



Understanding Consumer Preferences and Willingness to Pay for Improved Cookstoves in Nepal

FINAL REPORT

JUNE 2016



ABOUT WASHPLUS

The WASHplus project supports healthy households and communities by creating and delivering interventions that lead to improvements in WASH and household air pollution (HAP). This multi-year project (2010-2016), funded through USAID's Bureau for Global Health and led by FHI 360 in partnership with CARE and Winrock International, uses at-scale programming approaches to reduce diarrheal diseases and acute respiratory infections, the two top killers of children under age 5 globally.

RECOMMENDED CITATION

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ACRONYMS

AEPC	Alternative Energy Promotion Centre
CCS4All	Clean Cooking Solutions for All
CCT	Controlled Cooking Test
HH	Household
ICS	Improved cookstove
KPT	Kitchen performance test
LPG	Liquid petroleum gas
RDN	Right Direction Nepal
SUM	Stove use monitor
TIPs	Trials of Improved Practices
USAID	United States Agency for International Development
VDC	Village Development Committee
WASH	Water, sanitation and hygiene

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EXECUTIVE SUMMARY

Objectives and Methods

The USAID Asia Regional Bureau and Bureau of Global Health provided funding to the WASHplus project to explore consumer reactions to different manufactured, improved cookstoves shown to be efficient in the lab and popular in markets similar to Nepal, in order to make recommendations to the Government of Nepal's national cookstove program regarding the expansion of the program to include a selection of improved cookstoves (ICS) offered in the country. Specifically, the objectives of this study were to:

1. Elicit desired attributes and benefits of cookstoves (both improved and traditional stoves) from the viewpoint of the poor Nepali consumer
2. Document and compare consumer reactions, including willingness to pay, and consistency of use of five types of improved cookstoves in Nepal
3. Test the efficiency of the improved cookstoves and impact on in-home household fuel use

The WASHplus research in Nepal was designed in close consultation with Alternative Energy Promotion Center (AEPC), which is the government institution tasked with developing and promoting renewable and alternative energy technologies in Nepal, and the lead agency for the ambitious Clean Cooking Solutions for All by 2017 (CCS4All 2017) initiative.

To meet study objectives, WASHplus designed a mixed methods study combining a consumer preference methodology called Trials of Improved Practices, or TIPs, which tests and measures audience trials of products and behaviors over time, and other quantitative methods used in the marketing and household energy fields.

TIPs includes semi-structured questionnaires—qualitative and quantitative elicitation questions, asked at baseline, around one week, and at 16 weeks. In addition to the TIPs questionnaires, the following methods were added to achieve study objectives:

- Willingness to pay (two methods)
- Stove and fuel use monitoring
- Marketplace demonstrations reaching a slightly upper market segment of consumers

Districts and subdistricts were purposively selected to meet key criteria, including wood as the primary cooking fuel but where households do not depend on wood for heating. Households were then screened for key criteria and finally randomly selected into the study. The trials were undertaken in 136 households split among two clusters of Nawalparasi (totaling 70 households) and 33 households in each of two clusters of Dang (totaling 66 households).

Five stoves were selected for testing based on their particular characteristics as well as the variety of stove features they presented together as a group (single/double pot, built-in-place/portable, natural draft/ solar/battery). These stoves were:

1. Prakti—portable, metal, two-pot, with chimney
2. Greenway—portable, metal, one-pot, no chimney
3. EcoChula—portable, metal, one-pot, fan, no chimney
4. Xunda—portable, metal, one-pot, no chimney
5. Improved mud stove—fixed, mud, two-pot, with chimney (Local Chimney)

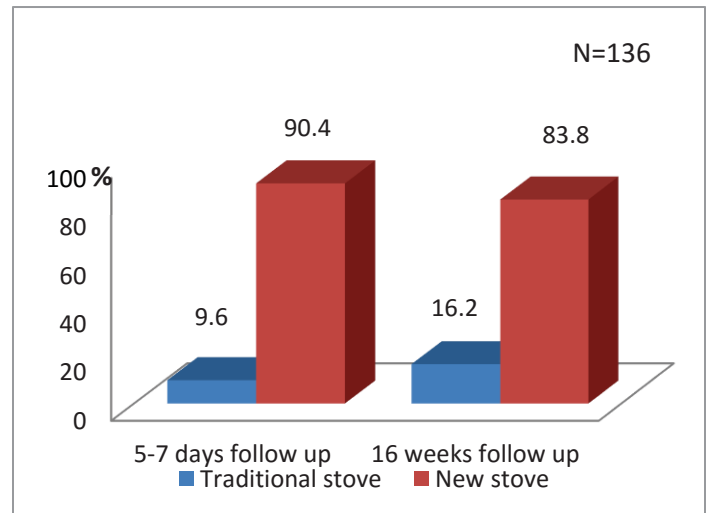
Findings

Consumer Preference

The five improved cookstoves were tested over time. The ICS were liked overall by the majority of cooks and households trying them; ICS are preferred by cooks over their traditional stoves, and the preference holds over time. Many cooks demonstrated clear willingness to pay a fair market price for the stoves. At both seven days and 16 weeks, the majority observed less smoke (91.9 percent); and many reported fewer ashes and a cleaner house. Likewise, at 16 weeks the majority (91.2 percent) said the new ICS used less fuel than their old stove and a few felt it consumed about the same amount (7.4 percent), measures almost identical to those at one week.

More than half reported the house and kitchen remained clean (51.8 percent). Respondents preferred the new cookstoves, after a week and after 16 weeks (see graph at right). Preference varied by stove type, with the Local Chimney users most enthusiastic about their new stoves over time, followed by Xunda, Greenway, EcoChula, and Prakti. The reasons given for preferring the ICS to the traditional stove are presented in aggregate in the word cloud below the graph.

Preferred stove after one and 16 weeks, and reasons given for preference of ICS (larger font represents higher frequency of response).



Responses from the 5–7 day survey showed most people found Nepali main course items such as rice, daal (lentils), vegetables, and meat cooked better on the new stove. They said foods that cooked better on their old stove were large-quantity items, like liquor, animal feed, and rice for



Above is a word cloud image that represents what cooks liked about the new ICS at the 5-7 day survey. Larger print represents higher frequency of response; font size is proportional and accurate.

many people. Post-trial data showed participants continued to use their old stoves for those activities, and for heating the house (despite the fact that not using wood to heat the house was a criteria for inclusion in the study). Cooks found activities requiring big vessels and large amounts of wood unsuitable for the new stove. At the post-trial survey, some cooks were using the ICS for activities they had initially thought were not possible during the 5–7 day follow up, such as making liquor, making food in big pots, and cooking chapatti.

Most participants did not encounter any problem with the functioning of their new stove. However, 30 respondents cited at least one problem, of which a few had multiple problems. Prakti users (9/28) had the most problems, followed by EcoChula users (7/28), Xunda users (6/28), Greenway (5/28), and Local Chimney users (3/24). The most common problem was starting the fire (15/30), which took longer, some cooks mentioned specifically (5/30), because they were not able to start the fire with plastics (at the request of researchers). Another issue was needing to remain in the kitchen longer as the fire went out early (6/30), and needing to add wood to keep the fire going (5/30). A few reported that they could not use large pieces of wood as they could in with their old stoves (3/30).

Five respondents slightly modified their stoves to make it easier to use (which was allowed if deemed helpful); two of them added an extra foot of chimney pipe, two made a chimney of tin for the Local Chimney to fit the layout of the house, and one Xunda user used rope to secure the stove's wood stand because it was loose.

When invited to suggest changes to improve the stoves, participants recommended a larger opening for fuel (65/120), a larger stove size (53/120), and better stability (18/120). EcoChula users suggested that the stove should have a separate grate for large pieces of wood (6/28) and suggested adding a chimney (4/28). Some of these changes would have negative impacts on stove efficiency and/or emissions and would have to be evaluated by manufacturers.

More than a half of the respondents (71/136) said they modified their cooking styles for the new stove. Cooks had to prepare everything before starting the fire or the fire would go to waste (32/71), and they had to chop wood into smaller pieces (33/71). When the respondents were asked what they didn't like about the new stove, more than half (55.4 percent) said they didn't like being unable to use wet or undried wood as they could with their old stove; 49.3 percent

said it took more time to chop the wood into small pieces; 46.3 percent said they needed to tend the fire more frequently; 36.8 percent said the new stove was not the proper size or was too small to prepare animal food and liquor, and 16.9 percent found the fire was difficult to start.



Overall, people felt the stoves were well suited for ordinary people “like themselves.” The primary features of a “good cookstove” were identified as: Consuming less firewood, emitting less smoke, easy to ignite, easy to cook; and cooks were overwhelmingly satisfied with these cookstoves, with 77 percent being either extremely satisfied or satisfied with the stoves.

Responses to: What Kind of Person Would Use a Stove Like this? (Larger font represents higher frequency of response.)

CCTS, KPTS, and Stove Use Monitoring

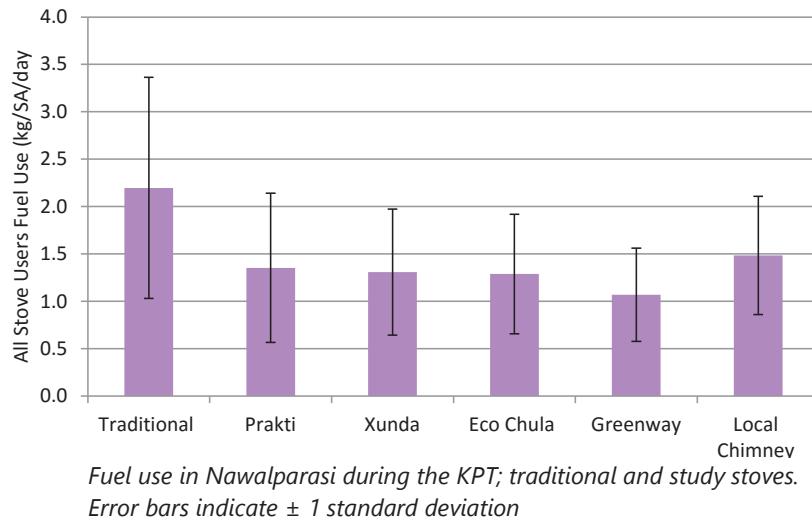
Before starting household trials, researchers conducted Controlled Cooking Tests (CCTs) to assess stove performance in a controlled, local setting. The tests found the five improved cookstoves used significantly less fuel (29 percent to 47 percent) than traditional stoves. Cooking also took 15 percent to 33 percent less time.

This study assessed real-world effects of improved stoves on household fuel use with the Kitchen Performance Test (KPT). Researchers measured fuelwood consumption in all study households for four consecutive days. The test measured the combined effects of stove performance, stove use, and user behavior on fuel use. The study incorporated stove use monitoring to measure levels of stove use during the KPT and during the entire project period. Political unrest in Dang in August–December precluded field visits and downloading of stove use monitoring data. The team ran the KPT in Nawalparasi in September (end of the summer), but not until December (winter) in Dang.

In Nawalparasi, nearly all improved stove groups used statistically less fuel than the traditional stove group, other than Local Chimney (a fixed, mud, two-pot stove, with chimney), which was nearly significant. Households using Greenway stoves (a portable, metal, one-pot stove with no chimney) showed the highest fuel savings (50 percent) and LC groups showed the least (32 percent) compared with the traditional stove group.

Based on stove use monitoring, households used the Greenway, Prakti (a portable, metal two-pot stove with chimney), and Xunda (a portable, metal, one-pot stove with no chimney) significantly more than the traditional stove. While households used the EcoChula (a portable,

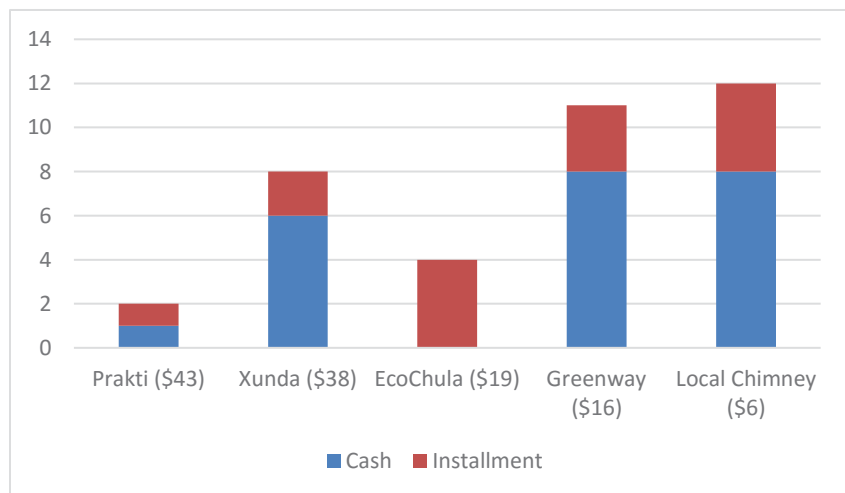
metal one-pot stove with a fan but no chimney) and LC regularly, they did not use them significantly more than the traditional stove. Improved stove use in Nawalparasi was relatively consistent over the four-month study period. Participants with the EcoChula, however, used that stove less over time, while those with Local Chimney increased use.



In Dang, households used improved stoves at consistent levels in the first three months of ownership, through the warm season, except for the LC, for which use decreased during that period. Households substantially cut their use of all improved stoves except LC in the cold season and used their traditional stove more. In addition, households used their traditional stoves as much as the traditional stove control group, meaning that use of the improved stoves was in addition to typical traditional stove cooking. On average, participants with improved stoves reported they cooked more meals than those with only a traditional stove. None of the groups with improved stoves in Dang showed statistically significant fuel savings during the KPT period, as expected given the low improved stoves use in the cold weather. However, despite these very low rates of improved stove use, more than 80 percent of participants said they preferred the ICS to their traditional stove in the endline survey, which was applied during this period.

Willingness to Pay

Not only were consumers in Dang and Nawalparasi satisfied, they were willing to purchase or forgo cash buyouts for the stoves. Installment payments improved willingness or ability to buy. The first of two willingness-to-pay methods was offered in Nawalparasi, where participants were invited to bargain for and purchase their study stove or any other study model. More than half (39) of the 70



Willingness to pay results in Nawalparasi by stove type and cash vs. installment payment choices

households surveyed were interested in purchasing a stove, and did so. Willingness-to-pay survey data showed target households were willing to pay more than the bottom-line price (\$6-\$43) for an improved stove, discounted from the market price. Of the 39 households that purchased the stove, 23 paid in full and 14 purchased on an installment plan.

In the second willingness-to-pay assessment, study participants in Dang were given the stove as a gift for participating in the study, then immediately offered the cash equivalent to sell it back. Participants overwhelmingly chose the stoves over the cash. Only four of 14 families with EcoChula stoves and two of 14 each with Prakti or Greenway stoves opted for the cash buyout. Preference was strong enough, as were both household willingness to pay and stove performance, to heartily recommend to AEPC these ICS or similar models for inclusion into the national stove program.

I. INTRODUCTION

1.1 Background

WASHplus is a six-year project funded by USAID's Bureau for Global Health and managed by FHI 360 in partnership with CARE and Winrock International. WASHplus aims to reduce household air pollution by assessing consumer needs and preferences for improved cookstoves (ICS), increasing household adoption, and consistent, correct use of ICS, and improving health and energy impacts. In 2012, WASHplus received funding from USAID/Bangladesh and the Asia Regional Bureau to do research on consumer needs and preferences to increase ICS use in Bangladesh. In a second phase, WASHplus refined the tools developed for that assessment and replicated the consumer research in Nepal. In a third phase, WASHplus developed a consumer preferences toolkit with guidance on conducting the research described in this report. Link to the toolkit [here](#).

The Alternative Energy Promotion Centre (AEPC), the government institution tasked with developing and promoting renewable and alternative energy technologies in Nepal, helped design the WASHplus consumer preference study. AEPC has disseminated more than 750,000 improved stoves, primarily basic improved mud stoves and, more recently, metal stoves. AEPC supports bringing additional choices to the stove market in Nepal and better engaging the private sector in promoting improved cookstoves. AEPC is looking at the success of the cookstove sector in India, with an eye to advancing stove design, quality, aesthetics, and portability. Through competitive selection, WASHplus selected Right Direction Nepal (RDN) to collaborate and carry out the Nepal consumer preference study. The study included in-home trials with one of five improved stoves installed in 136 households:

1. Prakti—portable, metal, two-pot, with chimney
2. Greenway—portable, metal, one-pot, no chimney
3. EcoChula—portable, metal, one-pot, fan, no chimney
4. Xunda—portable, metal, one-pot, no chimney
5. Improved mud stove—fixed, mud, two-pot, with chimney (Local Chimney)

These stoves were selected to represent a range of features—portable and built-in-place; single and double pot; chimney and no chimney; rocket design; natural draft; and forced draft fan stoves. Only the Local Chimney model was already promoted by AEPC.

1.2 Goal

The goal of the WASHplus assessment in Nepal was to investigate consumer preferences and willingness to pay for different manufactured improved cookstoves shown to be efficient in the lab and popular in similar markets. The study included a local mud stove AEPC is promoting (Local Chimney) to compare preference and performance of the new stoves to the current models being promoted. The assessment of the household trials using one of five stoves looked

at preferences that might lead to purchase and adoption by Nepali households cooking with firewood. The study used quantitative and qualitative data collection methods.

1.3 Objectives

1. To determine what poor Nepali consumers see as desired attributes and benefits of cookstoves (improved and traditional)
2. To document and compare consumer reactions, including willingness to pay and consistency of use of five types of improved cookstoves in Nepal

The findings contribute to the ability to develop more focused, strategic efforts to switch consumers from traditional cooking devices to new technologies that improve household air quality and reduce environmental degradation. These data encourage private sector entry into the cookstove market and can help public, NGO, and private sector promotion of stoves and clean cooking be more effective, because they address traditional marketing elements—product, price, placement, and promotion—the building blocks of a marketing strategy.

II. METHODOLOGY

2.1 Study Design

Researchers selected districts where wood is the primary cooking fuel but where households do not depend on wood for heating. The original study design included two village development committees (VDCs) from each of three districts: Dang, Dolakha, and Nawalparasi, with a total of 150 households. After the April 2015 earthquake, Dolakha was inaccessible, so researchers limited the study to two districts, but increased the number of households per village from 25 to 35, for a total of 140 households. The study was conducted in two clusters of Nawalparasi and two in Dang.

A Winrock/Nepal team, in consultation with AEPC, developed a roster of households in VDCs with key demographic data to create the sample households meeting the eligibility criteria. From that group, 140 households were selected at random; 35 from each cluster, with seven households in each cluster trying one of the five stove models.

Households had to meet the following criteria:

1. Use wood as the primary cooking fuel
2. Have 4–10 people with at least one child under 5 (modified to 3–10 people; at least one child under 10)*
3. Use a traditional stove
4. Have no prior experience with or ownership of ICS
5. Are poor, but with some expendable income
6. Are willing to participate as a volunteer

(*Not enough households met the original criteria, so household size and make-up criteria was changed.)

Prior to the household trials, researchers tested the stoves in-country to assess their performance in Controlled Cooking Tests. The CCT uses multiple cooks making a typical local meal (using the same amounts of the same ingredients) multiple times on each stove. Cooks practiced on each stove in their homes for 10 days ahead of the tests to reduce user error.

Winrock installed the stoves and instructed households on proper use after collecting baseline information. Four improved Local Chimneys installed in Dang households were destroyed and could not be reinstalled due to time and resource constraints, which reduced the final sample to 136 households.

The study included qualitative and quantitative data collection methods, including temperature-sensitive data loggers to track stove use throughout the study. In the first part of the study, the team administered a semi-structured questionnaire to gather baseline information just before the improved cook stoves (ICS) were installed, and another to track initial reactions 5–7 days later. Both interviews were conducted with the primary cook in the household. Two weeks before the final survey, field teams conducted Kitchen Performance Tests (KPT) to assess the impact of the improved stove on fuel consumption. Interviewers conducted the final post-trial interview with primary cooks using a semi-structured questionnaire four months after the baseline interview in Nawalparasi, and seven months after in Dang. The team also interviewed the financial decision-maker of the household, if other than the cook (usually husbands or mothers-in-law). During the same visit, one of two willingness-to-pay offers was made; one based on auctioning or bargaining for stove purchase, the other a gift and buyback offer.

The team held two community market demonstrations with potential consumers from a slightly different demographic. In market demonstrations in Damauli of Tanahu district and Banepa of Kavre district, discreet observers noted shoppers’ reactions to seeing cookstoves in action and sampling food made on them. This document highlights findings across all methods. Data collection methods are in Table 1:

Table 1. Data collection methods by study area

Activities	Districts	Nawalparasi		Dang		Total
		Bulingtar 1	Bulingtar 2	Satbariy	Fulbari	
Baseline household (HH) interviews		35	35	33	33	136
Initial reaction HH interviews (day 5-7)		35	35	33	33	136
Post-trial HH interviews (after 16 weeks)		35	35	33	33	136
Willingness-to-pay bargaining exercise (at 16 weeks)		35	35	-	-	70

Activities	Districts	Nawalparasi		Dang		Total
		Bulingtar 1	Bulingtar 2	Satbariy	Fulbari	
Willingness-to-pay buyback exercise (at 16 weeks)		-	-	33	33	66

Activities	Districts	Tanahu	Kavre	Total
Market demonstration		1	1	2
Total		283	267	550

2.3 Study Procedures

The RDN study team analyzed and adapted data collection tools, developed ethical consent forms, trained field staff, maintained quality control, analyzed data, and prepared reports.

