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Supportive Environments for Healthy Communities

FINAL REPORT

Understanding Consumer Preference and Willingness to Pay for Improved Cookstoves in Bangladesh

USAID WASHplus Project
August 2013

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WASHplus, a five-year (2010–2015) cooperative agreement implemented by FHI 360 with CARE and Winrock International as core partners, is funded through USAID's Bureau for Global Health. WASHplus creates supportive environments for healthy households and communities by delivering interventions that lead to improvements in water, sanitation, hygiene (WASH) and indoor air pollution (IAP). WASHplus uses at-scale as well as integrated programming approaches globally to reduce diarrheal diseases and acute respiratory infections, the two top killers of children under 5 years of age. For information, visit www.washplus.org or email: contact@washplus.org.

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Acknowledgments:

The WASHplus team would like to acknowledge and thank our colleagues at USAID, both in Washington and Bangladesh: Merri Weinger, Pam Baldinger, Sharon Hsu, Richard Greene, Sher Khan, Ramona El Hamzaoui, and Helen Petach.

We are also indebted to those who supported this study both in the field and back in Washington, DC, including Orlando Hernandez, A.K.M.Anowar Hossain Mollah, Kate Kennedy Freeman, Syeda Hosneara Akter, Shajahan Mia, Laila Ishrat Jahan Ruen, Nadia Rahman, Sultana Aziz, A.F.M. Iqbal, Nazmul Haque, Jibun Nessa Begum, Sarah Yagoda, Rachel Lenzi, Dana Charron, Kirstie Jagoe, Todd Wofchuck, David Pennise, Misti MacDonald, and Kathrin Tegenfeld.

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EXECUTIVE SUMMARY

As the evidence base linking improved cookstoves (ICS) with positive health and energy impacts grows, so does attention to how best to influence household uptake and consistent and correct use. Appropriately, attention focuses on both "hardware" and "software" issues—how to improve the field performance of the stoves themselves and make them more affordable, accessible, and appealing to the neediest consumers.

This study uses qualitative and quantitative methods that draw from social marketing and social science to explore consumer perceptions of five of the most promising ICS potentially available for distribution in Bangladesh. The study complements other efforts by a range of stakeholders to strengthen market-based approaches and consumer choice for improving household air quality and reducing the environmental impacts associated with dependence on biomass fuels.

Through support from USAID/Bangladesh, the USAID Asia Regional Bureau/Washington, and an additional grant contribution from U.S. State Department's Office of the Secretary of State, Global Partnership Initiative, WASHplus is laying a foundation for the USAID/Bangladesh Catalyzing Clean Energy in Bangladesh (CCEB) program and other key actors by conducting a comprehensive assessment to better understand consumer needs and preferences as they relate to increasing the uptake of ICS, including household trials of improved stoves not currently widely available in Bangladesh.

To assess consumer preferences, researchers applied an innovative methodology called Trials of Improved Practices, or TIPs. The WASHplus application of the TIPs method uses "elicitation questions," which are semi-structured questions that have been developed and validated to systematically identify barriers and motivators to change, including which factors are most influential in spurring the performance or nonperformance of a behavior.

ICS fuel efficiency was measured using a three-day kitchen performance test (KPT), widely acknowledged as the best currently available method for accurately estimating daily household fuel consumption. The KPT was carried out using a cross-sectional study design in 116 study households and 24 control households. Two approaches were used to measure the extent to which households adopted the new stoves and the manner in which they integrated them into their cooking and kitchen management practices: self-reported use of stoves at the end of each 24-hour KPT monitoring period and stove use monitoring sensors (SUMS). The SUMS recorded the stove temperature every 10 minutes for a total of approximately 10 days; the resulting temperature profiles were then analyzed to determine the frequency of "cooking events" (i.e., number of times the stoves were lit) per day. The impact of the interventions on household air quality was explored during the KPT monitoring; illustrative (not statistically significant) results were collected from measures of minute-by-minute kitchen concentrations (in a location approximating the breathing zone of the cook) of small particles ($PM_{2.5}$) and carbon monoxide (CO). The impact of the interventions on women and children's exposure was explored in the same subset of homes by

monitoring the 24-hour exposure to CO of both the cook and one child under the age of 5 in the household.

Procedure

Five different imported ICS models[1] were placed in homes, with three of each stove type per village, thus totaling 15 households per village in eight villages, or 120 total households. Each household in the trial was only provided one type of stove to test. In each household detailed cookstove operation and maintenance training was provided, and cooks were asked to try out the stove under normal conditions. Each household had the opportunity to try a new improved stove (not currently widely available in Bangladesh) for three weeks and was asked to offer its feedback and opinions. Unlike other survey methods, where all factors are held constant and researchers analyze the frequency and range of response, this qualitative methodology invites households to identify, discuss, and resolve barriers to using the new ICS. Households were also asked to compare cooking on the ICS with their traditional or previous stove on a range of criteria. Through these comparisons, researchers were able to elicit categories of attributes valued by the target consumer. Interviews were conducted at Day 1, Day 3, and Day 21.

Summary Findings

The study clearly showed that at least two stoves were perceived as preferable to traditional cookstoves by many of those who tried them. As is common among many improved stove interventions,[2] however, none as currently produced met all consumer needs, and none met sufficient consumer needs to completely replace traditional stoves. Consumers most appreciated the Prakti and Eco-Chula stoves, with the preference for each stove varying by district.

<u>Overall Consumer Reactions to New Stoves on Key Variables</u>

Overall, consumers "liked" the new stoves, which was a distinct indicator separate from whether or not they "preferred" the ICS to the traditional stove. These general reactions were common across stove types. Female cooks felt that the **taste of their food** was the same when cooked on an ICS versus the traditional stove. About two-thirds of the study participants said food tastes the same, with the others equally split between saying it was better (21) or worse (19). Respondents overwhelmingly felt the stove **used less fuel** than their old stove, with three-fourths of the group seeing fuel savings. Some of these cooks reported that the new stoves saved up to 60 percent of the wood they would have used in a traditional wood burning stove per cooking session. About a fifth

[1] Of note, the stoves tested in this study were all imported from elsewhere in the region and were not designed for the Bangladesh market. These were the single pot, built-in-place, rocket design stove (Envirofit Z3000), a single pot, portable, rocket design stove (EcoZoom Dura), a 2-pot portable metal chimney stove (Prakti LeoChimney), a single-pot portable fan gasifier stove (Eco-Chula), and a single-pot portable natural draft gasifier stove (Greenway). Only one of the five (Greenway) was available for purchase in Bangladesh at the time of the study.

[2] Ruiz-Mercado I. et al. 2013. Quantitative Metrics of Stove Adoption Using Stove Use Monitors (SUMs). Biomass and Bioenergy. URL http://dx.doi.org/10.1016/j.biombioe.2013.07.002
Pine K. et al. 2012. Adoption and Use of Improved Biomass Stoves in Rural Mexico. Energy for Sustained Development. URL http://dx.doi.org/10.1016/j.esd.2011.04.001
Ruiz-Mercado, I. et al. 2011. Adoption and Sustained Use of Improved Cookstoves. Energy Policy, DOI:10.1016/j.enpol.2011.03.028
Schepers J. and M. Wetzels. 2007. A Meta-Analysis of the Technology Acceptance Model: Investigating Subjective Norm and Moderation Effects. *Information & Management*, 44, 90-103.

of the participants thought the stoves used more fuel, which is interpreted in the discussion section.

When asked about **differences in smoke produced**, a vast majority (85) said the ICS produced less smoke than their traditional stoves. Husbands present at the time of the survey who answered the question had basically the same impressions as their wives regarding the reduction in smoke from the new ICS. When asked if the ICS had any **impact on cooking pots**, just over half the users (62) felt the new stoves kept their pots cleaner, a few saw no impact (15), and a third(40) felt it made the pots dirtier than the traditional stove. Again, this finding is discussed further in the discussion section, but some users "jammed" the ICS with wood to make flames visibly meet the cooking pot, which would clearly affect impressions and cookstove performance. A major obstacle reported is that the **cooking time** was slower using the ICS. Three-fourths of respondents (91) reported slower cooking time, a fifth (24) reported faster, and just a few (3) respondents said cooking time was the same.

When asked the open-ended question, "What do you think about the stove?" after three weeks, many gave the unprompted response that they enjoy cooking on the stove (49), and almost a fifth (21) said it looks nice. Women noted that changes were required to their cooking style, including the need to prepare all ingredients before initiating cooking and to sit in front of the stove tending the fire (as opposed to multi-tasking) while cooking (see chart on page 29).

Dislikes and suggestions for improvement fell into two general categories, those that can be addressed through fairly simple modifications to the stove design and others more appropriately addressed through point-of-purchase consumer education and follow up from service agents or health outreach workers.

The most overarching complaint about all the cookstoves included in the trial was their inability to cook large volumes of food in large pots, especially the Prakti and Greenway cookstoves. Study participants compensated for this by jamming the stove with more fuel and wrestling with large pots, which rendered some stoves less stable. As is common with other stove studies, participants were unaccustomed and/or unwilling to chop wood into small pieces, thus complaints were made about the size and angle of the wood opening. In addition, traditional stoves are constructed so as to allow a "natural feed" of large wood pieces and other agrofuels and dungsticks; because the opening into the combustion chamber angles downward, the fuel naturally slides further into the combustion chamber as it burns. Consumers missed this feature on the new stoves; improved stoves have a horizontal fuel entry, so fuel must be manually pushed into the stove as it burns. Lastly, consumers found excess ash collected in the stove and suggested a tray for easy emptying. While this last item can be considered, some of the ash build up was due to excessive amounts of wood being burned in the stoves (Figure 12). In case of the Prakti stove the major complaint was that the second pot was not effective for cooking. For the Greenway stove a major complaint was that the stove is not stable. Besides these two specific concerns, complaints were similar across all stove types.

Some of these problems and related suggestions for improvement can be appropriately addressed by improved consumer education, without which consumers will be less satisfied by the overall performance of their stove, which will affect use and word of

mouth recommendations for the new stoves. We suggest ramping up efforts in consumer education and behavior change because some stove features under discussion (e.g., size of fuel opening and lack of visible flames leaping from the stove) are critical to improved combustion efficiency and heat transfer; in other words they are key requirements of the improved stove.

Perceived Value and Willingness to Pay

Study participants valued stoves for certain features, but dramatically undervalued the monetary worth of the stove. Most participants estimated the monetary value of the stoves to be one half to one quarter of their actual calculated value (which already includes an assumed carbon subsidy) (Figures 14 and 15). However, as will be further discussed in the findings and discussion section, reported values were likely influenced by a shared (and perhaps discussed) perception that participants should be given the stoves as a token of appreciation for participating in the study.

Of the 120 households, 105 study participants were given the option to purchase the stoves at the market value. Only one opted to do so, and a second nonparticipant neighbor purchased a stove (see chart on page 33). Using a second methodology, however, the remaining 15 households were offered the stoves as gifts, and were then given an option of a cash buyout at market value. Surprisingly, only three opted for the (relatively significant amount of) cash; the other 12 preferred to keep their stove.

Summary KPT and SUMS Findings

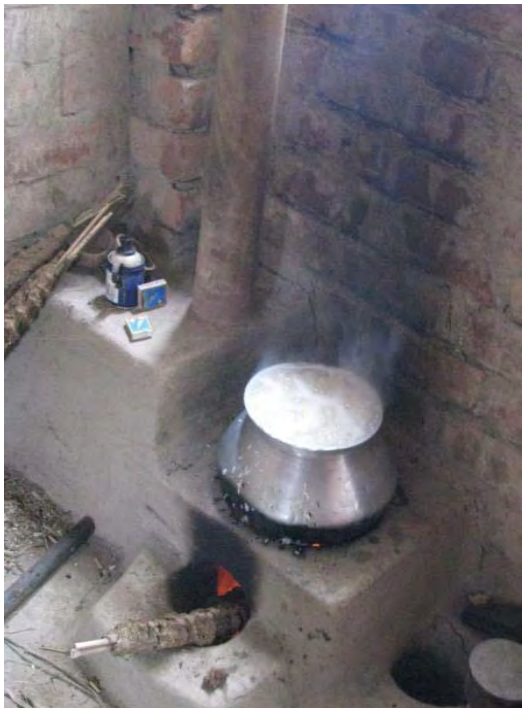
ICS fuel efficiency was measured using a KPT in 116 study households and 24 control households, and temperature-logging sensors (SUMS) affixed to all stoves in the house collected data on the frequency of cooking periods. Usage patterns captured during KPT monitoring suggest the intervention stoves were commonly used by the study households, but in all cases, did not fully displace the use of the traditional stoves (see chart on page 35). Homes using four out of the five improved stoves were found to use at least 16 percent to 30 percent less fuel than the control homes over the course of the KPT,[3] a range that may be somewhat artificially low due to underreported fuel mixing in control homes (see chart on page 37).

[3] It is important to note that this does not mean that the improved stoves used 16–30 percent less wood than the traditional stoves. Rather, homes using the improved stoves alongside their traditional stoves (which is what happened in most of the intervention households) used 16–30 percent less wood than homes using only the traditional stoves.

BACKGROUND

Consumers in Bangladesh to date have not experienced any choice in the improved cookstoves market and have not had the option to use high-end improved models, including imported portable models. The currently disseminated "improved" stove model, the Bondhu Chula, is a basic built-in-place stove with a cement combustion chamber and chimney, surrounded by clay/mud (see photo below right). The traditional stoves consist of a hole in the ground with a raised clay lip on which to rest the pot, with a separate fuel entry hole (see photo below left).

Traditional sunken-hole stove (two pot version)



Bondhu Chula built-in-place chimney stove; the current model of "improved" stove most widely disseminated in Bangladesh.

USAID/Bangladesh's Economic Growth Office provided field support to WASHplus to conduct an improved cookstove (ICS) consumer needs, preferences, and willingness to pay assessment in Bangladesh ("Phase 1"). The USAID Asia Regional Bureau provided complementary funding to identify key behavior change elements and develop a marketing plan and related tools ("Phase 2") based on the Phase 1 research findings and other regional lessons.

Under Phase 1, WASHplus is laying a foundation for the USAID/Bangladesh Catalyzing Clean Energy in Bangladesh (CCEB) program and other key stakeholders by conducting a comprehensive assessment to better understand consumer needs and preferences as they relate to increasing the uptake of ICS, including household trials of improved stoves not currently widely available in Bangladesh.

This Bangladesh ICS assessment represents USAID's first significant investment in behavior change and improved cookstoves and will form the basis for its first major investment in improved cookstoves in Bangladesh. The cookstove sector has seen consistent global trends of drop-off in improved stove use over time and parallel stove use (stove stacking)[4] in part because the improved stove does not meet all of the users'

[4] Ibid.

needs; by paying more attention to consumer needs and preferences, the benefits of improved stoves can be maximized, and attrition and parallel use reduced. Other reasons for low adoption and sustained use of improved cookstoves include deficiencies in distribution, consumer education, financing, and after-sales service.

STRATEGIC APPROACH

WASHplus, a five-year cooperative agreement (2010–2015) managed by the Bureau for Global Health's Maternal and Child Health Division, is implemented by FHI 360 (formerly the Academy for Educational Development), and includes Winrock International as a core partner, with primary responsibility for WASHplus's indoor air pollution (IAP) activities. WASHplus's overarching mission is to increase the availability and use of water, sanitation, and hygiene (WASH) and IAP interventions.

WASHplus focuses on improving the **practice** of key WASH and IAP-related behaviors, including the consistent and correct use of improved cookstoves. To this end, WASHplus incorporates methodologies and approaches that focus on increasing the performance of improved practices, not merely increasing latrine coverage or sales of improved cookstoves. Planning and promotion are undertaken from the consumer point of view, incorporating desired benefits and consequences rather than focusing on promoting "what's good for you" or what makes sense from a public health and or energy efficiency point of view. Equal emphasis is placed on improving health-related products (and services) that meet consumer needs and wants—changing the product if needed to better satisfy consumers rather than convincing consumers to buy products that they may not value or that may not meet their expectations and needs. Lastly, WASHplus also focuses on increasing household demand, in this case for ICS, by crafting promotional appeals that offer desired benefits through credible channels as described above; increasing affordable and accessible supply through product modification, enhanced distribution channels, and feasible payment options; and shaping an environment with supportive policy and adequate capacity to plan, manage, and deliver products and services.

WASHplus operates using the USAID Framework for Impact, which posits that to see improved practices, in this case improved cooking practices in Bangladesh, a program (whether pilot or at-scale) must ensure that effective and appealing products and services are available and accessible to consumers; that institutions and policies support the related products or behaviors; and that these products are promoted in a way that reaches consumers through convincing appeals and multiple credible channels. This means that a marketing plan for ICS in Bangladesh must take into account stove design, payment options, and fuel availability; assess if government policies inhibit import, distribution, or sales; and highlight ways for public and private sector institutions to build needed capacities and work in coordination. The actual implementation and uptake of the marketing plan would occur through a broad sector support program or private sector institutions; the marketing plan will present the analysis, rationale, and options.

