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Factors affecting household experience with the fuel-efficient Top-Lit Up Draft (TLUD) cookstove in Kinshasa, DRC

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B.A., The College of William & Mary, 2012
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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of Master of Public Health
in The Hubert Department of Global Public Health
2014

Abstract

Factors affecting household experience with the fuel-efficient Top-Lit Up Draft (TLUD) cookstove in Kinshasa, DRC

By Lisa Sthreshley

Background: Indoor air pollution, primarily emitted by burning solid fuels indoors in poorly ventilated conditions, is one of the greatest agitators of respiratory infection worldwide. In the Democratic Republic of Congo (DRC) indoor air pollution, linked to respiratory infection, is responsible for 19% of child deaths under five, outranking malaria and diarrhea as the top contributor to child mortality. One proposed solution to reducing the ill health effects of indoor air pollution is to promote improved clean cookstoves.

Objective: The primary objective of this study was to understand household experience with the Top-Lit Up Draft (TLUD) clean cookstove. Secondary objectives were to determine possible barriers and incentives to households' using and liking the stove, and finally to investigate households' willingness to pay for the stove.

Methods: A mixed methods sequential design study was used to examine household experience with the stove. Forty households in Mokali, Kinshasa, were randomly selected to receive the TLUD stove. One month after receiving the stove, five focus group discussions were conducted with household members that had used the stove. A month later, a survey was administered to the 40 households that received the TLUD stove. Survey questions were informed by data from the focus group discussions.

Results: Results of the study show that household experience with the TLUD stove was dependent upon the fuel market environment, the cost of fueling the TLUD stove, smoke, and design elements of the stove. The biggest barrier to having a positive experience with the stove centered around the kind of wood households used to fuel the stove. Willingness to pay for the stove, regardless of experience, was low**.**

Conclusion: The complex relationships of factors affecting stove experience and likelihood of adoption point to the necessity of understanding the context of household energy and fuel environments as well as household preferences. Household willingness to adopt clean cookstove technology extends far beyond the economics of fueling and purchasing, but also involves greater social, economic, and technological factors.

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Acknowledgments

There are many wonderful people who supported me on this undertaking. First, I'd like to thank Stan Foster and the Hubert Department GFE fund for giving me the support and means to travel to the DRC to do this research. Also, thank you to my supervisor, Mano Ntayingi, for helping me in the field and taking time out of his busy schedule to ensure this research took place.

J'aimerais aussi remercier Joseph Mbuyi, Esperent Cabalosh, Sandrine Makambo, et Koko Mbombo pour leurs travailles et soutien avec cette recherche.

Thank you to my amazing parents, Inge and Larry Sthreshley, who encouraged and supported me both in the field and during the writing process. Also thank you to friends, Hugh Green, Michael Connolly, Carissa Ruff, Claire Boyer, Drew Rizzo, and Jonathan Niles for words of encouragement when I needed them most.

Finally I'd like to thank my advisors, Deb McFarland and Monique Hennink, for their support, feedback, and guidance. This truly has been an educational experience and I'm grateful for all the mentorship I have received along the way.

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Chapter 1: Introduction

Exposure to indoor air pollution (IAP) is estimated to be responsible for 1.6 million deaths globally per year (Haines et al., 2009). Indoor air pollution, primarily emitted by burning solid fuels indoors in poorly ventilated conditions, is one of the greatest agitators of respiratory infection and is clearly linked with acute lower respiratory tract infection and chronic obstructive lung disease (Kadir et al., 2010). The effects of indoor air pollution is especially detrimental in Sub-Saharan Africa as approximately 700 million people in Sub-Saharan Africa rely on traditional use of biomass for fuel, which, when used for cooking on inefficient stoves, is a major contributor to rates of respiratory mortality and morbidity. Without intervention, the detrimental effect of IAP is only expected to increase in Sub-Saharan Africa as it is estimated that 900 million people will rely on biomass for fuel by the year 2030 (International Energy Agency, 2010).

In Kinshasa, the Democratic Republic of Congo (DRC), indoor air pollution is generally caused by excess smoke from inefficient cook stoves. Among this city of more than 8 million people, 87% of the population cooks on inefficient stoves with solid fuels like charcoal and wood (CIFOR, 2011). These cookstoves not only have detrimental effects on individuals' health, but are also costly to use and negatively impact the environment as they contribute to deforestation and greenhouse gas emissions, specifically carbon dioxide (Lambe & Atteridge, 2012). In terms of environmental impact, according to the Center for International Forestry Research, the volume of the wood fuel market in the cities of Kinshasa and Kisangani alone "exceeds the volume of the official national timber production by more than 12 times." Only 1% of trees cut down are being replanted (CIFOR,

2011). Additionally, in terms of health consequences, in the DRC respiratory infection is one of the leading causes of death, particularly among children under five. Pneumonia is responsible for 19% of child deaths under five, outranking malaria and diarrhea as the top contributor to child mortality (World Health Organization, 2012). Respiratory infection is also cited as the third largest cause of mortality for the entire country (CDC, 2012).

Figure 1.1 Indoor air pollution from cooking, DRC
Photo Credit: Jennifer Scott

Since the 1970's, fuel-efficient stoves have been lauded as a solution to address these many health, economic, and environmental misfortunes. One randomized control trial in Guatemala found that improved cookstoves reduced the incidence of severe forms of respiratory infection by around 30% (Kirk R. Smith et al., 2011). Two fuel-efficient stove interventions in Mexico and Guatemala showed reductions up to 70% in indoor pollution, 56% in household fuel consumption, and 74% in greenhouse gas emissions. (Perez-Padilla, Schilmann, & Riojas-Rodriguez, 2010). Unfortunately, despite the clear benefits of fuel-efficient stoves, programs have had mixed

success in encouraging fuel-efficient stove use. Several systematic reviews of the literature regarding studies on the acceptance and adoption of clean fuel and cooking technology find that though clean cookstove programs have been promoted regularly for several decades, there is little evidence of clean cookstoves programs managing to successfully convince households to adopt clean cookstove technology for permanent use, undermining the intended positive impact of these programs (Lewis & Pattanayak, 2012; Ruiz-Mercado, Masera, Zamora, & Smith, 2011). In these articles, the reviewers mainly attribute clean cookstove program failure to inadequate consideration of economic, social/cultural, and practical factors that contribute to households' reasons for adopting or rejecting these new kinds of stoves (Lambe & Atteridge, 2012).

Despite the vagaries of accumulated evidence, NGOs, the UN, and many developing country governments have shown renewed interest in committing to clean cookstoves production and dissemination. This perhaps is most notably demonstrated by the emergence of the Global Alliance for Clean Cookstoves (GACC), which has pledged to "foster the adoption of clean cookstoves and fuels in 100 million households by 2020" via support from a range of public, private, and non profit stakeholders (Global Alliance for Clean Cookstoves, 2014). Other countries have pledged their support to this cause including the Indian government which has re-launched a national clean cookstove program entitled the National Biomass Cookstoves Initiative (NBCI) following up on their previous, somewhat unsuccessful stove campaign, the National Improved Stoves Program (NISP), (Sesan, 2014). The Ugandan government has made a commitment to distribute improved cookstoves (ICS) to 2 million households (Global Alliance for Clean Cookstoves, 2012) showing that even on a national level, governments as well as NGO's, want and expect to see ICS programs

succeed. Additionally, many for profit clean cookstove organizations have emerged recently such as Enviofit®, Stovtec®, Burn, and many more, indicating even businesses see this as a viable market opportunity.

This renewed optimism in clean cookstove technology stems from several factors. One, with growing concerns regarding climate change and the direct contribution of inefficient biomass stoves to poor environmental degradation, there is pressing interest in investing and promoting clean stove technology that works. Two, there have been some historical successes in clean cookstove interventions, the most notable being China's National Improved Stove Program (NISP) that distributed stoves in the 1980's and maintained use of 100 million ICS to this day (K. R. Smith, Shuhua, Kun, & Daxiong, 1993). Three, recent developments in stove technology causing stoves to be even more efficient and durable than they were in the 80's and 90's has led many NGOs and governments to believe that this "new generation" of cookstoves will be more readily adopted (Global Alliance for Clean Cookstoves, 2011).

Considering the major impact that clean cookstove technology could have on population health, household savings in both money and time, and reduction in environmental degradation, the benefits of implementing a successful clean cookstove program are too promising to ignore. It was for all these reasons IMA World Health solicited the following research to investigate introducing the Top-Lit Up Draft (TLUD) stove to households in the Democratic Republic of Congo. Mindful of the fact that improved stoves programs have historically had such sporadic success, IMA World Health desired an in-depth investigation on whether this technology was acceptable for adoption specifically in the context of the DRC.

