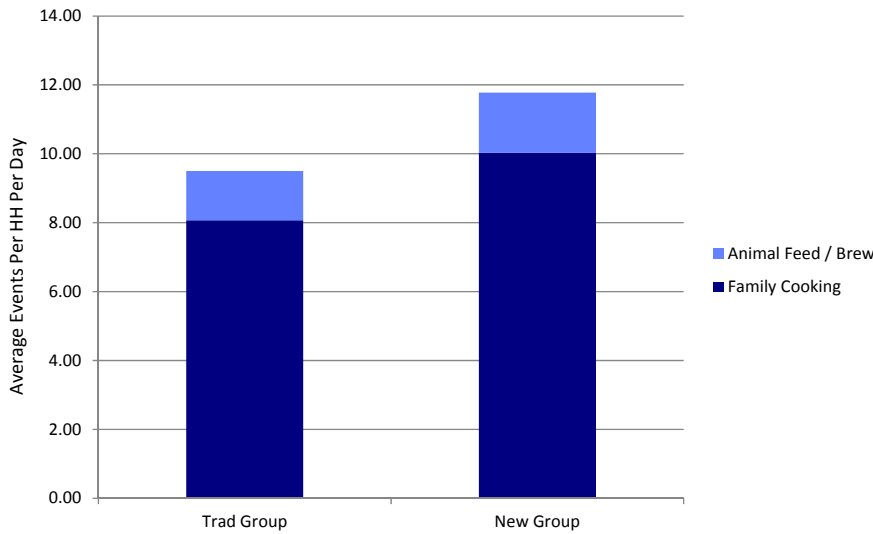
Figure 13. Average reported family cooking and animal feed plus brewing events per household per day on the traditional group and the improved group.

3.2.4   Fuel Use

In Dang, none of the participants from the traditional stove group cooked on an outdoor stove and, in general, the use of an outdoor stove was much less prevalent than in Nawalparasi, only occurring in 16 percent (n=12) of homes. Therefore, participants were not differentiated by indoor and outdoor stove use during analysis. For all users, there was no statistically significant difference in fuel use between the improved and traditional stove groups. A separate analysis, excluding outdoor stove users, ensured that animal feed cooking and brewing, highly fuel-intensive tasks, were not biasing the data, however, it did not reveal any statistically significant difference in fuel consumption between improved and traditional user groups. An additional sub-analysis of users which do not heat their homes, a common occurrence in Dang, also did not exhibit significant fuel savings.

Table 5. Dang Kitchen Performance Test results in all homes (top) and all homes that did not use outdoor stoves for cooking animal feed and/or brew alcohol (bottom). Results of fuel use per standard adult per day (kg/SA/day) are grouped by stove types, including five improved stoves and one traditional stove.

Dang					
All Users - All stoves					
Fuel use on all stoves (kg/SA/day)	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
Mean	1.6	1.4	1.6	2.2	2.4	1.5
SD	1.0	0.7	1.0	1.4	1.5	0.4
N	14	14	13	12	11	8
% difference of means		15%	2%	-32%	-46%	10%
p-value		0.47	0.95	0.28	0.15	0.59

Indoor Only Users					
Fuel use on all stoves (kg/SA/day)	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
Mean	1.6	1.3	1.6	2.2	2.6	1.4
SD	1.0	0.5	1.0	1.5	1.6	0.3
N	14	11	12	9	9	7
% difference of means		18%	3%	-35%	-61%	16%
p-value		0.34	0.89	0.32	0.13	0.39

Figure 14 shows combined fuel use for the different improved stove groups and the traditional group, which shows that the improved stove groups did not use less fuel during the KPT than the traditional group.
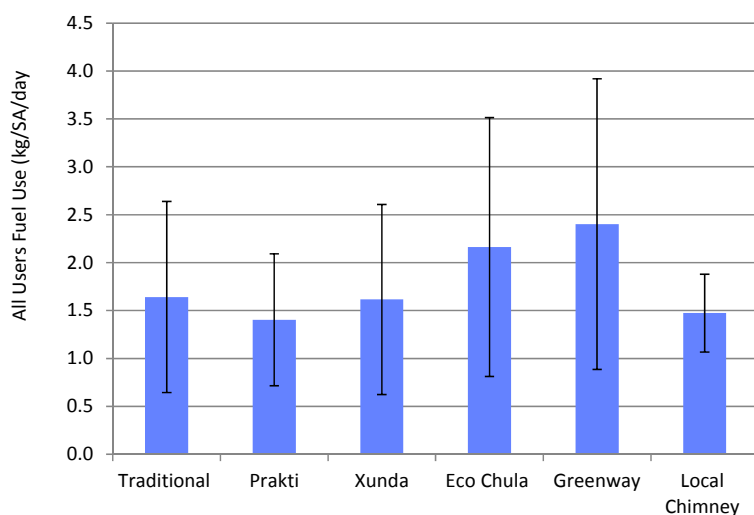
Figure 14. Fuel use in Dang during the three day KPTs, for all stoves in all households. Error bars indicate ± 1 standard deviation.