WASHplus formative research will answer gaps in information required to develop a comprehensive marketing approach for increasing the uptake of ICS in Bangladesh. WASHplus research will contribute not only to promotional strategies, but also to ICS design, distribution, and payment options. With increased understanding of what both

women and men want from a stove—the attributes, characteristics and benefits—stoves can be made more accessible, affordable, and appealing to low income consumers.

WASHplus will draw on lessons learned in behavior change, demand creation, and marketing of sanitation and water treatment products to develop an effective marketing and behavior change strategy that will suggest a limited number of evidence-based approaches to increase the uptake of stoves; concept test key elements of these approaches; and develop practical "how-to" tools to contribute to the goals and results of USAID energy and health objectives in Bangladesh.

STUDY OBJECTIVES

Formative research refers to a group of research methodologies specifically developed to guide or *inform* intervention designs. Guiding all formative research is one simple question developed by the "grandfather" of social marketing, Alan Andreason, as part of his *Backward Research Model*[5]: What information is needed to make decisions?

In this case, the question was framed as: *What information do we need to develop a solid marketing plan to increase the uptake of improved cookstoves in Bangladesh?*

With the larger guiding question in mind, the team developed a set of questions that this formative research sought to answer. These are:

Consumer Preference Research Questions

1. What are the desired attributes of a cookstove? This includes characteristics like size, portability, stability, color, and function (e.g., time to cook, high and low power capabilities). This included exploring current stove attributes and cooking experience and initial experience with new stoves.
2. What are the perceived barriers and dislikes to these five models of ICS based on a three-week trial? What makes a stove hard to use? Who approves or disapproves of the stove? Answering these questions required the use of SUMS monitors to measure the actual number of times and duration that stoves were used in houses, which could then be compared with self-reported use.
3. Are there feasible solutions to these barriers, either by changing household behaviors or the design of the stove?
4. What is good about the new stove? What do cooks and their families perceive as good things about each particular ICS?
5. What characteristics, attributes, likes, and dislikes are most persuasive to households? Besides savings in fuel costs, what other attributes will influence the purchase of an ICS? Are there cross-cutting "aspirational" attributes or other more abstract benefits people aspire to? For example, being seen as modern, a good provider, a gourmet cook—attributes that resound and motivate consumers from deep within.

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[5] Andreasen A. 1985. Backward Market Research. *Harvard Business Review*.

Willingness to Pay

6. What are consumers willing to pay for high-end improved stoves with features they desire?
7. How does offering installment payment options influence stove purchase?

Effectiveness of Various Improved Cookstoves

8. What are the actual fuel savings of the trial stoves when used under normal household conditions in Bangladesh? The five stove models tested have already been shown to significantly reduce fuel use and IAP in laboratory settings, and in some cases field settings elsewhere, and through this activity they will also be field tested for household effectiveness. On a smaller scale IAP and smoke exposure will also be monitored.

METHODOLOGY

To assess consumer preferences, researchers applied an innovative methodology called Trials of Improved Practices, or TIPs. The TIPs methodology is a qualitative method used to develop and test behavioral and product options with target consumers. It has been applied successfully to interventions related to HIV,[6] nutrition,[7] water filters,[8] dengue,[9] sanitation, and a range of other technical areas. The TIPs qualitative methodology was first developed for nutrition projects to rehabilitate undernourished children.[10] It draws from assets-based methodologies that look for feasible and effective behavioral improvements that use existing or readily available resources.[11]

The WASHplus application of the TIPs method uses "elicitation questions,"[12] which are semi-structured questions that have been developed and validated to systematically identify barriers and motivators to change and which factors are most influential in spurring the performance or nonperformance of a behavior.

The data collected through these methods will fill key information gaps essential to developing a comprehensive marketing approach for increasing the uptake of ICS in

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[6]Bery R. and J. Rosenbaum. 2010. How to Integrate Water, Sanitation and Hygiene Improvement into HIV/AIDS Programmes. World Health Organization (WHO)/USAID.

[7] Griffith M. 1992. Improving Young Child Feeding Practices. USAID/The Weaning Project.

[8]Rosenbaum J. 2006. Bringing the Consumer to the Table Research Brief: Developing a Marketing Strategy for Improving Household Water Quality in Nepal. USAID/Hygiene Improvement Project.

[9]Rosenbaum J. and E. Leontsini. 2002. Planning Social Mobilization and Communication for Dengue Fever Prevention and Control: A Step-by-Step Guide. Special Programme for Research and Training in Tropical Diseases, Communicable Diseases. WHO.

[10]Dickin K., M. Griffiths, and E. Piwoz. 1997. Trials of Improved Practices (TIPs): Giving Participants a Voice, and Designing by Dialogue: A Program Planners' Guide to Consultative Research for Improving Young Child Feeding. USAID/SARA Project.

[11] Lapping K., D. Marsh, and J. Rosenbaum. 2001. Comparison of Positive Deviance and Other Asset-Based Development Models. Save the Children/Academy for Educational Development.

[12]Middlestadt S., K. Bhattacharyya, J. Rosenbaum et al. 1996. The Use of Theory-Based Semi-Structured Elicitation Questionnaires: Formative Research for CDC's Prevention Marketing Initiative, Public Health Reports.

Bangladesh. Understanding perceived barriers and solutions; desired or executed modifications to stoves during the trial period (e.g., removal of fuel grate or addition of a makeshift stove-side shelf, expressed color change); and perceived and desired benefits and attributes will help program activities going forward to identify appropriate stoves in target areas and/or modify stoves for increased effectiveness, appeal, and use. This will also provide information vital to developing a marketing and behavior change strategy.

ICS fuel efficiency (reported in terms of reductions in fuel usage) was measured using a three-day KPT (version 3.0, www.pciaonline.org/ testing), widely acknowledged as the best currently available method for accurately estimating daily household fuel consumption[13]. The KPT was carried out using a cross-sectional study design in 116 study households (three households declined to participate and a fourth had incomplete data) and 24 control households.

Two approaches were used to measure the extent to which households adopted the new stoves and the manner in which they integrated them into their cooking and kitchen management practices: self-reported use of stoves at the end of each 24-hour KPT monitoring period and the use of SUMS. The SUMS temperature-logging sensors were affixed to all stoves in the house (including both traditional and intervention stoves) to collect data on how often the stoves were "turned on" (i.e., lit). The SUMS recorded the stove temperature every 10 minutes for a total of approximately 10 days; the resulting temperature profiles were then analyzed to determine the frequency of "cooking events" (i.e., number of times the stoves were lit) per day.

The impact of the interventions on household air quality was explored during the KPT monitoring in a subset of seven homes (two households from the traditional stove group and one household from each of the five intervention stove groups) to collect illustrative (not statistically significant) results. Minute-by-minute kitchen concentrations (in a location approximating the breathing zone of the cook) of small particles ($PM_{2.5}$) and carbon monoxide (CO) were measured. Environmental and contextual information that might impact indoor air quality, such as kitchen volume, was also collected during the studies.

The impact of the interventions on women's and children's exposure was explored in the same subset of homes through the monitoring of 24-hour exposure to CO of both the cook and one child under the age of 5 in the household.

Procedure

The WASHplus team selected partner NGOs in each of the study locations, who then helped the field team identify households to participate in the stove trial, distribute the stoves and collect them at the end of the study, and ensure stove users continued to use the ICS during the study even if some functional problem occurred with the stove. Based on the Partner NGO Selection Criteria (see Annex A), DESH GORI Bangladesh in Barisal and Institute of Development Affairs (IDEA) in Sylhet were selected to conduct site visits to each location.

[13] Bailis et al. 2007; Smith et al. 2007; WHO 2008.

WASHplus purchased 26 models of each stove (two extra of each model in case of any problems) and hired Bangladesh NGO field partner Village Education Resource Center (VERC) to coordinate with and train IDEA and DESH GORI, oversee field logistics, and support KPT work.

The partner NGOs, along with WASHplus staff, identified six villages in each of their intervention areas (for a total of 12 villages), based on a set Community Selection Criteria (see Annex A). Partner NGOs then identified 20 households in each village (for a total of 240 households), using Household Selection Criteria (see Annex A). To avoid selection bias of any kind, WASHplus staff together with VERC conducted a short intensive field survey to ensure villages and houses met all selection criteria and were representative of target consumers. Four project staff members from each partner NGO were given a two-day training on stove installation, use, and maintenance in a workshop conducted by VERC. Prakti sent a representative to participate in this workshop since manufacturing and proper installation of metal chimneys in households is vital for the performance of the stove. The other stove manufacturers sent detailed training materials and step-by-step guides for stove installation, use, and maintenance.

WASHplus worked with all local partners to make final household selections, distribute stoves, and provide training on their use to households. Stoves then were randomly assigned to 120 of the 240 identified households. The team placed one of the five different ICS models (see below) in each of the households for cooks to use and provide feedback on through semi-structured elicitation questions.

Based on high performing[14] stove models available in other South Asia markets and beyond, the WASHplus team selected the following wood-burning stoves for this study, shown in the photo below:

- Single pot, built-in-place, rocket design stove (Envirofit)
- Single pot, portable, rocket design stove (EcoZoom)
- Two-pot portable metal chimney stove (Prakti)
- Single-pot portable fan gasifier stove (Eco-Chula)
- Single-pot portable natural draft gasifier stove (Greenway)

Trial stoves, clockwise from top left: Eco-Chula, Prakti, Envirofit, EcoZoom, and Greenway.

Of note, all of these stoves were imported from elsewhere in the region and were not designed for the Bangladesh market. EcoZoom stoves are not currently available in the South Asian market, and only Greenway stoves are currently sold in Bangladesh.

[14] The 2012 ISO International Workshop Agreement for cookstove performance provides a system for categorizing stoves based on several performance metrics, including two metrics related to efficiency, from tier 0 representing traditional stoves to tier 4 representing aspirational gas technologies. The IWA tiers only provide comparative classification for stoves based on lab tests. All of the stoves selected for this study had achieved a tier 2 or higher rating for their efficiency metrics in the laboratory.

The study had planned to include the BioLite HomeStove, but because BioLite production was halted in late 2012 to address a fan issue, it was not included. The study also looked at an imported rice husk stove from India that may be a good fit for a segment of Bangladeshi consumers, but did not include it in the study due to logistical and geographic challenges of doing so, given the distinct user groups for wood versus rice husk fuel. Photos and more detailed descriptions of the five improved stoves included in the study are attached here in Annex C.

These five different stove models were placed in homes, with three of each stove type per village, thus totaling 15 households per village in eight villages, or 120 total households. Each household in the trial was provided with only one type of stove to test. In each household detailed cookstove operation and maintenance training was provided, and cooks were asked to try out the stoves under normal conditions. Each household had the opportunity to try a new improved stove (not previously available in Bangladesh) for three weeks and were asked to offer their ideas and opinions. Unlike other survey methods, where all factors are held constant and researchers analyze the frequency and range of response, this qualitative methodology invites households to identify, discuss, and resolve barriers to using the new ICS. Households were also asked to compare cooking on the ICS with their traditional or previous stove. Through these comparisons, researchers were able to elicit categories of attributes valued by the target consumer. Interviews were conducted on days 1, 3, and 21.

WASHplus recruited and selected a Dhaka-based team of interviewers and provided them with ethical and technical training to conduct the baseline, Day 3, and Day 21 questionnaires.

On Day 1 of the trial, the trained WASHplus enumerators visited each community and:

- Explained the study to each of the 15 participating households in each village (three households for each of five stove models), using a script in Bengali prepared by the WASHplus team (Stove-Trial Introduction); this script included all institutional review board (IRB)-required consents
- Conducted the "Baseline Questionnaire" with these households

Once the baseline questionnaire was completed, project staff of DESH GORI and IDEA (overseen by VERC) distributed the improved cookstoves to these households and trained cooks and heads of household on the correct usage and maintenance of the stove. Close attention was paid to quality control in training and application (by the NGOs) of the standard training procedure on correct usage for households, given the impact that training quality and quantity can have on improved stove usage and perceptions.

On Day 3 of the trial, trained WASHplus enumerators returned to each of the villages and conducted the "Day-3 Questionnaire" with each of the participant households. On Day 21 (after three weeks of stove use), trained WASHplus enumerators returned to each of the villages and conducted the "Week-3 Questionnaire" with each of the participant households over a period of seven days. In the process of data cleaning and analysis, records from two households needed to be excluded from Day 3 and Day 21 comparisons because of possible error/overlap in the data collection process. The two households removed from the Day 3 and Day 21 survey analysis were both in the

Kunarchor village, resulting in 58 villages from the Sylhet district and 60 from Barisal. The full complement of 120 household records is represented in the analysis and reporting of baseline findings. Sample sizes for each analysis are noted in charts.

KPTs were undertaken at different points between the Day 3 and Day 21 questionnaires. All household fuels to be used (wood, crop residues, charcoal, kerosene, etc.) were weighed at the beginning and end of each of the three 24-hour monitoring periods using digital hand-held scales. Wood moisture was measured daily in each household using a dual pin, electrical resistance-style moisture meter at three points on three randomly selected sticks in the woodpile. A short questionnaire was also administered daily to record information about cooking stove and fuel usage, the number and type of meals prepared, and the number of people cooked for. The households were asked to maintain their typical cooking patterns for the duration of the survey.

At the onset of the KPTs, SUMS temperature-sensing data loggers were placed on all intervention stoves, as well as on the pre-existing traditional stoves (whatever the family had been cooking on prior to the trial), so that usage of both the new stove and the old stove were measured. The SUMS tracked actual cooking periods for each improved and traditional stove over the course of the three-week trial. SUMS data was downloaded at the end of the three-week trial and analyzed, comparing actual to reported use, which helped determine any unreported problems with or nonusage of the improved stoves tested.

This activity applied the following tools/scripts:

Stove-Trial Introduction: This script was read to each of the participating households before the trial began. It included a full explanation of the trial, explained the follow-up questionnaires and when they would happen, explained any potential risks, and asked permission for participation, as required by the IRB. This script was prepared by the core study team, translated into Bengali, and read by the enumerators.

Baseline Questionnaire: This questionnaire was conducted with the participating households on the first day of the trial before the household was entrusted with a trial stove. This questionnaire determined the baseline stove model, stove cost, stove usage patterns, feedback on existing stoves, fuel use patterns, fuel expenditure, and other relevant characteristics of households participating in the stove trials.

Day 3 Questionnaire: This questionnaire was conducted after each participating household had the chance to use the stove for three days. This was used to determine initial preferences, use patterns, and other initial reactions after only three days. Examination of the stove itself and questions probed for any modifications already made to the stove and/or its designed/correct use (users were NOT encouraged to make modifications to the stove design or use, nor advised ahead of time that this was allowed). Interviewers noted any problems and then relayed these to partner NGO staff, who then visited the household to solve the problems, whether through retraining the users, or servicing the stove. Common problems included improper usage, functional problems of the stove (e.g., the battery of Eco-Chula running out during cooking), and using polythene and plastic to start the fire, which then created thick smoke. Both the

problems and acceptable/feasible solutions were noted as data of interest. NGO staff ensured that the stove was in proper working order before leaving.

Day 21 Questionnaire: This questionnaire was similar to the Day 3 questionnaire but was conducted after households had the opportunity to use the stove for 21 days. Semi-structured interview questions were again used to document preferences, use/experience with the stove, qualities attributed to new and old stoves, fuel use, cooking, and other outcomes.

Description of Study Group

The field survey was conducted in January and February 2013, in two wood-fuel burning areas of Bangladesh—Sylhet in the northwest and Barisal in the south. Both areas use wood as the primary fuel; this was confirmed in 105 of 120 households. About one-third of the study participants exclusively gathered their wood and about half "mostly purchased or exclusively purchased" wood. The remainder used some combination of purchased and collected wood as noted in Figure 2. During the study it was found that although wood was the preferred fuel throughout the year, dry leaf is used as a supplementary fuel in the winter months lasting from December until the end February (Figure 1). Many households burn this free fuel in special leaf-burning mud stoves, which they construct outside in the open courtyard to avoid the heavy smoke that is emitted by this fuel.