2.3.1 Final Study Tools

The RDN team reviewed the study methodology and data collection tools developed by WASHplus for Bangladesh and analyzed their relevance for Nepal. RDN brought questions, issues, and recommended adjustments to WASHplus for clarification. The RDN team finalized the data collection tools in consultation with WASHplus. The tools were translated into Nepali and back translated to ensure that the meaning remained intact. RDN pretested survey tools in Nallu VDC of Lalitpur district in March 2015 and shared the results with WASHplus. Field data were collected using the final, fine-tuned local language tools.

2.3.2 Ethical Consent

Researchers obtained ethical approval for the survey from the Nepal Health Research Council and the FHI 360 in-house ethical review board. The team explained the survey's objective and scope, the project's commitment to maintaining confidentiality, and the procedures in place to ensure confidentiality before asking for participants' written consent.

2.3.3 Field Staff Training and Field Data Collection

RDN developed two training seminars, one for the baseline and first week follow-up surveys, and one for the post-trial survey, willingness-to-pay assessments, focus groups, and market demonstrations.

Working with WASHplus, RDN trained 14 researchers on thematic and practical aspects of the first phase of the study in June 2015. The training consisted of in-class training and mock interviews and discussion, as well as cookstove overview sessions led by Winrock Nepal. The same researchers were trained for the second round of the survey in September 2015.

Field supervisors accompanied each study team to maintain quality during data collection. They ensured strict adherence to study methodology and established protocol. Nischal Basnet, project coordinator, and Bishnu Prasad Nepal, senior researcher, members of the core RDN

team, visited the study clusters to monitor fieldwork and provide quality control. Mr. Nepal led all focus group discussions and market demonstration teams.

2.3.4 Data Management, Analysis, and Report Preparation

RDN compiled the completed questionnaires at its office in Kathmandu. The core team conducted a second round of data scrutiny and developed a code list for open-ended questions. The team shared its list of themes and subthemes with WASHplus and refined them under the data manager's supervision. Team members handling data coding and entry were briefed on the scope of the fieldwork; the questionnaire structure, flow, and skips; and single and multiple responses. RDN staff used CPro software for data entry. Staff digitized the codes and entered them into a database using data entry software programmed to check for logical consistency, skip patterns, and noneligible or out-of-range variables. Staff developed and reviewed simple frequency tables to verify consistency of the data and cleaned the data. Data analysis was conducted using SPSS version 17. RDN shared the data tables with cross tabulation of key variables with WASHplus for comment and feedback. All focus group discussions were recorded and transcribed for thematic analysis. RDN core team members drafted the report. Because numbers were rounded, some findings total slightly more than 100 percent.

III. BASELINE FINDINGS

3.1 Introduction to the Study Group

The survey covered 136 households from two districts: Nawalparasi (70) and Dang (66). Data were collected from 35 households from each cluster in Nawalparasi and 33 from each cluster in Dang district. (See Table 2).

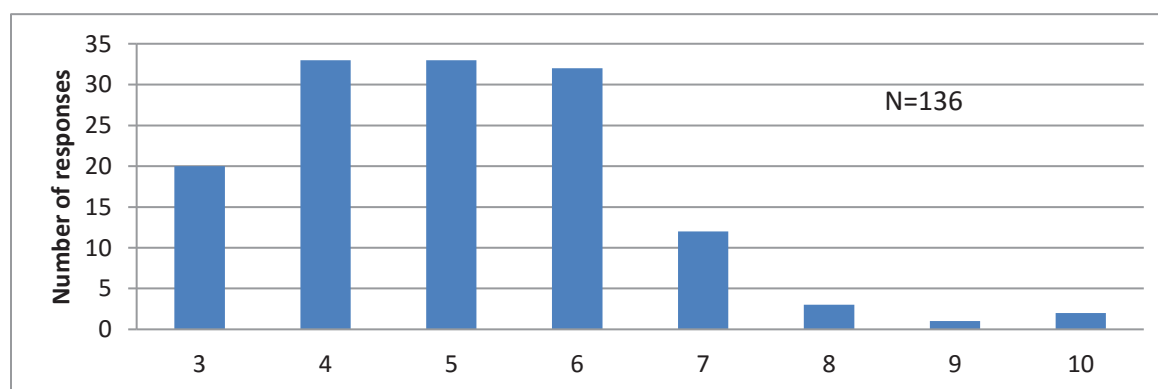
Table 2. Distribution of participant households

Cluster	Number of homes
Nawalparasi – Bulingtar 1st	35
Nawalparasi – Bulingtar 2nd	35
Dang – Satbariya	33
Dang – Fulbari	33
Total	136

All study participants were women and the primary cook in the household. About half were 21–30 years old; 22 percent were 31–40, 12 percent were 41–50, and about 10 percent were under 20. Most were Hindu (97 percent); Buddhists and Christians each comprised 1.5 percent of the total. All were in one of three ethnic groups: Janajati (60 percent), Brahmin/Chetri (26 percent), and Dalit (15 percent).

All households had at least one child under 10. Twenty-four households had two, and one household had four children under 10. (Households with more children were from Nawalparasi district.) Family size ranged from three to 10; the mean was five, on par with the national average in Nepal. Figure 1 shows the data on household size.

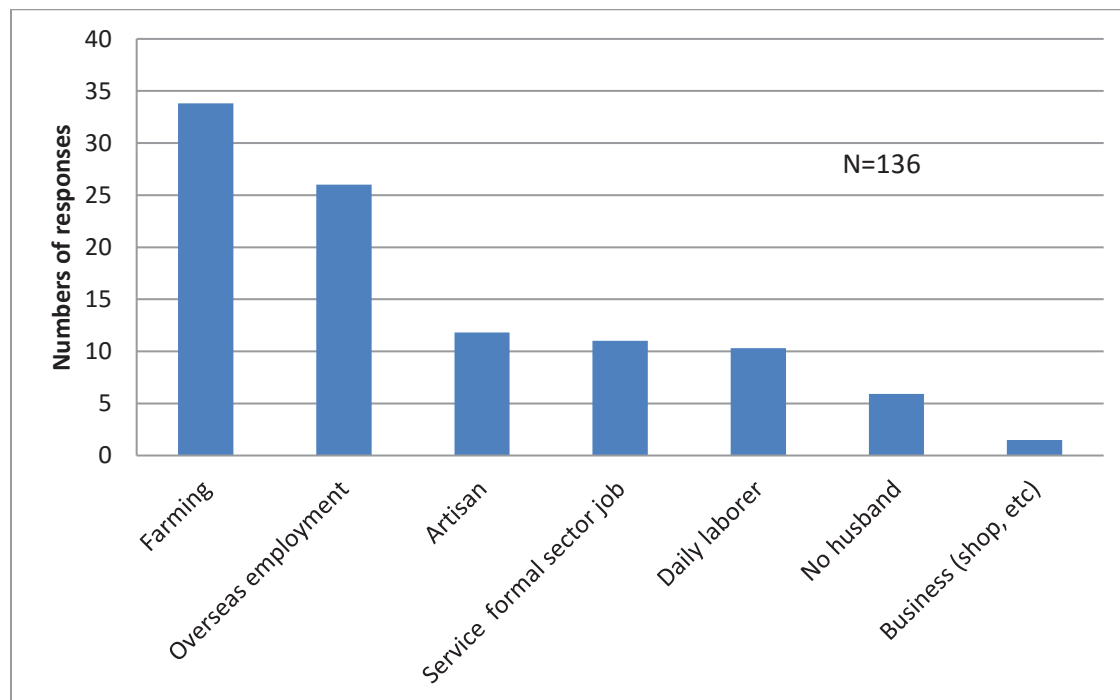
Figure 1. Household size (Response to “How many people usually sleep in the house?”)



As shown in Figure 2, the main occupation of participants’ husbands in both districts was farming (34 percent). The second most frequent occupation was overseas employment (26

percent). Other occupations were artisan (12 percent), formal service sector job (11 percent), and daily labor (10 percent); 6 percent had no husband, and 2 percent of husbands were involved in business.

Figure 2. Household's main occupation



3.2 Household Structure and Economic Behavior

To better understand the economic status of participants, RDN collected information on household assets and purchasing behavior. About 45 percent had roofs made of galvanized steel, and about 35 percent had thatched roofs. Other roof materials were tile (15.4 percent) and stone (3.7 percent). Nearly 50 percent of house walls were mud (alone or in combination with stone, bamboo, and wood), and 38 percent were brick and mud, used in households considered relatively well off. Houses with walls made of brick and mud were more common in Dang (50 percent, compared with only 27 percent in Nawalparasi). Other materials used for house walls were brick and cement (7.4 percent) followed by wood (7 percent).

Many of the households (90 of 136) did not have a kitchen separate from the main living area, 46 did. Most who had separate kitchens had four wall structures (96 percent).

Figure 3. Kitchen with no window, some ventilation



75 percent of kitchens had at least one window. The average number of windows was 1.28 and the maximum was five. Most kitchens had one door (90 percent); 11 households had two doors, and 10 percent had a door opening without a closable panel. (See sample kitchen in Figure 3.)

Only 30 percent of families had bought a major household item in the prior year, such as mobile phones (16.9 percent) and flashlights (14.7 percent). See Table 3 below for breakdown of household items owned by the 136 participant households.

Table 3. Major household items owned by participants

Household item	Number of owners out of 136 households
Mobile phone	123
Grid electricity	93
Flashlight with batteries	84
Radio	21
Television	19
Solar lantern	14
Kerosene lamp	12
Bicycle	8

Table 4. Sources of income for household purchases

Source of income	% of households
Own wages	37
Overseas employment	36
Cook's savings	15
Family	12
Livestock	10
Shop earnings	2
Cooperative group loan	2
Liquor sales	2

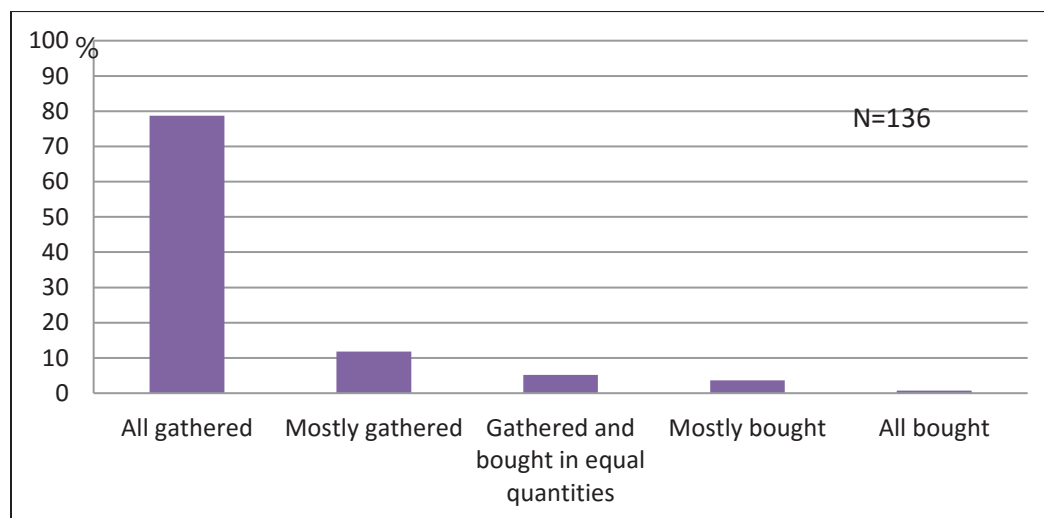
The majority of women (69 percent) belonged to one or more women’s groups. Of those, 59 percent belonged to one, 23 percent belonged to two, and 18 percent belonged to three or more groups. The average number of groups they belonged to was 1.72, and their average length of involvement was 3.82 years. The primary functions of the women’s groups were savings (94 percent), literacy (4 percent), and religion (2 percent).

3.3 Fuel Use and Procurement

All study households used wood as the primary fuel. A majority (78.7 percent) said they gathered the firewood, 11.8 percent gathered most of their wood, 5.1 percent gathered and bought wood in equal quantities, 3.7 percent primarily bought wood, and 0.7 percent always bought wood. 32 used one or more secondary fuels: agricultural residue (25/32 households), dung sticks or cakes (10/32), sawdust (4/32), kerosene (1/32), and grid electricity (1/32). Almost all gathered it (30/32); one mostly bought the secondary fuel and one always bought it.

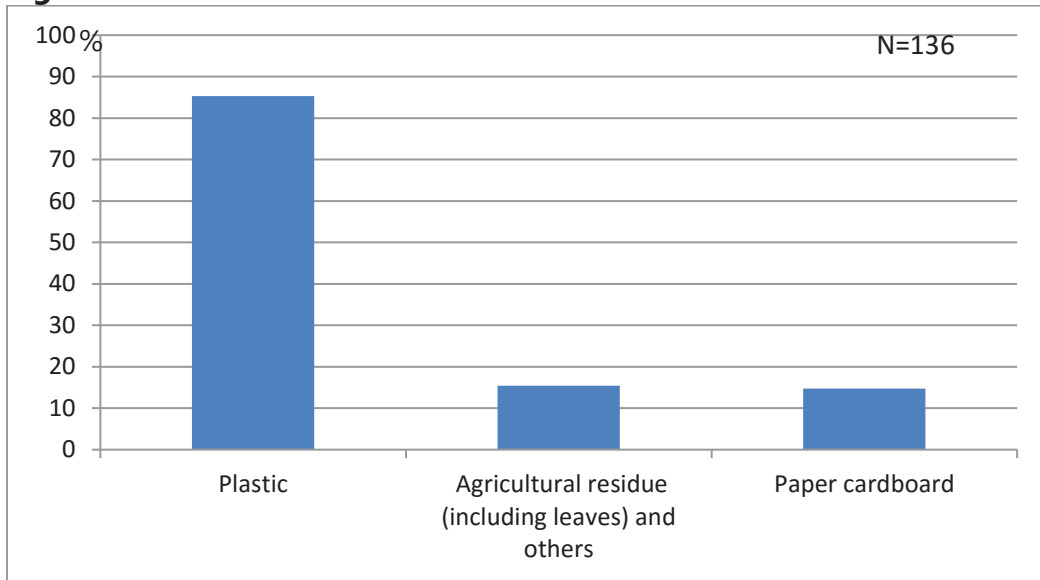
More than 75 percent of participants did not buy firewood, whereas 14 percent spent up to NRs 100 (Nepali rupees, equal to US \$0.92) a month, and 8.8 percent spent more than NRs 100 a month. Average expenditure on firewood among wood buyers was NRs 48/month (\$0.44). Seasonal variation in reported fuel consumption was mainly for heating; more fuel was consumed during winter.

Figure 4. Percentage of households gathering or buying fuelwood



Researchers were surprised to learn that 85 percent of households used plastic such as noodle snack bag wrappers to start fires. They instructed cooks not to use plastic to start fires in the ICS. Other fire-starting materials were paper or cardboard (14.7 percent), agriculture residue (8.1 percent), kindling (3.7 percent), and sawdust (0.7 percent). Some households used more than one material for starting fires.

Figure 5. Materials used to start fire



Most (130) households owned karai cooking vessels, followed by sauce pan (118), kasaudi (117), pressure cooker (79), tapke (77), frying pan (77), kettle (44), jhyanga (16), liquor distillation pots (15), and taulo and rice cooker (1 each).

Figure 6a. Nepali traditional cooking vessels, from top left: karai, kasaudi, tapke; second row: jhyanga, liquor distillation pot, taulo



3.4 Stove Experience

Baseline stoves used varied by household. Most used a three-stone fire (most prevalent in Nawalparasi district). The Odan, a metal tripod pot stand, was used in about a quarter of households. The third baseline was a traditional mud stove, used in only 17.6 percent of houses. A mix of these three baseline stoves were also used in the KPT control group.

Figure 6b. Nepali traditional cookstoves



Three-stone stove



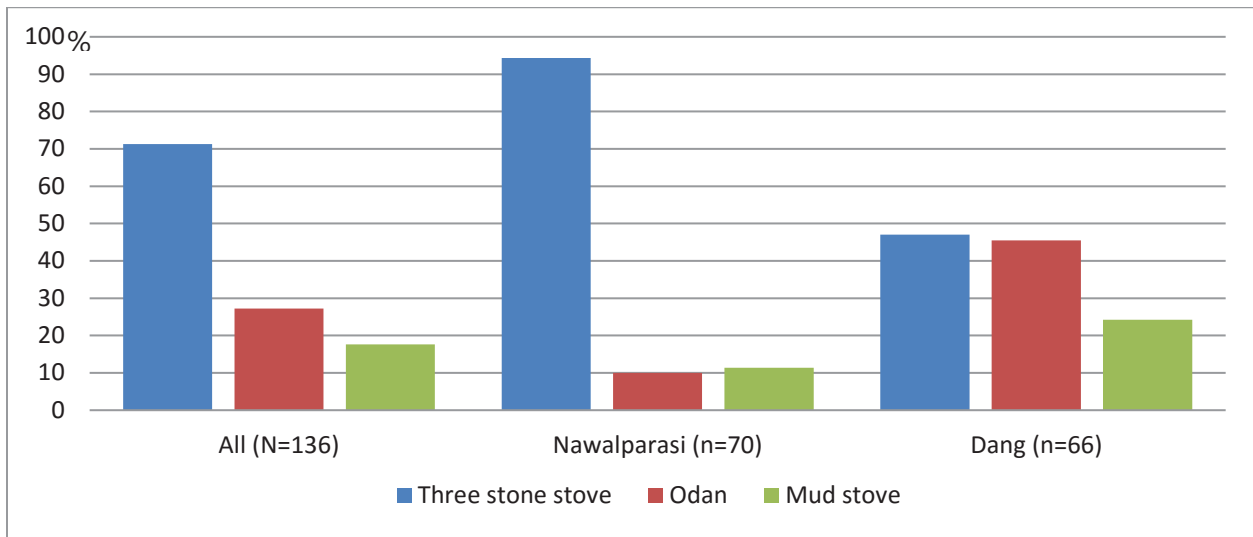
Traditional Mud stove



Odan

For data on stoves used in each district see Figure 7. Because some households use more than one stove, the “stove used in HH” totals exceed 100 percent.

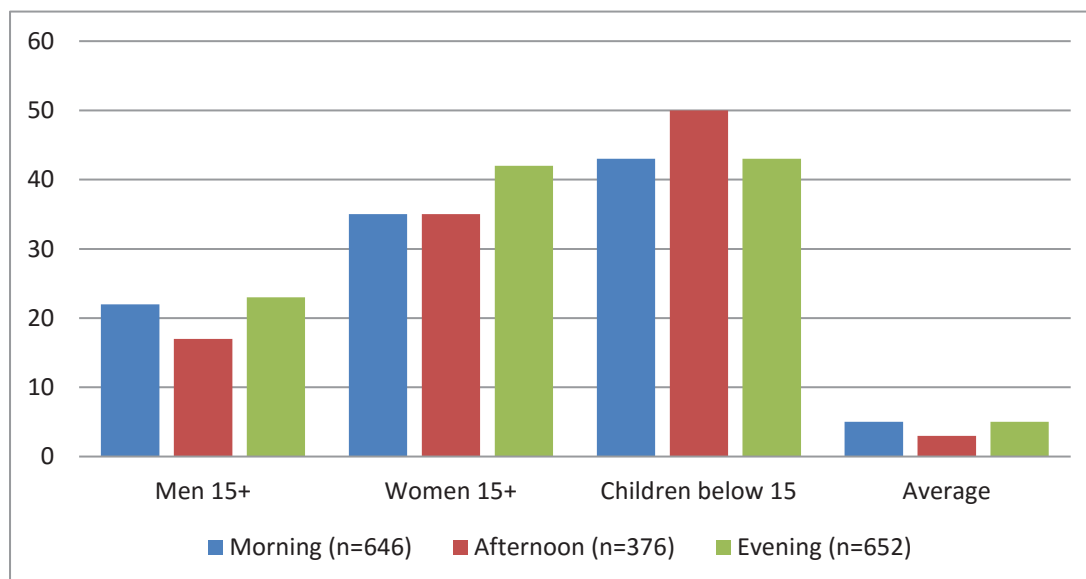
Figure 7. Baseline stove used in household



Participants owned the three-stone stove most frequently (71 percent), primarily in Nawalparasi district (94.3 percent). The Odan metal pot-stand, the second most popular overall, was owned by 27 percent of households. The mud stove was owned by 18 percent of participants.

Research indicates households cook food for the most household members in the evening (652 household members in all 136 households), followed by morning (646), and for the fewest in the afternoon (376). Each household cooked for an average of five members in the morning and evening and three in the afternoon. Food was cooked mainly for children (43 percent in the morning and evening, 50 percent during the afternoon), followed by adult women. Households cooked least frequently for adult males (22 percent in the morning, 23 percent in the evening, and 17 percent in the afternoon).

Figure 8. Number of people for whom food was cooked at home



Little variation was observed in type of stove used to prepare main meals vs. snacks and tea. However, the three-stone stove was used over others for cooking all types of food (see Table 5). All cooking was done indoors by 79.4 percent of the households, which increased to 86 percent during monsoon season.