3.2.5   Dang highlights

The main findings from the study in Dang are:

- Long-term stove use trends between improved stove dissemination and through the warm season were generally consistent for all stove types. After a three month data gap leading into the cold season, improved stove use went down on all accounts other than the Local

Chimney. Associated traditional stove use by the improved user group went up during that time.

- During the KPT monitoring period, median traditional stove use by the improved user group was similar to the baseline traditional group. Improved stove use was generally low, with the Local Chimney stove used most frequent and the Eco Chula used the least frequently.
- On average, improved stove participants report to cook family meals more frequently than the traditional group. Both groups cook animal feed or brew alcohol at similar rates.
- None of the intervention study groups saved fuel when compared to the traditional stove group.

4. Discussion

4.1 Nawalparasi

The stove use and total fuel use results from the full participant pool in Nawalparasi and tells a promising story of traditional stove displacement and fuel savings. The way and location in which the different stoves were being used varied in this area of rural Nepal and allowed for several separate sub-analyses to help depict stove use behavior and improve stove impact in the area.

SUMs data reveals substantial displacement of the traditional stove by the use of the improved stove in all user groups in Nawalparasi. This finding is clear both during the long-term observations and during the KPT-specific assessment. The one stove that showed a decreasing use trend over time was the Eco-Chula, which started with very high use rates, around 2 times per day, upon dissemination with a steady decrease over time, falling to about 0.5 times per day by the end of monitoring. Regardless, fuel savings were still apparent in the Eco Chula user group during the KPT assessment.

Reported stove use and SUMs data revealed that all indoor and outdoor stove user groups cooked approximately the same amount on their indoor stoves, however, the improved stove user group reported to cook about 18 percent fewer events on the outdoor stove than the traditional user group. The improved stove indoor-only group reported to cook around three events per day, approximately 39 percent fewer events than the corresponding traditional group's average of five events per day. The SUMS data, however, does not seem to corroborate this finding, showing instead that traditional stove events average closer to two per day in the traditional stove group. It should be noted, however, that the technique for counting events by these different methods is not the same. Participants may report as "events" several tasks accomplished during a single stove lighting, while SUMs will record a single event when the stove is lit. For example, a participant may report three events for a single stove lighting -- cooking animal feed, heating bath water, and making dinner -- while SUMs measurements will quantify this as one event.

The substantial amount of fuel-intensive cooking tasks done on outdoor traditional stoves in Nawalparasi meant that fuel savings resulting from the use of the improved stoves could potentially be masked by tasks completed on the outdoor traditional stove, hence the separate fuel inventories for the different stove types. In both the outdoor and indoor fuel piles, however, fuel savings were apparent. The outdoor stove fuel use by the traditional stove group was significantly higher than in any of the improved groups. This could be due to families moving family cooking events, and

potentially also animal feed or brewing events, from the outdoor stove to the indoor improved stove, a hypothesis that is supported by the smaller number of outdoor stove events reported by the improved user group than by the traditional group. The indoor stove fuel use was significantly lower in the Prakti, Eco Chula, and Greenway groups than the traditional group. The Xunda and Local Chimney groups did not show significantly lower fuel use on indoor stoves, but this may have been due to a large shift of previously outdoor cooking to indoor stoves. This explanation is supported by the finding that Xunda and Local Chimney users had two of the greatest outdoor stove fuel use savings in comparison to the traditional group, (72% (p <0.05) and 57% (p = 0.05), respectively).

The indoor-only improved stove users in Nawalparasi, while all using less fuel than the traditional group, did not show statistically significant differences in fuel use, but this is likely due to the small sample size not having enough power to detect significant differences.

4.2   Dang

The KPT in Dang was performed six months after participants received their improved stoves. During that time it appears that usage of all improved stoves decreased considerably, which corresponds to the lack of fuel savings in any of the improved groups when compared to the traditional stove. The lack of fuel savings is supported by the consistent use of the traditional stove by the improved stove user groups at approximately the same frequency as the traditional stove group. It appears that any improved stove use was in addition to the normal rate of traditional stove use, which is in agreement with the additional 2.0 family cooking events per day reported by the improved group when compared to the traditional group.