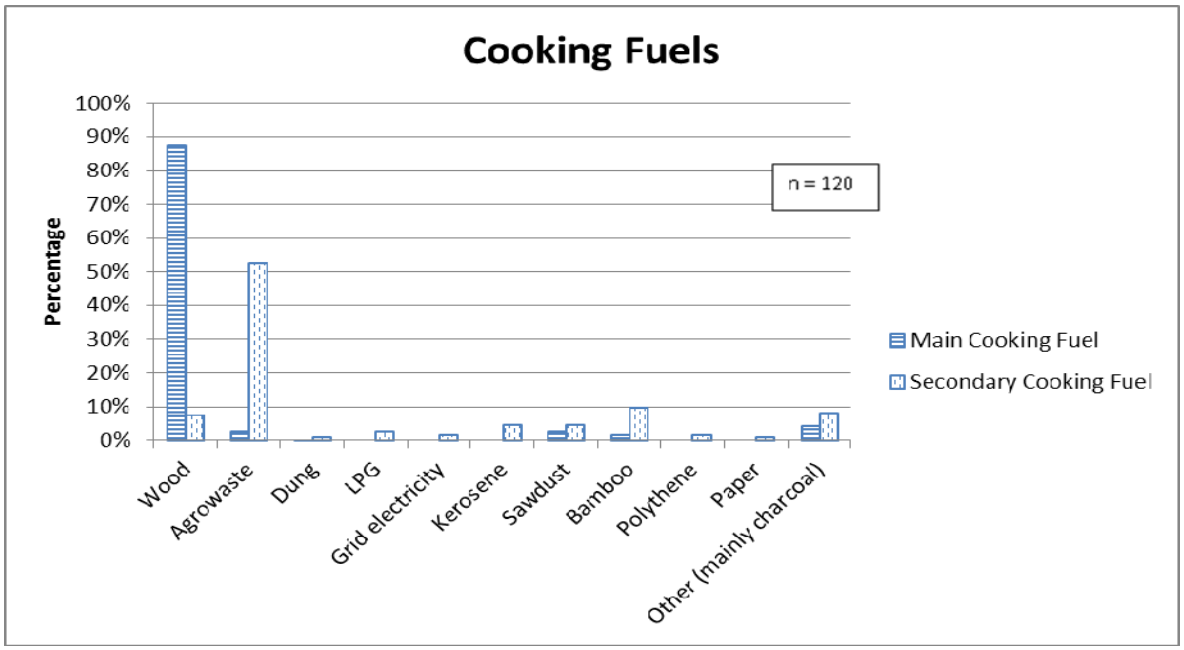


Figure 1

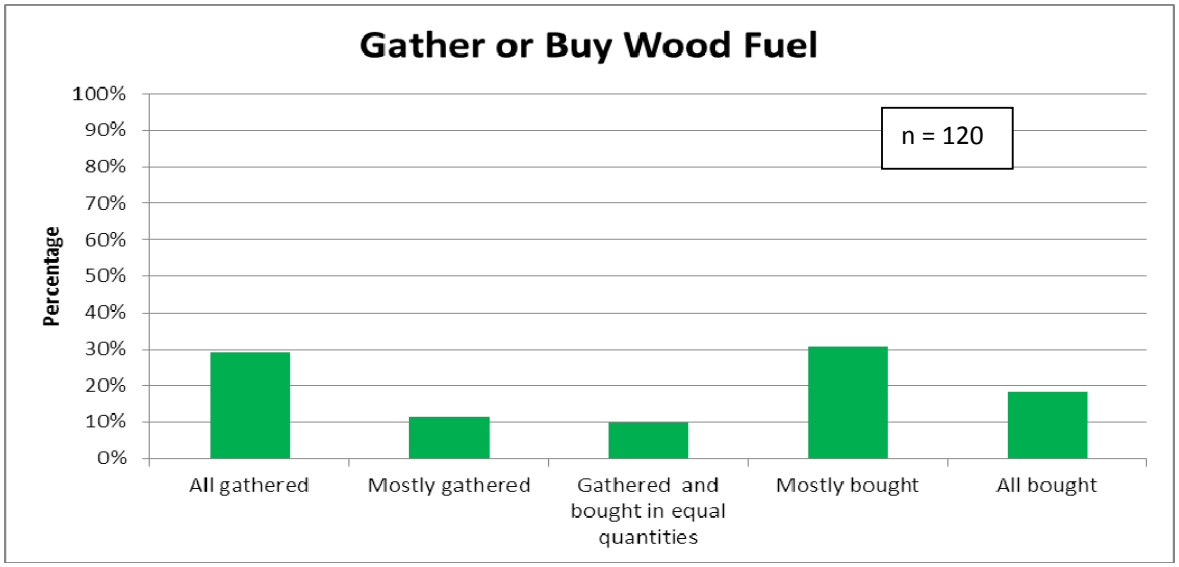


Figure 2

The partner NGOs, DESH GORI from Barisal and IDEA from Sylhet, selected the study villages. In Barisal the villages were Billobari, Bihangal, Ichakathi, and Gonpara. In Sylhet the villages selected for the study were Jangail, Kewa, Tilargaon, and Kunarchor. In Barisal cooking usually takes place either in an open courtyard in a semi-permanent structure or in a separate kitchen away from the main house. In Sylhet the cooking takes place in the main living quarters; the majority of the households cook on traditional stoves placed under chimney hoods (which act as chimneys, pulling smoke out of the living quarters).

Households were originally selected because they fit the basic criteria of using primarily wood for cooking, having at least four people in the household with at least one child under 5, and being willing to participate in the study. Unfortunately, around 20 smaller households made it past the household selection screening into the study, as the families included in their reported numbers household members who do not live full time in the house. Most households had four to five family members, with the average size (5.3) falling just above the national average (average household size in Bangladesh is 4.4 people). In some cases they reported the correct family size but failed to report that extra people (farm laborers) ate lunch and snacks with the family so that cooking was performed for a larger number of people (Figure 3).

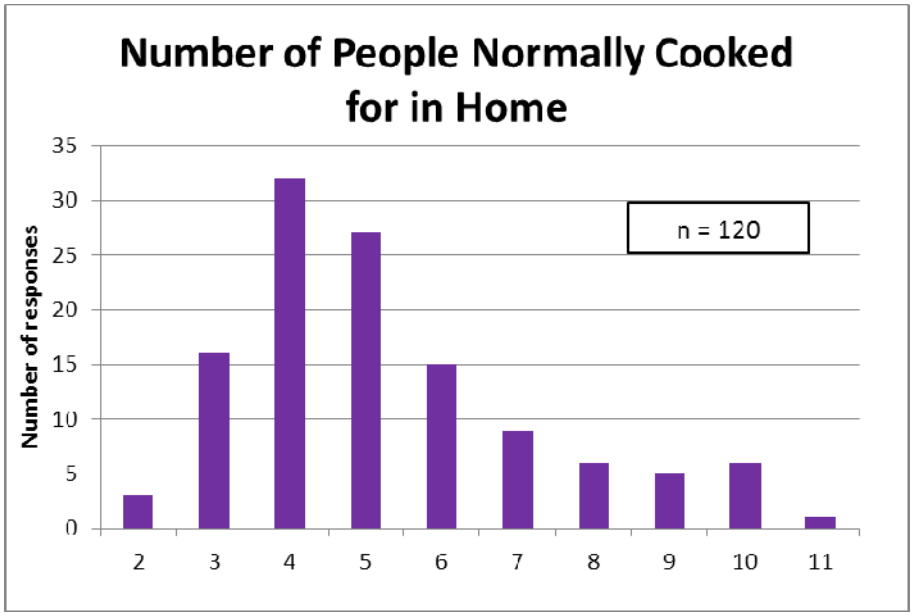


Figure 3

About 98 out of the 120 participant households were Muslim, 16 were Hindu, and six were Christian (all six in Barisal). The main occupation of the husband was business (30.83 percent), followed by service (22.5 percent). Other common occupations were driver of hired vehicles, farmers, artisans, and about 5.83 percent were daily laborers (Figure 4, representing frequencies). Among the women, 46 out of 120 were engaged in income-generating activities. Poultry rearing and sewing were the most common (Figure 5). About half (61/120) of the participants belong to some sort of women's group (such as savings cooperatives).

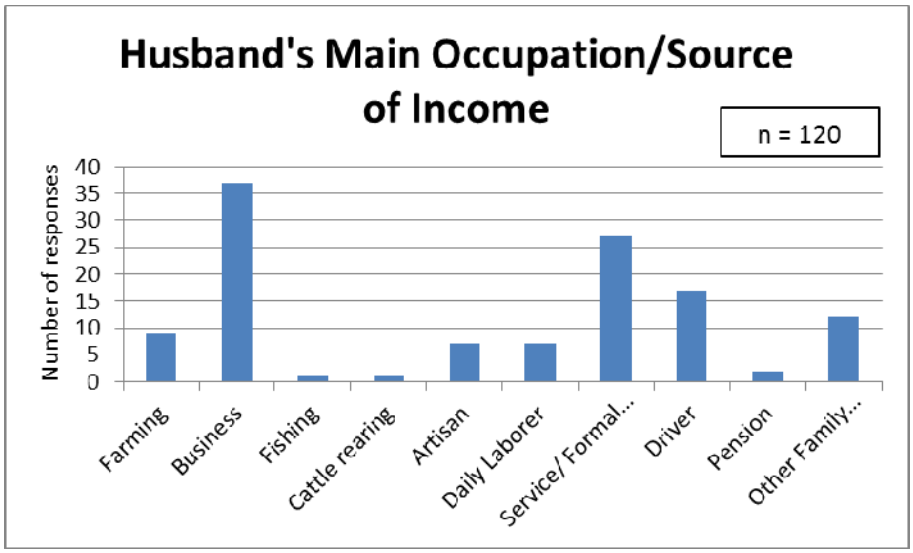


Figure 4

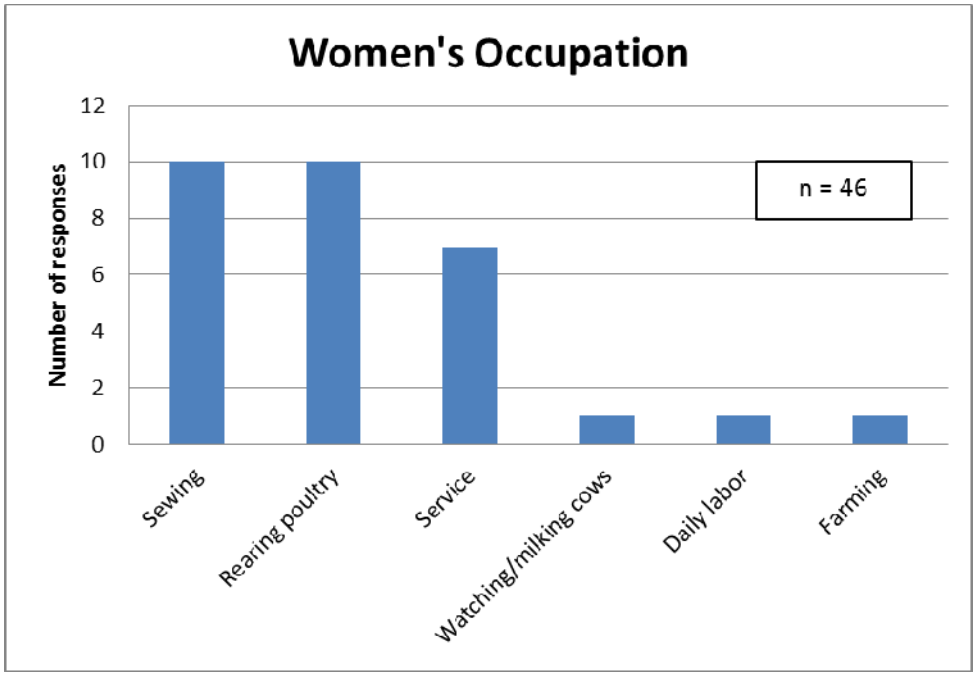


Figure 5

Among eligible households, WASHplus deliberately selected households that had some regular income (those who were not extremely poor) and would be able to buy the stoves at the end of the study if they really liked them. This excluded agricultural small farmers and farm hands. The study also excluded rich farming families, as they were likely to cook with liquefied petroleum gas (LPG) or have domestic help for cooking, rather than having the wife/mother of the household perform that task.

All the participants were within the age group of 16–65 years; about 60 percent of the participants were cooks below 35 years of age. Some 28 percent of the women were 16–25 years old, 32 percent were 26–35 years old, 23 percent were 36–45, and 13 percent were 46–55. Only 4 percent were above 55 years old.

Participants were randomly assigned one of five ICS and asked to try it over a three-week period, providing information to interviewers at baseline, three days, and three weeks as explained above.

NOTE ON PRESENTATION OF DATA AND FINDINGS

This study included both qualitative and quantitative methods. In depth, qualitative questions were asked of smaller subsamples trying particular stoves (where n is 118, there were 24 each using Eco-Chula, Envirofit, and Greenway; 23 using EcoZoom and Prakti) or small subsamples responding to particular questions. Following standard procedures for reporting qualitative data, we are reporting on these data using words (most, many, some, few) and numbers, and only use percentages when reporting on the entire study group of 120 for the baseline data, 118 for the 21-day group, and a few other rare instances. For the most part, results of each stove trial group are reported as follows:

Most = 90% or above (at least 20 of 24)
Many = 40% or more (at least 10)
Some = 15-39% (at least 4, less than 10)
Few = less than 15% (2-3)

FINDINGS

Overall Consumer Reactions to New Stoves on Key Variables

Based on their responses to the Day 21 survey, consumers felt that the **taste of their food was the same** when cooked on an ICS versus a traditional stove. About two-thirds of the study participants said food tastes the same, with the others equally split between saying it was better (21/118) or worse (19/118). Respondents overwhelmingly felt the improved stoves **used less fuel** than their old stoves, with almost three-fourths of the group seeing fuel savings (85/118). A few (8/118) respondents said the ICS used the same amount of fuel as the traditional stoves. Interestingly, about a fifth of the participants thought the new stoves used more fuel. Many Prakti users (16/118) and most Eco-Chula users (21/118) reported that their stoves used less fuel than the traditional stove. However some users of EcoZoom (6/118), Envirofit (6/118), and Greenway (6/118) reported needing more fuel to cook on these stoves than on their traditional stoves. This is interpreted in the discussion section below, but a couple of points are important to note here. First, some of the stove users took free leaf fuel into account in their mental calculations, which influenced these impressions, and secondly, a group of participants jammed extra wood into the fuel entry/combustion chambers to create larger flames from the stoves. Both of these points should be taken into consideration in the results related to fuel use for the new stoves. These general reactions were common across stove types.

When asked about **differences in smoke produced** by the ICS versus the traditional stove, a vast majority (85/118) said the ICS produced less smoke than their traditional stove. A few said no change (13/118), and a small group (19/118) reported more smoke. Husbands present at the time of the survey who answered the question had basically the same impressions as their wives regarding the reduction in smoke from the new ICS.

When asked if the ICS had any **impact on cooking pots**, just over half the users (62/118) felt the new stoves kept their pots cleaner, a few saw no impact (15/118), and a third (40/118) felt it made the pots dirtier than the traditional stove. Again, this finding was in part due to some users "jamming" the ICS with wood to make flames visibly meet the cooking pot, which would clearly affect impressions and is discussed further in the discussion section. A major obstacle reported is that the **cooking time** was slower using the ICS, especially for long-cooking food items like rice and daal. More than three-fourths of respondents (91/118) reported slower cooking time using the new stoves compared to their traditional stoves, a fifth (24/118) reported faster cooking, and just a few (3/118) respondents said cooking time was the same.

In response to an open-ended question, "What do you think about the stove?" after three weeks, a clear majority said it: was cleaner, releasing less soot and smoke into the house and kitchen; used less fire wood; and emitted less smoke. Many of the participants said—unprompted—that they enjoy cooking on the stove, and almost a fifth said it looks nice. For each of these positive attributes noted here, a small minority (less than 20 percent in each instance) said their stove emitted more smoke (14/118), that it used more wood (12/118), and that they did not enjoy cooking on the stove (21/118).

By Day 3, the majority of households preferred their new stove to their old traditional cookstove. After 21 days, however, far fewer households preferred the new cookstove to their traditional stove, with rates falling from 56 percent preferring the new stove after 3 days to only 41 percent preferring the new stove after using it for 21 days (Figure 6). The breakdown by model of stove (Figures 7 & 8) and by model and district (Figure 9) are below.

Three stoves—the Eco-Chula, Envirofit and Prakti—were clearly more acceptable to consumers at the Day 3 survey. More than half of consumers trying those stoves preferred the new stove to their traditional stove. By the Day 21 survey, however, user preference had dropped for all five stove types, most dramatically for the Eco-Chula. Reported reasons behind this are described in the discussion section and primarily have to do with changes related to their cooking practices (Figures 7, 8, and 9).