The TLUD stove was chosen over other stoves because it is designed to emit little smoke, burn less fuel, and has the potential to sequester carbon (Carter & Shackley, 2011). The TLUD is a gasifier-stove that burns wood, is energy efficient, and emits less CO2 and particle matter than its well-known clean-cookstove counterpart, the rocket stove. While charcoal stoves do not emit as much particulate matter (PM) as the TLUD stove they are incredibly fuel inefficient since around 90 percent of the energy from wood is immediately lost to the atmosphere in the charcoal production process. The TLUD stove, on the other hand, takes that energy and through pyrolysis burns it into gas. An additional benefit of the TLUD stove that many other ICS don't have is that after it's fired the wood used to fuel the stove is turned into a type of charcoal called biochar. This charcoal is very carbon dense and can be used as a soil amendment to retain water and nutrients, as well as adjust the PH of the soil.

If households in Kinshasa were to adopt this stove technology, it is expected they would benefit both financially and in improved health. Starting in Spring 2013 IMA World Health implemented a pilot program introducing the TLUD stove to a small peri-urban neighborhood in Kinshasa DRC. IMA, currently managing a $280 million primary health care program, was interested in examining the acceptability of this stove technology to Congolese households in order to inform a scale up of a clean cookstove dissemination program within their larger health care program. Considering all of the context specific factors that play into new technology adoption, a mixed methods qualitative and quantitative study was developed to evaluate household experience of the TLUD stove and to understand the potential barriers and incentives that might affect household adoption of these stoves in Kinshasa D.R.C. This research had three major objectives: first, to

understand household experience with the TLUD stove, second, to understand factors that might facilitate or hinder the adoption of the TLUD stove technology and third, to evaluate household willingness to pay for the stove. Willingness to pay for the TLUD stove was investigated as IMA World Health was interested to see if a business model approach, selling the TLUD stoves to households, could be used as a feasible dissemination strategy.

Figure 1.2 The TLUD stove produced by IMA World Health, Kinshasa, DRC
Photo credit: Joseph Mbuyi

There are several reasons why this research contributes to the body of literature on clean cookstove adoption. First, this research examines the performance of a less known clean cookstove technology in a country that has not had any serious clean cookstove interventions to date. Very little research has been conducted on the performance of TLUD

stove in the field and it appears no research has looked at the adoption of improved stove technology in the DRC. Additionally, an inadequate number of mixed method studies have been conducted regarding clean-cookstove adoption. This is unfortunate considering the complexity of household cooking needs and motivation for stove adoption. As many other researchers have noted multidimensional analysis is imperative to understanding both contextual and practical factors of stove use and adoption (Adkins, Tyler, Wang, Siriri, & Modi, 2010; Risseeuw, 2012). This research is significant, in a practical sense, as it will inform IMA's future clean cookstove program intervention. Since respiratory illness is one of the leading causes of death in the Democratic Republic of Congo and prevalence could be significantly reduced with the use of efficient stoves like the biomass TLUD, this research could contribute to efforts aimed at reducing indoor air pollution and improving the health of Congolese households.

In closing, this study aims to contribute to the field of knowledge on contextual social, cultural, economic, and technological factors that impact clean cookstove adoption, especially regarding Congolese households' experience with the TLUD stove, their likelihood to adopt this technology, and their willingness to pay for it. Many of the challenges which emerged in relationship to the TLUD clean-cook stove technology adoption will surely have similar parallels to clean cook-stove initiatives in other countries and it is expected that the study findings will help inform not only IMA World Health's future programs but other NGO, government, and business programs interested in facilitating the feasibility, effectiveness, and sustainability of clean cookstove adoption.

Chapter 2: Literature Review

This literature review will cover a number of subjects including the historical progression of clean cookstove initiatives, some of the current debates in the research regarding theoretical frameworks for clean cookstove adoption and interventions, what to date have been identified as important factors for ensuring sustained clean cookstove adoption, and finally some background on the Top-Lit Up Draft stove (TLUD). Much of the literature on this topic analyzes past stove programs, as well as household reasons for adopting or not adopting stoves. The literature tends to be found in sustainable energy, development, and global environmental health journals. Additionally, several non-governmental, bilateral donor, and multi-stakeholder organizations have published their own analyses of the evidence of success, best practices, and recommendations for future action in the field of clean cookstove programing. These types of analyses generally come from organizations such as the Global Alliance for Clean Cookstove (GACC), the World Health Organization (WHO), and the Department for International Development (DFID).

Historical background of clean cookstove initiatives

The literature summarizing the history of clean cookstove programs speaks of clean cookstove programs progressing in several distinct historical stages. The motivations behind the push for clean cookstove dissemination have varied over time depending on evolving issues of western political consciousness and the current development concerns of the decade. It can be somewhat discouraging to note that “improved stoves” have been promoted since the 1970’s and yet only modest successes accomplished in terms of

adoption and sustained use. There are several reasons, however, that clean cookstoves are now once again popular in the aid and development world.

According to several reviewers, over the past few decades stove program interventions have gone through three main philosophical shifts. First, in the 1970's clean cookstoves were distributed as a part of an "expert led" intervention. In this stage, the case for clean cookstoves was mainly focused on fuel efficiency. Implementers were interested in the fuel-efficient aspect of clean cookstoves as way to decrease deforestation. Most assumed that beneficiaries would immediately see the advantage of such a technology (Sesan, 2014). Furthermore, during the 70s' political concern regarding the looming "energy crisis" and projected population explosion also contributed to international aid and national government interest in promoting clean cookstove technologies (Kshirsagar & Kalamkar, 2014).

A decade later in the 1980's, interest in promoting clean cookstoves expanded even more as laboratory testing built the case for clean cookstove efficiency. International aid and national governments became interested in the ways clean cookstove technology could contribute to natural resources conservation, women's empowerment, and enhancement of livelihoods. Disappointingly to many, however, towards the early 1990's, most of these clean cookstove programs were found to be ineffective. (Kshirsagar & Kalamkar, 2014).

Two noteworthy clean cookstove programs of the 1980's were the Indian National Programme on Improved Chulhas (NPIC) and the Chinese National Improved Stoves Programme (NISP). The Indian program, while large, is widely considered to have failed as more than 60 different types of stoves were developed and over 35 million disseminated yet sustained adoption and use were not maintained over time. Many attribute the failure

of the program to a lack of oversight of the quality of the production of the stoves, meaning that many stoves broke down and became useless. Additionally, due to the lack of central oversight of the program, some "improved stoves" were actually worse in terms of emissions and fuel savings than traditional cooking technologies. The China program on the other had was recognized as one of the only successful programs of the time. Over 100 million biomass and coal clean cookstoves were distributed in this program and are still used today. The success of this program is attributed mainly to high levels of organization and quality control (K. R. Smith et al., 1993).

The second recognized shift in clean cookstoves program interventions began in the late 1980's and throughout the 1990's as focus turned towards the necessity of understanding context drivers that affected beneficiaries' reactions to clean cookstove programs. However, perhaps more lip service was given to this concept than action as one reviewer found that between 1983-1994, only "26% of programs reported that they used design input from potential end-users, while 18% did not and 61% had no data" (Gifford, 2010). At the time there was a growing interest in links between respiratory illness and smoke reduction. In general, however, clean cookstoves were losing their novelty as interesting or effective aid interventions and interest began turning to the possibility of rural electrification (The World Bank, 2011).

The 2000's to the present day can now be identified as the third phase in clean cookstove program interventions. During this time period evidence emerged that exposure to indoor air pollution, caused by smoke and small particle emission of fuel inefficient stoves in poorly ventilated housing, is responsible for 1.6–2 million deaths each year, mainly of women and children (The World Bank, 2011). In Uganda, a recent study using

national survey data found that burning biomass for cooking was more highly associated with morbidity than any other physical housing attribute measured (Herrin, Amaral, & Balihuta, 2013). Inefficient fuel emission has also been solidly linked with climate change as evidence suggests that soot, also know as black carbon, is a significant contributor to climate change with 18 percent of the earth's warming due to black carbon, making it the second largest contributor after carbon dioxide (Sesan, 2014). In light of this new information as well as a general shift away from electrification projects and a new more efficient "generation" of clean cookstoves emerging on the scene, many NGO, government, and bilateral donors have renewed interest in investing in clean cookstove program interventions.