One potential reason for why the improved stove use decreased during the Dang KPT, could be that temperatures were much cooler than during the Nawalparasi KPT, evidenced by the higher rate of user-reported heating in Dang (28 instances) than in Nawalparasi (0 instances). While an analysis of Dang participants who reported not to heat their homes during the KPT also failed to show statistically significant differences in fuel use between the improved and traditional stove users, these results to do not rule out heating as a potential explanation for the results. It is possible that Dang participants preferred to use the traditional stove over the improved stove during cold winter months because it created more latent heat during cooking, even though they did not report actively heating their homes. This finding also follows the trend of generally consistent improved stove use over the summer months, with a substantial drop in the winter months. The one stove group that showed consistent improved stove use was the Local Chimney group, which is the one stove that has a large thermal mass and might potentially provide more heat when compared to the lower thermal mass improved stoves. Additionally, the number of outdoor stoves and frequency of preparing animal feed and brewing in Dang was lower than Nawalparasi. This may mean that participants in Dang did generally less cooking than in Nawalparasi, causing a suppressed demand for additional stoves when compared to Nawalparasi and contributing to the incidence of unused improved stoves in Dang.

4.3   Comparisons with the CCT

In an earlier, associated Controlled Cooking Test (CCT) in Nepal (Berkeley Air 2015), all five of the improved stoves had significantly lower specific fuel consumption than the Traditional stove, with savings ranging from 29 to 47 percent. While the performance outcomes from the CCTs provide an indication of the potential these stoves may have, they do not consider real-world conditions,

including stove use or stove stacking. The discrepancy in fuel savings between the CCT and KPT can likely be attributed to continued use of the traditional stove and a declined use of the improved stove after dissemination, as is evident from the SUMS data in Dang. For example, in Dang, improved stove use is three times higher at the start of the monitoring period than the end, and the reduced use of the improved stove is accompanied by a dramatic increase in traditional stove use. Further, the CCT is structured to measure family meals and does not consider the prevalent practices of animal cooking or alcohol brewing, which seem to heavily impact fuel use. On average, homes that cooked food for animals and/or brewed alcohol used 1.70 kg/SA of fuel per day whereas homes that did not, used only 1.55 kg/SA of fuel per day.

5. Recommendations for the Future

Results from this study have provided insight on stove usage, sustained use, and fuel savings, as well as provided some contextual information on cooking and stove use behavior in Nepal. This information could be enriched by the following additional investigations.

- Further feedback from participants on their stove use experience will help to better understand the potential for these cookstoves to be absorbed into communities. This would also help inform which of the improved stoves has the most potential to make an impact in Nepali homes similar to those in the study districts of Nawalparasi and Dang.
  - o Research into seasonal differences in cookstove use, specifically focusing on how seasonal changes may act as a barrier to improved stove adoption, may clarify trends observed here.
- While the stoves studied during this project seem to have been well received during the summer in both Nawalparasi and Dang, in Dang in winter the stoves were essentially abandoned. Further investigation into seasonal impacts on stove adoption by performing longer-term stove use monitoring could help to understand this observation, with the potential to see community's re-uptake stoves with another seasonal shift.
- An investigation into what tasks are most commonly completed on the continually used traditional stoves may provide an indication of what the improved stoves are lacking in terms of cooking capacity.
- Performing another usage study in a diverse range of locations could allow an assessment of improved stove use by culturally different Nepali communities.
- An improved usage sensor, such as one with short message service (sms) capabilities or a larger memory, would provide more security when working in difficult to reach locations.
- Investigate the influence of gender on the uptake and sustained use of improved stoves. A greater presence of men in kitchens, possibly doing non-family cooking tasks, such as brewing alcohol and cooking animal feed, may contribute to a community's inclination to adopt improved stoves.

6. References

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7. Appendices

7.1 Scale Calibration and Maintenance

Example of scale maintenance database:

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%

7.2 Field team

7.3   Field Sampling Form

Kitchen Performance Tests

Participant Identification Sheet

Use this form for BOTH traditional and improved stove households

A. Participant Identification			
A1	Date [dd / mm / yyyy]	_ _ / _ _ / _ _ _ _	
A2	Time of visit [hh:mm] 24-hr time	_ _ : _ _	
A3	Household ID		
A4	Study district [circle one]	Nawalparasi	1
		Dang	2
A5	Village/ cluster name [circle one]	Bulingtar; Dalit tole	1
		Bulingtar: Magar tole	2
		Satbariya	3
		Fulbari	4
A6	Study group [circle one]	Greenway	1
		Prakti	2
		Xunda	3
		Eco-Chula	4
		Local Chimney	5
		Trad Stove	6
A7	Surveyor Name/ ID		
A8	Name of main cook		
A9	Age of main cook		
A10	Telephone number		

Kitchen Performance Tests: DRAFT Version

Visit 1

B. Household Demographic Information: Visit #1		
Date [dd-mm-yy]	_ _ / _ _ / _ _ _ _	
Time of visit [hh:mm] 24-hr time	_ _ : _ _	
B1	How many people usually EAT food from your household stoves each day at this time of year? Note; This can include people outside your direct family but eat from your stove on a regular basis at this time of year.	
B2	Number of children aged 0- 14 years old currently eating food made on stoves in this home?	