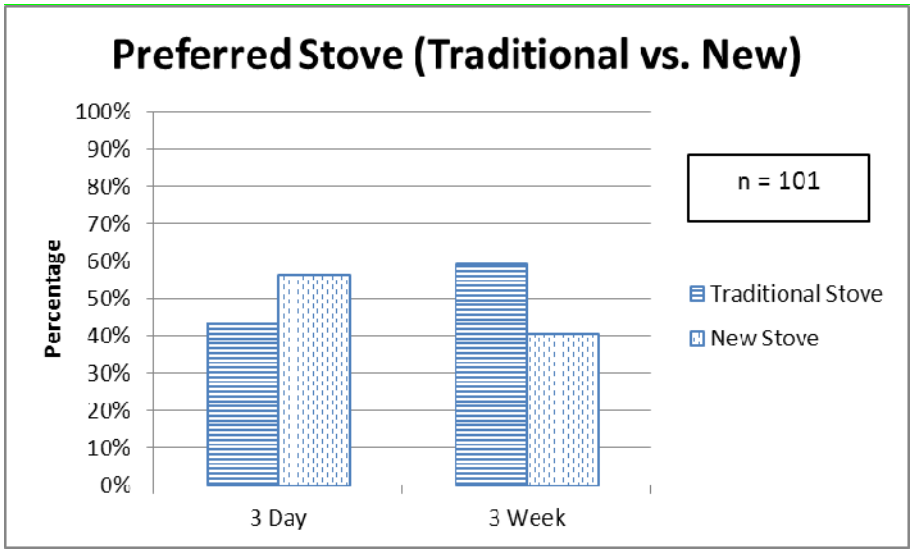


Figure 6: Households were included in this comparison only if the age of the respondent at Day 3 was the same as Day 21 to be certain preferences of the same person were being compared.

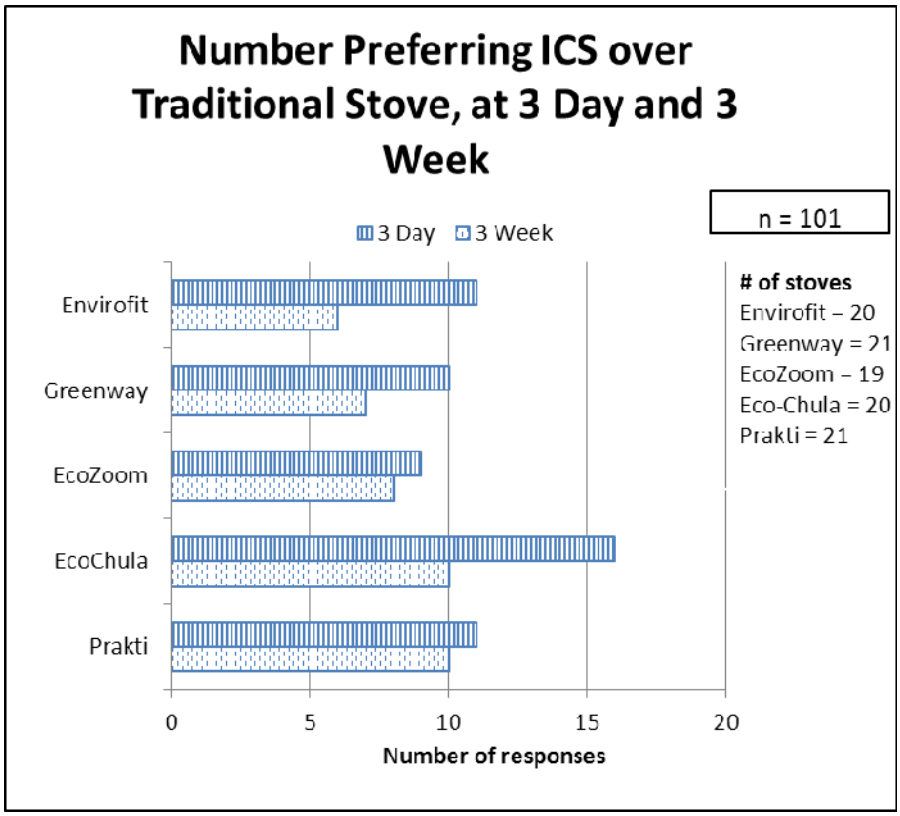


Figure 7: Households were included in this comparison only if the age of the respondent at Day 3 was the same as Day 21 to be certain preferences of the same person were being compared.

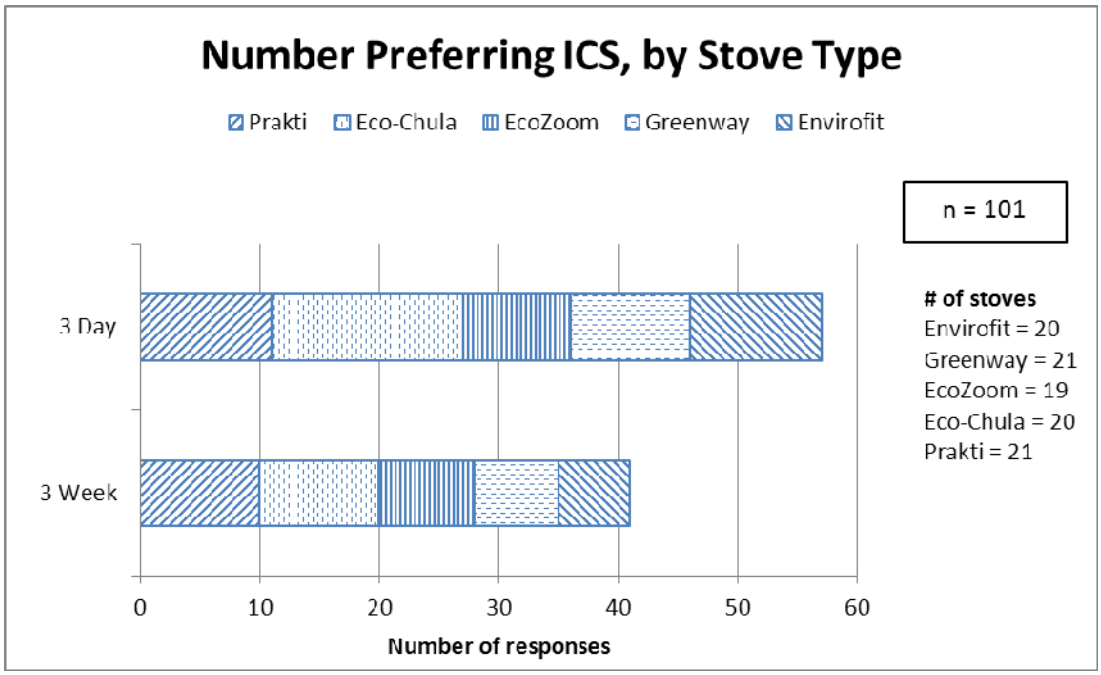


Figure 8: Households were included in this comparison only if the age of the respondent at Day 3 was the same as Day 21 to be certain preferences of the same person were being compared.

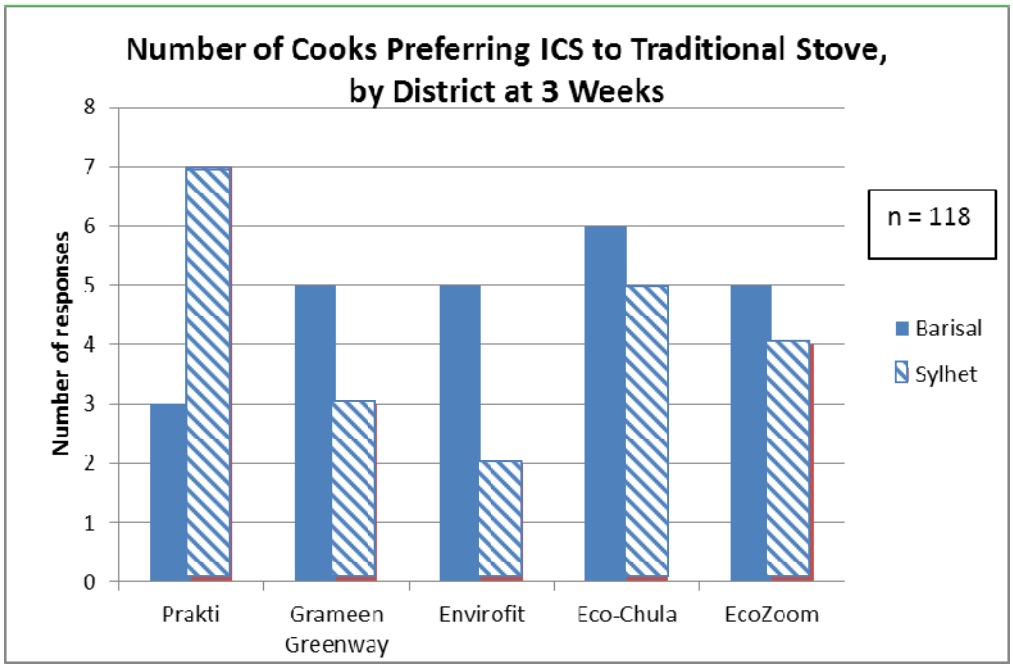


Figure 9: The stoves preferred by the users in Sylhet in decreasing order are: Prakti, Eco-Chula, EcoZoom, Greenway, and Envirofit. In Barisal the decreasing order of preference for stoves is: Eco-Chula, equal preference for Envirofit, Greenway, EcoZoom, and third, Prakti.

The data points that follow explain what consumers liked and did not like about the different stoves by model of stove. Analysis of these results is included in the discussion section. Despite the decreased preference for the new stoves versus traditional stoves, 78 percent of participants overall still said their new stove was a "good" stove after three weeks of use. Percentage perception by stove type is found below in Figure 10.

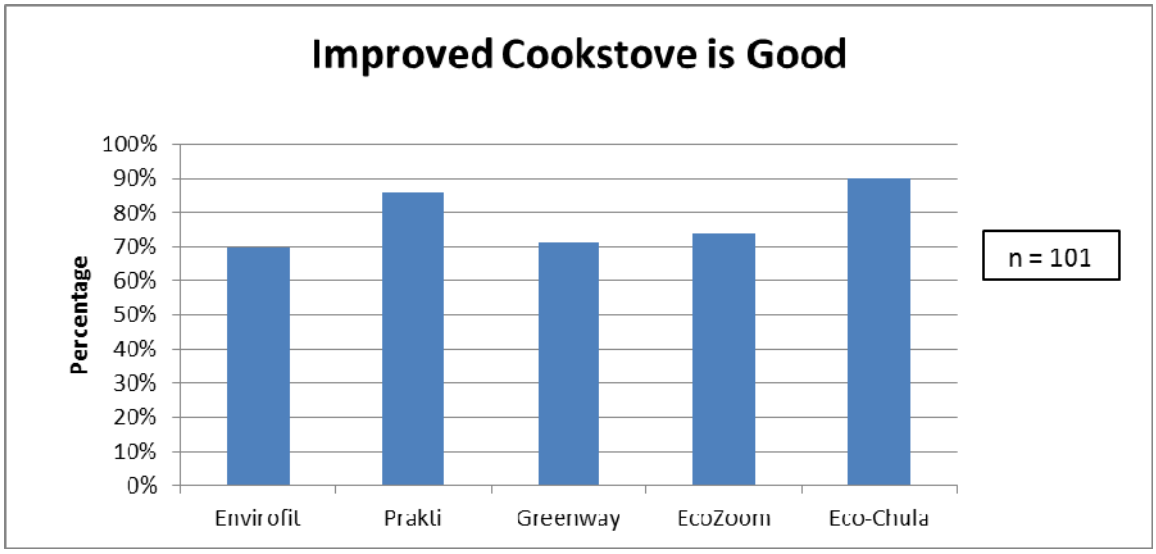


Figure 10: Households were included in this comparison only if the age of the respondent at Day 3 was the same as Day 21 to be certain that preferences of the same person were being compared.

Exploration of the qualitative and quantitative data sheds light on these seemingly contradictory findings (see discussion section below). Households appeared to "like" and "value" the stoves but still felt the stoves didn't satisfy all their kitchen needs in the way their traditional stoves did. Our conclusions on what it would take (including consideration of stove design modifications) to get participants interested in purchasing and using an ICS are included in the discussion section.

Profiles of Specific Stoves

Envirofit – More than half of users said it uses less fuel and emits less smoke, and some liked the looks and said that their house was cleaner. Lastly, some mentioned that it was well manufactured.

Prakti – Almost everyone commented that the stove emits less smoke, and a majority also mentioned the Prakti leaves their house cleaner, uses less fuel, and looks nice.

Greenway – A majority commented that less fuel was needed, that it looks nice, and they liked the portability. Some (but not a majority) mentioned it emits less smoke. Concerns cooks noted included that it appeared delicate and unstable, and they worried the stove would tip over.

EcoZoom – Compared to their traditional stove, a majority mentioned it uses less fuel and around half said it emits less smoke, it looks nice, and they appreciate its portability. Cooks noted that they liked that it looked big (in diameter and height) yet portable, and has a broad base that makes it stable. They also noted that the appearance and weight of the stove convinced them it was durable.

Eco-Chula – Compared to their traditional stove, many mentioned it uses less wood, emits less smoke, and looks nice. About half also mentioned the house was cleaner than when using the traditional stove and many mentioned it cooks food quickly and is portable. Concerns cooks noted included that it appeared delicate and therefore might not be durable. They reported liking the fan, and the gas stove-like flame that aided cooking. They liked that it is portable, and that the cooking vessels are placed on a separate metal "quadrapod" frame, so there was no fear that the stove might tip over due to the weight of the pot.

People most liked the ICS overall because they emit less smoke and use less fuel. Ranking almost as high was that the stoves looked nice. The stoves were perceived to be cleaner and produce less soot. Less frequent but still strong responses included the stoves' portability, and to a lesser extent, their overall quality and ability to cook food quickly. Other responses included both aspirational benefits such as: "impresses others and brings pride to my house," features like "the flame is like that of an LPG stove," and that it retains heat and produces more flame and heat (see word cloud below).

Figure 11: The word cloud above represents attributes named by all consumers trying the ICS in response to asking what the participants liked about the new stoves compared to their old primary stove after three weeks of usage. Larger type size reflects the frequency of mention of the attribute.

Answers were similar in response to a general question about why <u>someone</u> (anyone) might choose these stoves (as opposed to why do YOU like the stove, which correlates with the word cloud above), with the exception of "looking nice" and "cooks fast," which were mentioned far less often (see chart below).

Chart 1: Description of People Who Would Use ICS

Why Would <u>Someone</u> (Else) Choose These Stoves?	**Frequency N = 118**	**%**
Less smoke	80	68
Saves fuel	80	68
Portable	61	52
Kitchen/pots stay cleaner	58	49
Looks smart/modern	4	3
Looks nice	3	2.5
Cooks fast	27	23
No one will like to use it/no good reason to use	4	3
Other	6	5

Whether they preferred the improved stove over their traditional stove or not, all users encountered some problems or barriers to using the new stove. There was little variation across stoves, with some notable exceptions, often directly attributable to the design of that particular stove. Some of the major problems were that in all the stove models it took a longer time to cook large quantities of food in

large vessels. Users felt that big pots did not work well with these small portable stove models because the flame does not spread to cover enough of the pot and the cooking pot might tip over. In Bangladesh the staple food is rice, and it is consumed in all three meals of the day. Depending on the family size, the stove users found it very difficult to cook large quantities of rice in these stove models (Figure 12). This was an especially large obstacle during the month in which the stove trials took place, as families tended to cook larger quantities of rice all in the morning during the cooler December- February season, rather than during multiple cooking periods spread throughout the day as is more typical the rest of the year. Users who belonged to small families of up to three to four members liked the stove models.

Stove users were asked about whether anything about the improved stove wasn't functioning properly due to the design of the stove. In the case of the Prakti stove, the major complaint was that the second pot was not effective for cooking (13/23). For all stove models, especially Prakti and Greenway, a recurring complaint was that the stove size was too small for most tasks (15/23 and 14/24). For the Greenway stove another major complaint was that the stove was not stable (13/24).

When users were then asked about problems cooking on the ICS, users found it difficult to chop wood into small pieces for these stove types; this was noted especially frequently by Eco-Chula (16/24) and Envirofit (10/24) users and to a lesser extent Greenway (7/24) and Prakti (8/23). Some users of the Prakti stove (5/23) complained they could not use the second pot hole (this was the only stove that had this issue because it was the only stove with two potholes). Some Prakti (3/23) and EcoZoom (5/23) users reported that the fuel chamber was small. A few users of Eco-Chula and Greenway found it difficult to ignite the stove even after 21 days of regular use. Other problems for some Greenway stove users were that ash would build up quickly (10/24) and fuel wood kept falling off the tray while cooking (4/24). Beyond these complaints, other complaints were common across all stove types. Differences by stove type are highlighted in the chart that follows (Figure 12).