Table 5. Stove uses

Activities	Base 'N'	Three stone stove 'N'	Odan 'N'	Mud stove 'N'
Stove used for cooking meals	136	94	30	12
Stove used for snacks	136	86	29	9
Stove used for animal feed	136	73	21	7
Stove used for tea	136	70	29	7
Stove used for bath water	136	75	20	4
Stove used for liquor	136	51	3	4

Only 27 of the 136 households (20 percent) reported that they used the stove for income generation. Of those, all but one prepared liquor for sale; one prepared snacks and lunch for sale.

Most said what they liked about their primary stove was that it cooked food quickly (117/136), kept pots in place so they did not tip over (36/136), was the appropriate height (16/136), and was safe during cooking (14/136). Negative aspects reported: it emitted a lot of smoke (116/136), consumed a lot of firewood (110/136), got pots dirty (83/136), required high fuel costs (26/136), was difficult to start (14/136), and looked ugly (14/136).

Table 6. Likes and dislikes about old primary stove (multiple responses accepted)

Likes about old primary stove	Total	Nawalparasi	Dang
	N=136	n= 70	N=66
Cooks food quickly	117	66	51
Stable/doesn't tip over	36	23	13
Stove is at the right height to sit and cook comfortably	16	7	9
Safe during cooking	14	10	4
Easy to light/ignite; not affected by wind	11	8	3
Dislikes about old primary stove			
Emits too much smoke	116	64	52
Uses too much firewood	110	65	45
Makes pots too dirty	83	50	33
Fuel costs high	26	21	5
Aesthetics; looks ugly	14	13	1
Difficult to light/ignite	14	12	2

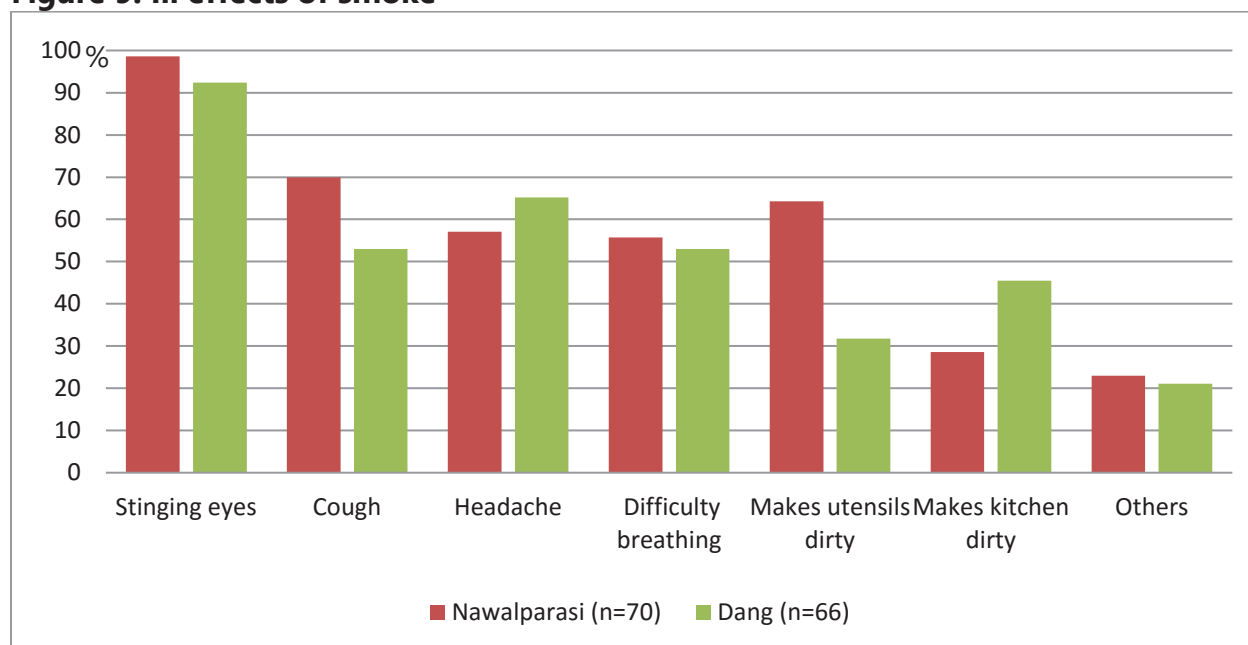
3.5 Smoke Exposure

Participants reported their old stove produced a lot of smoke while cooking (88 percent), some smoke (9.6 percent), and hardly any smoke (only 2.2 percent), with little variation by district.

Asked to detail the negative effects of the smoke their stove produced, 95.6 percent said it burned their eyes, 61.8 percent said it made them cough, and 61 percent said it gave them headaches. Other responses included difficulty breathing (54.4 percent), making cooking pots dirty (48.5 percent), and making the kitchen dirty (36.8 percent).

Asked to report any perceived benefits of the smoke, more than half (52.9 percent) said there was nothing good about it, 34.6 percent said it kept insects away, and 18.4 percent said it heated the house.

Figure 9. Ill effects of smoke



Of the 49 households with non-walking children, 12 said their children usually crawled in and out of the kitchen while they cooked, 11 said the children usually stayed with them in the kitchen, nine said they tied the child on their back while cooking, seven said the children were in the same building, but not in the kitchen, seven said the children were in a separate building, and three said the children were kept in a swing. Of 111 households with children under 5 who could walk (which included some of the 49 households with non-walking children), close to half (54.1 percent) said the children usually came in and out of the kitchen, 15.3 percent said the children were with them in the kitchen, 10.8 percent said children were in the same building but not in the kitchen, 9 percent said the children were playing outside, 6.3 percent said they were not in the kitchen but in a separate building, 3.6 percent said they were in a swing, and the final respondent said the child was tied on her back.

In houses with kitchen windows (102), all but five with one window and one with two windows said they kept the windows open while cooking.

The baseline study revealed the study participants to be typical rural Nepali families, of average household size, who primarily gather and burn wood for cooking on traditional stoves. They are farmers, artisans, work in the service sector or as daily laborers, or are employed overseas. They are generally poor, but most have mobile phones and a majority have grid electricity. A majority of women belong to one or more women's groups, which overwhelmingly focus on savings, which can be tapped into in exploring financing options for cookstoves. They like that their traditional stove cooks food quickly, and dislike that it uses so much firewood and emits too much smoke.

IV: FINDINGS OF THE FIVE TO SEVEN DAY FOLLOW UP

4.1 Consumer Reaction to New Improved Cookstoves

RDN conducted a follow-up survey 5–7 days after installation of the ICS. Participants' initial reactions were favorable. Most could name at least one feature they liked; many named several. The range of desirable attributes is presented in Figure 10 below by attribute and stove type. Most common (71.4 percent) was pot cleanliness: "It saved dishwashing time, as pots remained clean." This was noted most often for Prakti (85 percent). The second most common attribute, noted for all stoves, was that they consumed less firewood (70.6 percent). Many Local Chimney users (50 percent) said the ICS used less fuel and 25.7 percent added that they felt proud to have a "nice and attractive" stove. Prakti users also listed fuel savings often (35.7 percent). The attribute that "house and pot remains clean" (16 percent) was applied most often to Prakti (25 percent), and "can cook two foods at a time" (15.4 percent) was applied to the Local Chimney (62.5 percent) and Prakti (21.4 percent). "Food cooks well" (14.7 percent) was applied most often to Greenway (32.1 percent). That the stove was "portable" (14 percent) was applied most to Greenway (35.7 percent).

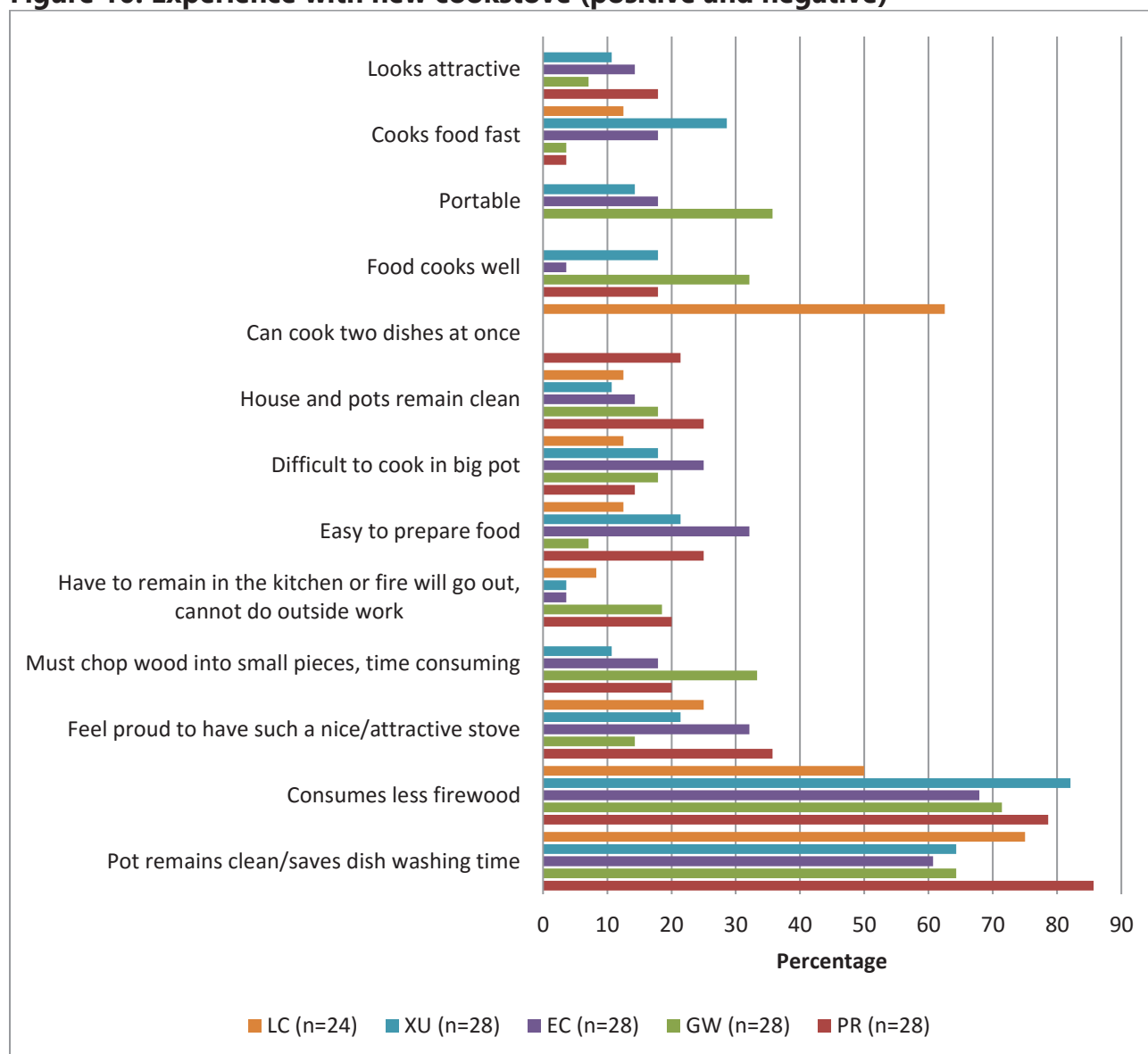
Other attributes were "aesthetic look" (10.3 percent), most applied to Prakti (17.9 percent); pride of home (25.7 percent), most applied to Prakti (35.7 percent); easy to prepare food (20 percent), most applied to EcoChula (32.1 percent); and food cooks fast (13.1 percent), most applied to Xunda (28.6 percent).



Above is a word cloud image that represents what cooks liked about the new ICS at the 5-7 day survey. Larger print represents higher frequency of response; font size is proportional and accurate.

Negative characteristics cooks reported included "difficult to cook in big pots" (17.6 percent), most applied to Prakti (17.9 percent); "have to chop wood in small pieces, which is time consuming" (16.9 percent), most applied to Greenway (33.3 percent); and "have to remain in the kitchen longer as the fire goes out frequently" (11 percent), most applied to Prakti (20 percent).

Figure 10. Experience with new cookstove (positive and negative)

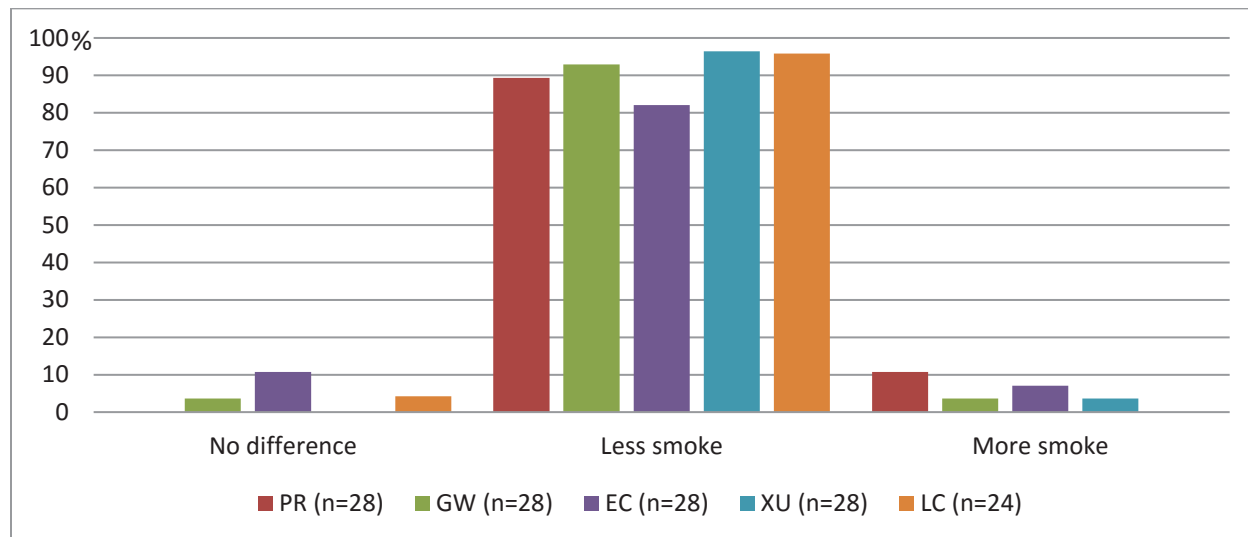


On average, 33.8 percent of cooks were very satisfied with their new ICS, and 48.5 percent were satisfied. Xunda ranked highest among extremely satisfied users (46.4 percent), followed by Local Chimney users (38 percent), and EcoChula users (36 percent). More than 60 percent (60.7) of Prakti users and 53.6 percent of EcoChula users were satisfied with their ICS; 16.2 percent said they were somewhat satisfied, and only 1.5 percent were not at all satisfied with their new stove. Greenway users comprised the largest proportion of somewhat satisfied users (25 percent); Prakti users comprised the largest proportion of users not at all satisfied (7.1 percent). Most (66.5 percent) could correctly explain how to use their stove.

After they started using the new stove 83.8 percent of users observed changes in their household. This was true for all stove types, but only 67 percent of Local Chimney users reported changes. The majority (75 percent) observed less smoke, and some reported fewer

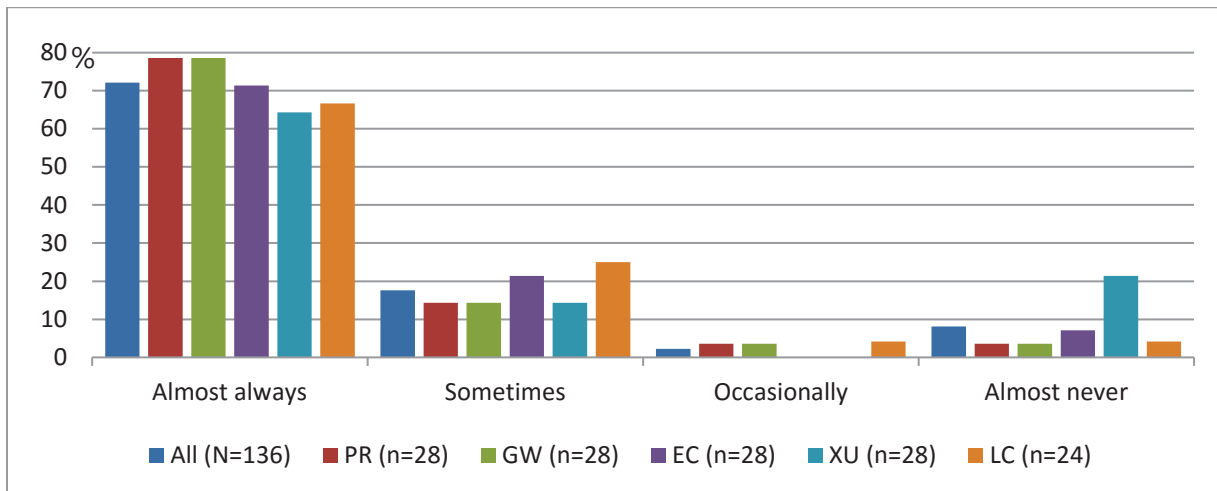
ashes (25.4 percent). More than half reported the house and kitchen remained clean (51.8 percent), 30.7 percent said they had to go to the forest less often to collect wood, and 11.4 percent said they could now cook two foods at a time (for Prakti this was 38.1 percent and Local Chimneys 31.3 percent). Asked to compare the amount of smoke produced by the new and old stoves, most (91.2 percent) said the new stove produced less smoke. However, 11 percent of EcoChula users saw no change, and 11 percent of Prakti users said the new stove produced more smoke.

Figure 11. Smoke produced by new vs. old primary cookstove in kitchen



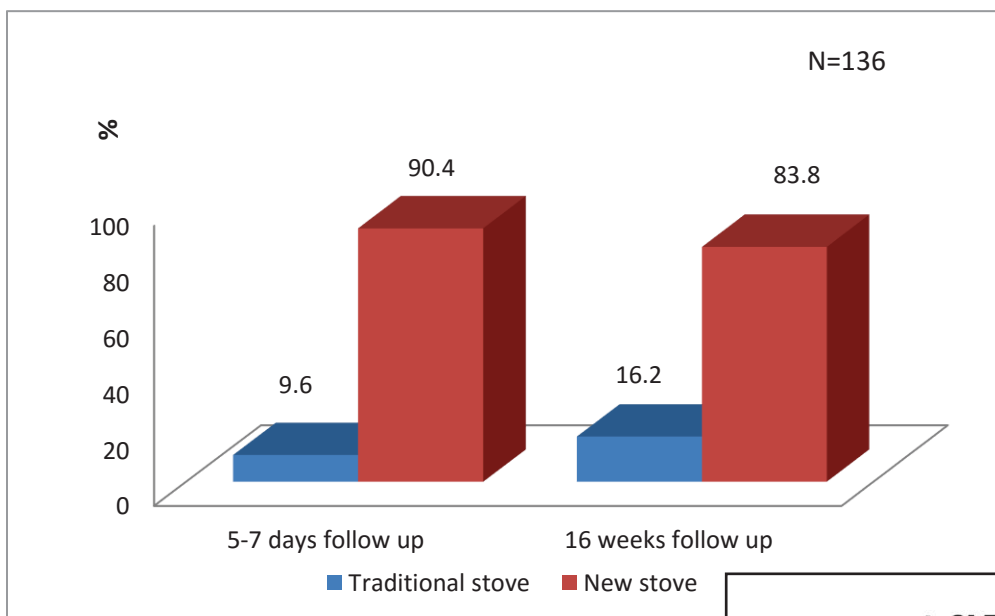
Three-quarters of participants said the ICS was better for cooking some foods than others (86.4 percent in Dang and 61.4 percent in Nawalparasi). The majority mentioned staple Nepali main course items: rice (84.6 percent), daal (89 percent), vegetables (73.5 percent), and meat (31.6 percent) as foods that cooked better using the ICS. Cooks said food cooked in larger quantities, like liquor (48.5 percent), large quantities of rice (48.5 percent), animal feed (45.6 percent), and chapatti/puri (30.9 percent) cooked better on their old stoves. However, 72.1 percent said the ICS was almost always the proper size for cooking most meals. This was higher in Nawalparasi district (81.4 percent), than Dang (62.1 percent). A few participants said the ICS was almost never the proper size for cooking most of the meals (Nawalparasi—2.9 percent; Dang—13.6 percent).

Figure 12. Proper size of new stove for cooking



Most (90.4 percent) participants preferred the ICS to their old primary stove. Consumer preference overall, and reasons for preferring, are shown in Figure 13 and the word cloud below.

Figure 13. Preferred stove after 1 and 16 weeks



This word cloud displays the reasons given for preference of ICS (larger font represents higher frequency of response).