B3	Number of females 15+ years old currently eating food made on stoves in this home?	
B4	Number of males 15-59 years old currently eating food made on stoves in this home?	
B5	Number of males 60+ years old currently eating food made on stoves in this home?	

[Note: Before moving on please make sure the totals of everyone eating from the household stoves from questions B2-B5 equals the amount given by the participant for B1]

C. Cooking and fuel: Visit #1

C1	Main stove type *[Only include 1 stove type. Use codes from sheet. If 'other stove type not on list enter 99 and describe.]*			
C2	Where do you usually use this stove at this time of year?	Inside		1
		Outside		2
		Both places		3
C3	C3.1 Secondary stove(s) types used at least once per week *[Use codes from sheet]* C3.2 Where do you use this stove? *[Ask about all stoves used by the household at least once per week and enter all information. If they have no secondary stove please enter a '77']*		Stove code	Inside=1 Outside=2 Both places=3
		1st		
		2nd		
		3rd		
C4	Do you have a stove used mostly for making animal feed/brewing alcohol?	Yes		1
		No [go to C6]		2
C5	Which stove type do you mostly use for making animal feed/brewing alcohol? *[Use codes from sheet]*			
C6	How would you describe the current season? *[Write down exactly what the participant says]*			
C7	Do you currently use more, less, or the same amount of wood fuel per day this time of year as at other times of the year?	1= More *[Answer C8]* 2= Less *[Answer C9]* 3= Same *[Go to D1]*		
C8	For what reasons do you currently use more wood at this time of year? *[Do not prompt. Select all that apply]*	To heat the room(s)		1
		Wood is wet/rainy season		2
		To heat water		3
		Cook different types of food		4
		Cook for more people		5

	*Describe 'other'*_____ _____	Other [*Enter 99 and describe*]	99
C9	For what reasons do you currently use less wood at this time of year? [*Do not prompt. Select all that apply*] *Describe 'other'*_____ _____	Do not need to heat room(s)	1
		The wood is dry	2
		Cook different types of food	3
		Cook for less people	4
		There are agricultural residues	5
		Other [*Enter 99 and describe*]	99

D			
D			
D1	ID # scales		
D2	ID # moisture meter		
D			

[Please ask the main cook which fuels they use on the **STOVES USED MAINLY FOR FAMILY COOKING**

Ask him/her to show you how much they use of each fuel type in one day.

Add up to 3 times more of that fuel to the pile to make a SEPARATE inventory for this stove(s). If a particular fuel type is not used please enter a 0.]

D3.1	New wood total [kg]	_ _ · _ _	D3.2	New charcoal total [kg]		_ _ · _ _
D3.3	New plastic/ rubber total [kg]	_ _ · _ _	D3.4	New crop/forest residue [kg]		_ _ · _ _
D3.5	New dung [kg]	_ _ · _ _	D3.6	New LPG		_ _ · _ _
D3.7	New other fuel total [kg]	_ _ · _ _	D3.8	Description of 'other' fuel		

W

[

		Reading 1	Reading 2	Reading 3
D3.9	Sample 1	_ _ · _ _	_ _ · _ _	_ _ · _ _
D3.10	Sample 2	_ _ · _ _	_ _ · _ _	_ _ · _ _
D3.11	Sample 3	_ _ · _ _	_ _ · _ _	_ _ · _ _

D3.12 Notes and observations from FAMILY COOKING STOVE visit 1

	D4.OUTSIDE STOVE USED MAINLY FOR ANIMAL FEED/BREWING		
D4.1	Does the household have an outdoor stove, which is used mostly for making animal feed and/or brewing with only a small amount or no household meals?	Yes	1
		No [*Finished with Day 1, review form and move to next household*]	2

[*Please ask the main cook which fuels they use on the* **STOVE USED MAINLY FOR ANIMAL FEED/BREWING**.

Ask him/her to show you how much they use of each fuel type in one day.