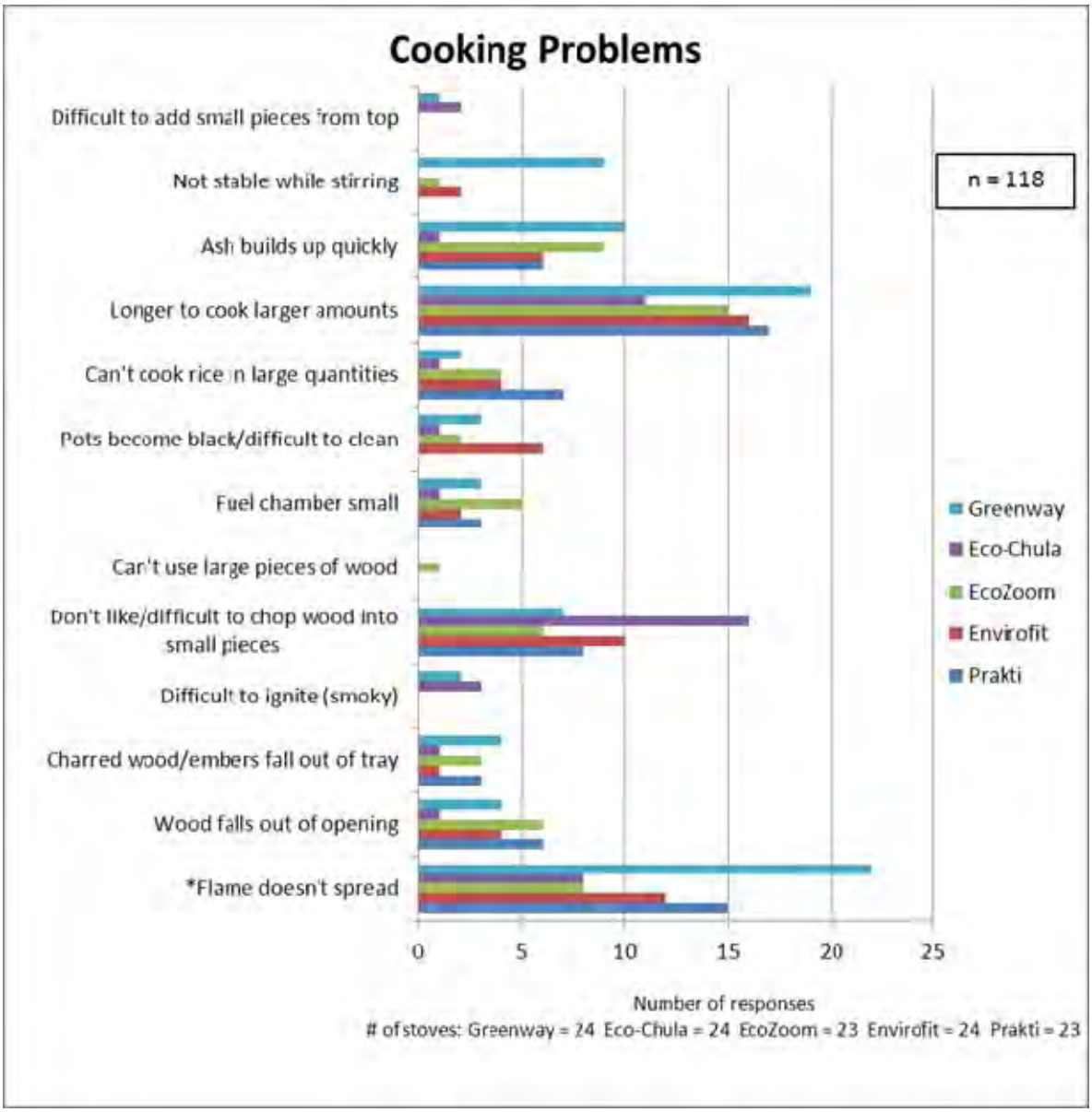
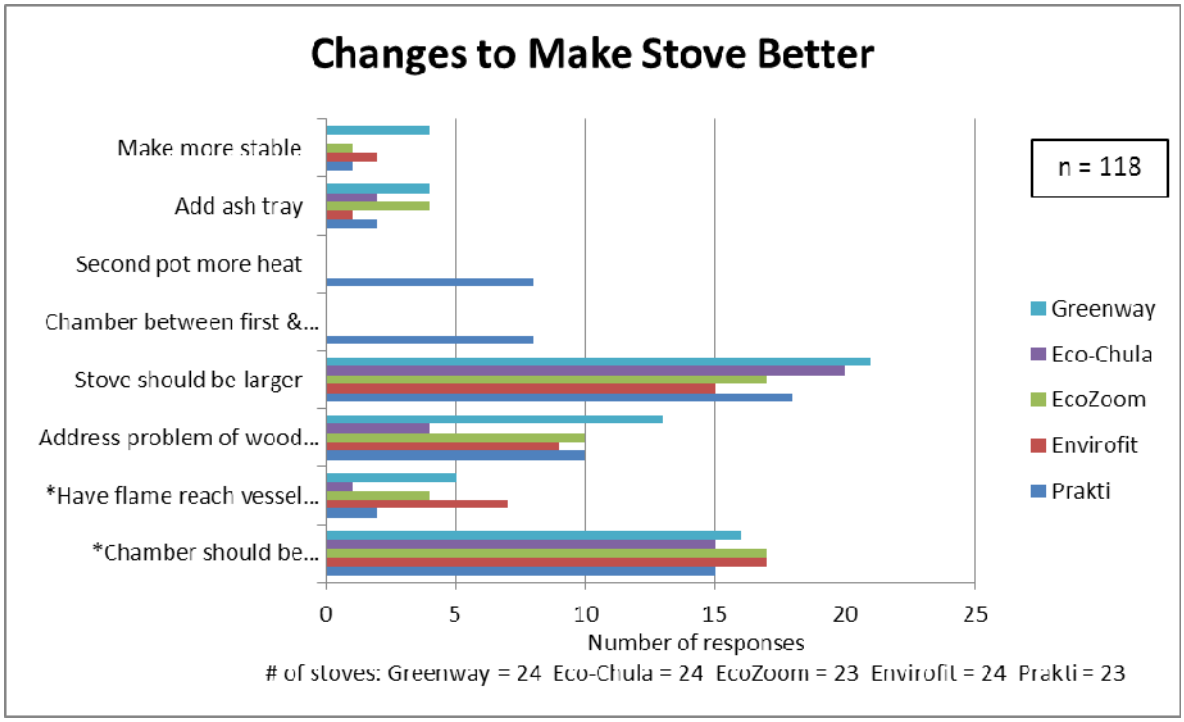


Figure 12: *Cooking problems denoted with an asterisk are issues that are opportunities for consumer awareness and education, rather than changes that should actually be made to stoves, since enlarging the combustion chamber and increasing flame height are detrimental to stove performance in terms of fuel savings and emission reductions. Rather, consumers can be educated on how to get the best performance out of their stoves using methods that optimize its design.

After using the stove for three weeks the users provided some solutions that they perceive will make these stove models better and more acceptable. More than 90 of the 118 users for all stove models said that the stoves should be larger in size. They reported that the combustion chamber should be larger for all stove models so that more wood can be fed into the stove. Some Greenway stove users (4/24) suggested that the stove could be made more stable by making the top plate thicker and sturdier so to better bear the weight of the pots and vessels placed on them. Some Prakti stove users wanted more heat in the second pot mouth and suggested placing the combustion chamber between first and second pot so that both pots can be used

for cooking (8/24). A small percentage of users wanted the stoves to have visible flames which would reach the pots, particularly for Envirofit and Greenway. Although some of the suggestions were constructive and would require some simple design changes, other suggestions are better addressed through consumer education at the point of sale and during after sales service for these stove models (Figure 13).



Figures 13: *Suggested changes denoted with an asterisk are issues that are opportunities for consumer awareness and education, rather than changes that should actually be made to stoves, since enlarging the combustion chamber and increasing flame height are detrimental to stove performance in terms of fuel savings and emission reductions. Rather, consumers can be educated on how to get the best performance out of their stoves using methods that optimize its design.

In this stove trial a majority of the users were forced to modify their cooking habits to accommodate the designs of the new stoves. Instead of multi-tasking during cooking, 59 percent of users had to sit in front of the stove for the entire cooking session, adding wood pieces at regular short intervals. Some 31 percent of stove users said they had to plan their cooking and prepare everything like chopping the vegetables and cleaning the daal and rice in advance before starting the actual cooking, since the new stoves afforded less time for multi-tasking. Only 29 percent of users said they did not need to make any change in cooking style to use these stove models (see chart below).

Chart 2: Changes in Cooking Pattern

Changes in Cooking Pattern, if Any, as Adapted by the Users for the New Stoves (All Stoves)	Frequency (n = 118)	%
Sit in front of the stove to cook everything	70	59
Prepare everything first and then cook	37	31
No change	34	29

Perceptions of "Who is the Stove Good for?" and "What is it Worth?"

In addition to conducting a rigorous willingness to pay exercise, stove users were also asked to describe the kind of person these stoves were good for, as well as to estimate how much the stove was worth. This was distinct from whether they wanted to *buy* the stove, rather their estimate of its value.

The users reported that the stove models were small in size, and overwhelmingly suggested that these stoves are good for small families. To the descriptions of small families, few to some added different other descriptions: "small families who buy their wood," "who live in urban or peri-urban areas," "who rent or lack space to install stoves outdoors," and a few suggested they are best for bachelors! Another few users said that since the stoves are expensive, the people who can afford the stoves would have to be salaried professional people or people who have a good income (see chart below).

Upon completion of the study, general comments about the stoves included that they were good but too small for daily cooking since the average family size for these rural households was more than five. Participants reported that they would like to use the present smaller models in the summer and rainy season when they cannot cook outside. They noted that they use only wood fuel (gathered and saved during winter) during these months and need to save on fuelwood.

Participants recommended that these stoves would be in demand with small families (57/118) and, to a much lesser extent, mentioned they are appropriate in urban and semi-urban areas (9/118). Because of the lack of space in urban areas, users (5/118) suggested those families would welcome portable stove models that can be used inside the apartment. Some participants (9/118) also noted that wood fuel is almost exclusively purchased not collected in urban areas, and since these stoves save fuel there should be a good demand for these stoves (see chart below).

Chart 3: Perception of People Who Would Use These New Stoves

What Kind of People Would Use This (These) New Stove(s)?	Frequency n = 118	%
Small families	57	48
Modern people	52	44
Thrifty people	25	21
Poorer people	11	9
Simple, ordinary family	23	19
Someone people respect	11	9
People/families living in urban or peri-urban areas	9	8
Small families who buy wood	9	8
Smart people	8	7
People living in rented or lack space outdoors	5	4
Professional people or people with good incomes	4	3
Middle class families	3	3
Bachelors	3	3

Study participants "valued" stoves for certain features, but dramatically "undervalued" the (anticipated) price of the stove. Many (49/111, or 44 percent) estimated the stove at 0 to 25 percent of anticipated sales price (which already includes an assumed carbon subsidy); another 35/111 (32 percent) estimated the value to be between 26 and 50 percent of the anticipated sales price. Only 13/111 (12 percent) estimated between 51 and 75 percent, and 6/111 (5 percent) between 76 percent and the sales price. Few overestimated pricing across all models (Figure 14). However, as will be further discussed in the findings and discussion section, reported values were likely influenced by a shared (and perhaps discussed) perception that participants should be given the stoves as a token of appreciation for participating in the study.

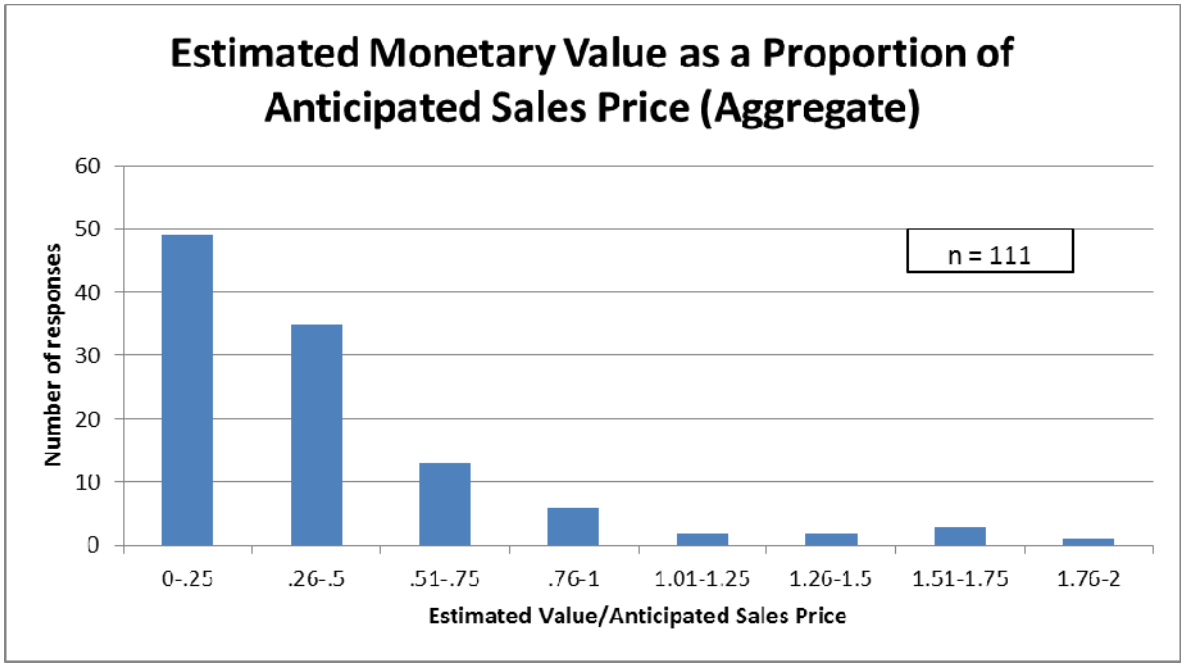


Figure 14: These proportions are generated by dividing the estimated value by the anticipated sales price, thus creating a value to compare across stoves, which ranged in price.

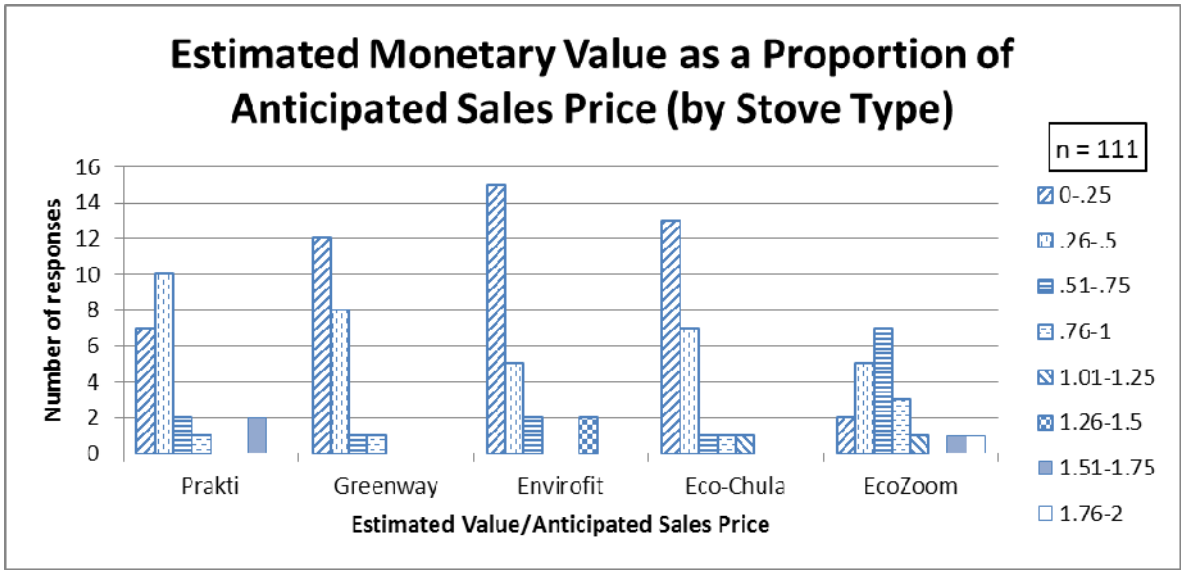


Figure 15: Study participants' estimates of stove prices are displayed as a proportion of anticipated sales price, by stove type. Stoves were for the most part undervalued across all stove types, with the exception of EcoZoom, which consumers thought was worth more than other stoves (thus it fell into the higher ratios), apparently because of its larger size and heavier weight; some consumers mistakenly thought the entire stove was made out of cast iron, which would demand a higher price.

WILLINGNESS TO PAY

Two different innovative willingness to pay (WTP) assessments (based on a review of regional and other IAP WTP methods used to date and discussions with experts including TRAction grant recipients) marked the completion of the stove trial.[15] Final formats are found as Appendix B.

In seven villages, all 105 households were given the opportunity to purchase the study stoves in a bargaining exercise that included installment payment options, and in one village all 15 households were given the stove as a gift, but offered cash to "sell" it back. Of the 105 households offered the chance to buy their stove, 12 entered into negotiations, but only one study home (and one non-study home) eventually purchased the stove.