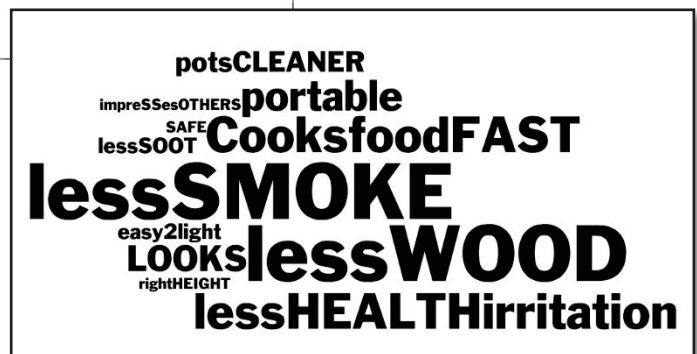
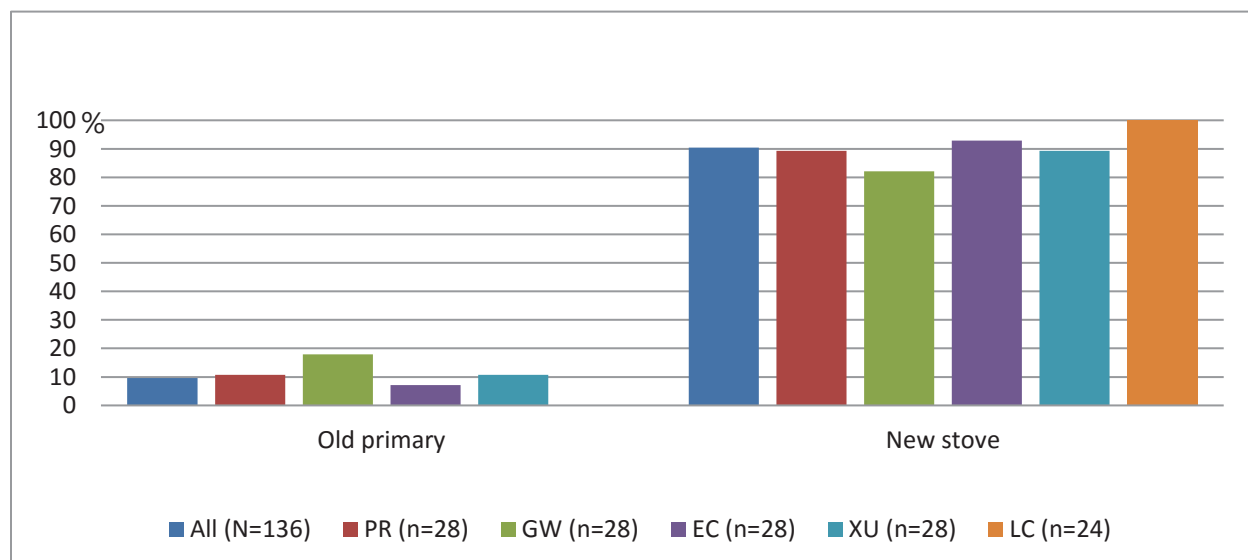


Figure 14. Preference for old or new cookstove



The primary reasons consumers preferred the new stove were: it emitted less smoke—85 percent (105/123); consumed less firewood—82 percent (101/123); cooked food quickly—50 percent (61/123); kept away health problems (eye irritation, headache, chest pain, cough)—49 percent (60/123); was portable—40 percent (49/123); and had an aesthetic look—34 percent (42/123). Those who preferred their old primary stove said it was because it cooked food quickly—77 percent (10/13). (See Table 7.)

Table 7. Reason for stove preference

	All	PR	GW	EC	XU	LC
Base: All participants	136	28	28	28	28	24
Those preferring old stove	13	3	5	2	3	-
Cooks food quickly	10	2	5	1	2	-
Emits less smoke	2	-	1	-	1	-
Portable, good handle	2	-	1	-	1	-
Stable, doesn't tip over	1	-	1	-	-	-
Safe during cooking	1	-	1	-	-	-
Pots are cleaner	1	-	-	-	1	-
Reduced smoke-related health problems (eye irritation, headache, chest pain, cough)	1	-	1	-	-	-
Saves money on fuel	1	-	1	-	-	-
At the right height to sit and cook comfortably	1	-	-	-	1	-

Those preferring new stove	123	25	23	26	25	24
Emits less smoke	105	23	22	21	22	17
Uses less firewood	101	22	23	25	22	9
Cooks food quickly	61	10	10	17	12	12
Reduced smoke-related health problems (eye irritation, headache, chest pain, cough)	60	15	11	12	9	13
Portable, good handle	49	-	16	20	13	-
Aesthetics—looks nice	42	12	7	11	9	3
Pots are cleaner	34	12	5	2	8	7
Easy to light/ignite, not affected by wind	24	2	3	7	5	7
Less soot and dust, cleaner house and kitchen	16	4	-	3	2	7
Stove is at the right height to sit and cook comfortably	15	2	4	2	4	3
Impresses others, pride to home	13	6	1	4	2	-
Safe during cooking	11	1	1	3	1	5
Well manufactured	6	-	-	2	2	2
Saves money on fuel	6	2	1	-	1	2
Stable, doesn't tip over	2	-	-	-	-	2

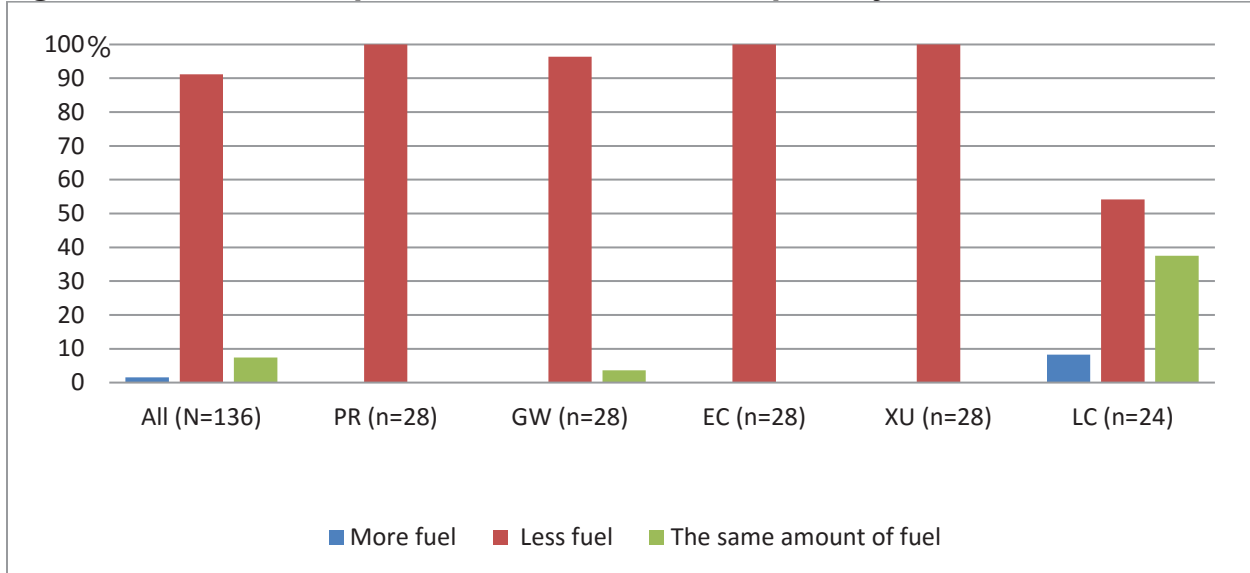
After the ICS was installed in study households, most reported using it most or all of the time. Almost half (49.3 percent) reported using it more than the old primary stove, and 33.8 percent reported using only the ICS. Most (88.2 percent) had used their new ICS on the day of the follow-up interview, as interviewers observed warmth (28.7 percent), ashes on the tray (45.6 percent), and soot on top (36.8 percent). Most cooks (89 percent) reported maintaining the stove regularly by removing the ashes and coals from the stove (95.9 percent) and cleaning with a damp cloth (80.2 percent).

Of the 136 households, 46 reported only using their new stoves (findings not corroborated by stove use monitoring data), two reported using only their old stoves, and 88 reported using both. Of those, 32 used the new stove to cook all meals every day (and the traditional stove for non-meal use. Local Chimney users were more likely to use the old stove more (8/13). Of those who used both, 40 used the new stove to cook some meals every day, and 37 used the old stove to cook some meals every day, while 33 used the old stove a few times a week. About 45 percent said even if they owned an ICS, they would use the old stove to cook for 12 or more people (38/62), to prepare liquor (29/62), to cook animal feed (17/62), and to cook chapatti (10/62).

Participants found the ICS consumed less fuel (91.2 percent) and was cheaper to operate (79.4 percent) than their old stove, although Local Chimney users were less likely to find savings in fuel or operating costs (54.2 percent). Among mud ICS users, 37.5 percent thought it consumed

the same amount of fuel (8.3 percent found it consumed more fuel), and 45.8 percent found it was equally expensive to run.

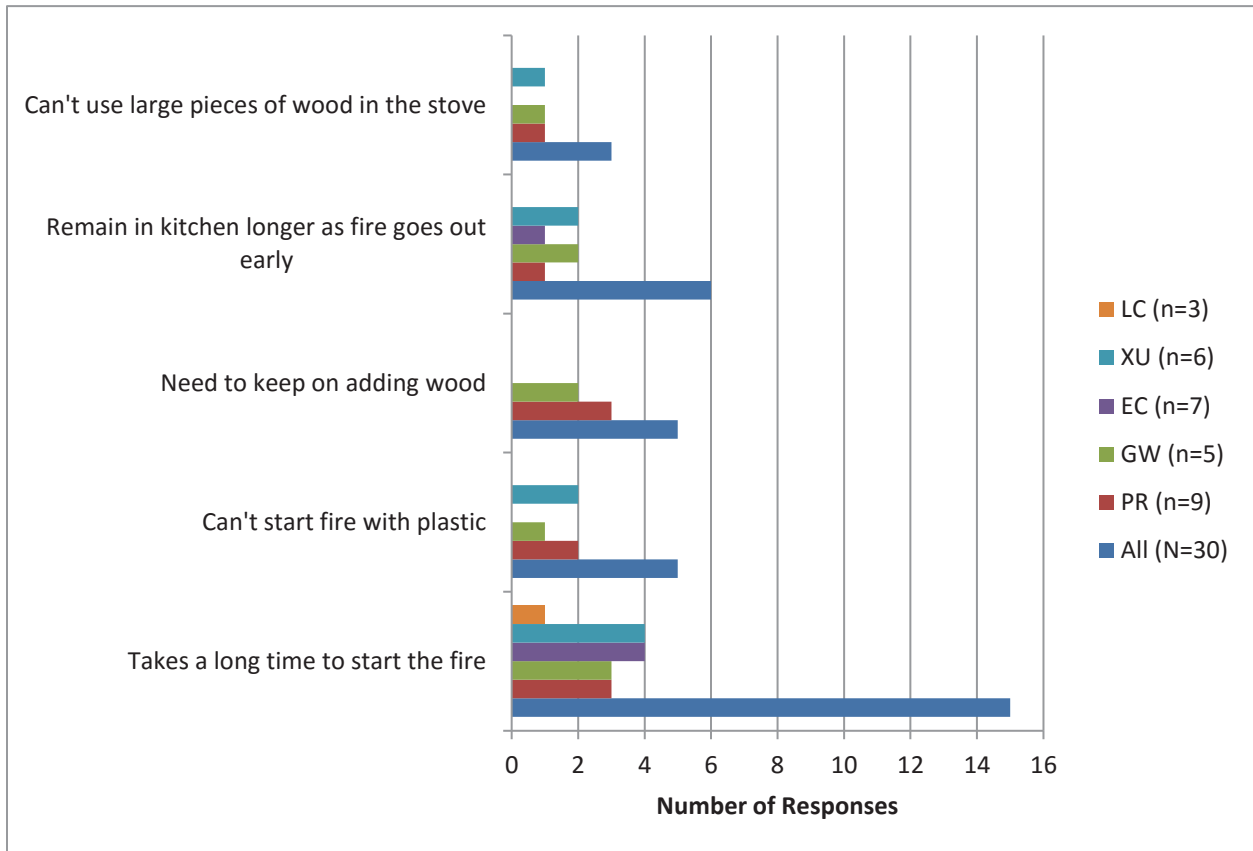
Figure 15. Fuel consumption variation: new vs. old primary cookstove



4.2 Problems with New ICS—Modification and Solutions

Most (94.9 percent) participants did not encounter any problem with the functioning of their new stove. However, 30 cooks cited at least one problem, and a few had multiple problems. Prakti users (9/28) had the most problems, followed by EcoChula users (7/28), Xunda users (6/28), Greenway (5/28), and Local Chimney users (3/24). The most common problem was starting the fire (15/30), which took longer, some cooks mentioned specifically (5/30), because they were not able to start the fire with plastics. Another issue was having to remain in the kitchen longer because the fire went out early (6/30), and needing to add wood to keep the fire going (5/30), a problem not mentioned for the Local Chimney. A few reported they could not use large pieces of wood as they could in their old stoves (3/30).

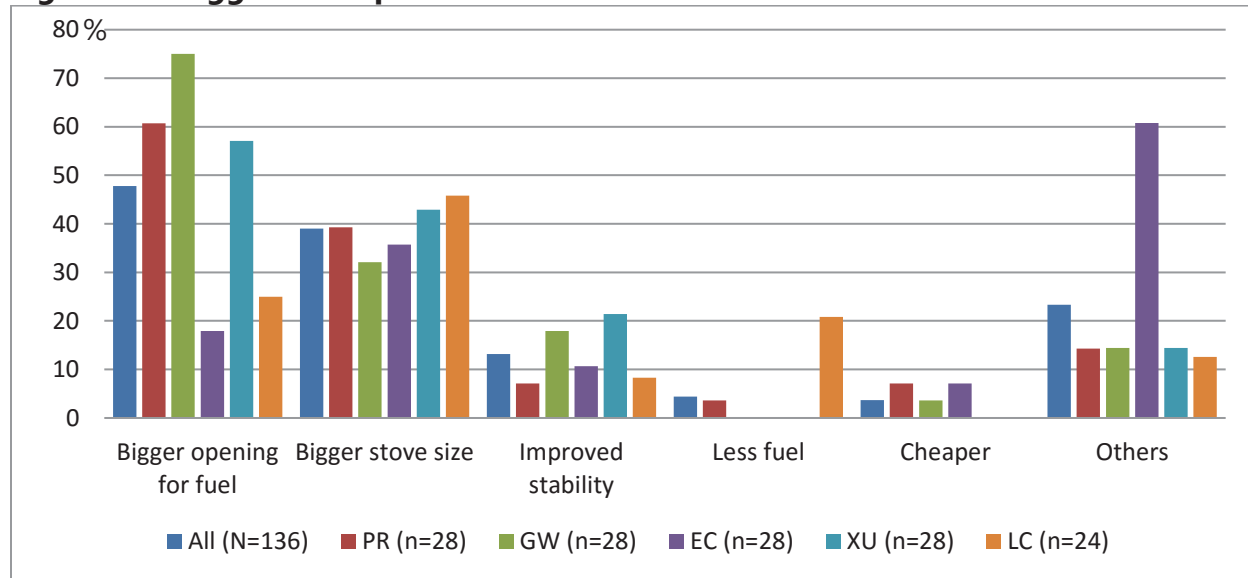
Figure 16. Cooking problems



Five participants slightly modified their stoves to make them easier to use (this was allowed). Two added an extra foot of chimney pipe, two made a chimney of tin for the Local Chimney to fit the layout of the house, and one Xunda user used rope to secure the stove's wood stand because it was loose.

Participants recommended the following improvements: a larger opening for fuel (65/120), a larger stove (53/120), and better stability (18/120). EcoChula users suggested the stove have a separate grate for large pieces of wood (6/28) and suggested adding a chimney (4/28) (see Figure 17 below). Some of these changes could lower stove efficiency or increase emissions and would have to be evaluated by manufacturers. The "other" category includes a significant number of unrelated responses that could not be further coded (for example "it should be suitable for cooking chapatti," "it should not make the pot dirty," and "it should cook food from solar energy.")

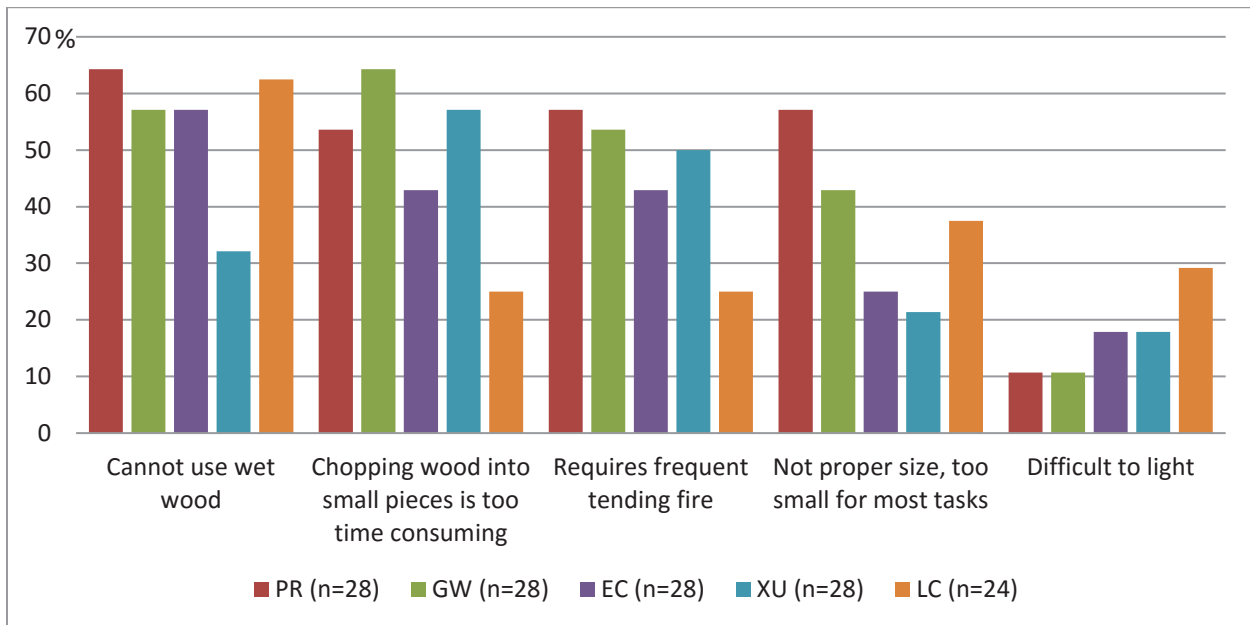
Figure 17. Suggested improvements to ICS



About a third of participants (33.8 percent) moved the stove from its original place, mainly for their convenience of cooking indoors/outdoors and because of the stove’s versatility.

More than half (71/136) said they modified cooking styles for the new stove. Cooks had to prepare everything before starting the fire or the fire would go to waste (32/71); they had to chop wood into smaller pieces (33/71). They had been instructed to start fires with paper, not plastic, and 22 of 71 found that change difficult. On the minus side, more than half (55.4 percent) said they did not like being unable to use wet or undried wood as they could with their old stove; 49.3 percent said it took more time to chop the wood into small pieces; 46.3 percent said they needed to tend the fire more frequently; 36.8 percent said the new stove was not the proper size or was too small to prepare animal food and liquor; and 16.9 percent found the fire was difficult to start.

Figure 18. Negatives about new stove compared with old cookstove



The study participants had overwhelmingly positive initial reactions to the study stoves, with cleanliness and fuel savings noted as the most popular benefits. Cooks preferred them over their traditional stoves at an average rate of 90 percent, with a range of 82 percent to 100 percent, varying by stove type. More than 82 percent reported being satisfied or very satisfied with their new stoves. Most found the stoves to use less wood, and produce less smoke, and found them to be appropriate/preferred for cooking typical Nepali meals. Common negative reactions to ICS in general (complaints about fuel preparation and stove tending requirements and the stove's inability to accommodate large pots) were reported in just under half the households. Most participants reported using the new stove most or all of the time although stove use monitoring data showed very few exclusive users of the improved stoves. This initial assessment found that the study stoves generally met participant needs and were well-liked, indicating promise for the study stoves in Nepal.

V: FINDINGS OF ENDLINE SURVEY

5.1 Consumers' Reaction to New vs. Old Stoves

The post-trial survey measured users' perceptions of the new cookstove over time. Researchers asked users to compare the ICS with their traditional stoves. Most said food cooked on the ICS tasted the same (116/136). Some thought the food tasted better (18/136), one thought it tasted worse, and one had no opinion.