Add up to 3 times more of that fuel *to the pile to make an inventory for this stove. If a particular fuel type is not used please enter a 0.]*

D4.2	New wood total [kg]	_ _ . _ _	D4.3	New charcoal total [kg]	_ _ . _ _
D4.4	New plastic/ rubber total [kg]	_ _ . _ _	D4.5	New crop/forest residue [kg]	_ _ . _ _
D4.6	New dung [kg]	_ _ . _ _	D4.7	New LPG	_ _ . _ _
D4.8	New other fuel total [kg]	_ _ . _ _	D4.9	Description of 'other' fuel	

Wood Moisture Readings: ANIMAL FEED STOVE

[*Take three samples of fuel used on this stove and three readings of each sample*]

		Reading 1	Reading 2	Reading 3
D4.10	Sample 1	_ _ . _ _	_ _ . _ _	_ _ . _ _
D4.11	Sample 2	_ _ . _ _	_ _ . _ _	_ _ . _ _
D4.12	Sample 3	_ _ . _ _	_ _ . _ _	_ _ . _ _

D4. 13 Notes and observations from ANIMAL FEED STOVE visit 1

Kitchen Performance Test: Visit 2

F: VISIT #2			
F1	Date [dd-mm-yy]	_ _ / _ _ / _ _ _ _	
F2	Time of visit [hh:mm] 24-hr time	_ _ : _ _	
F3	Household ID		
F4	Surveyor Name/ ID		
F5	Study group	Greenway	1
		Prakti	2
		Xunda	3
		Eco-Chula	4
		Local chimney	5
		Trad Stove	6

G. Fuel measurements: Visit #2			
ASK THE COOK ABOUT **ALL** FUELS USED ON ALL THEIR STOVES			
G1	ID # scales		
G2	ID # moisture meter		

G3.STOVES USED MAINLY FOR FAMILY COOKING

[NOTE: *Ensure this refers to stove or group of stoves documented as the 'main family cooking stove(s)' on visit #1. If a particular fuel type is not used please enter a 0.*]

G3.1	Unused wood total [kg]	_ _ . _ _	G3.2	Unused charcoal total [kg]	_ _ . _ _
G3.3	Unused plastic/ rubber total [kg]	_ _ . _ _	G3.4	Unused crop/forest residue [kg]	_ _ . _ _
G3.5	Unused dung [kg]	_ _ . _ _	G3.6	Unused LPG	_ _ . _ _
G3.7	Unused other fuel total [kg]	_ _ . _ _	G3.8	Description of 'other' fuel	

[NOTE: Combine unused fuel from previous day with any new fuel added to fuel inventory and weight all together for "New" fuel]

G3.9	New wood total [kg]	_ _ . _ _	G3.10	New charcoal total [kg]	_ _ . _ _
G3.11	New plastic/ rubber total [kg]	_ _ . _ _	G3.12	New crop/forest residue [kg]	_ _ . _ _
G3.13	New dung [kg]	_ _ . _ _	G3.14	New LPG	_ _ . _ _
G3.15	New other fuel total [kg]	_ _ . _ _	G3.16	Description of 'other' fuel	

Wood Moisture Readings: FAMILY COOKING STOVE(S)

[*Take three samples of fuel used on this stove and three readings of each sample*]

		Reading 1	Reading 2	Reading 3
G3.17	Sample 1	_ _ . _ _	_ _ . _ _	_ _ . _ _
G3.18	Sample 2	_ _ . _ _	_ _ . _ _	_ _ . _ _

G3.19	Sample 3	_ _ . _ _		_ _ . _ _		_ _ . _ _	

Stove **Events: FAMILY COOKING STOVE(S)**

G3.20- G3.26	What stoves have you used since my last visit? What did you use these stoves for? Please include all tasks such as making reheating food, heating bathing water etc as well as all cooking events. How many people did you cook for at each stove event?

	G3.20	G3.21	G3.22	G3.23	G3.24	G3.25	G3.26
Stove type *[use codes]*							
Event *[use codes]*							
Number of people cooked for [*If event is not for feeding people, i.e. heating, enter the duration in hours followed by "hrs"*]							

G3.27	Notes/observations for 'FAMILY COOKING STOVE' stove/fuel use *[Explain other types of stove use and events here].*

G4.OUTSIDE STOVE USED MAINLY FOR ANIMAL FEED/BREWING		

G4.1	Does the household have an outdoor stove, which is used mostly for making animal feed and/or brewing with only a small amount or no household meals?	Yes	1
		No [Go to G4]	2

[NOTE: *Ensure this refers to stove documented as the 'animal feeding' stove on visit #1. If a particular fuel type is not used please enter a 0.*]