The willingness to pay forms were used only in these 12 households; the rest did not wish to even bargain given the high stated value of the stove. They wanted the stove models to be given to them for free as a token of appreciation for having participated in the study for three to four weeks. Some users said they had participated in the study to help the concerned organizations to bring in new stove models into Bangladesh. To help the study, they used wood fuel, which they either buy or gather and keep for the summer and rainy season. During the winter months they generally use dry leafy biomass as fuel, which is available for free, in specially designed mud stoves that they themselves construct outside in the open courtyard to save money.

The users were very vocal in stating that although they knew the cost of the stove varied from 1600–4000 Taka, they wanted to buy it at a subsidized price ranging from 200–500 Taka, depending on stove model. There were clear signs of "collusion" and discussion among study participants within villages and perhaps across study villages. They did not think they would be making a good decision if they bought these smaller stoves at the quoted price because these stoves although good would not replace the traditional stove for their daily cooking needs. It would remain an additional/supplementary stove for the family. The majority were not willing to bargain or negotiate.

Below is a description of the 12 households who were interested in purchase and engaged in the willingness to pay "bargain" but did not purchase a stove, along with the one study participant and one non-study participant who did purchase stoves. In all households both husband and wife participated in the negotiations, with husband ending up being the main respondent for bargaining.

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[15] After reviewing all available IAP studies and a mid-depth review of the willingness to pay literature, as well as a few discussions with researchers, none of the researchers were particularly satisfied with available WTP assessment methodologies. Essentially, most methodologies consist of ASKING people if they would WANT to buy a consumer item, and then asking what price they would pay. The most popular/best practice of engaging participants in an "auction" turns out not to be a true auction, but a "step DOWN offering" between participant and interviewer (would you pay X? okay then, would you pay X–$10?). In the end the item is sold for the SECOND highest bid, to the highest bidder. Only one person is allowed to buy a stove in the end. The concern with this approach is that 1) it doesn't take into account the accepted custom of bargaining for ANY purchase, where the purchaser would be in a "losing position" to reveal how much they are willing to pay for an item; and 2) it doesn't take into account the importance of financing to trigger and enable a purchase.

Chart 4: Willingness to Pay for ICS – Method 1

	Willingness to Pay—Bargain and Financing Offered Description of Those 12 Interested in Buying (2 Bought in End)			
Village	**Stove**	**Lowest Acceptable Offer Based on Stove Value (BDT)**	**Initial Price Offered by Participant (BDT)**	**Final Price/Resolution**
Sylhet District				
Kewa	Prakti	3000	200	250 Final price declared by the husband [not purchased, as final offer below threshold]
Kewa	EcoZoom	1600	300	Refused to bargain beyond that price even after repeated persuasion [not purchased]
Kewa	Greenway	2400	300	400 after lot of persuasion [not purchased, as final offer below threshold]
Kunarchor	EcoZoom *although used Greenway in study*	1600	500	Husband was not ready to negotiate [not purchased]
Kunarchor	EcoZoom	1600		Wanted to participate but backed off after hearing the stated value of the stove [not purchased]
Tilargaon	Prakti	3000	5 installments 5 x 750	PURCHASED
Tilargaon	Prakti	3000	3000	3000 PURCHASED *Landlady of other purchaser*
Barisal District				
Billobari	Prakti	3000	300	500 after negotiation [not purchased, as final offer below threshold]
Bihangal	EcoZoom	1600	300	[not purchased]
Gonpara	Eco-Chula	4300	600	[not purchased]
Gonpara	Greenway	2400	1200	Said unable to pay more as he was poor [not purchased]
Gonpara	Envirofit	2000	500	Refused to negotiate beyond that price [not purchased]

In one village in Sylhet households were offered their study stoves as gifts, then given the option of selling back the stoves at the prices detailed below. In 12 of the 15 households every family member opted to retain the stoves, irrespective of the stove model. In one household the husband said that although he, his wife, and son like the Eco-Chula and would like to keep it they were being forced to sell since his wife has a heart problem and he requires ready cash for her treatment. As such, three of the 15 households traded their stoves for cash, and the others turned down the money in favor

of the stove. The three stoves that were exchanged for cash were the Greenway (for 2400 Taka), the Eco-Chula (for 4300 Taka), and the Envirofit (for 2000 Taka).

Chart 5: Willingness to Pay Pricing Scenarios – Methods 1 & 2

Stove model	Stove value (US$)	Buy-back offer, lowest sale price (US$)	Stove value (BD taka)	Buy-back offer, lowest sale price (BD taka)
Prakti	70	38	***5000***	***3000***
Greenway	45	29	***3300***	***2400***
Envirofit	40	24	***3000***	***2000***
Eco-Chula	70	54	***5000***	***4300***
EcoZoom	35	19	***2600***	***1600***

The "stove value" is based on the actual cost WASHplus paid for the stove (not including shipping and handling), plus $5/stove for shipping (assuming bulk shipping in a future market scenario), plus a 10 percent mark-up for a national distributer, $4 for transport out of Dhaka, and 10 percent mark-up for rural/local distributer (up to $5).

The "buy-back offer, lowest sales price" takes that high end and subtracts possible carbon revenue from it (assuming a four-year lifespan for the Prakti stove and two years for all others, and $8/ton/stove/year for carbon pricing) to reach a realistic value that these stoves could sell for in the Bangladeshi market once more widely promoted. Of note, these lifespans are conservative estimates; according to manufacturer specifications, expected lifespans for these stove models can commonly reach five years.

SUMS

Semi-structured survey instruments were complemented by SUMS, temperature-sensing data loggers placed on all intervention stoves, all traditional stoves in the control group, and on the traditional stoves in 51 percent of the intervention homes to track actual stove use.

With additional funding from the U.S. State Department's Office of the Global Partnership Initiative, Berkeley Air Monitoring Group trained a group of 10 field workers in kitchen performance test protocol and procedures. Together with a Berkeley Air supervisor, this team undertook kitchen performance tests in all but four study households, as well as 24 control households, to track changes in fuel use. Berkeley Air also oversaw limited indoor air pollution monitoring and personal exposure monitoring.

SUMS-measured usage rates for all intervention stoves were between 2.1 (Envirofit) and 3.3 (Eco-Chula) uses per day during the KPT monitoring, with all groups including the traditional stove in their cooking systems between 1.3 and 1.9 times per day. These usage patterns during KPT monitoring suggest the intervention stoves were commonly used by the study households, but in all cases, did not fully displace the use of the traditional stoves. The following chart shows the percentage of cooking tasks performed in the intervention homes that had SUMS on both intervention and traditional stoves, both during and after the KPT.

Chart 6: Proportion of All Recorded Cooking Events Performed by the Intervention Stove (by stove group)

	% Cooking performed on ICS: During KPT	% Cooking performed on ICS: Post KPT
EcoZoom (n=9)	65%	34%
Prakti (n=11)	72%	43%
Eco-Chula (n=11)	73%	46%
Envirofit (n=16)	60%	29%
Greenway (n=9)	69%	30%

Interestingly, once the field teams stopped visiting the test homes daily to take fuel measurements, all stove groups, including the traditional stove control homes, showed a marked reduction in the use of any stoves, both intervention and traditional. The largest decline was seen in the use of the intervention stoves (Figure 16).

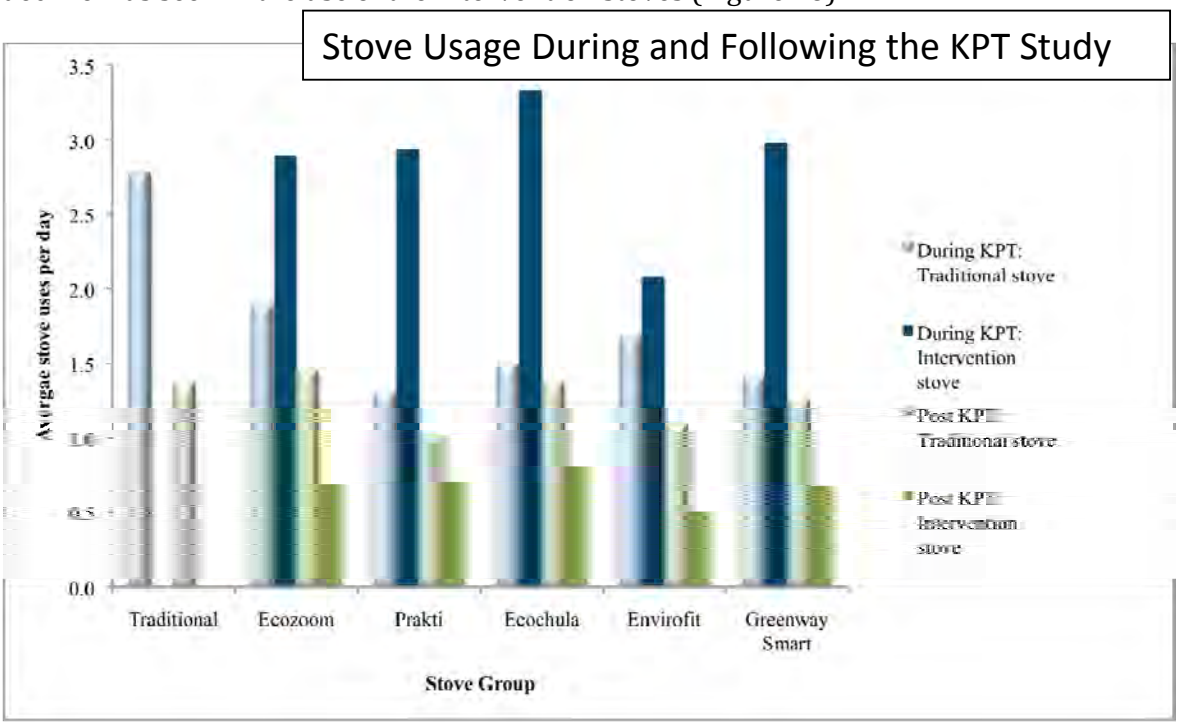

Figure 16

The stove use rates reported at the end of each day of KPT monitoring were compared to the SUMS data from the same period. Cooks with an intervention stove were likely to under-report use of the traditional stove but reported use of the intervention stove with relative accuracy (Figure 17).

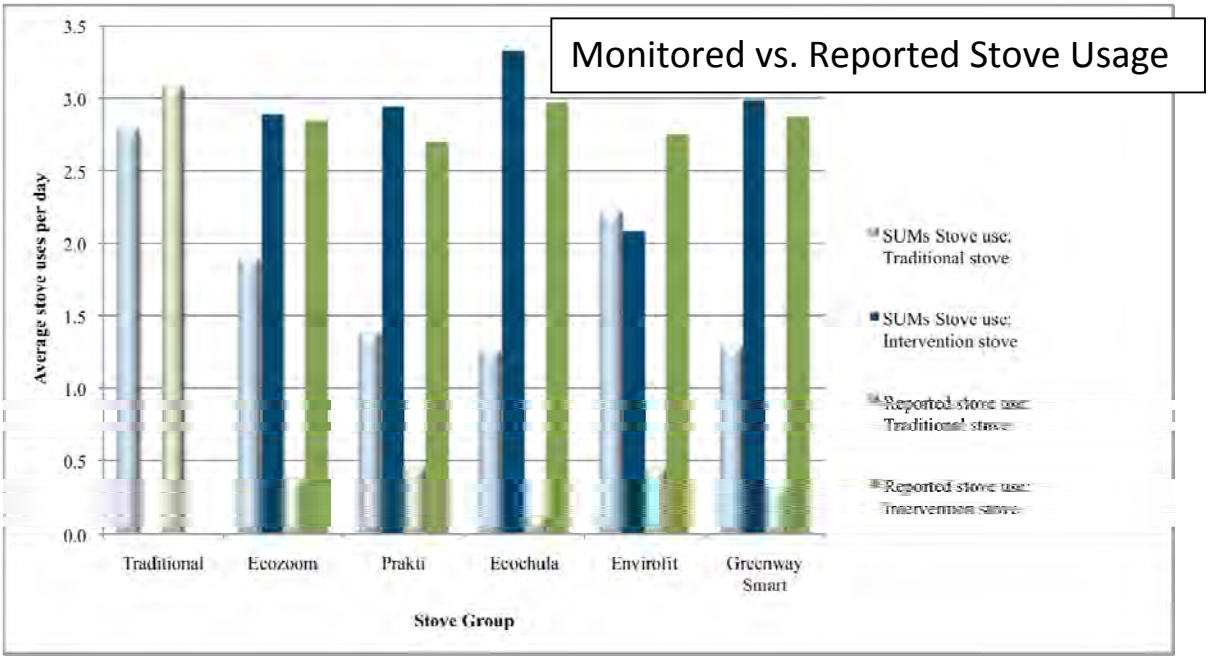

Figure 17

Kitchen Performance Testing

The KPT was carried out in 140 households. After removal of inaccurate or missing data, the final sample size was 134 (Barisal: 65 and Sylhet: 69 households). All households in each stove group used wood as their main cooking fuel during the monitoring period, with a small number of homes in Barisal reporting using crop residue (in the form of dried leaves) as a secondary fuel (9 percent, n=12). The KPT data suggest that all intervention stove groups except one used 16 to 30 percent less fuel per household per day compared to the traditional stove-using homes.[16]

[16] It is important to note that this does not mean that the improved stoves used 16–30 percent less wood than the traditional stoves. Rather, homes using the improved stoves alongside their traditional stoves (which is what happened in most of the intervention households) used 16–30 percent less wood than homes using only the traditional stoves.

Chart 7: Mean Daily Fuel Consumption Estimates (reported as kg per standard adult (SA) per day and by household (HH) per day. ± represents 1 standard deviation)

	Wood (kg/HH/ day)	% savings compared to trad stove	Wood (kg/SA/ day)	% savings compared to trad stove	P value*
Traditional stove (n=23)	3.09 ± 1.69	-	0.73 ± 0.30	-	-
EcoZoom (n=22)	2.39 ± 0.77	22.7	0.60 ± 0.19	17.8	0.106
Prakti (n=22)	2.58 ± 1.16	16.5	0.69 ± 0.41	5.5	0.746
Eco-Chula (n=22)	2.19 ± 0.79	29.1	0.63 ± 0.23	13.7	0.223
Envirofit (n=24)	3.63 ± 1.24	-17.4	0.87 ± 0.47	-19.2	0.214
Greenway (n=21)	2.32 ± 0.94	24.9	0.62 ± 0.22	15.1	0.217

* Comparing intervention stove with traditional stove for (kg/SA/day value). Equal variances assumed in all cases.

A box plot of the kg wood/standard adult/day by stove group was examined for the presence of outliers that might have an impact on the sample mean. Figure 18 below identifies one outlier[17] (denoted as circles) in the Prakti stove group and two in the Envirofit group.

Box Plot Showing Fuel Consumption by Stove Group (Kg/SA/Day)

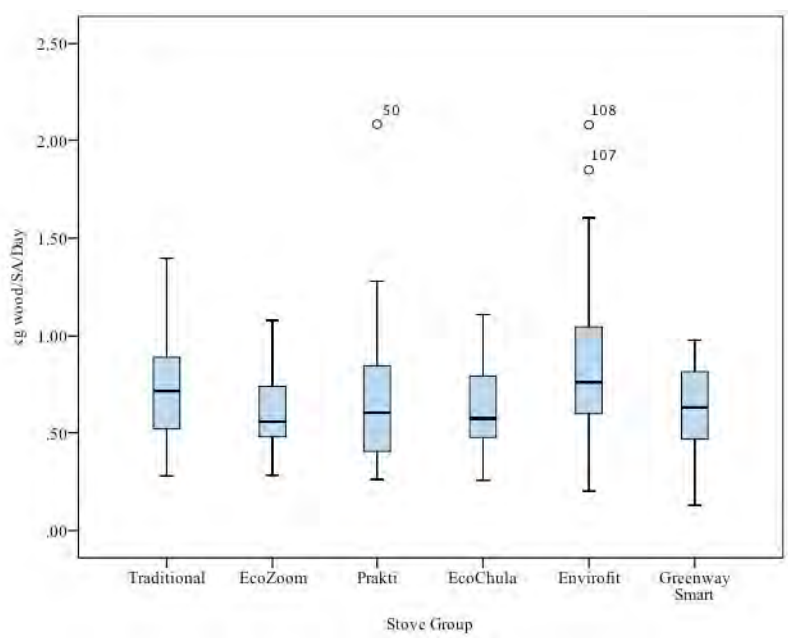

Figure 18

[17] Outlier is defined as 1.5 times the inter-quartile range from the third (75th) quartile.

Although these data points were found to be valid, their removal was explored, which changes the mean wood fuel consumption for the Prakti stove to 0.63 **kg/SA/day** (SD 0.28 n=21). This estimate is 13.7 percent lower than the wood fuel consumption in the traditional stove households (versus a 5.5 percent reduction when the data point is included). Removal of the two outliers in the Envirofit stove group would reduce the fuel consumption to 0.77 **kg/SA/day** (SD 0.34 n=22), an increase of 5.5 percent compared to the traditional stove estimates (versus a 19.2 percent increase when the outliers are included).