Two big initiatives mark this renewed interest in clean cookstove technology. First, the formation of the Global Alliance for Clean Cookstoves (GACC), organized by the UN consisting of a consortium of national, nongovernmental, and for profit stakeholders. The GACC pledged in 2012 to distribute and facilitate the adoption of 10 million cookstoves by 2020. The GACC is also working hard to connect with all partners in the field doing work with clean cookstoves, and they are in the process of creating a standardized global monitoring and evaluation system to measure if they reach their goal (GACC). Second, the government of India recently launched in 2009 the National Biomass Cookstoves Initiative (NBCI). Unlike the failed program (the NPIC), the NBCI is calling upon a competition of technical experts to submit proven improved biomass stoves which will then be distributed via market channels (Ruiz-Mercado et al., 2011).

The third wave of cookstove interventions has centered on market-based interventions as the main mechanism for stove promotion (Bailis, Cowan, Berrueta, &

Masera, 2009; Sesan, 2014). While subsidies are still included in clean cookstove programs, it is argued that market based interventions are most sustainable. As one reviewer states "renewed attention in (improved cookstove) programs has occurred in tandem with an increasing emphasis from the donor community for stove developers to adopt business-like approaches to stove dissemination. Stove developers are expected to shed donor-dependency and become more innovative, efficient and profitable at what they do as a business" (Bailis et al., 2009). The GACC, now the umbrella organization for all clean cookstove interventions, has adopted this approach. Its widely disseminated report, *Igniting Change: A strategy for Universal Adoption of Clean Cookstoves and Fuels* has three main recommendations for "strengthening the sector": enhance demand, strengthen supply, and foster an enabling environment for stove use, dissemination, and production (Global Alliance for Clean Cookstoves, 2011).

So what accounts for clean cookstoves' new popularity and the recent surge of interest and funding? First, it is believed that past programs failed because stoves performed well in the laboratory or when first installed, but then quickly deteriorated due to lack of testing in the field and lack of quality-control in production. Furthermore, little attention was paid to the kind of design features "consumers" were looking for in a stove. Finally, there was no attention paid to the supply mechanisms needed to replace and maintain stoves. Now, with a new generation of stoves that are more efficient which reportedly can continue to be energy efficient in the field, as well as the lessons learned in production, sale, and upkeep of stove adoption, many organizations believe they can make these stove programs work (The World Bank, 2011).

Proposed theories explaining clean cookstove and fuel adoption

There are several proposed theories that delineate factors that affect clean cookstove adoption and clean cookstove program success. One early model proposed that households choose to switch to cleaner energy and technology as their available income increases. This model was referred to as the energy ladder and pictured households evolving from primitive, to transitional, to advanced fuels. This model has since been contested and research has show that in fact instead of "energy switching" households tend to "energy stack", meaning that they often use several types of fuels at once even as income increases (see Figure 1.1). Research also indicates that fuel switching is not even unidirectional and households can switch back to traditional fuels after adopting more

Figure 2.1 The Energy Transition Process

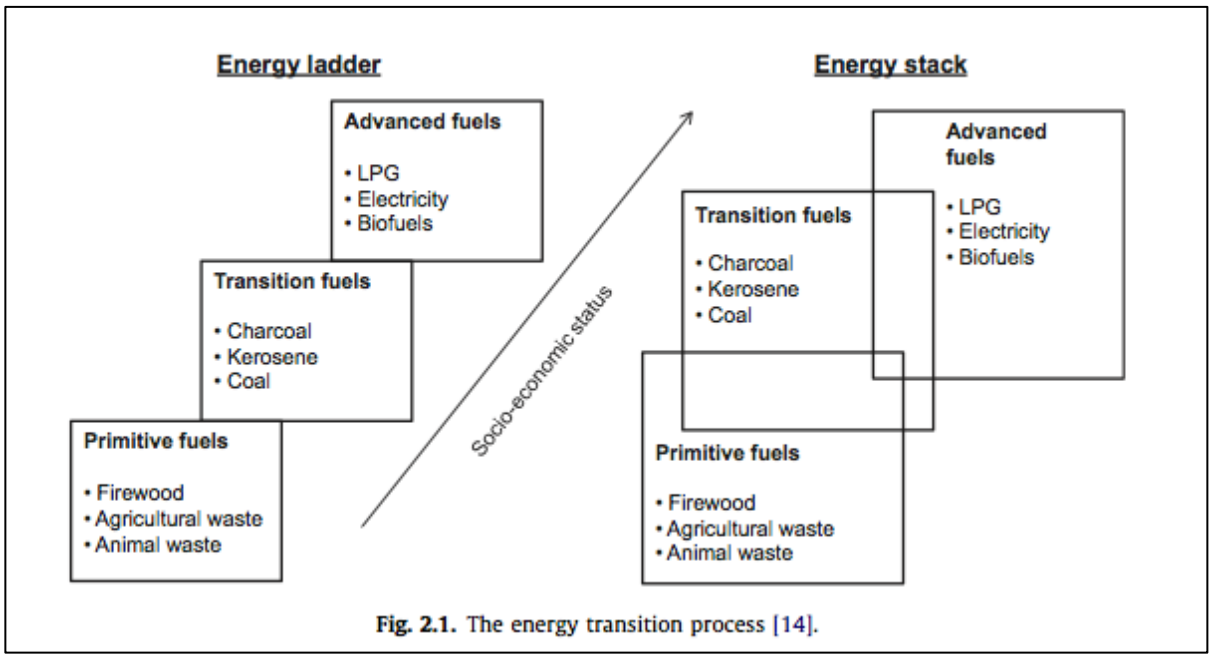


Fig. 2.1. The energy transition process [14].

(van der Kroon, Brouwer, & van Beukering, 2013)

"modern" fuels (van der Kroon et al., 2013). Proposed reasons for fuel stacking include the need for flexible household budgets as advanced fuels in developing countries are often erratic and supply can be unreliable. Additionally, culture and social preferences can result

in some households using more traditional fuels. This finding has several implications for the success of clean cookstove adoption. One, it suggests that even if households are using more advanced/transitional fuels, they might be willing to switch to a clean cookstove technology that uses biomass, like the TLUD stove. Two, this finding suggests that programs introducing clean-cookstoves will likely face obstacles in maintaining exclusive use of clean cookstove technology, which is a major challenge to ensuring programs achieve their health goal of reducing indoor air pollution. Finally, this finding challenges the idea that households will naturally improve their energy choices with rising income or that money and fuel savings are the only factors that affect household energy and technology decisions.

Several research studies have examined reasons that households may or may not be interested in adopting improved stove technology and fuels. Natasha Risseuw conducted thesis research in Mozambique examining "household factors that play a role in determining clean cookstove adoption, and the switch from firewood and charcoal to other fuels." After conducting both survey and qualitative research her research found that technology adoption is hampered by affordability, availability, and accessibility (Risseeuw, 2012). Based on her findings she theorized that household likeliness to adopt new fuels is determined by both endogenous factors, which include household economics, stove preference, and behavioral and cultural preferences, as well as exogenous factors, which include physical environment, policies, energy supply factors and energy device characteristics. This tentative framework for what affects household energy technology adoption speaks to how adoption is not only affected by factors within households, but from the outside as well.

Several other studies, which examined characteristics that affect household adoption tended to focus on testing the influence of two to three factors on adoption, using survey or quantitative data. Others focused on recurring themes from qualitative research. The following is a quick sample of some of the general findings from these different studies.

In an article entitled *Field testing and survey evaluation of household biomass cookstoves in rural sub-Saharan Africa*, Adkins et al. found that while cooks saw fuel wood savings as an important benefit, household users were also interested in factors such as cooking time, stove size, and ease of use (Adkins et al., 2010). Another study conducted by the Stockholm Environmental institute in India found that regulating heat and willingness to pay were the most important factors for clean cookstove adoption. (Lambe & Atteridge, 2012; Thurber et al., 2013). A study conducted in Uganda tested a market based sales model in both Kampala and in rural Uganda, selling a charcoal efficient stove in Kampala and a rocket stove in the rural area. In Kampala and the rural area two randomized control studies were conducted with one group of households presented either with traditional payment options (paying up front or on credit over 4 years), while the other group of households received a novel offer, being encouraged to use the stove for a free week trial and then paying for the stove on their own determined credit schedule. The results found stove uptake increased dramatically. In Kampala, households took up the stove at 4% with the traditional offer and 45% with the non-traditional offer, and households in the rural area took up the stove at 5 % with the traditional offer and 45% with the novel offer. This study suggested that liquidity constraints and imperfect information were barriers to adoption. (Levine, Beltramo, Blalock, & Cotterman, 2013). One literature review, *Who adopts improved fuels and cookstoves? A systematic review*, cited income, education, and

urban location as characteristics positively associated with adoption and influence of fuel availability/price, households' size, and sex as unclear. This review is interesting as it concludes the literature on adoption of clean energy to be "scattered" and perhaps largely qualitative (Lewis & Pattanayak, 2012).