G4.2	Unused wood total [kg]	_ _ . _ _	G4.3	Unused charcoal total [kg]	_ _ . _ _
G4.4	Unused plastic/ rubber total [kg]	_ _ . _ _	G4.5	Unused crop/forest residue [kg]	_ _ . _ _
G4.6	Unused dung [kg]	_ _ . _ _	G4.7	Unused LPG	_ _ . _ _
G4.8	Unused other fuel total [kg]	_ _ . _ _	G4.9	Description of 'other' fuel	

[NOTE: *Combine unused fuel from previous day with any new fuel added to fuel inventory and weight all together for "New" fuel*]

G4.10	New wood total [kg]	_ _ . _ _	G4.11	New charcoal total [kg]	_ _ . _ _
G4.12	New plastic/ rubber total [kg]	_ _ . _ _	G4.13	New crop/forest residue [kg]	_ _ . _ _
G4.14	New dung [kg]	_ _ . _ _	G4.15	New LPG	_ _ . _ _
G4.16	New other fuel total [kg]	_ _ . _ _	G4.17	Description of 'other' fuel	

	G4.21	G4.22	G4.23	G4.24	G4.25	G4.26	G4.27
Stove type *[use codes]*							
Event *[use codes]*							
Duration [hrs] [*If the event is for particular people, i.e. a meal cooked, enter number of*							

people cooked for followed by "people"]								

G4.28	Notes/observations for 'ANIMAL FEED' stove/fuel use. *[Explain other types of stove use and events here].*	

H. Relative Fuel Use

H1	Was the amount of fuel you used **since our last visit** more, less, or the same as you usually use in a day?	More *[Go to H2]*	1
		Less *[Go to H3]*	2
		Same *[Go to H4]*	3
H2	Please describe the reasons why you used **more** wood than you usually do. *[Do not prompt. Can circle more than one reason]* *Describe 'other'_____ _____*	Had visitors	1
		Prepared food for other days this week	2
		Cooked foods for animals	3
		Had a celebration	4
		Cooked 'hard' foods	5
		Wood was wet	6
		Made food to sell	7
		Other *[please describe]*	99
H3	Please describe the reasons why you used **less** wood than you usually do. *[Do not prompt. Can circle more than one reason]* *Describe 'other'_____ _____*	Did not eat at home	1
		Less people than usual to cook for	2
		Used different type of wood	3
		Less food available	4
		Fasting	5
		Other *[please describe]*	99

H4. Notes and observations:

Kitchen Performance Test: Visit 3

J: VISIT #3		
J1	Date [dd-mm-yy]	_ _ / _ _ / _ _ _ _
J2	Time of visit [hh:mm] 24-hr time	_ _ : _ _
J3	Household ID	
J4	Surveyor Name/ ID	

J5	Study group [circle one]	Greenway	1
		Prakti	2
		Xunda	3
		Eco-Chula	4
		Local Chimney	5
		Trad Stove	6

K. Fuel measurements: Visit #3		
ASK THE COOK ABOUT **ALL** FUELS USED ON ALL THEIR STOVES		
K1	ID # scales	
K2	ID # moisture meter	

K3.STOVES USED MAINLY FOR FAMILY COOKING

[NOTE: *Ensure this refers to stove or group of stoves documented as the 'main family cooking stove(s)' on visit #1. If a particular fuel type is not used please enter a 0.*]

K3.1	Unused wood total [kg]	_ _ . _ _	K3.2	Unused charcoal total [kg]	_ _ . _ _
K3.3	Unused plastic/ rubber total [kg]	_ _ . _ _	K3.4	Unused crop/forest residue [kg]	_ _ . _ _
K3.5	Unused dung [kg]	_ _ . _ _	K3.6	Unused LPG	_ _ . _ _
K3.7	Unused other fuel total [kg]	_ _ . _ _	K3.8	Description of 'other' fuel	

[NOTE: Combine unused fuel from previous day with any new fuel added to fuel inventory and weight all together for "New" fuel]

K3.9	New wood total [kg]	_ _ . _ _	K3.10	New charcoal total [kg]	_ _ . _ _
K3.11	New plastic/ rubber total [kg]	_ _ . _ _	K3.12	New crop/forest residue [kg]	_ _ . _ _
K3.13	New dung [kg]	_ _ . _ _	K3.14	New LPG	_ _ . _ _
K3.15	New other fuel total [kg]	_ _ . _ _	K3.16	Description of 'other' fuel	

Wood Moisture Readings: FAMILY COOKING STOVE(S)

[*Take three samples of fuel used on this stove and three readings of each sample*]

		Reading 1	Reading 2	Reading 3
K3.17	Sample 1	_ _ . _ _	_ _ . _ _	_ _ . _ _
K3.18	Sample 2	_ _ . _ _	_ _ . _ _	_ _ . _ _
K3.19	Sample 3	_ _ . _ _	_ _ . _ _	_ _ . _ _

Stove Events: FAMILY COOKING STOVE(S)

K3.20-K3.26	What stoves have you used since my last visit?
	What did you use these stoves for? Please include all tasks such as making reheating food, heating bathing water etc as well as all cooking events.
	How many people did you cook for at each stove event?