Of note, it was expected that all of these stoves would achieve at least a 35 percent reduction in fuel use, based on their laboratory performance.[18] Our results do not show the percent reduction that each stove achieved, but rather the percent reduction in fuel use in the household. Given that we know that the households were using the intervention stoves and traditional stoves in parallel, we cannot say whether the intervention stoves were performing as expected, in terms of efficiency, in the field. We do know that they weren't meeting cooks' needs, based on this parallel use. The one exception is the Envirofit stove group, which was found to use MORE fuel than the traditional stove group. Based on this stove's performance in the laboratory, it is likely that the study stoves were installed or used incorrectly, which highlights the grave importance of proper training for both stove installers and stove users.

It is also possible that wood savings for the improved stoves was actually higher than the data suggest due to underreported leaf litter use, as further explored in the discussion section.

In a very limited snapshot of indoor air pollution, all of the intervention stoves were seen to reduce kitchen concentrations of carbon monoxide and particulates, although not to the health-protective level of WHO or Environmental Protection Agency guidelines. The pilot measurements of 24-hour exposure to carbon monoxide revealed low exposure levels that were not health threatening, even in homes with traditional stoves.

The kitchen concentrations of $PM_{2.5}$ and CO are reported in the chart below. This exploratory data should be seen only as an indicative pilot, however, since there is only one household per stove type (two in the traditional stove group). Without a larger sample size, the comparison of household air pollution levels can be misleading, since many of the factors that affect pollution levels vary from home to home. Factors include ventilation rates, the size and type of kitchen, the mix of stoves and fuels used, the number of people cooked for, lighting, and other indoor sources of pollution, such as incense and cigarettes.

[18] The 2012 ISO International Workshop Agreement for cookstove performance provides a system for categorizing stoves based on several performance metrics, including two metrics related to efficiency, from tier 0 representing traditional stoves to tier 4 representing aspirational gas technologies. The IWA tiers only provide comparative classification for stoves based on lab tests. All of the stoves selected for this study had achieved a tier 2 or higher rating for their efficiency metrics in the laboratory.

Chart 8: Mean 24-hour Air Pollutant Concentrations in the Kitchen

	$PM_{2.5}$ ($\mu g/m^3$)	CO (ppm)
Traditional stove HH1	11,017	31.5
Traditional stove HH2	2,737	14.1
EcoZoom	1,744	2.8
Prakti	626	9.1
Eco-Chula	2,587	7.8
Envirofit	1,343	0.9
Greenway	1,472	3.2

DISCUSSION

Limitations of the Study

Ideally, a stove trial would be long enough for users to try out a stove for several months, rather than several weeks, since it can take that long to get used to a new cooking apparatus and a new style of cooking, and users may not settle into new use patterns for a number of months. Given budget and timing constraints, we were not able to extend the trial beyond three weeks.

For the current study, WASHplus selected five promising improved stove models based on their laboratory performance testing results and their acceptance elsewhere in the region and beyond. We were not able to include in the study the truly aspirational BioLite HomeStove, which may have been very popular in Bangladesh, given cell phone penetration rates and the stove's ability to recharge cell phones. The BioLite is now back in production, and we recommend its inclusion in a future stove trial.

In addition, given the mixed reception of the improved stoves trialed in this study, and clear unwillingness to pay for the improved stoves, WASHplus recommends that these improved stoves be compared with Bondhu Chula models to assess relative preferences and performance, since our policy-making and program implementing audience may interpret from the findings of this report that they should continue to promote Bondu Chula stoves going forward, despite their mediocre field performance.

Furthermore, WASHplus recommends that larger and higher firepower two-pot stoves be trialed in Bangladesh. Although we did include a two-pot stove in the trial, users complained that the second burner did not burn hot enough to boil water or cook rice. Because of dependence on free agrofuels, trialing of a rice husk and/or mixed fuel stove is suggested.

Lastly, while the study was designed to generally apply to all wood-burning stove users, the results of this study in two small districts of Bangladesh cannot necessarily be extrapolated to the entire country; further trials should be undertaken in other parts of the country to add more data points.

Fuel Use/Seasonality

Overall, study participants felt that the improved stoves trialed were not big enough (in terms of both physical size and firepower) to cook the meals needed. This was in part because during the season in which the study took place, when the weather is relatively cooler and food therefore keeps longer, households prefer to cook rice for the whole day all at once in the morning, rather than at each meal time, as is customary during the rest of the year. None of the study stoves were designed to cook 1.5 kg of rice at one time and did not meet user satisfaction for that task. As such, most households ended up using the study stoves for side dishes, while continuing to cook rice in their traditional stoves.

During the study period, households were also accustomed to supplementing their wood use with free gathered leaf litter for fuel, enabling them to save up fuelwood for the summer rainy season during April–August/September, when dry wood or agrowaste is harder to come by. So although most study participants reported that the improved stoves used less wood then their traditional stoves, they would have

preferred to be using leaf litter, and in fact did so in their traditional stoves. The ability to burn leaf litter in traditional stoves may have been a secondary contributing factor to higher traditional stove usage and lower improved stove acceptance, preference, and usage during the study period.

We only discovered during the course of the study that many households built special leaf-burning stoves for use during December–February. These stoves were built away from the houses in an open courtyard and/or semi-enclosed space because of the thick smoke that burning leaves can create. In addition, results from the Day 3 and Day 21 qualitative surveys suggest that leaves were used extensively for cooking fuel during the time the KPTs were conducted. This could have potentially influenced the extent and nature of wood fuel consumption in both the control and intervention stove households.

That said, the KPT team did not see many houses using leaves. The team weighed the leaves whenever the household reported using them, whether used in their outside stove or in the traditional stove in their house. Some 12 of the 134 total households had leaves weighed during the KPT, and all 12 of these households were in Barisal. This fact is in line with the field team reports that leaves are used as a cooking fuel in addition to wood in Barisal due to the abundance of trees there, while in Sylhet, where trees are less abundant, leaf use is less common. Only one of these 12 households was a control household.

It is possible that some unreported, and therefore unmeasured, leaf use took place during the KPT. The KPT team did not have any strong evidence to indicate that this occurred, or that it occurred more for leaves than for wood (e.g., small sticks and twigs). Also this "leakage" in the measurement of leaf litter is likely to have had a similar impact across all stove groups, including the control households, so that any bias is spread out across the study population.

There is also the possibility that the process of monitoring influenced the way the household used their stoves and fuels. If the households perceived the main focus of the KPT to be wood fuel (even though they had been asked to show all fuels to be weighed), they could have altered their habits to use more wood and less leaves for the period of the KPT. The SUMS data support this hypothesis in that there was a reduction in stove use (including both traditional and improved stoves) in all households after the end of the KPT monitoring. This suggests that they may have moved from the improved and traditional wood burning stoves, which had SUMS units placed on them, to the leaf burning stove, which was not monitored (due to fears they might be stolen as the stove was located outside). The extent to which leaf use reduces wood use is not clear.

As demonstrated in Figure 8, the two districts had different stove preferences. In Sylhet households often have chimney hoods under which they use their traditional stoves in kitchens attached to the main household. Because they were accustomed to cooking indoors without heavy smoke emissions, the Prakti stove was the best match for them (as it has a chimney, so can be used inside with very little indoor smoke). These households thought the other stoves too smoky, especially during the lighting process. In Barisal households usually cook outside in semi-enclosed spaces, or separate rooms, rather than in the main house/living space. Since it rains a lot in Barisal, and they're accustomed to cooking out of the living area, they like the portability of the Eco-Chula.

One surprising finding from the study was the dramatic decrease in acceptance of ALL the improved stoves between the Day 3 and Day 21 surveys. This was especially pronounced for the Eco-Chula stove. Our reporting indicated that people initially liked the Eco-Chula because it was portable and clean burning with little smoke (especially valuable in Barisal where people cook in semi-enclosed areas), but that over time they grew to resent having to chop wood into small pieces, as required by the stove, and having to sit by the stove continuously adding wood pieces, rather than being able to multi-task as they were accustomed to doing with their traditional stove.

Willingness to Pay

An initial interpretation of the willingness to pay findings suggests that when acquisition barriers are removed (as modeled in the second WTP "buy-back" scenario, where households were "given" the stove and then offered a sum of money to "buy it back"), households valued the stoves highly. Prices were identical in both cases; the lowest price the team would accept for selling the stove in scenario one equaled the offered price for which the team would buy back the stove in scenario two, as per the table found in the WTP findings section.

People saw benefits and positive attributes to the stoves. Some, but not a majority, preferred the ICS to traditional stoves. But everyone underestimated the monetary value of the stove, and few were willing to pay anything close to market value for the stove, even when offered installment options (that included interest of 20 percent over five installment payments). This was surprising, as the authors hypothesized that finance options not often available for stoves would increase their appeal and acquisition.

According to the stove users, they like the stoves and would have liked to keep them if given for free or at a nominal cost. Improved stoves would not replace traditional stoves, rather complement their use under various conditions. Householders realized that these metal stoves are expensive, but they were not ready to buy them at market price. The various reasons put forward by them were, as follows:

a. The stove model is small and cannot completely replace the primary stove. It will be a supplementary stove that will be very useful in the summer and rainy season when wood is the only fuel and cooking needs to be done indoors.
b. They had participated in the study, so the stove should be given to them at a nominal price or free.
c. They could not risk paying so much money for an experimental model since after the study there will be no after sales service.
d. They do not want to buy the stoves on installments (or at least on the installment plan offered) since they did payment calculations in their heads and realized they would end up paying much more for the stove once interest and/or service fee for the loan was incorporated.

Fundamentally, study participants viewed the WASHplus study field team as NGO staff, and in rural Bangladesh there is a strong culture/background of NGOs giving away or at least subsidizing goods and services. As such, study participants strongly felt that they should be given the improved stoves free or at a heavily discounted rate. This was especially true in cases where they felt the improved stove would only be used for specific tasks, and was not a total cooking solution.

Our second willingness to pay assessment (the buy-back exercise), however, demonstrated that consumers DID tremendously value the improved stoves, once they owned them. Given the low purchase rate of the stoves, the team was surprised to find that so many families opted to keep their gifted stoves, rather than exchanging them for cash. This lead the team to observe that the participants valued the stove and preferred it over its cash equivalent when they did not have to make sacrifices to their household economy to keep it and when they did not have to come up with funds from what was an already tight household budget in most cases.

Of note, participation in a women's group had a slight but not significant positive correlation with expressed interest in purchasing a stove (independent of whether they ultimately did purchase a stove). Almost half (55/120) of the participants belong to some sort of women's group (such as savings cooperatives). Of this women's group subset, 60 percent expressed interest in purchasing a stove, compared to 55.4 percent of the 65 women who did not belong to a women's group. With such a small sample size, it's very difficult to say whether women's group participation had any real influence on stove purchase decisions. These women's groups are still being considered as a potential "vehicle"for promotion and distribution of stoves.

The baseline survey also asked whether respondents were able to independently make the decision whether or not to purchase a stove. The graph below shows the results by age brackets. Women participants within the 16–25 age bracket were probably newly married or unmarried daughters who did not yet have authority to make decisions for the family. The graph shows a gradual rise in decision making powers as age increases and then a slight dip when the older women likely begin to hand over household responsibilities to the daughter-in-law (Figure 19).

Out of 120 study participants, 113 answered the question "Are you the person that would make the decision to purchase [the improved stove]?"Out of 31 women respondents within the 16–25 age bracket, only about a quarter said yes. Out of 38 respondents within the 26–35 age bracket, the majority said yes. Out of 26 respondents within the 36–45 age bracket, almost all said yes. Out of 14 respondents within the 46–55 age bracket, most said yes. Out of four respondents within the 56–65 age bracket, most all confirmed they were able to independently make the decision whether or not to purchase a stove (Figure 19).

Percentage of Women Respondents Reporting Independent Decision Making on Household Purchases, by Age Group

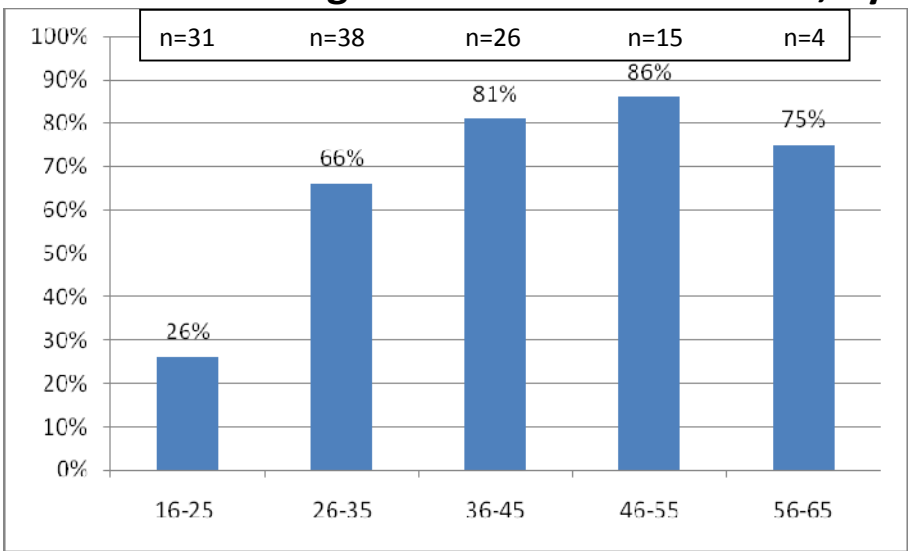

Figure 19

CONCLUSIONS AND NEXT STEPS

As the evidence base linking improved cookstoves with improved health and energy impacts grows, so does attention on how best to influence household uptake and consistent and correct use of stoves. Appropriately, attention focuses on how to improve stoves and make them more affordable and appealing to the neediest consumers. Important work has started, including in South Asia, to identify the "drivers" of cookstove adoption.

Under Phase 2 of WASHplus activities, WASHplus will develop a generic marketing and behavior change strategy; suggest a limited number of evidence-based approaches to increase the uptake of stoves; concept test key elements of these approaches; and develop practical "how-to" tools to contribute to the goals and results of USAID energy and health objectives in Bangladesh. This will draw on lessons learned in Bangladesh and other countries in the South Asia region in behavior change, demand creation, and marketing of sanitation, water treatment products, and cookstoves.

A marketing strategy addresses what is classically referred to as the 4Ps of marketing—product, place, price, and promotion—to suggest a vibrant "marketing mix" of elements that will make improved cookstoves appealing and affordable to the most vulnerable Bangladeshi market. To highlight the way forward and how these findings will be applied, we "preview" some applications in the follow paragraphs. The study has shed light on some essential changes to all five stoves before they are appealing enough to consumers for them to open their purses to purchase them, and before they are able to use them consistently and correctly.

The stove many consumers "want" is large and stable, yet portable, with a modern, well-made design. It cooks large volumes of food and has two active burners. Flames are hot and leap to touch the pots, but do not make them black. The stove can use multiple fuels, which can be fed in relatively unprocessed. Wood in particular can be stuffed in large pieces, and left to feed almost automatically.

The stove described above would be considered the "ideal" for many in the study, but not what is currently available nor necessarily what we are aiming for. Some of the criteria are contradictory (leaping flames and clean pots), thermo-dynamically impossible, undesirable from a fuel-efficiency standpoint, and far from what is currently available in the market. The five stoves tested by consumers over the three-week trial period met some of the desired attributes described, but users expressed many problems with the current ICS models. Some of the problems and suggested changes can be addressed by manufacturers without much effort or "R&D" (research and development), such as stabilizing the stove and/or enlarging the burner to accommodate larger pots, or adding an ash try to catch burnt ashes. However, other problems and suggested changes reveal consumer preference but are not recommended changes, because they will clearly affect the efficiency and emissions of the stoves. This does not mean they should be dismissed; however, they clearly indicate a range of education and information that should be delivered to consumers through point of purchase sales materials and interaction with distributors and sales people, in **promotion**al material, and through health or other outreach activities. Addressing such issues will be essential for consistent and correct use of ICS, for consumer satisfaction, and related word-of-mouth recommendations.

Understanding the preference and obstacles to purchase and consistent and correct use of stoves feeds directly into **promotion** strategies, as well. Although the study did not reveal much about the drivers of stove uptake (because the stoves were not particularly well received), when taken in context with what is already known about drivers of adoption[19] we have identified key issues around seasonality of cooking patterns and of free fuel availability such as leaves; of the visual appeal of the metal stoves as "well made, nice looking, and modern"; and a number of other features that were liked or disliked and can serve as the foundation of promotional appeals.

This study has also identified consumer groups most likely to be interested and empowered to purchase improved cookstoves, and promotional strategies should target these potential early adopters: small families, especially poor but not destitute peri-urban families, headed by 30- to 55-year-old women.