The above articles paint a picture as to what leads to adoption of clean cookstove technologies; however these studies tend to focus just on one or two factors that can be tested or examined as having a relationship with increasing clean cookstove adoption. These series of studies in and of themselves do not provide a holistic picture of what exactly leads to clean cookstove adoption. Perhaps one of the most helpful theoretical frameworks developed to understand clean cookstove adoption and program success, is the framework developed by the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) at the University of London. In this framework the EPPI-Centre proposes that there are 7 domains relevant to energy uptake: 1) Fuel and technology characteristics; 2) Household and setting characteristics; 3) Knowledge and perceptions; 4) Financial, tax and subsidy; 5) Market development; 6) Regulation; legislation standards; and 7) Programmatic and policy mechanisms (Puzzolo, Stanistreet, Pope, Bruce, & Rehfuess, 2013). These domains may seem straight forward, but they actually cover the complex range of factors that impact household energy decisions quite well. The EPPI-Centre took this domain framework and conducted a systematic review of 101 eligible studies from around the world. Fifty-one of the studies focused on clean cookstoves.

EPPI-Centre developed some helpful sub-categories. For example, "Fuel and technology characteristics" included the subcategories fuel savings, impact on time, general

design requirements, durability/specific design requirements, and fuel requirements. Each of these categories lists a series of enabling or obstructing factors that can affect household adoption and continued use of the clean cookstoves. The first domain has more to do with characteristics of clean cookstove technology and its mechanics, domains 2-3 have to do with household characteristics, while domains 4-7 have to do with external factors incorporating economics, environment, and program characteristics. This framework demonstrates the complexity of clean-cookstove adoption and the multiplicity of factors that must work simultaneously in order for clean-cookstove programs to be successful. In this framework no one category is more important than another and they must all work synergistically.

Figure 2.2 Example of Domain Characteristics of EPPI-Center framework: Knowledge and perceptions

Table 4.3: Domain 3. Knowledge and perceptions: ICS

Factor	Examples	Country and setting*	Type and quality of evidence**
Smoke, health and safety	• Smoke exposure • Health effects • Burn injuries	Bangladesh (65, 77), Cambodia (59), Guatemala (86), India (53-58, 64, 68, 79), Indonesia (82), Kenya (62, 98), Mexico (48, 78, 80, 89), Mongolia (73), Nepal (66), Niger (61), Uganda (67)	QL=6 (3=S; 3=M) QN=5 (1=S; 2=M; 2=W) CS=13 (8=S; 4=M; 1=W)
Cleanliness and home improvement	• Cleaner home • Family benefits	Guatemala (83, 86), India (53-58, 69, 79), Kenya (62, 71, 98), Mexico (76, 78, 80, 89), Mongolia (73), Nepal (84), Niger (61), Uganda (67)	QL=8 (2=S; 6=M) QN=2 (1=M; 1=W) CS=11 (6=S; 4=M; 1=W)
Total perceived benefit	• Willingness to pay • Overall perceived advantages	Bangladesh (85), India (55, 57, 68, 79, 81, 102), Kenya (71, 98), Mexico (76), Nepal (66, 84), Niger (61), Sudan (101)	QL=6 (2=S; 4=M) QN=5 (1=S; 1=M; 3=W) CS=4 (2=S; 2=M)
Social influence	• Influence of social networks and opinion leaders	Bangladesh (65), India (53-55), Indonesia (82), Kenya (62, 71), Mexico (48, 76, 78, 80, 89), Nepal (66, 84), Niger (61), Peru (104); Uganda (67)	QL=5 (2=S; 3=M) QN=5 (2=S; 1=M; 2=W) CS=8 (2=S; 5=M; 1=W)
Tradition and culture	• Suitability for preparing local dishes • Food taste	Bangladesh (77), India (56, 68, 69, 81), Kenya (71), Mexico (76, 78, 88), Nepal (66, 84), Uganda (67)	QL=9 (3=S; 6=M) QN=2 (2=W) CS=1 (1=S)

QL=qualitative studies; QN=quantitative studies; CS=case studies; *S*=strong; *M*=moderate; *W*=weak. *All factors are supported by findings in rural as well as urban settings. **Quality of evidence not comparable across different study designs.

(Puzzolo et al., 2013)

Determination of successful clean cookstove adoption is complex and multifaceted. As Ruiz et al. said in their article *Adoption and sustained use of improved cookstove,* "the introduction of new fuels/ devices takes place in a dynamic system with strong interactions between the user, the technology, the fuels and the larger socio-economic and ecological contexts" (Ruiz-Mercado et al., 2011). This ultimately explains why clean cookstove adoption has been so difficult historically. Adoption is complex requiring favorable conditions among many stakeholders and factors including household preferences and need, stove producers, the local economy (especially regarding fuel availability and supply), the natural environment, infrastructure, governmental policies, and the capacity of the organization that is trying to introduce the stove whether that be an NGO, business, or government.

Trending topics in clean cookstove interventions

The following section will cover some of the trending topics in the literature regarding best practices and the importance of certain components of clean cookstove program objectives. Many of these topics revolve around issues of economics and the role of fuel savings, the feasibility of market based approaches, and increasing demand. Additionally, there is emerging dialogue regarding ways gender can best be incorporated into clean cookstove programs.

So how important are fuel savings to successful clean cookstove programs? This subject was touched upon in the section above, yet it is important enough, it should be revisited. Most studies cite fuel savings to the household as a key part of clean cookstoves success (Puzzolo et al., 2013) (Martin et al., 2013). However, most of these studies also

mention that economic savings on the part of the household are not enough to encourage adoption. One study found among a survey of clean cookstove adopters that only half cited fuel savings as an important factor in their decision to adopt the new stove. (Bailis et al., 2009). In a study conducted in Uganda, households, when presented with three different cookstove varieties, did not choose the stove with the best efficiency, but rather the one that was slightly more efficient but easier to use (Adkins et al., 2010). While economics play a large role in determining stove adoption and this is a finding many researchers like to comment on as the most limiting factor to successful adoption of clean cookstove technology, a further look at findings suggests that economics and savings are a *necessary* component of successful adoption, but not *sufficient* for success. Financial barriers and incentives aside, stoves have to meet household preferences, be easy to use, and other external factors relating to energy supply and stove maintenance must also be in place in order to really encourage stove adoption (Risseeuw, 2012; van der Kroon et al., 2013).

These financial considerations lead to another crucial debate in the literature. Should clean cookstove programs be market-based, include subsidies, or both? In the resurgence of clean cookstove programs, market based approaches have become increasingly the norm. The Global Alliance for Clean Cookstoves discusses stove interventions strictly in market-based terms. According to one analysis more than 50% of current clean cookstove programs are market based. This choice is interesting because apart from the Chinese or Indian national programs, neither of which were market based, no clean cookstove program has yet gone to scale beyond a few thousand stoves (Gifford, 2010).

This trend has become so prominent as to attract criticism. In an article by Ballis et al. entitled *Arresting the Killer in the Kitchen*, the argument is made that while market based interventions are promising in terms of innovation and increasing sustainability, setting up a small business in the developing world context can be difficult as many countries have bureaucratic and legal obstacles to starting a business, requiring heavy taxes and high start up costs. Additionally, in many developing economies, weak lending markets make it difficult to get a small business off the ground. Ballis et al. also point out that moving clean cookstoves to a solely market based approach often prevents the poorest households of society who need the technology the most from obtaining clean-cookstove technology (Bailis et al., 2009).

One well-documented barrier to buying clean cookstove technology is the initial stove cost, sometimes referred to as the 'stove barrier' (Martin et al., 2013; van der Kroon et al., 2013). Clean cookstove technologies can equal up to weeks or months of households' income. Though these stoves may ultimately save money in fuel savings, households cannot feasibly pay so much money up front especially since there is no guarantee it will meet their preferences or will really work to be more fuel-efficient. This is why stoves sold at a subsidized price, usually on credit, have routinely been more successful (Levine et al., 2013).

Ballis et al. make an interesting point that stoves have characteristics of both private and public goods.