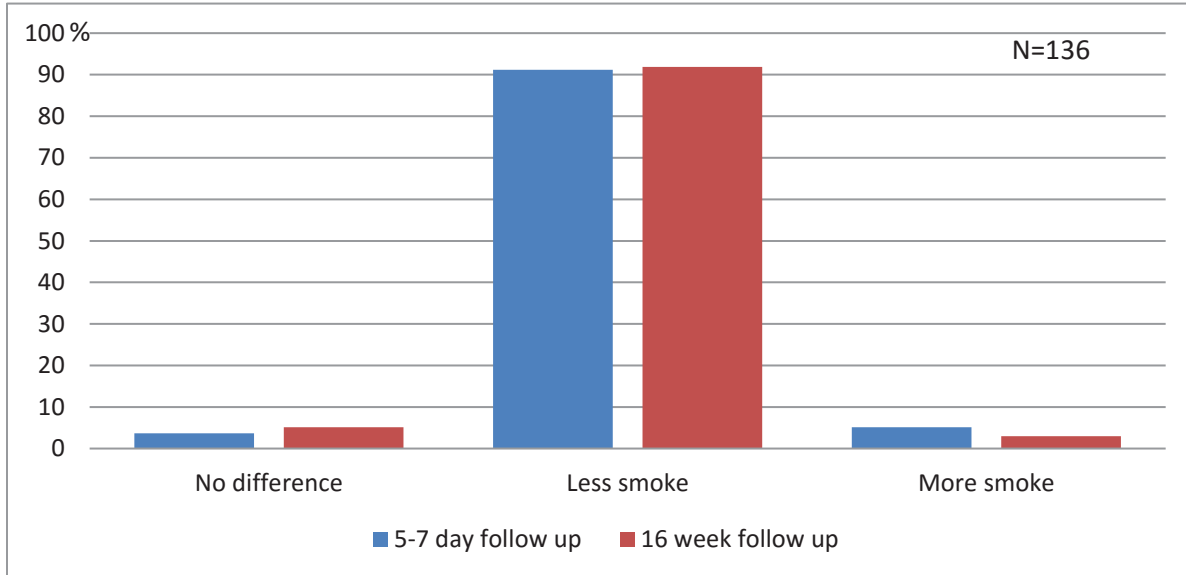
Most (91.2 percent) said the new ICS used less fuel than their old stove; 7.4 percent said it consumed the same amount of fuel, and one (a Prakti user) thought the ICS used more fuel. All Xunda users thought that their ICS used less fuel than their traditional stove. By stove type, 96.4 percent of Greenway users, 92.9 percent of EcoChula users, 89.3 percent of Prakti users, and 75 percent of LC users thought the ICS used less fuel than their traditional stoves. More participants from Nawalparasi (81 percent) thought the ICS used less fuel than from Dang (64 percent).

Husbands who participated in the survey shared the perception that the ICS used less fuel (88.4 percent); 11.6 percent felt both types used the same amount of fuel. Fuel consumption perceptions were identical in the 5–7 day survey and the post-trial survey.

Asked about the difference in smoke produced, most participants (91.9 percent) said the ICS produced less smoke; some (5.1 percent) found no change in smoke produced; and a few (2.9 percent) said the ICS produced more smoke than the traditional stove.

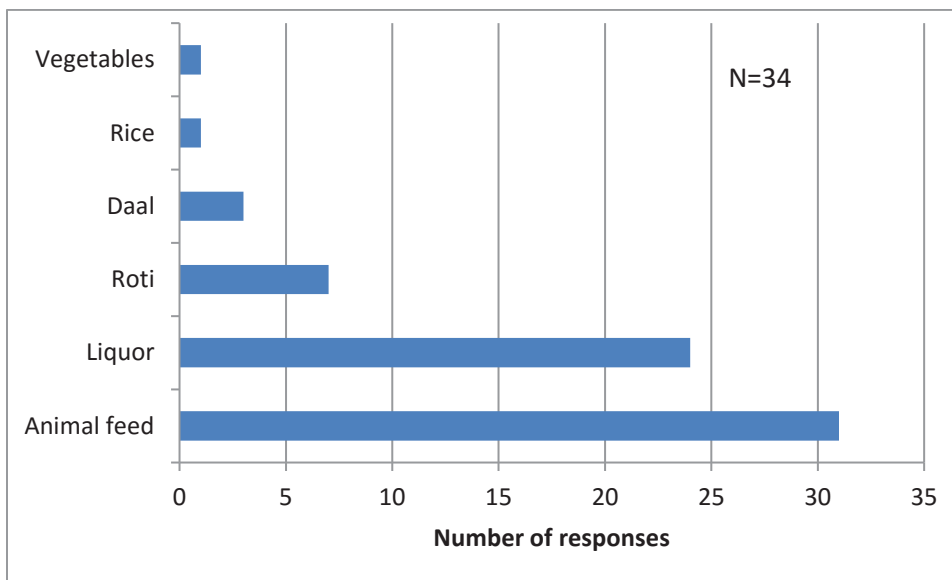
Most (83 percent) of the cooks' husbands agreed that the ICS produced less smoke in the initial and endline surveys. Interviewers were surprised to find 7.1 percent of Prakti users said the ICS produced more smoke than the traditional stove. Consumers' observations on smoke did not change from the initial to the end survey.

Figure 19. Difference in smoke produced, new stove vs. traditional stove



Responses from the 5–7 day survey showed most people found Nepali main course items such as rice, daal, vegetables, and meat cooked better on the new stove. They said foods that cooked better on their old stove were large-quantity items, like liquor, animal feed, and rice for many people. Post-trial data showed participants continued to use their old stoves for those activities, and for heating the house (see Figure 20).

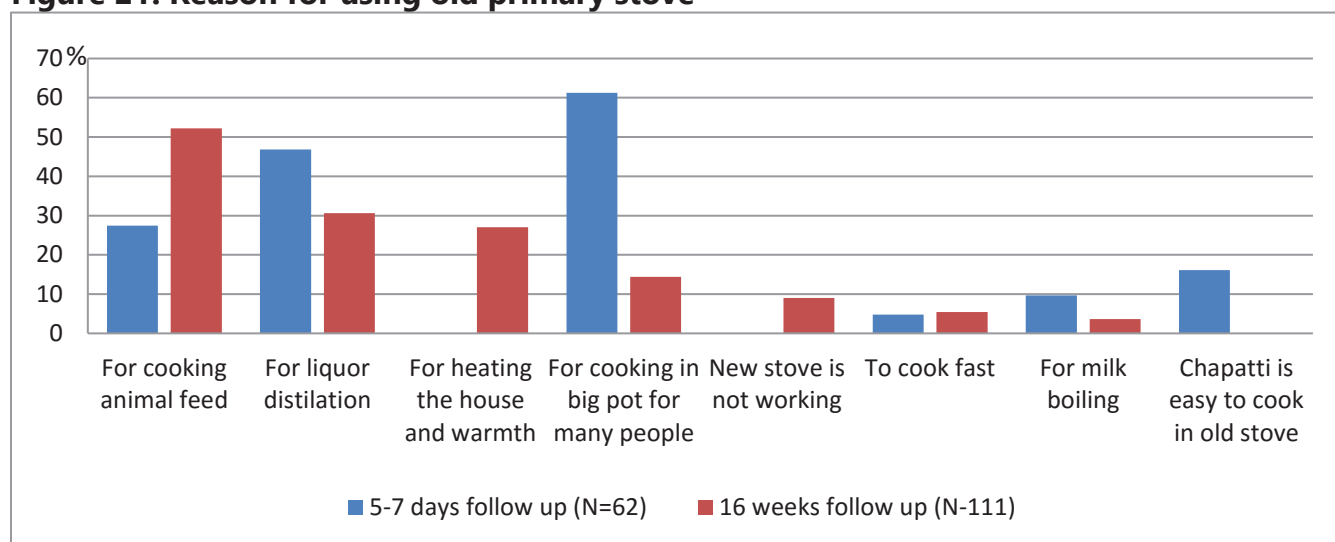
Figure 20. Foods not prepared on new stove



Cooks found activities requiring big vessels and large amounts of wood unsuitable for the new stove. At the post trial survey, some cooks were using the ICS for activities they had initially thought were not possible during the 5-7 day follow up, such as making liquor, making food in big pots, and cooking chapatti (see Figure 21).

During the winter 60 percent of Dang participants used the old stove for heating the house; none did in Nawalparasi. However, when the study was conducted, it was winter in Dang and fall in Nawalparasi. Because their new stove was not working 10 percent of participants used the old stove. This was the case for EcoChula users (32 percent) and Local Chimney users (21.4 percent), most likely because the EcoChula battery or fan was not functioning and the Local Chimneys were damaged by earthquake aftershocks.

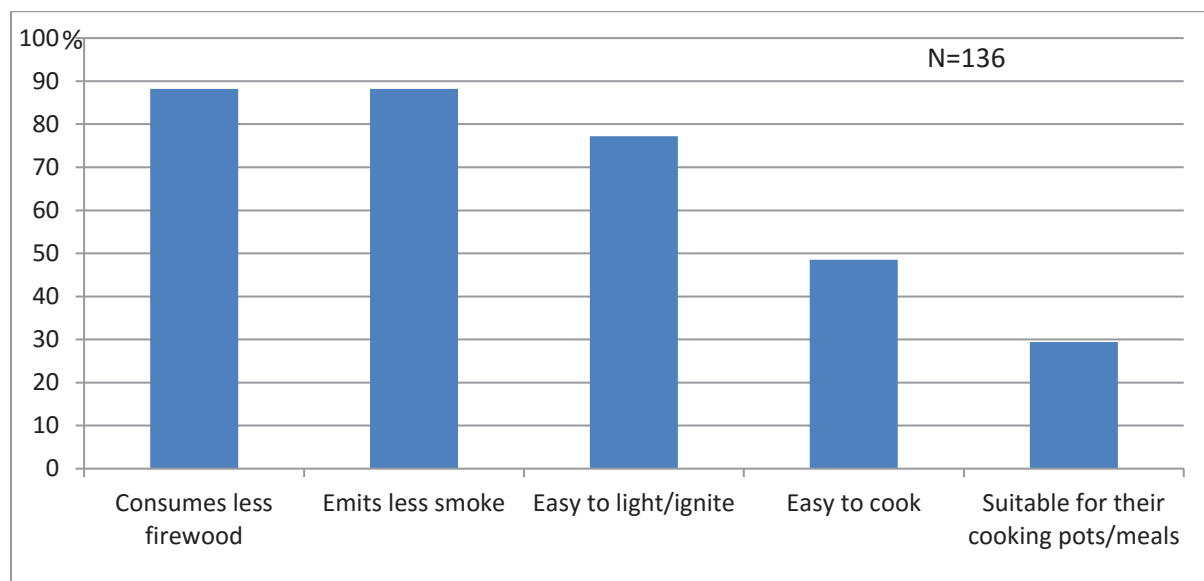
Figure 21. Reason for using old primary stove



5.2 Satisfaction and Preference

In the post-trial survey, consumers rated economical fuel consumption and lower smoke emission (120/136), ease of ignition (105/136), ease of cooking (66/136), and suitability for cooking pots/meals (40/136) as the most important features in a cookstove. Responses from both districts were similar except in two cases: 65 percent of participants from Dang compared with 33 percent from Nawalparasi ranked ease of cooking as an important factor in a good stove; in Nawalparasi, half the participants thought suitability for cooking pots/meals was more important, compared with 8 percent in Dang.

Figure 22. Important features of a good cookstove



When consumers were asked open-ended questions about their experiences with the ICS, they noted the following attributes: Most (99/136) said the ICS used less fuel; some (51/136) said they could keep children with them while cooking; others said food cooked fast (41/136) and pots remained clean (30/136). These are some of the positive features that consumers said they were looking for in an ideal stove, discussed above.

Asked to rate their new stove, 24 percent were extremely satisfied, more than half (53 percent) were satisfied, 18 percent were somewhat satisfied, and 5 percent were not at all satisfied. The overall reaction was similar to the 5–7 day survey response, although extremely satisfied users dropped from 34 percent to 24 percent, and satisfied users increased from 49 percent to 53 percent. Taken together, fewer users were extremely satisfied or satisfied with the new stoves over time (83 percent down to 77 percent). EcoChula users were most likely to report they were not at all satisfied (14 percent) or somewhat satisfied (27 percent). Xunda users were most likely to be extremely satisfied (39 percent); none was not at all satisfied.

Figure 23. Satisfaction with new cookstove

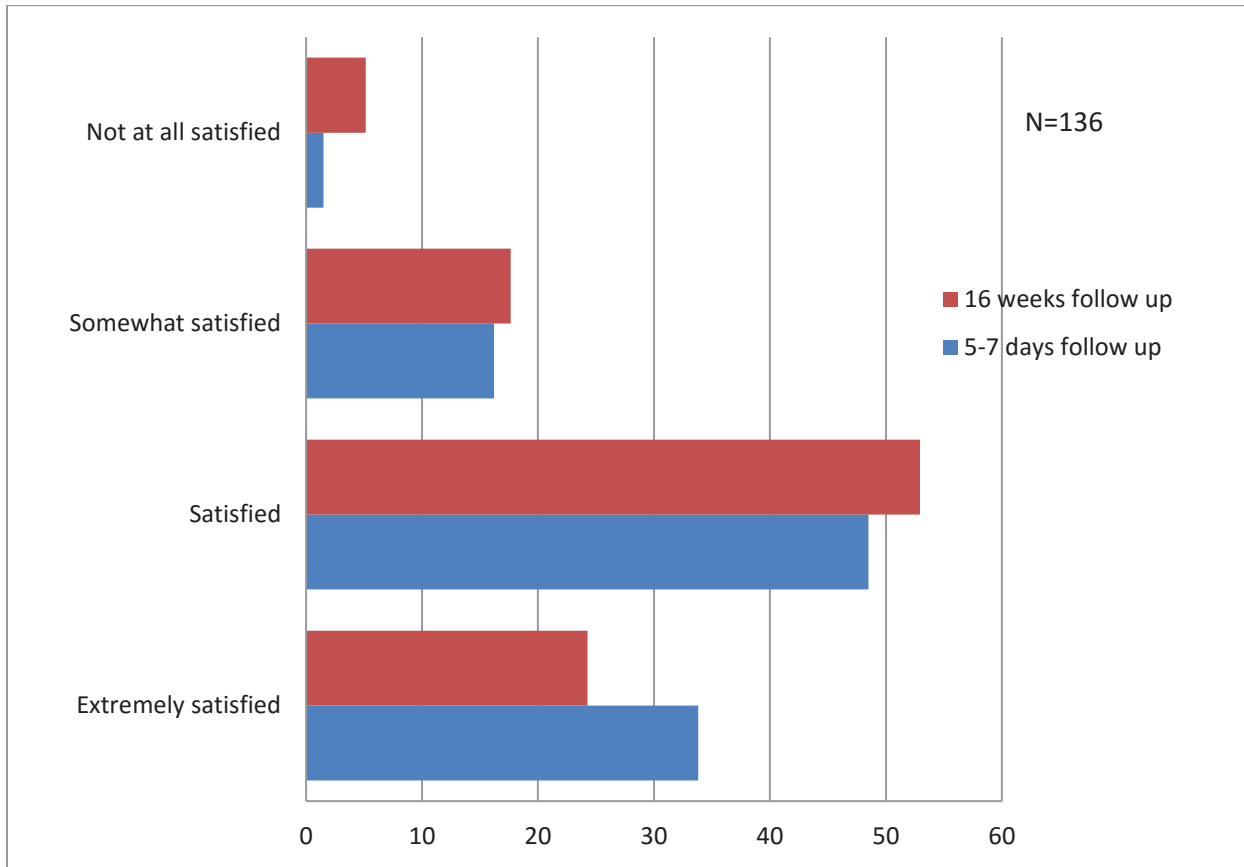
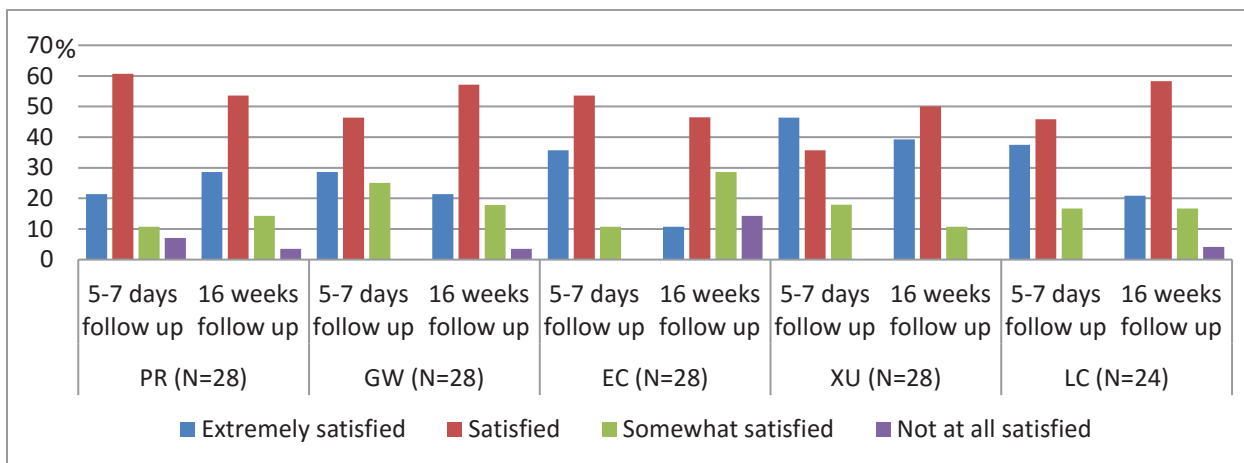


Figure 24. Satisfaction level with new cookstove by type of stove

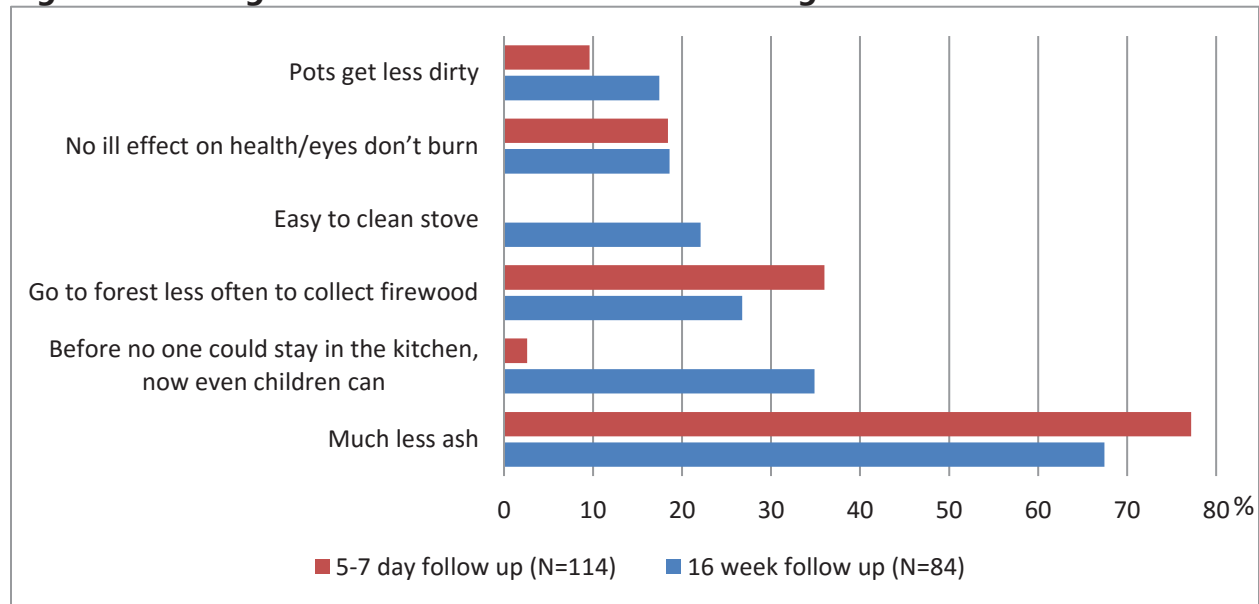


Asked if they noticed any difference in their household since they started using the new stove, 62 percent of participants said yes compared with 83.8 percent in the 5–7 day survey. Of those who said yes, 67 percent reported less ash, 35 percent noted that even children could stay in the kitchen when no one could before, and 27 percent said they went to the forest less frequently to collect firewood. Other changes included: the stove was easy to clean (22 percent), did not have

a bad effect on health/did not burn eyes (19 percent), and the pots got less dirty (17 percent). Changes participants noted in the 5–7 day survey were similar to those they noted in the post-trial survey—less smoke, fewer ashes, and a cleaner house.

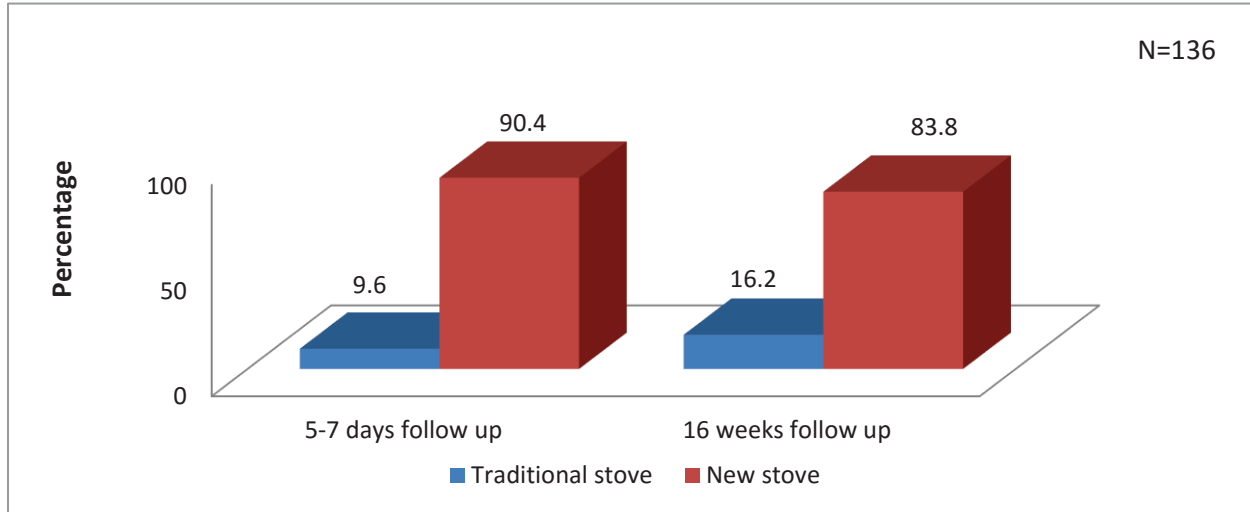
More participants from Nawalparasi (80 percent) experienced less ash than from Dang (53 percent); 45 percent of participants from Dang said they collected firewood less often, compared with 11 percent from Nawalparasi; 40 percent of Dang participants said the stove was easy to clean, compared with only 7 percent from Nawalparasi; and 28 percent from Dang said pots got less dirty, compared with 9 percent from Nawalparasi.