	K3.20	K3.21	K3.22	K3.23	K3.24	K3.25	K3.26
Stove type *[use codes]*							
Event *[use codes]*							
Number of people cooked for [*If event is not for feeding people, i.e. heating, enter the duration in hours followed by "hrs"*]							

K3.27	Notes/observations for 'FAMILY COOKING STOVE' stove/fuel use. *[Explain other types of stove use and events here].*

K4. OUTSIDE STOVE USED MAINLY FOR ANIMAL FEED/BREWING

K4.1	Does the household have an outdoor stove, which is used mostly for making animal feed and/or brewing with only a small amount or no household meals?	Yes	1
		No [*Go to "Relative Fuel Use" questions (Section L)]*	2

[NOTE: *Ensure this refers to stove documented as the 'animal feeding' stove on visit #1. If a particular fuel type is not used please enter a 0.]*

K4.2	Unused wood total [kg]	_ _ . _ _	K4.3	Unused charcoal total [kg]	_ _ . _ _
K4.4	Unused plastic/ rubber total [kg]	_ _ . _ _	K4.5	Unused crop/forest residue [kg]	_ _ . _ _
K4.6	Unused dung [kg]	_ _ . _ _	K4.7	Unused LPG	_ _ . _ _
K4.8	Unused other fuel total [kg]	_ _ . _ _	K4.9	Description of 'other' fuel	

[NOTE: *Combine unused fuel from previous day with any new fuel added to fuel inventory and weight all together for "New" fuel]*

K4.10	New wood total [kg]	_ _ . _ _	K4.11	New charcoal total [kg]	_ _ . _ _
K4.12	New plastic/ rubber total [kg]	_ _ . _ _	K4.13	New crop/forest residue [kg]	_ _ . _ _
K4.14	New dung [kg]	_ _ . _ _	K4.15	New LPG	_ _ . _ _
K4.16	New other fuel total [kg]	_ _ . _ _	K4.17	Description of 'other' fuel	

Wood Moisture Readings: ANIMAL FEED STOVE

[*Take three samples of fuel used on this stove and three readings of each sample*]				
		Reading 1	Reading 2	Reading 3
K4.18	Sample 1	_ _ . _ _	_ _ . _ _	_ _ . _ _
K4.19	Sample 2	_ _ . _ _	_ _ . _ _	_ _ . _ _
K4.20	Sample 3	_ _ . _ _	_ _ . _ _	_ _ . _ _

Stove **Events: ANIMAL FEED STOVE**	
K4.21-K4.27	What have you used this stove for since my last visit? Approximately how long did each event last? Please include all tasks such as making animal feed, warming bath water, brewing drinks, etc as well as all cooking events.

	K4.21	K4.22	K4.23	K4.24	K4.25	K4.26	K4.27
Stove type *[use codes]*							
Event *[use codes]*							
Duration [hrs] [*If the event is for particular people, i.e. a meal cooked, enter number of people cooked for followed by "people"*]							

K4.28	Notes/observations for 'ANIMAL FEED' stove/fuel use. *[Explain other types of stove use and events here].*

L. Relative Fuel Use			
L1	Was the amount of fuel you used **since our last visit** more, less, or the same as you usually use in a day?	More *[Go to L2]*	1
		Less *[Go to L3]*	2
		Same *[Go to L4]*	3
L2	Please describe the reasons why you used **more** wood than you usually do. *[Do not prompt. Can circle more than one reason]* *Describe 'other'_____*	Had visitors	1
		Prepared food for other days this week	2
		Cooked foods for animals	3
		Had a celebration	4
		Cooked 'hard' foods	5
		Wood was wet	6
		Made food to sell	7
		Other *[please describe]*	99

	_____		
L3	Please describe the reasons why you used **less** wood than you usually do. *[Do not prompt. Can circle more than one reason]* *Describe 'other'_____* _____	Did not eat at home	1
		Less people than usual to cook for	2
		Used different type of wood	3
		Less food available	4
		Fasting	5
		Other *[please describe]*	99
L4. Notes and observations:			