> " *It is easy to argue that anti-malarial drugs and TB treatments should be subsidized, if not distributed freely to the world's poor. However, though the toll on global health resulting from exposure to wood smoke is similar in magnitude to malaria and TB, the dissemination of low-emission stoves is more challenging than disseminating medication or bednets. Improved stoves blur the line between health-improving*

> *technology and household consumer goods. They are distinct from other health interventions because of their fundamental link to consumption and food culture."*

The lack of demand for clean cookstoves is another challenge that complicates the sale of clean cookstove technology. Some studies show that even when clean cookstoves are provided for free, there is no guarantee households will use them (Bailis et al., 2009). So what accounts for this low demand? Some research suggests that indoor air pollution is not perceived as a great threat and households tend to prioritize other more obvious needs over clean cookstoves, meaning they will not invest in stove technology (A. M. Mobarak, Dwivedi, Bailis, Hildemann, & Miller, 2012; Thurber et al., 2013). No study has yet been done to determine if educating end-users of stove technology on their potential health and various positive impacts would increase demand. It is also unclear if increasing demand would have the desired effect of increasing willingness to pay. Currently, the literature shows that willingness to pay for clean cookstoves is rather low (Adkins et al., 2010). The challenges of choosing market based interventions vs. subsidies, knowing how much to subsidize clean cookstove technologies, how to increase demand, and willingness to pay are all major trends in the literature and require ongoing research. These questions in addition to how to improve the supply chain of both fuel and stoves are some of the biggest challenges faced by stove programs today.

Importance of incorporating women in stove programs

Another current topic in the clean cookstove literature regards the importance of incorporating women into clean cookstove programs. Several research studies find that targeting women in households, even in traditionally patriarchal societies, is the most effective way to increase adoption of stoves. In one study conducted in Sudan, regression

analysis was used to analyze data from 300 interviews finding that the "cookstoves relative advantage, housewife's' exposure to messages about improved cookstoves, educational level of the housewife and the average educational level of the female household's members had significant positive effect on the household's disposition to adopt improved cookstoves." (El Tayeb Muneer & Mukhtar Mohamed el, 2003). A similar result was found in a study from Uganda where women were also found to be the main decision makers regarding new cookstove purchases (Martin et al., 2013). This fact makes sense, as women in many of these communities are the primary stove users and cooking is seen as women's domain. That is not to say, however, that incorporating men in the decision-making processes is not important. Other studies find that the acceptance of clean cookstove technology by social networks and key opinion leaders at early stages of a clean cookstove technology's introduction can make a large difference in adoption of the technology (M. Mobarak & Miller, 2013).

Regarding the subject of women's involvement, The Global Alliance for Clean Cookstoves is highly engaged around the idea of incorporating women into clean cookstove programs. So much so, they recently published a report entitled *Scaling Adoption of Clean Cooking Solutions through Women's Empowerment: Global Alliance for Clean Cookstoves.* In this report GACC proposed that women can be incorporated into clean cookstove programs at several stages including the design phase as they are the primary users of the technology, the production phase, if they are trained to do so, and finance options for purchasing stoves. Women's microcredit programs may provide a vehicle for greater involvement of women. The report also proposes that women could be incorporated into clean-cookstove intatives as salespeople (Global Alliance for Clean Cookstoves, 2013).

The TLUD stove

The term “clean cookstove” is a catchall word that refers to many different kinds of stove technologies. Some of these stoves are objectively “cleaner’ than others and each stove model has its strengths and weaknesses. Clean-cookstoves generally are fuel-efficient and produce less smoke than traditional stoves, though not all stoves do both. Clean-cookstoves also can emit less particulate matter, carbon dioxide (CO_2), and carbon (CO) than traditional stoves or open fires, but again there are variations. For example, some clean cookstoves may dramatically reduce particulate matter emissions but still emit high levels of other detrimental air pollutants like carbon. There are several different genres of clean cookstoves. Biomass clean cookstoves burn wood, charcoal, dung or various bits of biomass matter. Most research conducted on adoption clean cookstove technology has examined receptivity to biomass stoves. Other varieties of stoves include those fueled by kerosene, liquefied petroleum gas (LPG), and solar energy/electricity. Currently in the field, programs are switching from promoting stoves that run on LPG and electricity, back to biomass stoves as it has become clear that biomass fuel is still widely used and is often the only type of fuel consistently available to households in developing economies (The World Bank, 2011). Additionally, a “new generation” of biomass clean cookstoves has emerged to reinvigorate donor and program interest. The Top Lit Up-Draft (TLUD) stove is one of the “new generation” stoves garnering interest. Due to its recent emergence, to date little research has been conducted on the reception of this stove technology in the field (Puzzolo et al., 2013).

The TLUD stove is a gasifier, meaning that it has a two-stage combustion process. In the first stage wood is burned which release gases, in the second stage gases are burned at

the top of the stove creating fire. In the process of combustion, the wood undergoes pyrolysis, turning into a dense, carbon rich charcoal also known as biochar. Biochar has many advantages and can either be reused for cooking or put in the soil to improve agricultural yields. Biochar has the capacity to reduce leaching of nutrients in the soil, reduce soil acidity by changing the PH of the soil, improve water retention, and stimulate nitrogen fixations in legumes (International Biochar Intiative, 2014). Technological reviewers find that compared to other stoves, gasifier stoves like the TLUD have the advantage of being quick to heat up, are energy and emissions efficient, lightweight, portable, and produce biochar.

Currently, the research is still unclear on how well gasifier stoves perform in the field; however there are several studies that point to the incredible efficiency and effectiveness of TLUD stoves compared to other clean cookstove varieties if the TLUD stove is used correctly. Figure 2.3 depicts the high performance thermal efficiency of well performing fan/gasifier stoves, which according to tests has greater thermal efficiency than all other stove varieties besides gas/liquid stoves. This figure came from a stove performance inventory report produced by the Berkeley Air Monitoring for the purpose of informing the GACC's development of international standards for monitoring and evaluation (Berkeley Air Monitoring Group, 2012). A second graph from the report (Figure 2.4) compares both clean cookstoves and traditional stoves according to how much carbon they emit per mega jewel of energy spent by how much particulate matter they expend by mega jewel of energy spent. Notably, according to this ranking, all well performing gasifier stoves out-compete most other stove technologies (including rocket stoves) in terms of low carbon and particle matter emissions.

<u>Figure 2.3</u> Thermal efficiency performance of key stove groups

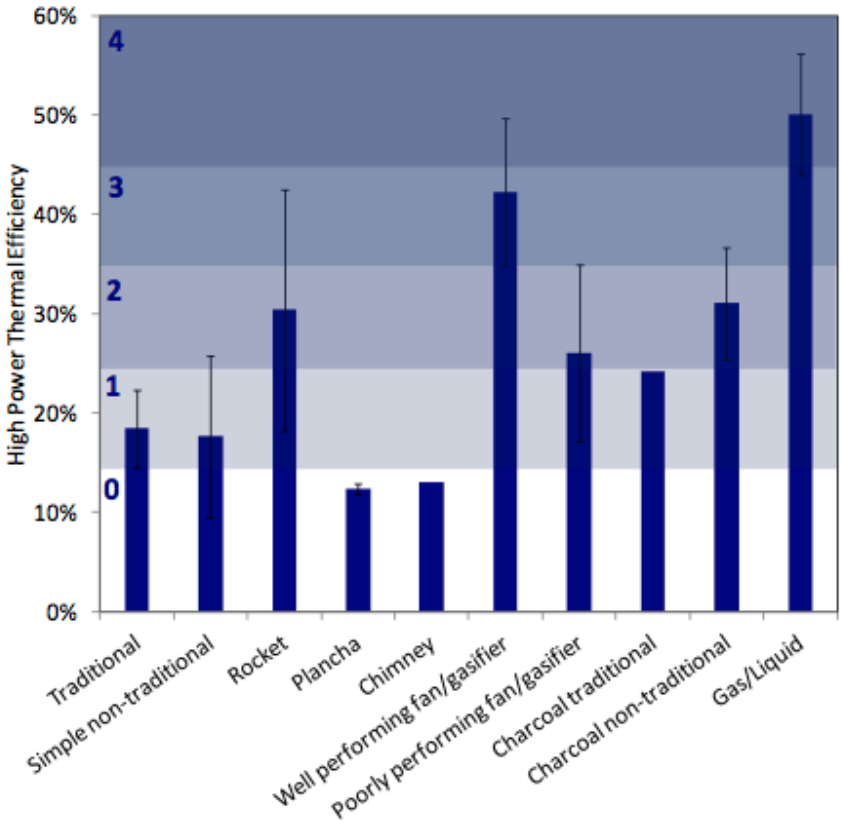


Figure 7. Thermal efficiency performance for key stove/fuel classes across the IWA Tiers for the VITA WBT. Error bars represent ± one standard deviation of the available tests sets. Tiers are indicated by blue numbers.