Figure 25: Changes observed in household after using new stove



As in the 5–7 day survey, many (84 percent) preferred the ICS to their traditional stove in the post-trial survey. Husbands also preferred the new stove (75 percent) to the traditional stove (25 percent). Reasons for preferring the new stove were similar to those given in the 5–7 day survey: emits less smoke, uses less firewood, cooks food fast, is stable, pots are cleaner, and easy to ignite. However, preference for the new stove declined slightly (see Figure 26 below).

Figure 26: Preference new vs. traditional stove



Data from the post-trial survey on consumer preference for new vs. old stove by type, showed the LC was most preferred (96 percent), followed by Xunda (89 percent), Greenway (82 percent), EcoChula (79 percent), and Prakti (75 percent).

Figure 27. Preference for new vs. traditional stove, by stove type

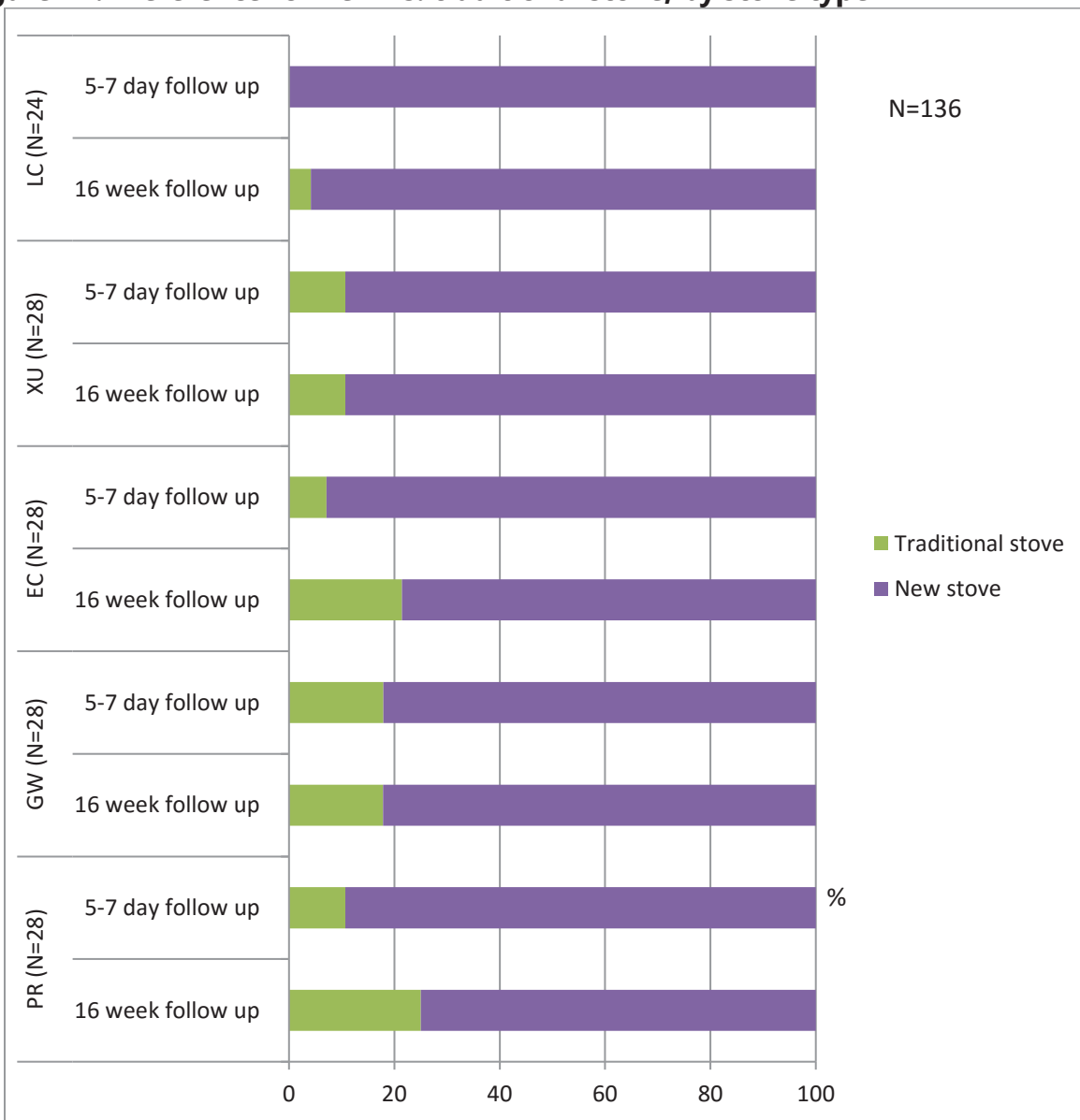
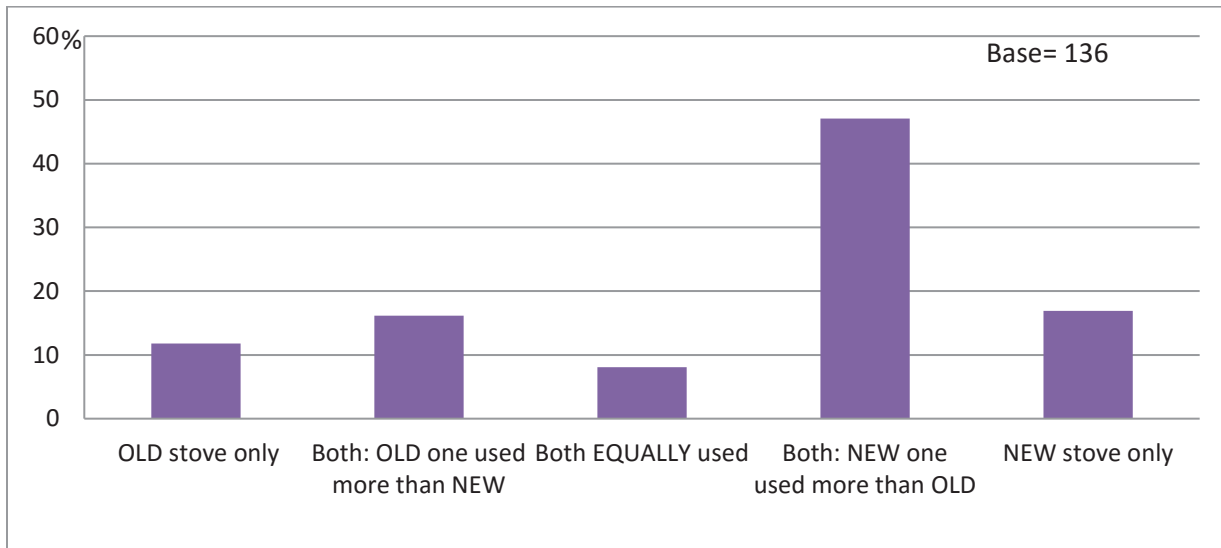
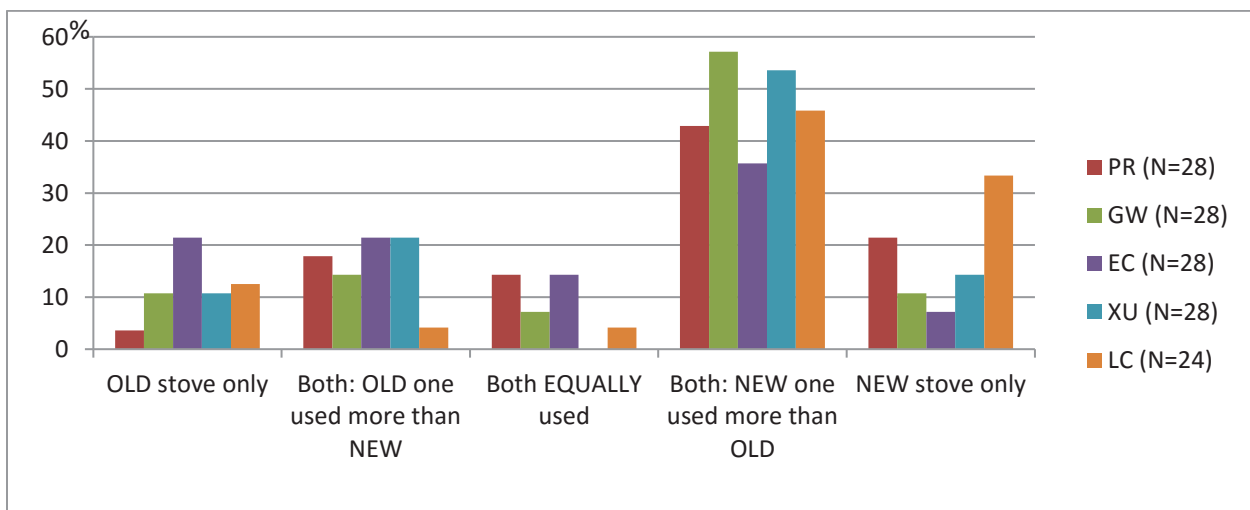


Figure 28. Use of traditional vs. new stove after new stove installed



Preferences were confirmed by number of consumers who reported using the new stove more than the old (64/136), only the new stove (23/136), both equally (11/136), old stoves more than new (22/136), and only the old stove (16/136) (see Figure 28). Participants from Nawalparasi district were more likely to use the new stove more than the old (71 percent), compared with only 21 percent from Dang district, but a higher percentage of participants from Dang (26 percent) used only the new stove, compared with 7 percent from Nawalparasi. The proportion of consumers using only the new stove was highest among Local Chimney users (8/24), followed by Prakti users (6/28). Consumers who used the old stove only were mainly EcoChula (6/28) users, followed by Local Chimney users (3/24) (see Figure 29).

Figure 29. Use of traditional vs. new stove since new stove in use



5.3 Consumers' Perceptions of Specific Stoves

The following paragraphs provide a summary profile of each group trialing a particular stove type. These summaries are based on frequency of responses among participants commenting on their own stove type, rather than comparing different stove types.

Prakti: Compared with other participants, Prakti users most often reported the stove emitted less smoke, took longer to cook food, and used less wood than the traditional stove. Prakti users considered the stove less portable because of the chimney. Cooks reported that they had to modify their cooking procedure to accommodate the new stove. They had to prepare cooking ingredients in advance and could not multitask because they had to tend to the fire frequently.

EcoChula: Users considered EcoChula fuel efficient. Its disadvantages were having to prepare ingredients in advance and having to chop wood into small pieces. In the post-trial survey, participants liked EcoChula for its portability, appearance, and stability. In the 5–7 day survey, no users reported being “not at all satisfied.” That jumped to 14 percent in the post-trial survey. One of the main reasons users did not like EcoChula, and, presumably, for the increase in dissatisfied users, was that they had problems operating the fan, or the fan was damaged or its battery was not working.

Greenway: The post-trial survey data showed that Greenway emitted less smoke, cooked food faster, and consumed less fuel than participants' traditional stoves. Users also liked that it was easy to clean and portable. Some negatives mentioned were it was hard to ignite, chopping wood into small pieces was difficult, and the stove got very hot.

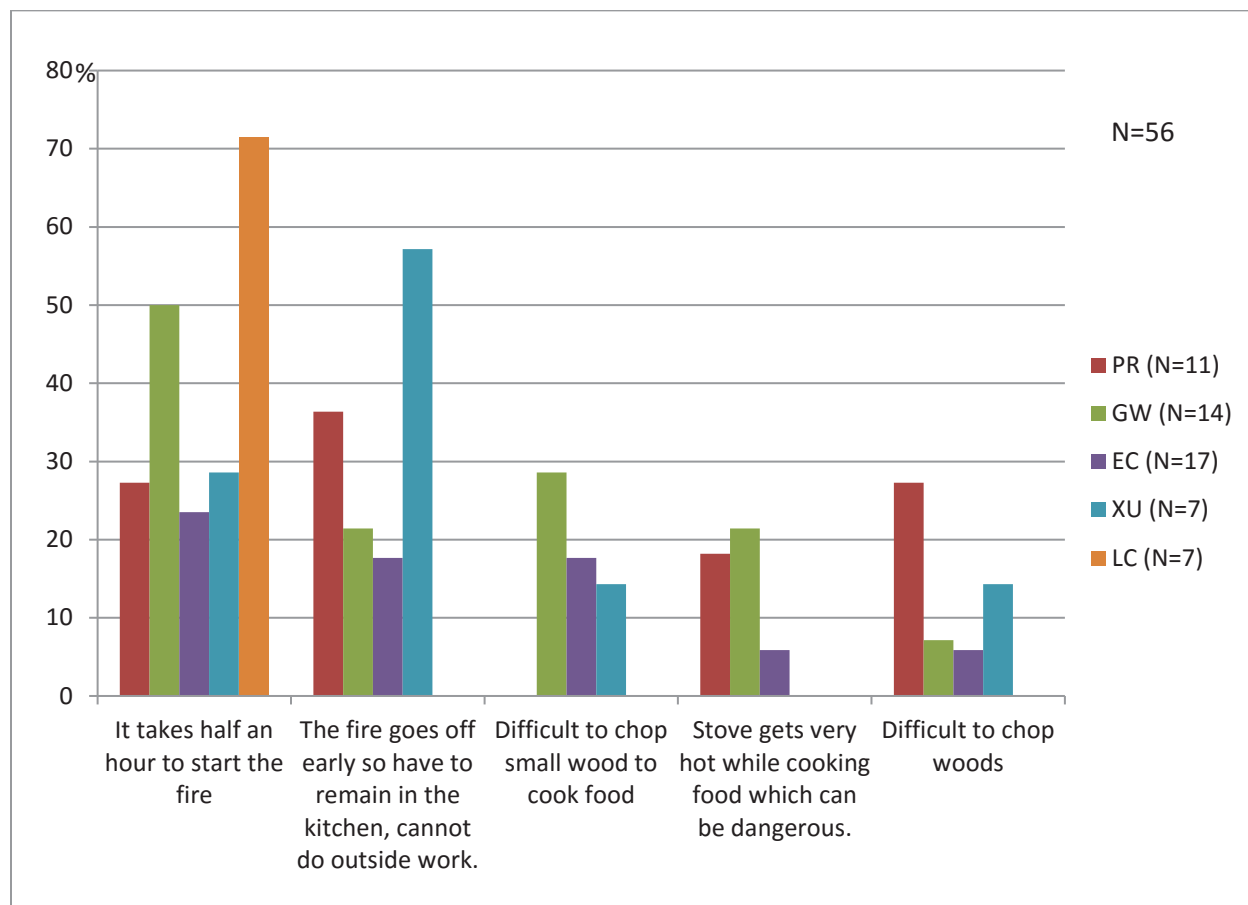
Xunda: Participants liked Xunda because it used less fuel, cooked food quickly, and emitted less smoke. They also liked its portability and aesthetics. What users did not like about Xunda was that ingredients had to be prepared in advance because the cook couldn't multitask while cooking, and wood had to be chopped into small pieces.

Local Chimney: Most said the Local Chimney used less fuel, emitted less smoke and ash, and pots remained cleaner than their traditional stoves. Consumers noted that the stove could be used for all kinds of cooking purposes, unlike other stoves that could only accommodate small quantities of food. Users liked its appearance and stability, and the ability to use all sizes of wood. However, some found it was difficult to start the fire.

5.4 Problems of the New Stove

More than half (59 percent) reported no problems in operating their new stove; 41 percent faced problems. Those with problems listed hard to ignite (37.5 percent), fire goes out comparatively quickly, cook must remain in the kitchen (25 percent), stove gets very hot (10 percent), and wood must be chopped into small pieces (10 percent). A small minority (10 percent) mentioned other problems. EcoChula users listed most of the problems, followed by Greenway, Prakti, and Xunda; LC users said only that the stove was “hard to ignite” (see Figure 30).

Figure 30. Cooking problems with new stove by type



When consumers were asked if they had made any changes to the stoves for convenience or better performance, only one consumer said yes at the post-trial survey, in addition to the five in the 5–7 day survey. The change was to increase the height of the pot stand in the Xunda stove; the rest (129/136) had not made any changes.

All consumers seemed to be comfortable working with the new stove. Most (121/136) said they hadn't made any modification to their cooking style, and only 15 consumers had made changes.

The modifications to cooking style included: preparing the ingredients in advance before starting the fire (12/15); using something other than plastic (as instructed by the team) to start the fire, which made it more difficult to get the fire going; not being able to multitask (3/15 each); and having to chop firewood in small pieces (2/15), modifications similar to those reported during the 5–7 day response. Note that field researchers observed that many households changed from plastic to paper, cardboard, and/or agricultural residue to start their fire, but few (just 3) spontaneously mentioned this as a change to their cooking style when directly asked.

Even after using the stove for 16 weeks and being comfortable with it, consumers did not think the ICS was good for all cooking purposes. Asked if the stove size was appropriate for cooking most of their meals, 67 of 136 said sometimes, 48 said almost always, 13 said occasionally, and eight said rarely. The new stove was not appropriate for cooking in large vessels for animal feed or liquor distillation, cooking large quantities of food, or heating the house. They used the old stove for these purposes, as they had reported doing in the 5–7 day survey.

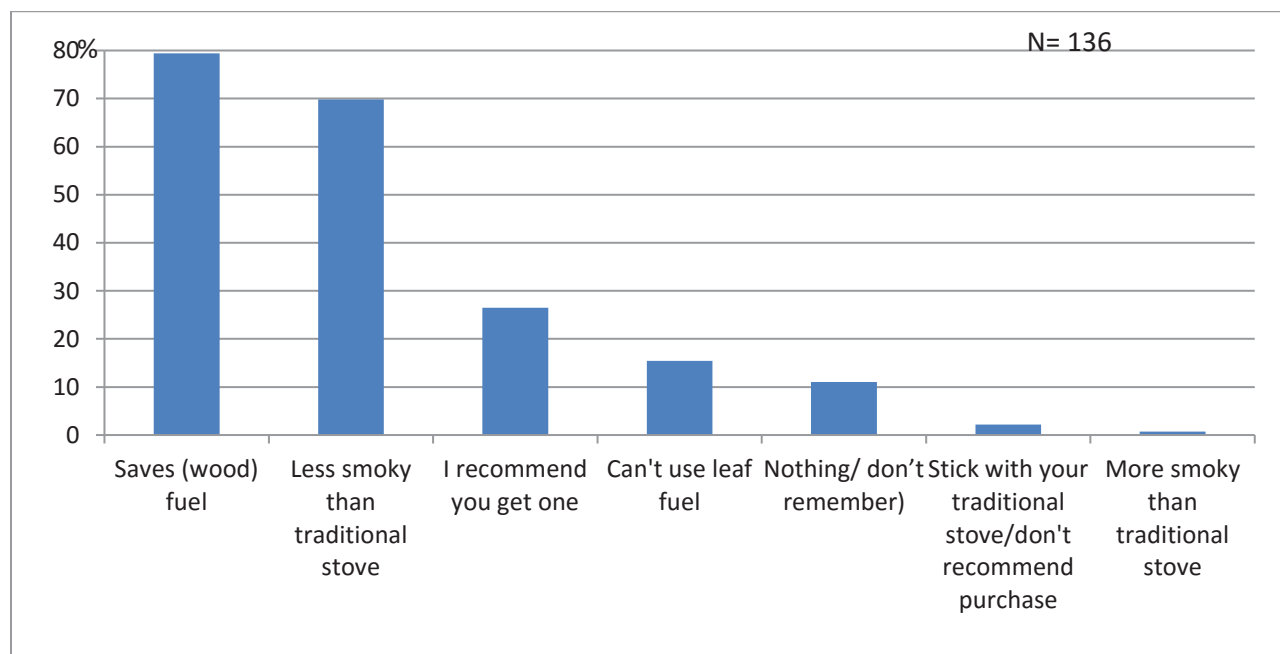
5.5 Perceptions About “Who Should use the Stove?” and “What is it Worth?”

To understand stove users’ perceptions and their willingness to pay for the stove before launching the willingness-to-pay exercises, researchers asked users to describe the kind of person who would use the stoves and to estimate their price.

Most (94 percent) thought the stoves were suitable for an ordinary person, versus modern people (6 percent). Some thought it was suitable for poor people (12 percent), thrifty people (8 percent), and smart people (2 percent). Most (79 percent) said using the ICS would not change others’ view of them. Some participants from Nawalparasi thought using the new stove would make them more modern (26 percent). This was not the case in Dang (0 percent).

Researchers asked what users had shared with their neighbors and family about the stoves (see Figure 31). Most had shared positive aspects of the stove—it saved fuel (79 percent) and emitted less smoke (70 percent), and recommended getting one (27 percent). Negative aspects shared included not being able to use leaf fuel (15 percent), and emitting more smoke (1 percent). Only 2 percent recommended against the new stove, and 11 percent were neutral.