Kitchen Performance Test: Visit 4

M: VISIT #4			
M1	Date [dd-mm-yy]	_ _ / _ _ / _ _ _ _	
M2	Time of visit [hh:mm] 24-hr time	_ _ : _ _	
M3	Household ID		
M4	Surveyor Name/ ID		
M5	Study group [circle one]	Greenway	1
		Prakti	2
		Xunda	3
		Eco-Chula	4
		Local chimney	5
		Trad Stove	6

N. Fuel measurements: Visit #4		
ASK THE COOK ABOUT **ALL** FUELS USED ON ALL THEIR STOVES		
N1	ID # scales	
N2	ID # moisture meter	

N3.STOVES USED MAINLY FOR FAMILY COOKING
[NOTE: *Ensure this refers to stove or group of stoves documented as the 'main family cooking stove(s)' on visit #1. If a particular fuel type is not used please enter a 0.]*

N3.1	Unused wood total [kg]	_ _ . _ _	N3.2	Unused charcoal total [kg]	_ _ . _ _
N3.3	Unused plastic/ rubber total [kg]	_ _ . _ _	N3.4	Unused crop/forest residue [kg]	_ _ . _ _
N3.5	Unused dung [kg]	_ _ . _ _	N3.6	Unused LPG	_ _ . _ _
N3.7	Unused other fuel total [kg]	_ _ . _ _	N3.8	Description of 'other' fuel	

Stove **Events: FAMILY COOKING STOVE(S)**							
N3.9-N3.15	What stoves have you used since my last visit? What did you use these stoves for? Please include all tasks such as making reheating food, heating bathing water etc as well as all cooking events. How many people did you cook for at each stove event?						

	N3.9	N3.10	N3.11	N3.12	N3.13	N3.14	N3.15
Stove type *[use codes]*							
Event *[use codes]*							
Number of people cooked for [*If event is not for feeding people, i.e. heating, enter the duration in hours followed by "hrs"]*							

N3.16	Notes/observations for 'FAMILY COOKING STOVE' stove/fuel use. *[Explain other types of stove use and events here].*

N4.OUTSIDE STOVE USED MAINLY FOR ANIMAL FEED/BREWING				
N4.1	Does the household have an outdoor stove, which is used mostly for making animal feed and/or brewing with only a small amount or no household meals?	Yes		1
		No [Go to "Relative Fuel Use" questions (Section P)]		2

[NOTE: *Ensure this refers to stove documented as the 'animal feeding' stove on visit #1. If a particular fuel type is not used please enter a 0.]*

N4.2	Unused wood total [kg]	_ _ . _ _	N4.3	Unused charcoal total [kg]	_ _ . _ _
N4.4	Unused plastic/ rubber total [kg]	_ _ . _ _	N4.5	Unused crop/forest residue [kg]	_ _ . _ _
N4.6	Unused dung [kg]	_ _ . _ _	N4.7	Unused LPG	_ _ . _ _
N4.8	Unused other fuel total [kg]	_ _ . _ _	N4.9	Description of 'other' fuel	

Stove **Events: ANIMAL FEED STOVE**							
N4.10-N4.16	What have you used this stove for since my last visit? Approximately how long did each event last? Please include all tasks such as making animal feed, warming bath water, brewing drinks, etc as well as all cooking events.						

	N4.10	N4.11	N4.12	N4.13	N4.14	N4.15	N4.16

Stove type *[use codes]*							
Event *[use codes]*							
Duration [hrs] *[If the event is for particular people, i.e. a meal cooked, enter number of people cooked for followed by "people"]*							

	Notes/observations for 'ANIMAL FEED' stove/fuel use. *[Explain other types of stove use and events here].*
N4.17	

P. Relative Fuel Use			
P1	Was the amount of fuel you used **since our last visit** more, less, or the same as you usually use in a day?	More *[Go to P2]*	1
		Less *[Go to P3]*	2
		Same *[Go to P4]*	3
P2	Please describe the reasons why you used **more** wood than you usually do. [Do not prompt. Can circle more than one reason] *Describe 'other'_____ _____*	Had visitors	1
		Prepared food for other days this week	2
		Cooked foods for animals	3
		Had a celebration	4
		Cooked 'hard' foods	5
		Wood was wet	6
		Made food to sell	7
		Other *[please describe]*	99
P3	Please describe the reasons why you used **less** wood than you usually do. *[Do not prompt. Can circle more than one reason]* *Describe 'other'_____ _____*	Did not eat at home	1
		Less people than usual to cook for	2
		Used different type of wood	3
		Less food available	4
		Fasting	5
		Other *[please describe]*	99

P4. Notes and observations:

END OF MONITORING. Please review form and move to next household.