(Berkeley Air Monitoring Group, 2012)

<u>Figure 1.4</u> Comparing stove performance by Carbon and Particulate Matter emissions

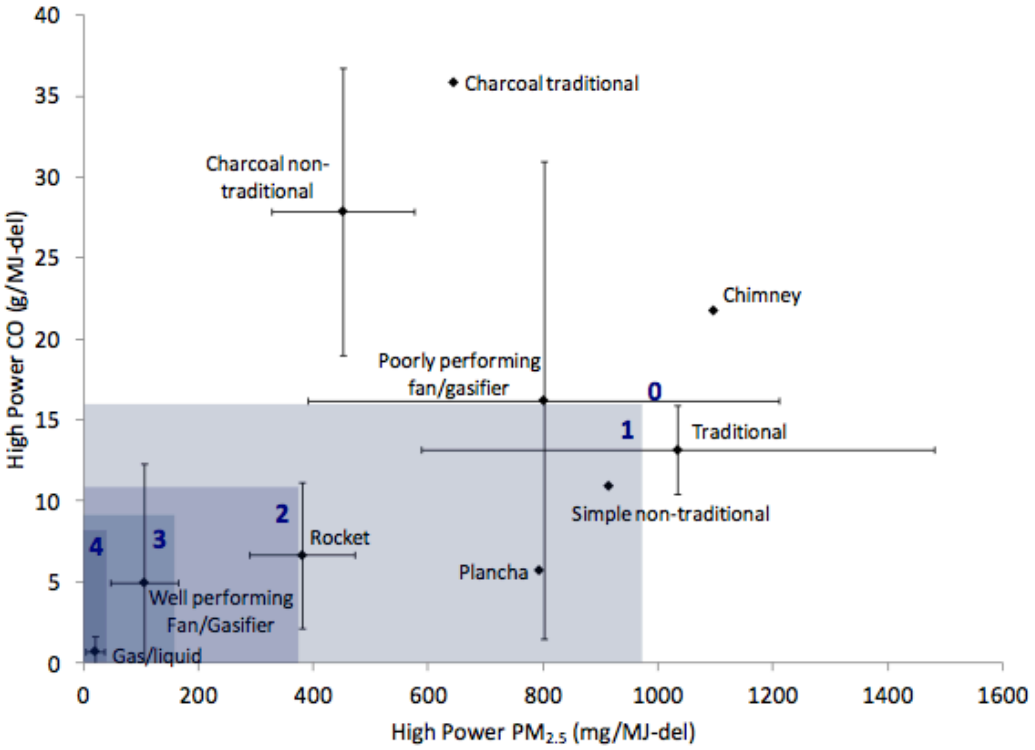


Figure 5. High power emissions performance for key stove/fuel classes across the IWA Tiers for the WBT. Error bars represent ± one standard deviation of the available tests sets. Stove/fuel classes with no error bars consist of two or less data points. Tiers are indicated by blue numbers.

(Berkeley Air Monitoring Group, 2012)

There are, however, some drawbacks to fan and gasifier stoves that need to be further researched. Some reviewers find that gasifies are usually expensive, and suggest they can only be fueled one firing at a time, are sometimes slow to ignite, and are fuel specific, only able to burn wood (Kshirsagar & Kalamkar, 2014). Forced air gasifier stoves which have fans at the base to quicken air movement are usually very efficient as the fans serve to introduce more oxygen and thus achieve greater combustion of the fuel. Having an extra component with fans, however, often weakens the stove model in the field, as they

must be run on batteries or solar power and can break easily. There also is a gap in the literature regarding exactly how commonly gasifier stoves like the TLUD are adopted among households. One study from Uganda that did examine household receptivity to the TLUD stove via a qualitative study found that many households needed to be informed of the benefits of the stove before they were interested in it and that financial considerations were cited as the most influential factor in adopting or not adopting the stove (Martin et al., 2013).

Conclusion: What the literature does and does not tell us

In summary, the history of clean cookstove interventions and its evolution speaks to the difficulty of successful promotion and adoption of clean cookstove technologies. Factors that contribute to household adoption of stoves are complex and multidimensional. It is hard for households to change energy technologies and even once they do, stove or energy stacking is common. Financial incentives play a major role in determining household's ability to buy clean cookstove technologies, but beyond that there are other stove characteristics that affect households' adoption of new stoves. Additionally, it is important to consider whether market based models or subsides are most appropriate for stove dissemination, as well as willingness to pay and demand for the stove itself. It is a given that a stove dissemination program will be more effective if it adopts a gendered lens integrating both men and women in an appropriate manner. In terms of the TLUD stove, little is known about receptivity to the TLUD stove in the field and more research regarding adoption of this technology in the DRC, a location where little research has been conducted on any stoves to date, is important to informing and shaping future biomass, gasifier stove programs.

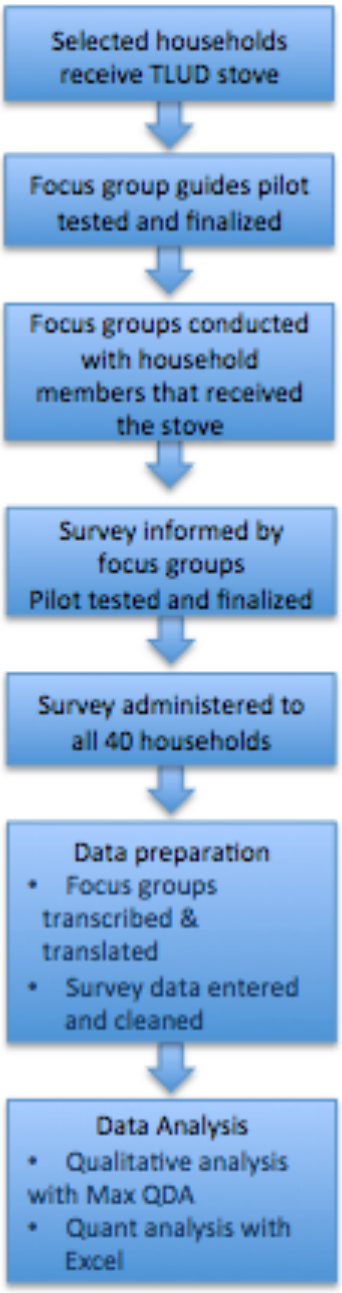
Chapter 3: Methods

Study design

Due to the complex nature of stove adoption, which is affected by practical and contextual factors, a mixed methods sequential design study was chosen to examine household experience with the TLUD stove. In May 2013, forty households in Mokali, a peri-urban neighborhood in Kinshasa, were selected and invited to receive a TLUD stove and attend a short training on how to use it. One month after receiving the stove, five focus group discussions were conducted, four with stove users from the households that had received the stove, and one with a group of community health promoters who also had received the stove, but were not a part of the initial sample. The group that was not a part of the initial sample was included due to the suggestion of IMA colleagues. The focus groups were conducted to explore users' perception and experience with the stove. A month later, a survey was administered to the 40 households that

Figure 3.1

Chronology of study implementation



received the TLUD stove. Survey questions were informed by data from the focus groups and measured household cooking practices, stove preferences, perception of the TLUD stove, and household finances for purchasing stoves and fuel.

Ethical Consideration: Emory University IRB deemed this study exempt since it did not involve human subjects research. The study did not require DRC IRB approval since it was considered a part of IMA World Health's regular program evaluation activities. Other ethical considerations taken into account in the research included maintaining confidentiality of participants and maintaining anonymity in the data through de-identification. Participants were formally informed at the point of data collection as to the reason behind the study as well as what would happen with the information they provided. The focus group moderators and the surveyors orally received consent from those participating in the study for both the focus groups and surveys.