Figure 31. Stove attributes shared with family and friends



Asked why someone else would choose these stoves, most users listed the attributes mentioned above, such as it saves fuel (125/136), emits less smoke (115/136), cooks food fast (68/136), impresses others (62/136), is portable (36/136), looks nice (34/136), and saves money on fuel (30/136) (see Table 8). The perception that using the stove would make a positive impression on others was frequently mentioned in this open-ended question, but was not mentioned at any other time in the interviews.

Table 8. Why would someone else (like your neighbor) choose to use this stove?

	Base	PR	GW	EC	XU	LC
	N=136	n=28	n=28	n=28	n=28	n=24
Uses less firewood	125	27	28	26	26	18
Emits less smoke	115	27	24	17	24	23
Cooks food quickly	68	9	17	11	15	16
Impresses others, brings pride to my house	62	16	11	11	11	13
Portable; good handle	36	-	13	11	12	-
Aesthetics; looks nice	34	7	2	11	8	6
Saves money on fuel	30	8	6	2	7	7
Reduced smoke-related health problems (eye irritation, headache, chest pain, cough)	28	11	6	4	6	1
Less soot and dust; cleaner house and kitchen; stable/doesn't tip over	15	3	-	3	1	8

Easy to light/ignite; not affected by wind	12	4	-	4	1	3
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Asked why someone would not use the ICS, consumers indicated that chopping wood into small pieces was the biggest problem. This was cited most frequently by EcoChula users (20/28) and Xunda users (20/28), followed by Greenway users (16/28). Other reasons cited: the need to tend to the fire frequently, difficulty igniting the fire, and the stove being too small for many tasks. The majority of Dang participants said that chopping wood into small pieces (73 percent) and the need for frequent fire tending (79 percent) were shortcomings, compared with only 29 percent and 23 percent of participants from Nawalparasi.

Even though most consumers said they were satisfied with the stove and valued it highly, when asked to estimate its cost, most vastly undervalued the price. As shown in Table 9, most (65 percent) estimated the value was NRs. 0–3000 (\$0–\$27.67), 16 percent estimated the value between NRs. 4000–7000 (\$36.87–\$64.55), and 4 percent estimated the value between NRs. 10000–12000 (\$92.22–\$110.66). Most ICS users estimated the price of Prakti, EcoChula, and Xunda at NRs. 2000–2500 (\$18.44–\$23.05), Greenway at NRs. 1000–1500 (\$9.22–\$13.83), and the Local Chimney at NRs. 500–1500 (\$4.61–\$13.83).

Table 9. Estimates of ICS price

Stove model	Stove cost (to WASHplus) NRs	Estimate of stove value NRs
Prakti	7060 (\$71)	2000–2500
Xunda	6500 (\$65)	2000–2500
EcoChula	4181 (\$42)	2000–500
Greenway	3783 (\$38)	1000–1500
Local Chimney	1412 (\$14)	500–1500

Asked which of the five stoves they preferred (by the end of the study, all participants knew the options), most cited Prakti (37/136), followed by the Local Chimney (28/136), Xunda (22/136), Greenway (21/136), and EcoChula (17/136); 11 had no preference (see Table 10). Users' preference was strongly associated with the stove they had tried, particularly LC users (22/24), less so among EcoChula users (12/28).

Table 10. Preferred stove

	Total	PR	GW	XU	EC	LC
BASE	136	28	28	28	28	24
A. Prakti	37	19	5	2	10	1
B. Greenway	21	-	17	1	2	1
C. Xunda	22	1	-	19	2	-
D. EcoChula	17	1	2	2	12	0
E. Local Chimney	28	1	1	3	1	22
F. None	11	6	3	1	1	-

Over the course of the trial, household preference for the new stoves over the traditional stoves declined slightly from 90 percent to 84 percent, with ranges declining from 82–100 percent to 75–96 percent. Preference for the Local Chimney, EcoChula, and Prakti declined, while preference for the Greenway and Xunda remained constant. Households continued to find the new stoves appropriate for cooking typical Nepali meals, but over the course of the trial used the traditional stoves more for cooking animal feed. Cooks continued to value fuel savings and reduced smoke emissions as the most important features in a stove, and perceptions of fuel savings of the study stoves remained constant from initial responses at 5–7 days, as did perceptions smoke reductions. Families reporting being satisfied or very satisfied with their new stoves went down from 82 percent to 77 percent over the course of the trial, with the numbers reporting to be “extremely satisfied” decreasing and all other categories (satisfied, somewhat satisfied, and not at all satisfied) increasing slightly. Most thought the stoves were suitable for an ordinary person, and thought it most likely that someone would choose to use the stove because of fuel savings and smoke reduction. The most frequent responses for why someone would not use the stove were the need to chop fuel into small pieces, and the need for frequent tending of the stove.

This survey demonstrated a continued albeit slightly reduced preference for the study stoves, with the stoves continuing to meet prioritized household needs.

VI. FINDINGS OF MARKET DEMONSTRATIONS

The team conducted marketplace demonstrations in Damauli market in Tanahu district and in Banepa market in Kavre district. Both markets are considered to be in peri-urban areas where LPG and firewood are common sources of fuel for cooking. Banepa is closer to Kathmandu and has better access to LPG, so locals use it more than firewood.

The purpose of the market demonstrations was to assess consumer reactions to the new stoves, extending the research beyond the intensive home trials. The team considered consumer comments, reactions, and questions as data points.

6.1 Stove Demonstration

The demonstrations were set up near bus junctions, where the team expected many people from different backgrounds in nearby villages to visit. The four portable stove models (Prakti, Greenway, Xunda and Greenway) were shown. The team set up the stoves in stalls, with ICS displays on one side and ICS cooking demonstrations on the other. Staff members from Winrock showed the public different types of ICS, offered them food cooked on the ICS, explained how the stoves worked, and answered questions. RDN staff announced on loudspeakers that an advanced version of cooking stoves were being introduced and were on display for public opinion. RDN staff recorded initial reactions and answered questions. The staff also recorded the event with still photos and on audio and video recordings. Staff asked people about their backgrounds, fuel options for cooking, and views on stoves, and made suggestions about how the stove could be made better.

6.2 Background Characteristics of Customers

Most of the people were local residents. Men and women from varied backgrounds visited the stalls. Women, though curious, were shy to ask questions, whereas men were vocal in their queries. Most of the women who visited were homemakers; some owned small shops. Men were either self-employed (shop owners, small work contractors) or worked for the government as school teachers, drivers, construction workers, or were retired. Some were engaged in agriculture.

Most had families of four to six people and lived near the market. Some lived in their own house; some rented rooms. Those living furthest from the market owned their own house and were engaged in agriculture. Those living in the market area primarily used LPG for cooking, while those living in the suburbs used both LPG for making tea and snacks as a quick cooking option and firewood for cooking and boiling water.

6.3 Initial Reaction to Stove Stall

Many people were attracted by the stalls themselves, as they were colorful, located at primary junctions, had appealing stoves on display, and invited people in via loudspeakers. When people saw the stoves, they were very curious to find out more about them and why they were displayed. They asked if they were for sale or just on display.

6.4 Visitors' Reactions and Queries on Stoves

Most visitors thought the stoves, especially Greenway and Xunda but not Prakti, were like *bhusa chulo*, a traditional Nepali chulo fueled by *bhusa* (rice or grain husk). They were very curious about EcoChula, thinking it was solar-powered, instead of having a solar-powered fan. Visitors liked Prakti and EcoChula. Usually their first question was about the stove's fuel source and whether it was wood or *bhusa*.

Visitors liked Prakti at both locations for its smoke chimney, which funneled the smoke from the kitchen. People deemed Prakti more practical because it reduced smoke in the house and had a two-pot hole, which meant two dishes could be cooked at the same time. Visitors liked EcoChula for its solar-powered fan that blew the fire automatically, relieving the cook from manually blowing on the firewood. People were intrigued by EcoChula's solar panel, which made it more advanced than the traditional *bhusa chulo*.

Visitors most frequently asked how the stoves worked, what they cost, their availability, where they were made, warranty, and after-sale services. Women said they were reluctant to try a new stove they had never seen and were unsure how to run them. They were also concerned about the warranty and after-sale services, especially as the products were new. Some asked about the materials used to make the stoves and were concerned about the possibility of rust. Most visitors thought wood was not a good source of fuel, as firewood was scarce. They thought new products should be more technologically advanced, with an alternative, cheaper fuel source. Because these stoves were introduced when LPG was scarce in Nepal, consumers expected to see stoves with such fuel options as solar or electricity.

When asked to guess the price of the stove, most undervalued it by nearly half. When told the price, most thought the ICS were expensive and more expensive than LPG stoves being sold in the market. Few said they were ready to buy a stove if it was available in the market.

6.5 Visitors Reaction in Banepa vs. Damauli

The questions and reactions of participants in both the places were similar. However, those in Banepa were more willing to buy the stove immediately, if available, than those in Damauli. The market demonstrations were conducted at a time when Nepal was facing an acute LPG shortage, so people were looking for stoves that offered an alternative fuel option. Their reaction could have been affected by the shortage. Residents of Banepa relied more on LPG for cooking than residents of Damauli, so the shortage affected Banepa residents more. Another factor could be that residents of Banepa are more affluent and therefore more willing to spend money on a new stove with an alternate fuel option.

The market demonstrations were a less rigorous study component to gauge initial reactions of a larger group of consumers to the same suite of cookstoves. The market shoppers were typical but perhaps slightly more affluent than home trial study participants, and represented what might be "early adopter" segments of consumers, less risk adverse consumers with a bit more money, eager to try new technologies. The reaction of marketplace shoppers was mixed. The

new looking stove designs generated a lot of interest, which is in itself a finding, and encouraging for marketing this new class of improved cookstoves. The excitement, however, was matched with disappointment when shoppers realized the stoves were still reliant on fuels that weren't based on new technology. Many of these consumers either used or aspired to cleaner fuels like LPG, which was currently in short supply in Nepal; and were hoping for a step up. It was not clear that these consumers would jump at the chance to buy the stoves, although in Banepa there was greater interest in purchasing the stoves.

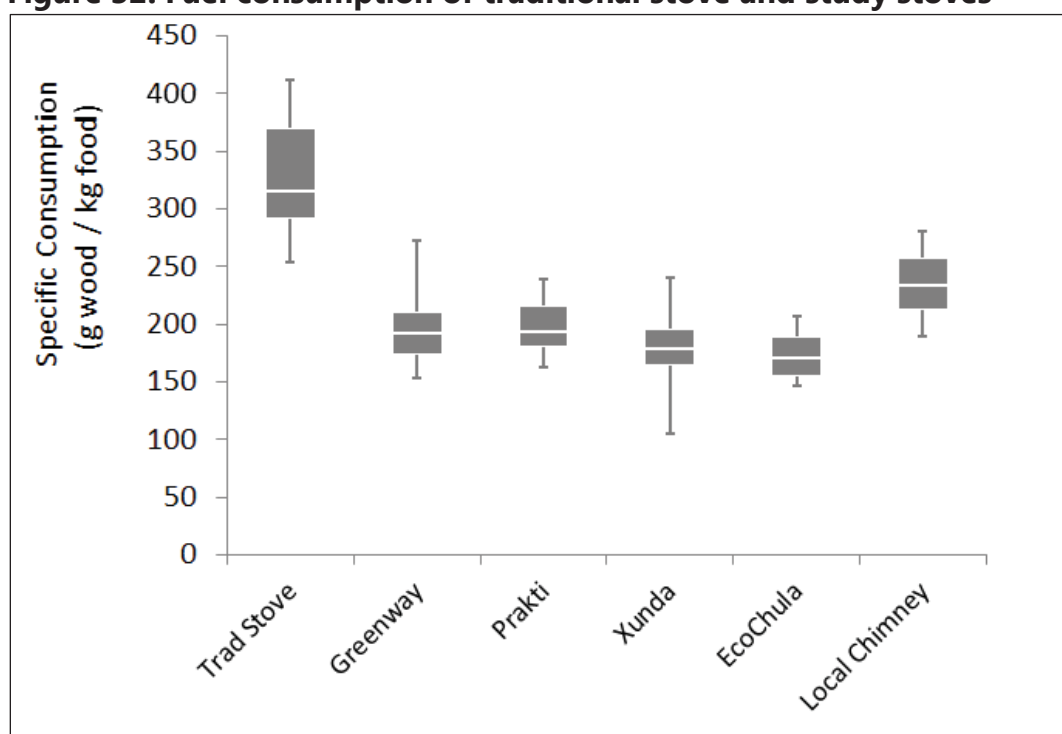
These market shoppers reinforced desirable attributes and service expectations; they liked the "bells and whistles" add-ons of each particular stove, such as the Prakti chimney and the EcoChula fan. Shoppers were vocal inquiring about construction materials, durability, warranty, and after-sale services.

VII: CCTs, SUMS, AND KPT

7.1 Controlled Cooking Tests

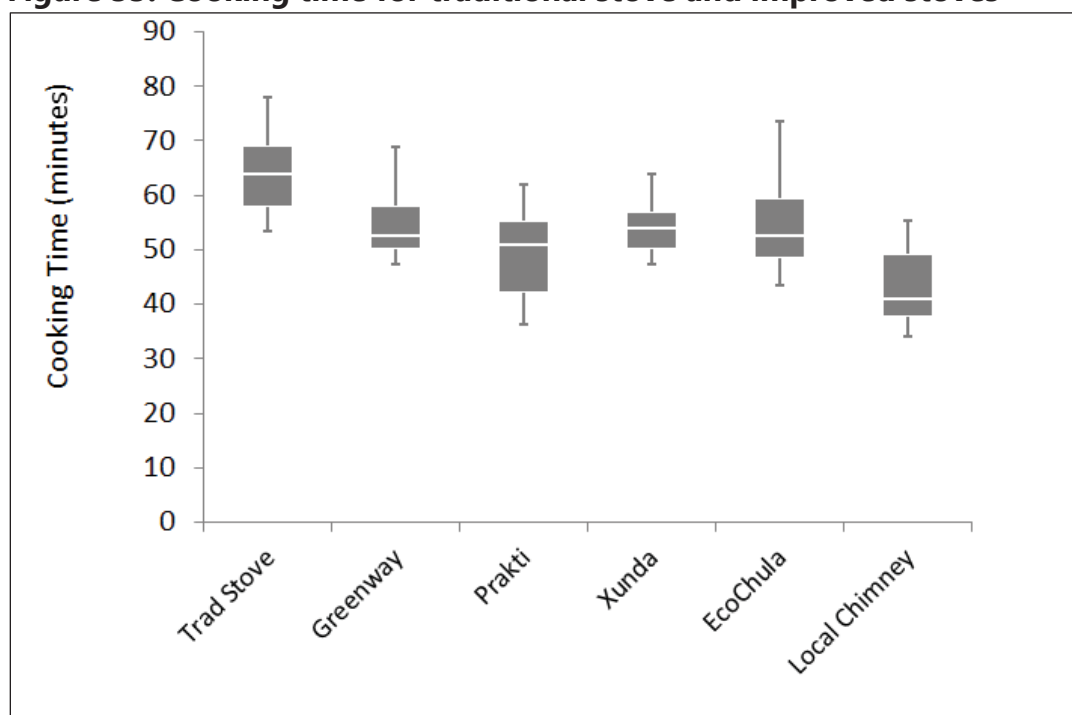
Prior to the household trials, researchers tested the stoves in-country to assess their performance in Controlled Cooking Tests. The CCT uses multiple cooks making a typical local meal (using the same amounts of the same ingredients) multiple times on each stove. In addition to gauging whether proposed technologies will meet local cooking needs, the tests can identify necessary use and maintenance instructions for study cooks. Cooks practiced for 10 days on each stove in their homes, to reduce user error in the testing.

Figure 32. Fuel consumption of traditional stove and study stoves



Test results showed all five stoves used significantly less fuel than the traditional three-stone stove, with savings from 29 percent (LC) to 47 percent (EcoChula). The Xunda used 45 percent less fuel; the Greenway and Prakti stoves used 40 percent less.

Figure 33. Cooking time for traditional stove and improved stoves



Time saving was also significant, with mean cooking times cut by 15 percent (Greenway, Xunda, EcoChula) 23 percent (Prakti), and 33 percent (LC) over the traditional stove. The ability to cook two dishes at the same time was a significant factor in reducing overall cooking time for the Prakti and LC stoves; all the new, single-pot cooking stoves reduced cooking time due solely to their ability to cook single dishes more quickly than the traditional stove.

7.2 Kitchen Performance Tests and Stove Use Monitoring

During the trials, the study used the KPT to assess the effect of improved stoves on fuel use, measuring fuelwood consumption in 150 representative households over four consecutive days. This included 123 study households, and a 27-household control group, which used the same baseline stove mix as the study households: the three-stone stove, Odan, and mud stoves. The study's primary output metric is mass of wood consumed per standard adult per day (kg/SA/day). SUMs were used to track stove temperature as a proxy for use for several months before and during the KPT to determine adoption levels of the five ICS.

Staff ran the KPT in rural districts of Nawalparasi and Dang during two seasons, at the end of summer in Nawalparasi and, because of political unrest, in winter in Dang. Political unrest in Dang delayed field visits 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 (this was the case for 77 percent of participant homes in Nawalparasi and 16

percent in Dang). Outdoor stoves may also be used for supplementary cooking for the family. The team made fuel piles in these homes during the KPT—one for the outside animal feed and brewing and one for the inside family-cooking stoves, although there was no restriction on what could be cooked where. Outdoor stoves were not monitored through SUMs.

Data from each location were analyzed separately owing to distinctly different cooking behaviors and seasonal differences between the two study periods. For example, participants in Nawalparasi did substantially more animal feed cooking and alcohol brewing, while participants in Dang reported using their cookstove for household heating more.

Based on SUMs data, improved stove use in Nawalparasi during the KPT was higher than traditional stove use based on events per day in all study groups, although all groups still used traditional stoves. Improved stove use in Nawalparasi was relatively consistent over the four-month study period. However, EcoChula use decreased with time, from an average of 2.25 events per day to 0.5 events per day, while the LC increased in popularity over time, from 0 events per day to 1 event per day. The Greenway, Prakti, and Xunda groups used the improved stove significantly more than the traditional stove ($p < 0.05$). The EcoChula and LC, while used regularly, were not used significantly more than the traditional stove ($p = 0.3$ and $p = 0.4$, respectively).

Figure 34. Weekly average stove events, Nawalparasi

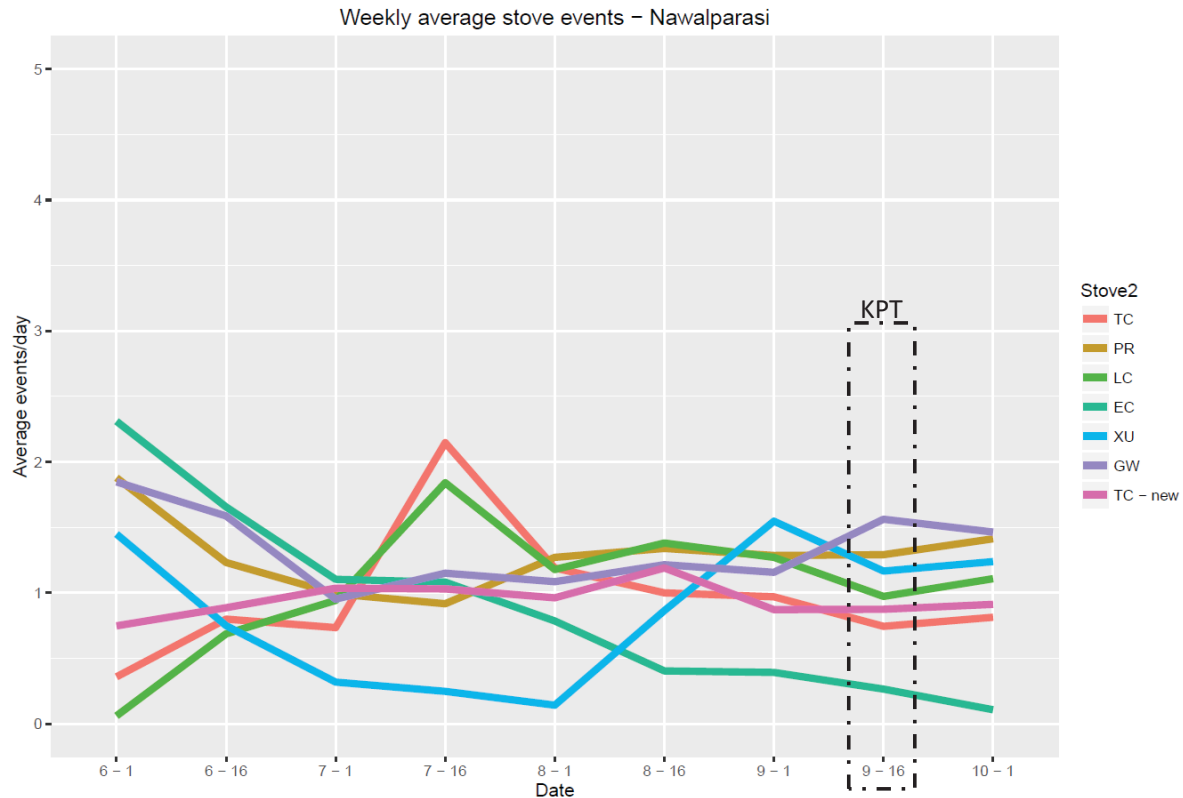
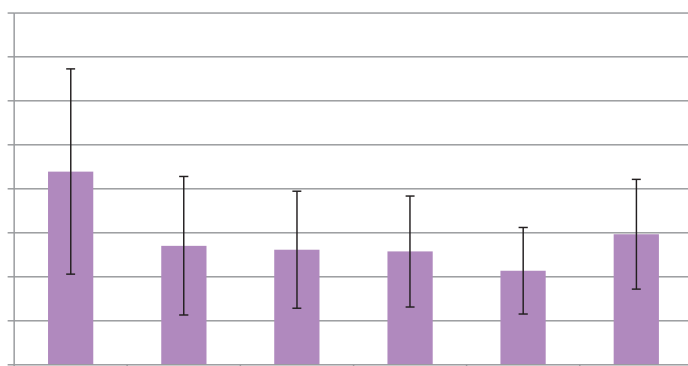


Figure 34: Twice-monthly, binned average cooking events per day for each stove participant group in Nawalparasi over five-month SUM. Traditional stove use is combined for all improved stove users for simplification (TC-New). A baseline group used only the traditional stove (TC). The dashed rectangle designates the KPT monitoring period bin. Error bars are ± 1 standard deviation.