The study has also revealed the low willingness to pay for stoves **(price)**, at least for current models. Financing options were explored but inconclusive because consumers were not particularly interested in buying such a (relatively) high priced item that didn't deliver desired benefits. The few interested in buying valued the stoves higher than they were willing to pay, expecting some sort of subsidy from the NGOs bringing them to test for market. Overall they rejected installments with any significant interest or loan service costs attached to the loans.

[19] Lewis and Pattanayak. 2012. Environ Health Perspectives.

Place refers to the place of sales and distribution. Again the study shows that NGOs may have an unintended effect on poor households' willingness to pay. Although consumers in this study trusted NGOs, they put them in a category of "do-gooders for the people" and not salespersons. In the mind of the participants of this study, NGOs give things away; they do not finance or sell them.

It is predictable that all research presentations end with the call for more research, and this study is no different, since it generates another set of questions and areas to investigate. WASHplus offers the findings of this final report to a range of stakeholders in Bangladesh, including USAID's Catalyzing Clean Energy for Bangladesh project and plans to discuss the findings in various forums with the hopes of applying lessons and deepening learning. And while some stakeholders take stock of these findings and other inputs to date, and move forward with evidence-based interventions, others can further the applied research agenda in a coordinated, parallel track to advance our systematic understanding of the market drivers and consumer context that will open the improved cookstove market in Bangladesh and support uptake and use.

Annex A

Selection Criteria

Partner NGO Selection Criteria

- The NGO must work in one of the three divisions where wood is most prominently used as a primary fuel source for cooking (Sylhet division, Chittagong division, Barisal division, data from 2011 DHS survey)
- The NGO must have an office or on-the-ground staff in one of the three divisions where wood is most prominently used as a primary fuel source for cooking
- NGO must have previous experience with working at the household level and good community relationships.

Community Selection Criteria

- The villages must be located in one of the three divisions where wood is most prominently used as a primary fuel source
- Must be within geographic range of partner organization
- Must be accessible by road in Oct/Nov
- At least one of the villages chosen must not have had any former stove interventions. At least one of the villages chosen must have had a BCSIR/bondhu chulha intervention in the past
- Villages will be selected reflecting the religious make-up of Bangladesh (primarily Muslim with some Hindu)

Household Selection Criteria

- Primary cooking fuel must be wood
- Must have **at least** four people in the household (average HH size in Bangladesh= 4.4 people) w/ child under 5
- The majority of the households selected should have no prior experience with or ownership of ICS; approximately 10 percent of the total sample will be purposively selected for having used an ICS previously, for purposes of comparison. *Note: We could not find bondhu chula or other ICS previous users to recruit.*
- Is willing to participate in trials

Cookstove Selection Criteria

- Follow the criteria of the International Standards Organization (ISO) International Workshop on Clean and Efficient Cookstoves International Workshop Agreement (ISO –IWA)—the internationally agreed upon cookstove standards and protocols: http://pciaonline.org/files/ISO-IWA-Cookstoves.pdf
- The stoves must meet either the TIER 2 or TIER 3 requirements in ISO-IWA
- May be either portable stoves that may be metal and capable of cooking meals for at least 4-6 persons or fixed stoves with chimneys that are easy to install (may be in 2/3 pieces for easy cleaning.)
- Wood stoves but may also be multi-fuel

Annex B

All survey instruments and questionnaires available on request and in full report.

COST/WILLINGNESS TO PAY SECTION *House #* *Village #*

Interviewer: *Unique ID#* _____

- *Select the ROW of the stove being used by your respondent.*
- *Begin by repeating that they have the opportunity to buy the stove, but are under no obligation at all.*

Then say:

1. *This stove is worth [insert the value in column A]*
2. *But because you've participated in the study, and because there is only limited servicing available on the stove at this point, we can offer it to you for _____ [insert the value in column labeled B]*
3. *Would you like to buy the stove? Record in column C [check X if yes, make – if no and proceed if no]*
4. *We can offer installment payments if easier. Are you interested in the stove if you could buy it for [say the amount in column D] _____*
   RECORD response in column E [check X if yes, make – if no and proceed if no]
5. *You know, here in Barisol/Sylhet, we never buy for the asking price, of course we bargain. So please, I invite you to bargain with me and tell me what you are wanting to pay.*
6. *Note amount in column F, then accept if above the minimum, or bargain using columns G and H.*
7. *Note if they accept that price in column I.*
8. *Give last chance to counter-bargain. Note in J.*
9. *If still no, go back to the thank you and close the questionnaire.*
10. *If yes, make the financing/payment arrangement.*

	A	B	C	D	E	F	G	H	I	J	K	L
STOVE TYPE	Value (BDT)	. Offering price (BDT)	2.1. Accept?	Offer payments (calculate at 20% interest)	2.2. Accept?	Invite bargaining. Note below the price they offer	**IF they offer … (circle which)** **(BDT)**	Your counter offer (BDT)	2.3. They agree Offered price (BDT)	2.4. They make final offer? **(note)** **IF NO, PUT 'X'**	Agree to anything this amount or above (BDT)	2.7. They request installment payments for your counter offer? **Note** and accept if above min
Stove 1: Prakti	5600	5000		5x1200			4000 3500	4500 4000			3000 Or	

							3000	*okay*			*5x750*	
Stove 2: *Greenway*	*3700*	*3300*		*5x800*			*2500* *2200* *2000*	*3000* *2600* *2500*			*2400* *Or* *5x600*	
Stove 3: *Envirofit*	*3300*	*3000*		*5x700*			*2500* *2200* *2000*	*2800* *2500* *okay*			*2000* *Or* *5x500*	
Stove 4: *Eco-Chula*	*5600*	*5000*		*5x 1200*			*4500* *4000* *3500*	*5000* *4500* *okay*			*4300* *Or* *5x1050*	
Stove 5: *EcoZoom*	*2900*	*2600*		*5x 600*			*2000* *1800* *1500*	*2500* *2100* *1600*			*1600* *Or* *5x400*	
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*

Interviewer: *House #* *Village #*

Unique ID# _____

Before beginning, please find the row that corresponds to the stove given to the respondent. Then say:

1. We thank you for your participation in this survey, and as part of our thank you, we're giving you this stove. It's actually valued at [*pick from column B*] _____

A	B	C
	Value	**Buy Back***
Prakti	***5000***	***3000***
Greenway	***3300***	***2400***
Envirofit	***3000***	***2000***
Eco-Chula	***5000***	***4300***
EcoZoom	***2600***	***1600***

Buy back value considers potential but realistic carbon credit subsidy in pricing.

2. *Note any reaction. Wait a little bit, like one minute, before offering the buy back.*

_____

_____
_____
_____

3. *Now say:*
   As an alternative, if you don't want to keep the stove, we can buy it back from you and give you cash. The amount is a bit lower because the stove is now used of course, so it's not worth as much. It's completely your choice. Would you prefer the stove, or XX [select the corresponding amount from column C].

   Note choice, and any reaction.
   [ ] Chooses stove
   [ ] Chooses cash

Reactions:

[ ] Asks for a different stove
[ ] Tries to demand full pricing
[ ] Other

_____
_____
_____
_____

Annex C

EcoZoom Dura

- Single-pot portable rocket-design stove
- Mass manufactured in China by Shenzhou Stove Manufacturers, sold globally
- Ceramic combustion chamber with refractory metal liner, reinforced metal doorframe, carry handles and removable stick support system

http://ecozoomstove.com/portfolio-type/zoom-dura/

ATTRIBUTES NAMED BY ECOZOOM USERS WHO PREFERRED ICS OVER TRADITIONAL STOVE: When comparing EcoZoom to their traditional stove, a majority mentioned it uses less fuel, over half said it emits less smoke and they appreciate its portability, and some said it looks nice.

PREFERENCE RATES: Just under half (9/19) preferred the EcoZoom to their traditional stove after three days; this slipped to 8/19 after three weeks. Of note, the EcoZoom and the Prakti had the smallest decrease in preference rates out of the five stoves.

PROBLEMS: Whether they preferred the EcoZoom to their traditional stove or not, many experienced some problems with the stove. Users were most bothered by the difficulty of cooking large quantities of food in bigger pots on the stove. Specifically, 15/23 said it takes longer to cook (on ICS than traditional stoves) with large vessels and large amounts of food. Ash buildup was a big problem for EcoZoom users (9/23). Less often than with other ICSs, some users (8/23) said that big pots cannot be used as the flame does not spread. Related to this same issue, a few (4/23) also said they had problems cooking rice in large quantities. Lastly, some (5/23) mentioned problems of wood slipping out due to the slant of the opening. Just a few users found chopping wood into small pieces (3/23) and the small fuel chamber (4/23) to be a problem.

SUGGESTED IMPROVEMENTS: The majority (17/23) said the stove should be larger to accommodate bigger pots and bigger families. They suggested addressing wood falling out and not self-feeding; specifically, they suggested the place for entering the wood in the stove should be slanting inwards to prevent the wood pieces from falling out of the chamber (10/23), and also an ash tray to make it easier to remove the ash (4/23).

As with other stoves, users wanted to have a larger combustion chamber to add wider and bigger wood (16/23). A few said the flame should reach the vessel bottom and spread (4/23). These final suggestions fall into the category of suggestions that will be taken into account and addressed through sales and education efforts, but not implemented because it would diminish the effectiveness of the stove.

ATTRIBUTES NAMED BY PRAKTI USERS WHO PREFERRED ICS OVER TRADITIONAL STOVE: Everyone commented that the Prakti stove emits less smoke, and a majority also mentioned that it leaves the house cleaner. Half said it looks nice and just under half said it uses less fuel.

PREFERENCE RATES: At three days, just over half of those trying the Prakti said they preferred the stove compared to their traditional stove. After three weeks, this slipped slightly to just under half (10/21) of the users.

PROBLEMS: Whether they preferred the Prakti to their traditional stove or not, many experienced some problems with the stove. Users were most bothered by the difficulties in cooking large quantities of food in bigger pots on the stove. Specifically 17/23 said it takes longer to cook (on ICS than traditional stoves) with large vessels and large amounts of food and that big pots cannot be used as the flame does not spread (15/23). Related to this same issue, some (7/23) specifically addressed problems cooking rice in large quantities. Users of the Prakti stove complained that they could not use the second pot for cooking (5/23), and also that they needed to chop the wood (5/23) and could not use large wood pieces. Some mentioned problems of ash buildup (6/23) and wood pieces slipping out (6/23) due to the slant of the opening. Lastly, some (3/23) complained that the fuel chamber was too small and that they wanted to add more wood than the existing chamber allowed.

SUGGESTED IMPROVEMENTS: Most users (18/23) said the stove should be larger to accommodate the cooking needs of big families. As mentioned above as a problem, many (15/23) wanted the chamber to be bigger/wider to allow for larger pieces of wood (this suggestion falls into the category of suggestions that will be taken into account but not implemented because it would diminish the efficiency of the stove). Many suggested addressing the problem of wood "falling out" of the entry; specifically, they wanted a slanted entry to hold the wood and have it "self-feed" (10/23). Many had suggestions about changing the stove to make the second pot more functional. Related to this, some suggested that the combustion chamber should be between the first and second pot so that both pots can be used for cooking, and an equal number said that the second pot should have more heat for cooking (8/23). A few suggested adding an ash tray to make it easier to remove the ash (2/23).

ATTRIBUTES NAMED BY GREENWAY USERS WHO PREFERRED ICS OVER TRADITIONAL STOVE: Regarding the Greenway, a majority commented that less fuel was needed, that it looks nice, and half said they liked the portability. Some, but not a majority, mentioned that it emits less smoke.

PREFERENCE RATES: Just under half (10/21) preferred the Greenway to their traditional stove after three days, and this fell slightly after three weeks to 7/21.

PROBLEMS: Whether they preferred the Greenway to their traditional stove or not, many experienced some problems with the stove. Users were most bothered by the difficulties in cooking large quantities of food in bigger pots on the stove, more than with all other stoves. Specifically, 19/24 said it takes longer to cook (on ICS than traditional stoves) with large vessels and large amounts of food, and almost everyone complained that big pots cannot be used as the flame does not spread (22/24). Almost half (10/24) mentioned problems of ash buildup (most probably due to overfeeding), more than any other stove. The most critical complaint, not as much for user satisfaction as for safety concerns, was the large number (9/24) (far more than any other stove) saying the stove was not stable when stirring pots, requiring pots to be held when stirring to avoid the pot falling from the burner. Some (3/24) complained that wood or embers fall off the tray, and 6/24 users found it difficult to chop the wood into small pieces and complained that they could not use large pieces of wood. A small group of users (2/24) said that pots become black.

SUGGESTED IMPROVEMENTS: More than any other stove, the vast majority (21/24) said the stove should be larger to accommodate bigger pots and bigger families. They suggested addressing the problem of wood pieces falling out of the chamber by slanting the place for introducing wood into the stove (13/24). As with the other stoves, many (16/24) wanted the chamber to be bigger/wider to allow for larger pieces of wood (this suggestion falls into the category of suggestions that will be taken into account and addressed through sales and/or education efforts, but not implemented because it would diminish the efficiency of the stove). A few (4/24) suggested adding an ash tray to make it easier to remove the ash, and a few also said the flame should reach the vessel bottom and spread (5/24). A few strongly suggested dealing with the stability issue by making the plate with "stands" on top thicker to prevent vessels from sliding and tipping over (4/24).

ATTRIBUTES NAMED BY ECO-CHULA USERS WHO PREFERRED ICS OVER TRADITIONAL STOVE: The popular Eco-Chula was preferred over the traditional stove because it uses less wood, emits less smoke, and looks nice. Over half also mentioned the house was cleaner than when using the traditional stove, and that it cooks food quickly.

PREFERENCE RATES: Many (16/20) preferred the Eco-Chula to their traditional stove after three days, and although it was the most popular of all the stoves, it fell dramatically in preference after three weeks, to 10/20.

PROBLEMS: Whether they preferred the Eco-Chula to their traditional stove or not, many experienced some problems with the stove. Many Eco-Chula users (16/24) found chopping the wood into small pieces very difficult, and 3/24 users found it difficult to ignite the stove, even after using it for 21 days. Still an issue but less so than with other stoves, users were bothered by the difficulties in cooking large quantities of food in bigger pots. Specifically, 11/24 said it takes longer to cook (on ICS than traditional stoves) with large vessels and large amounts of food, and some said that big pots cannot be used as the flame does not spread (8/24), but again less than with other ICS. Unlike other ICS, few other problems were mentioned.

SUGGESTED IMPROVEMENTS: As with other stoves, the vast majority (20/24) said the stove should be larger to accommodate bigger pots and bigger families. Related to the cooking capacity, many (15/24) wanted the fuel chamber to be bigger/wider to accommodate more and bigger wood, something that needs to be addressed but not by making the chamber bigger (which would negatively affect the stove's efficiency).

Less than other stove users, only a few suggested the opening for entering the wood in the stove be changed (slanted) to prevent the wood pieces from falling out of the chamber (4/24), and ash and flame size were not particularly problematic with the Eco-Chula.

ATTRIBUTES NAMED BY ENVIROFIT USERS WHO PREFERRED ICS OVER TRADITIONAL STOVE: More than half of users said the Envirofit stove uses less fuel, looks nice and keeps the house cleaner. Some, but not a majority, mentioned that it emits less smoke and is well manufactured.

PREFERENCE RATES: More than half (11/20) preferred the Envirofit to their traditional stove after three days, but this dropped to less than half after three weeks, to 6/20.

PROBLEMS: Whether they preferred the Envirofit to their traditional stove or not, many experienced some problems with the stove. Users were most bothered by the difficulties in cooking large quantities on the stove. Specifically, 16/24 said it takes longer to cook (on ICS than traditional stoves) with large vessels and large amounts of food, and that big pots cannot be used as the flame does not spread (12/24). Related to this same issue, a few (4/24) specifically addressed problems cooking rice in large quantities. Some (9/24) mentioned chopping wood as a problem. Lastly, some (6/24) mentioned problems of ash buildup and wood pieces slipping out (4/24) due to the slant of the opening. Just 2/24 mentioned problems with stability of the stove when stirring pots.

SUGGESTED IMPROVEMENTS: As with the other stoves, the majority (15/24) said the stove should be larger to accommodate bigger pots and bigger families. Related to the cooking capacity, many (17/24) wanted the fuel chamber to be bigger/wider to accommodate more and bigger wood, something that needs to be addressed but not by making the chamber bigger (which would negatively affect the stove's efficiency).

Some suggested the place for entering the wood in the stove should be modified (specifically, slanting inwards) to prevent the wood pieces from falling out of the chamber (9/24), but fewer than most other stove users. Ash and tipping were not of particular concern to Envirofit users due to the stove design, but flame size was perceived to be too small and users suggested the flame should reach the vessel bottom and spread (7/24).