Study site selection

Selecting the study site

This study was conducted in Mokali, a semi-rural neighborhood in Kinshasa, DRC. IMA World Health selected this neighborhood for this study for several reasons. First, because Mokali is a peri-urban area, IMA believed this neighborhood would be the closest representation of populations living in small cities and rural areas, the type of populations to whom IMA health services are most often targeted. It was IMA's hope that this study would provide insights regarding household reactions and experience with the stove in other rural and semi urban parts of Congo. Also, IMA's member agency, the Presbyterian Church USA (PCUSA), has worked in this area for many years and built relationships with the Mokali community and the local health clinic through various health interventions and

Figure 3.2 Map of Study Site

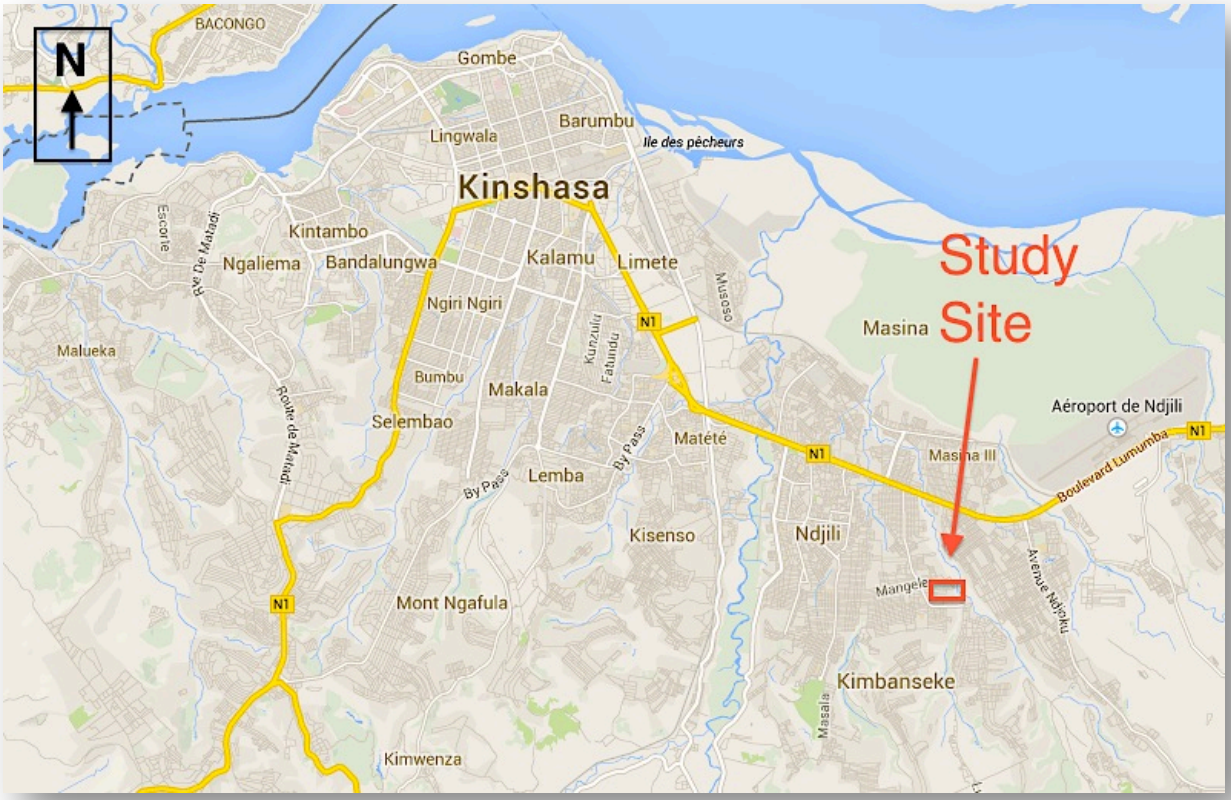


Image from: Google Maps

community outreach programs. It was believed that the neighborhood would be amenable to participating in the study because of the trust fostered between PCUSA and the local community. It also meant that the resources needed to do the study, including a familiarity with the location, were already available to help in the administration of the study. Crucial to the success of the study were a team of community health promoters, the Mama Bongisa, a group of women who regularly help with health and development projects in the area connected with the local health center. The Mama Bongisa's assistance, providing feedback on the stove and serving as enumerators for the survey, was a great asset to the study and another good reason for the selection of Mokali as a site for this study.

Selecting study households and distributing the stoves

Within Mokali, a cluster of households was randomly selected to receive a TLUD stove. To select the households, first, one street in the neighborhood was randomly chosen. Next one house was randomly selected on that street and given an invitation to receive a free TLUD stove and a short training on how to use it at the local health center. The first selected house was the starting point for the subsequent selection of households for the study as the study team traveled up the street from the first house and gave an invitation to every house along the street. When the study team reached the end of the street they would turn the corner onto the next street and give invitations to all the houses along that avenue. This continued until eventually 40 invitations were distributed. The cluster sampling method was used for this study because it was believed that concentrating the distribution of the stove in the neighborhood would later lead to a better understanding of neighbors' influence on use and perception of the stove. Additionally, some studies have found that not sampling every house can lead to biased results in selection when enumerators choose to skip over houses because they appear too small or difficult to reach. According to this logic, cluster sampling was deemed a better choice for capturing the full range of household users' perspective on the stove.

Unfortunately, the weekend of the training and distribution of the stove it rained and only members from 27 of the 40 households attended the training and received the stove. Rain can be a deterrent to venture outside neighborhoods like Mokali because none of the streets are paved and the roads can turn muddy. Mokali is also in a marsh area, making travel by foot particularly inconvenient. Another training was held on the following Monday where the majority of the missing households received the stove and training.

Around three households never showed up to receive the stove, so three more were invited to participate in the study using the same selection methodology. Four more houses were selected starting from the household to which the study team had last given an invitation. When household members attended the training and received the stove they were also notified of IMA's interest in researching their feelings about the stove so it could be improved. They were told they should expect to be contacted again to answer questions. Additionally, during the training, questions were asked regarding household members current stove and fuel use.

Data Collection: Focus group discussions

Selection criteria and recruitment for 5 focus group discussions

Due to limited time and resources, as well as the fact that focus group participants could only be recruited from 40 households, it was determined that five focus group discussions should be conducted to explore household experience and perception of the TLUD stove. In order to get diverse opinions regarding the stove, each focus group comprised of a different demographic characteristic. The first focus group discussion was conducted with a group of the Mama Bongisa, the community health promoters who had received the stove several months before the distribution of the stove to the 40 households in the neighborhood. The Mama Bongisa were added as a focus group discussion because they had used the stoves the longest and could therefore provide additional perspective compared with the household users. Additionally, even though they were likely to be the most positive about the stove since they worked to promote it, it was expected they would also be invested in seeing the stove improved. Next, two focus groups were conducted with

women from the households that had received the stoves. This demographic was chosen because in Congo women are the ones who cook and are therefore most likely to have daily use of the stove. Hearing about their experience with the TLUD stove was crucial to understanding if it was acceptable and desirable to the average user. The third focus group discussion was conducted with men, recruited from the 40 households that received the stove. Even though men do not typically cook or use the stove in Congolese households, it was important to know their perceptions of the technology and whether they found it desirable. We were interested in talking with men considering gender power dynamics and hoped to learn if men would prevent or encourage their wife from buying a stove and how they might influence that decision. The final focus group was conducted with individuals from households who had expressed a public dislike for the stove. We were interested in recruiting this category of participants since we estimated critical household members would have the most valuable information on what was wrong with the stove technology and what, if anything could be improved. Though we had expected that all the members interested in participating in this focus group would be women there was also a male household member interested in participating meaning the final focus group was mixed gender.

Two key community organizers managed the recruitment for all the focus groups. These community organizers worked for PCUSA and had experience working in the Mokali community for many years. For the focus groups they went door to door to households that had received the TLUD stove and invited them to the different focus group discussions. The strategy for recruitment was the same for men, women, and those that disliked the stove. The recruiters informed household members of the time, place, and location of the focus

groups and encouraged them to come. For the final focus group discussion with people who did not like the stove, households had used the stove for several months by that point, and for that particular discussion the recruiters knew who the individuals were who disliked the stove the most and recruited them. Small snacks and sodas were offered at the focus groups in compensation for participants' time. All of the focus groups were conducted at a small, open-air restaurant/bar located near the health center in the neighborhood very close to the study site and in easy walking distance for the participants.