Nearly all improved stove groups demonstrated statistically lower fuel use (kg/SA/day) than the traditional stove group, other than Local Chimney, which was nearly significant ($p = 0.07$). The Greenway showed the greatest fuel savings (50 percent), and the Local Chimney showed the least (32 percent) compared with the traditional stove group.

Figure 35. Fuel use, Nawalparasi during KPT



Error bars indicate ± 1 standard deviation.

ICS users saved fuel in indoor and outdoor inventories, which correlates with their report of using the outdoor stove less often. Participants with an outdoor stove seemed to use their ICS more often than those who only had an indoor stove. The team hypothesized that these households may need more cooking capacity for animal feed and brewing liquor.

Table 11. Nawalparasi KPT results in homes that use outdoor stoves for cooking animal feed and/or brewing alcohol

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)	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
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						
	Traditional	Prakti	Xunda	Eco Chula	Greenway	Local Chimney
% difference of means		47%	50%	51%	51%	44%
p-value		0.02	0.02	0.01	0.03	0.03

In Dang, cooks used the ICS consistently in the first three months of ownership through the warm season, except the Local Chimney group, which dropped from 2.5 events per day in June to 0.8 events per day in August. After the four-month gap in data because the team could not

make field visits, the cold season arrived and the team observed a substantial decrease in all ICS, other than the Local Chimney, as use of traditional stoves increased.

By December 2015, when the KPT was conducted, use had dropped from 0.5–2 events per day to 0–0.75 events per day. Those with ICS used their traditional stoves the same amount as the baseline group—ICS use was in addition to typical traditional stove cooking. On average, improved stove participants reported cooking family meals more frequently than the traditional group; the baseline group cooked fewer family meals. Both groups cooked animal feed or brewed alcohol at similar rates. None of the improved stove user groups demonstrated statistically significant fuel savings during the KPT period, which was expected as they used the ICS infrequently in December.

Figure 36. Weekly average stove events, Dang

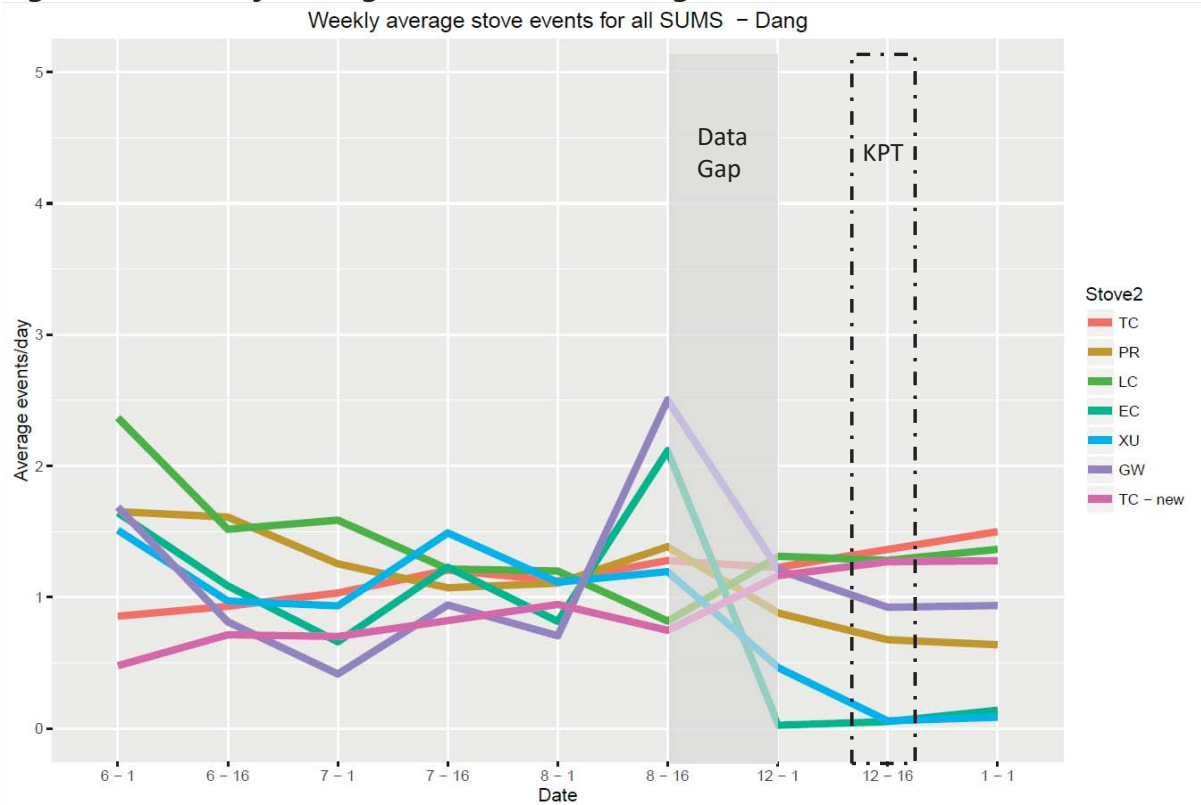


Figure 36: Bi-monthly binned averages not taken for Sept.–Nov SUM period because political turbulence precluded field visits (grayed out). Participants using a traditional stove with an ICS are grouped as (TC–New). TC designates the control group, which used only the traditional stove. The bin containing the KPT is the dashed box. Error bars represent ± 1 standard deviation.

The difference in use and fuel savings in Nawalparasi and Dang seem related to seasonal heating and the fact that in Dang, households do less cooking of animal feed and brewing liquor. This could mean there is a suppressed demand for increased cooking capacity there. The improved stoves may not provide as much latent heat as the traditional stove, so during cold winter months, they are used less frequently. Markedly dissimilar findings from the KPTs in Nawalparasi and Dang demonstrate the importance of accounting for cultural, climate, seasonal, and behavioral variability in communities even in the same country.

In both districts, study stoves were generally used consistently over the first several months of ownership, during the warm season. In Nawalparasi, Greenway, Prakti, and Xunda stoves were used significantly more than traditional stoves; EcoChula and Local Chimney were used more than the traditional stoves, but not significantly. EcoChula started out with the highest usage rates, but dropped to the lowest by the end of the trial, and the Local Chimney started out with the lowest usage rates, but surpassed the traditional stoves by the end. In Dang, improved stove use dropped dramatically following the four-month gap in data collection, with a commensurate increase in traditional stove use. Further, the improved stove use was found to be additional to typical traditional stove cooking; families with improved stoves were cooking more meals than the control group with just the traditional stoves.

Follow-up conversations with families from Dang revealed that families enjoyed the latent heat from their traditional stoves while making breakfast on cold mornings in December. It was then easy to just keep cooking on the traditional stove throughout the day, rather than switching to the study stove. In spite of the fact that households in Dang were using the study stoves very little by the end of the study, 80 percent still reported preferring them over the traditional stoves at the endline study. Further follow-up conversations with a subset of households in May 2016 (when warm weather had returned) revealed that they had resumed use of the ICS again.

Pre-trial stove performance testing found significant fuel savings, of 29-47 percent, and savings of cooking time of 15 percent (for single pot stoves) and 23-33 percent (for two pot stoves). These fuel savings were borne out in study households, where KPTs in Nawalparasi found household fuel savings of 44-51 percent, higher than expected because study households ended up using their study stoves for tasks beyond family cooking, for cooking animal feed and brewing alcohol, resulting in very high savings for those energy-intensive tasks. Researchers initially worried that households may be increasing their smoke exposure by bringing these energy-intensive tasks from the outdoors into the house, however, follow-up conversations with a subset of houses clarified that they were bringing the improved stoves outdoors for these cooking tasks. Researchers were pleased to see that families found these large cooking tasks possible on the improved stoves, for which they were not designed.

Stove and fuel use assessments ultimately found significant benefits for households during the warmer months, but not during the winter in Dang.

VIII: WILLINGNESS TO PAY

8.1 Willingness-to-Pay Auction/Bargaining Exercise

The team conducted a willingness-to-pay bargaining exercise in two VDCs in Nawalparasi district. Seventy households were given the opportunity to bargain for and buy any of the study ICS models, regardless of which stove they had used. They could pay for the stove in a lump sum or on an installment plan (with 14 percent interest), set up through a local microfinance institution that agreed to collect payments twice a month for six months. The minimum amount researchers would accept for each stove (not revealed to study participants) is shown in Table 12.

Table 12. Minimum buyback amounts for each stove

	Costs to study participants	
	Cash (NRs, US\$)	12 installments (NRs, US\$)
Prakti	4300 (~\$43)	409 (~\$4.09)
Xunda	3800 (~\$38)	361 (~\$3.61)
EcoChula	1900 (~\$19)	181 (~\$1.81)
Greenway	1600 (~\$16)	152 (~\$1.52)
Local Chimney	600 (~\$6)	57 (~\$0.57)

Cash costs to participants were calculated based on what WASHplus paid for the stoves (excluding shipping), minus an anticipated AEPC subsidy of 50 percent or NRs 2000 discount (whichever was less), with an additional 25 percent discount for participation in the study, because the stoves were no longer new and follow-up service would not be readily available in the study areas.

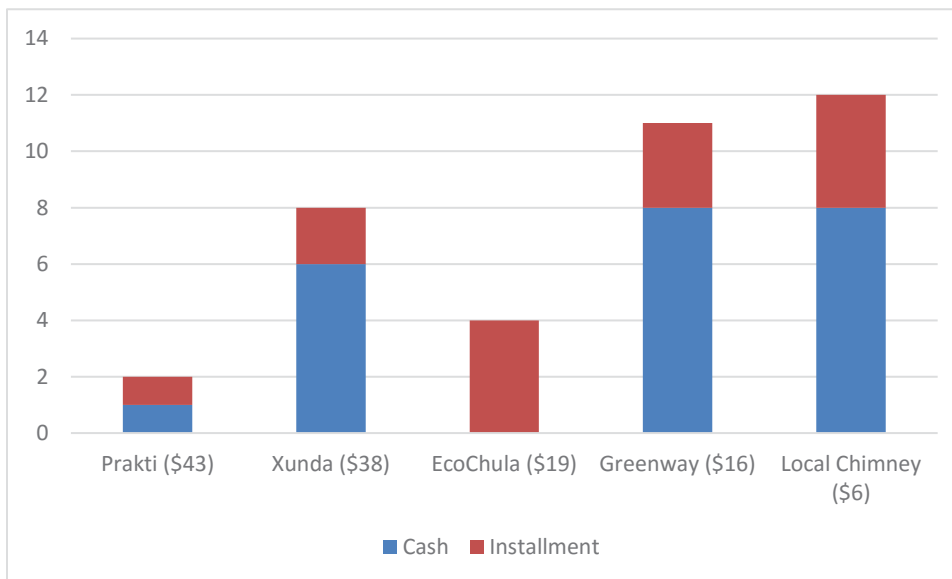
Of the 70 households, 53 percent (37) were interested in purchasing a stove and participated in the bargaining (see Table 13). Participation was nearly equal in both VDCs.

Table 13. Participation in bargaining and purchase of stoves

	Costs to study participants		# of buyers		
	Cash	12 installments	Cash	Installment	Total
Prakti	\$43	\$4.09	1	1	2
Xunda	\$38	\$3.61	6	2	8
EcoChula	\$19	\$1.81	0	4	4
Greenway	\$16	\$1.52	8	3	11
Local Chimney	\$6	\$0.57	8	4	12
					37

All consumers who bargained bought a stove. Participants were most willing to pay for the improved Local Chimney, (bought by 12 of 14 households); closely followed by Greenway (11 of 14 households). Of the 14 households who'd used the Xunda, 8 bought the stove. The fewest consumers bought EcoChula (4/14), which had repeated fan and battery malfunctions, and Prakti, which was the most expensive (2/14). Three households bought a different stove than the one they had used; one Xunda instead of a Prakti, one EcoChula instead of a Greenway, and one Greenway instead of a Xunda.

Figure 37. Study stove purchases in Nawalparasi, by cash and installment plans



8.2 Buyback Exercise

A second willingness-to-pay method was used in two other VDCs. (One of two methods was randomly assigned to Dang or Nawalparasi VDCs, at the request of the institutional review board, to give each VDC an equal chance to be in either group.) The buyback exercise was conducted in two Dang VDCs. All Dang participants were invited to participate in the buyback. Participants were given their trial stove (or, in the case of families whose EcoChula was not functioning, a replacement EcoChula) as a gift for participating in the study, and were immediately offered a set price for the stove, the same as the lowest acceptable price in the bargaining exercise in Nawalparasi.

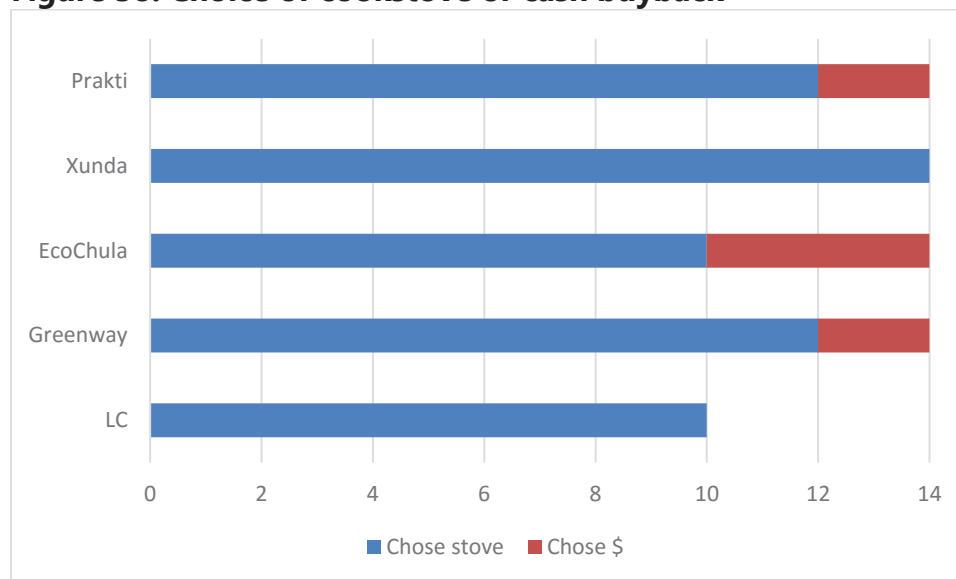
Participants, told the stove was a gift, responded as follows: 50 percent "thanked with happiness," 22 percent "felt very happy," 9 percent "felt happy to get it for free," and a minority smiled and said they "never imagined they would get such a gift," said "it would be useful for summer season," or "would be sad to return the stove." Only a few had negative comments, such as "no use keeping the stove," or no comment.

Of the 66 study households in Dang, eight chose the buyback; the vast majority (58) chose to keep the stove. Of the 14 EcoChula households, half (seven) had malfunctioning stoves with a failed fan or battery. They were given the choice of a replacement EcoChula or the buyback. Three (and one family with a functioning EcoChula) chose money; the other 10 EcoChula families opted for the EcoChula. Two of the 14 Prakti users (one with a damaged chimney) chose cash over the stove, as did two of the 14 Greenway users. All others, including all 14 Xunda and all 10 Local Chimney users, chose to keep their stove (see Table 13 and Figure 38 below).

Table 13. Willingness to pay exercise in Dang district

Option	N=66	PR	GW	EC	XU	LC
		n=14	n=14	n=14	n=14	n=10
Choose stove	58	12	12	10	14	10
Choose money	8	2	2	4	-	-
Total	66	14	14	14	14	10

Figure 38. Choice of cookstove or cash buyback



Overall, households were willing to pay for the stoves at slightly discounted but realistic market prices.

IX. CONCLUSION

WASHplus found participants in this study liked their improved stoves and overwhelmingly preferred them to their traditional stoves, at rates of 75-96 percent. They liked that the stoves used less fuel, emitted less smoke, kept their pots cleaner, and cooked food quickly. Participants confirmed that the stoves were good for cooking typical Nepali meals for average-sized families. While they reported that the stoves were not good for preparing large batches of animal feed or liquor, tasks for which they were not designed, some participants in Nawalparasi used them for these tasks anyway and saw tremendous fuel savings.

SUMS and KPT data show that study households used the stoves consistently (but not exclusively) during spring and summer, and accrued fuel savings of 44-51 percent in Nawalparasi. This did not carry through to the winter in Dang, when latent heat from traditional stoves may have been more appealing; participants in Dang had mostly reverted to traditional stove use by December. A post-study poll of a subset of study homes in Dang showed resumed use of these improved stoves the following summer, confirming they were valued despite not being used frequently in the winter.

Willingness-to-pay results showed that households valued the stoves and were willing to pay for them with appropriate financing options. In Nawalparasi, more than half the participants bought the stove at the end of the study, often willing to pay more than the WASHplus-established lowest price. In Dang, 88 percent of study households chose to keep the stove over a cash buyout, even though they were using them very little at the time the willingness-to-pay exercise was conducted.

There was a general trend of increased willingness to pay for lower cost stoves, with the exception of the EcoChula, which had frequent fan and battery malfunctions. Participants were equally (in the case of Prakti) or more likely (in the case of Xunda, Greenway, and Local Chimney) to pay for the stoves with cash, vs. the offered installment plan, except for EcoChula, for which all buyers chose the plan; perhaps so that they could return it if it stopped working before the payments were complete. Overall, 60 percent of the stove purchases were made in cash and 40 percent were made through the installment. Similarly, cash payments represented 63 percent of the value of the stoves purchased, with installment plans covering 37 percent of the purchased stove costs, so it wasn't just that people were paying for the cheapest stoves with cash.

Participants generally found the stoves convenient to use, although many complained about having to chop wood into small pieces, and needing to tend the fire more closely. Addressing this perceived barrier will likely increase consumer satisfaction with the stoves. Other stove programs have addressed the stove/fuel dyad as a linked issue; involving wood sellers to innovate and meet the fuel challenge is a possible solution that has been proposed in other settings. The stoves performed as expected, except the EcoChula, which had the malfunctions noted above. The manufacturer worked with WASHplus to remedy the problems, but until those

problems are resolved systemically, the stoves should be promoted, if at all, only in areas where service follow-up is easily accessible.

Of the remaining study stoves, the most popular, by stated preference compared to the traditional stove and willingness to pay, were the Greenway, the Xunda, and the Local Chimney stoves. By both of those metrics, the Prakti was slightly less popular. Given that there is no one-size-fits all cookstove, and cooking needs and preferences can vary by district, village, and even households, WASHplus recommends including a menu of the study stoves or improved stove types with similar characteristics in the CCS4All initiative, so that consumers can choose from among the features more important to them. With the exception of the EcoChula's malfunctions, all of the study stoves were sufficiently well-liked and high-performing to be considered for inclusion in CCS4All.

Given the mix of cash and installment plans chosen by participants, WASHplus recommends the inclusion of financing options in AEPC's promotion programs; the installment plan included in the study (12 payments of \$0.57-\$4 each over 6 months) worked well for study participants; CCS4All may be interested in exploring more options. In light of complaints about the fuel preparation, proper consumer awareness at the point of sale should include full information about the need to chop wood into smaller-than-usual pieces, and how to correctly load and add fuel into the stoves. Consumer education can also correct misconceptions made by some study participants that stoves made with thin stainless steel were made of tin; consumers should be told how long the stove is expected to last, and be provided with information on after-sale service and warranties.

This study yielded sufficient and relevant findings to construct a "4Ps" Marketing Mix—product, price, promotion, and place—that incorporates consumer perspective and willingness to pay into:

- Product—selection of appropriate stoves (and fuel)
- Price—as it relates to willingness to pay and financing
- Promotion—to reflect consumer preferences, desired stove attributes, and performance expectations, as well as misconceptions about stove properties leading to misuse and/or dissatisfaction
- Place—trusted points of sale appropriate for bottom of the pyramid consumers, who still expect and demand warranty, service, and a trusted vendor to sell a consumer item of this sort

The market demonstrations found different perceptions with a smaller, more limited group of more urban and more affluent consumers who did not try cooking on the stoves. WASHplus recommends further research into consumer preference and willingness to pay with this demographic; the findings from the WASHplus market demos was not comprehensive enough to make recommendations for that audience at this time.