Preparation for focus groups

The focus group discussion guides were first developed in English and then translated into French. Upon arriving in Kinshasa the discussion guides were reviewed by the IMA staff so they could judge the cultural appropriateness of the questions and their wording. The guide for the women from households that had received the stove and the Mama Bongisa were the same and they covered in general three main topics regarding experience and preference with the TLUD stove. The first set of questions asked women what they liked about the stove, what they didn't like, how it compared to other stove technologies they had used before, and their general experience using the TLUD stove. Another set of questions in the guide asked about the experience of gathering fuel for the stove, price of fuel, and the experience of financing the TLUD stove. The final set of questions asked women more about their social experience with the stove, how their family members and neighbors felt about it, and if they talked about the stove with their neighbors. The discussion guide concluded asking women what they'd most like to see improved about the TLUD stove. The men's discussion guide was shorter and modified to not ask any direct questions about cooking with the stove since it was expected that no

men actually used the stove. Their guide asked similar questions to the women's guide regarding what they liked and didn't like about the TLUD stove, what they thought of financing the use of the TLUD stove, and basically their experience with the new stove in the households. The last guide for household members who explicitly didn't like the stove was very different and was modified to explore more in depth other types of stoves these households preferred over the TLUD stove. This guide also asked very specifically what household members didn't like about the TLUD stove and what exactly they would have liked to improve it. Once these three discussion guides were approved they were translated into Lingala, the local language that residents of Kinshasa are usually most comfortable speaking, especially women who often have less opportunity to formally learn French in school.

The next step in preparing for the focus groups was training the research assistants. The first assistant was an intern at IMA World Health. She spoke fluent Lingala and did most of the translations and group facilitation. This assistant was from a relatively wealthy family in Kinshasa and not familiar with the Mokali community, so in the training it was stressed that she be sure to dress down for the focus group discussions and be aware of how she managed discussions. A community health worker from the Mokali neighborhood was also hired to help with translation and group facilitation. She was a great asset to the research because she was familiar with the project, the neighborhood and friends with most of the Mama Bongisa. Her familiarity with the community however, may have affected women's ability to open up or be critical and we asked her to be cognizant of that in the data collection processes. Neither woman had previous experience working with qualitative methods, so they were trained in qualitative methods and group moderation

skills. For both assistants it was stressed in their training that they should not influence focus group participants to be more positive about the stove than they really were and that in fact for this research it was good to hear criticism about the stove and whatever else participants wanted to say.

Once the focus group guides were ready and the two research assistants completed their training, the guides were pilot tested in Mokali with a volunteer group of Mama Bongisa. This exercise helped to discover a few awkwardly worded questions and made clear that a few new questions should be added to the guide. It also provided a chance for the research assistants to improve their discussion facilitation skills. After the pilot test the research assistants went into the field every weekend for three weeks to moderate the focus group discussions. It was decided they should conduct the focus groups over the weekend because that was when household members were most available to meet. As a non-local researcher, I did not participate in the focus groups discussions as I did not want to distract or bias the responses by influencing participants to either speak too positively about the stove and not open up, or to center their discussion on the stoves problems and requests for more resources. I attempted to follow up with the research assistants after each weekend to gage how the conversations went. For each of the focus group discussions the research assistants used two recorders to capture the discussion to ensure no data was lost.

Data preparation and analysis: Qualitative data

The qualitative data went through several stages of preparation. First the two research assistants transcribed the data in Lingala. Next, all transcripts were translated from Lingala to French. The two research assistants did the translation from Lingala to

French consulted with each other if there was any confusion in translation. Finally the transcripts were translated into to English. The data was analyzed using a grounded theory approach in MAXqda. First the data were memoed in MAXQDA to identify concepts or themes emerging in the data. Both deductive and inductive codes emerged. The deductive codes were topics or ideas that were elicited by questions from focus group discussion guides. The inductive codes were commonly reoccurring topics or themes that emerged from the participants themselves without direct prompting in the discussions. Several relevant codes emerged. For example, "money" and "design" were two codes that came up often. MAXqda was then used to retrieve text pertaining to each code and examined to develop thick descriptions looking for breadth, depth or nuance that seemed to be relevant to each code. These kinds of codes were examined for patterns and were compared by subgroups. For example, for the design code, first the design issues raised by the Mama Bongisa group were retrieved and examined, then issues raised by the Mama Bongisa were compared to the design issues raised by participants who 'did not like the stove'. This kind of analysis helped to build a conceptual framework to explain the patterns and relationships that were emerging in the data. The conceptual framework sometimes worked as a reference point to go back to the data to check if relationships drawn actually existed. Results from the survey data as well as background knowledge of findings from existing research on stove adoption and the TLUD stove informed the analysis and helped to triangulate key findings.

Data quality

Upon reviewing the transcripts, each focus group discussion had strengths and weaknesses when it came to quality of discussion. One common weakness in the discussions was the moderator's lack of ability to manage the group dynamics to ensure that all members participated well in the discussions. For example, in the focus group with people who didn't like the stove, only 4 out of 7 people in the focus groups participated frequently in the conversation. Another weakness was a failure to follow up and ask more probing questions to gain a depth of information from certain responses. There were a few opportunities in the discussion where participants shared surprising reactions and experiences and some follow up explaining these reactions would have been helpful. These weaknesses in moderation were somewhat addressed during data collection by following up with moderators after each weekend where moderators were given recommendations on how to improve moderation. However, since this was the first time the research assistants had ever facilitated focus group discussions and it was hard to know exactly how the focus groups were going due to language barriers, this weakness wasn't fully amended.

Strengths of the discussion were that participants regularly offered personal opinions and stories regarding the stove. In general, responses in the discussions were varied in length and it was clear that many of the participants were passionate and interested in offering their opinions. The commentary provided by the participants was rich enough for analysis.

The quality of the transcriptions and translations on the part of the research assistants were quite good. It was easy to distinguish in the transcripts when the interviewer was speaking and when the participants spoke. The translations, from Lingala

to French also seemed well done, especially since the two research assistants would double check each other's work and consult if there was confusion in translation.

Limitations and challenges of qualitative data preparation and analysis

There were several limitations in the qualitative portion of the study. One involved the challenge of conducting the research in three different languages. While steps were taken to ensure that instructions and follow were clear, training the research assistants and monitoring the quality of data collection was made more difficult because of the language barrier. Additionally there was the limitation of the last focus group with 'people who don't like the stove' being mixed gender, which may have affected the quality of the discussion. Another limitation was the inexperience of the two research assistants in qualitative methods. As mentioned earlier perhaps a longer training session would have helped to rectify this weakness. Unfortunately the assistants' inexperience with qualitative methods did reflect somewhat in the quality of the transcripts. Additionally, even though the research site was in the same city as the office headquarters, it could take hours to get the other side of town and this limited the amount of time and resources the office could dedicate to going to the Mokali neighborhood. More site visits could have been made without this challenge. Another challenge in the preparation and analysis of the qualitative data was the difficulty of working with the data in so many languages. With each translation it is possible certain nuances were lost. Also it was unfortunate that the focus groups were not as lengthy as they could have been if the research assistants had probed from more information.

Data collection: Survey

Preparation of the survey tool

The survey instrument was administered approximately 3 months after households received the stove. The purpose of the survey was to capture quantitatively the demographics of households that had received the stove, to understand what stove technologies these households typically used before the introduction of the TLUD stove, specific likes and dislikes of the TLUD stove, as well as households willingness to pay for the TLUD stove and fuel consumption post introduction of the TLUD stove. A first draft of the survey questionnaire was developed in spring 2013. A second draft was developed after the focus group discussions and was informed by information that emerged from the discussions. The survey was first written in English, then translated to French and then the local language (See Appendix B). After the survey instrument was translated it was pilot tested with 10 Mama Bongisa. In the pilot, one of the last questions regarding the amount of fuel purchased per week was changed in order to better reflect the means by which households purchased their fuel. When the survey was finalized 10 Mama Bongisa were trained to administer the survey.

Execution of the survey

The survey of the forty households was completed in one weekend. There was a one hundred percent response rate from all households' surveyed. When reviewing the completed surveys it became clear that the first question, regarding number of family members per household, was not answered correctly thus the Mama Bongisa went back to

the households later in the week to follow up on the question and correct the data. The Mama Bongisa were compensated and paid for their time.

Data preparation and analysis: Survey

Survey data were entered into an excel sheet by the two research assistants. Some of the data were disorganized and required cleaning up. I later conducted a second round of data entry to verify responses and catch for any data entry mistakes. Additionally, a corresponding codebook was created which organized responses by language and corresponding number. Data cleaning took place over Fall 2013 (See Appendix C for codebook). After the data preparation, the data was analyzed using excel, mainly looking at frequencies of the different responses regarding preferences, willingness to pay, and fuel use and expenses. Cross tabulation was not chosen for analysis.

Limitations and challenges in survey data collection, preparation, and analysis

Besides the limitations of having difficulty sampling in the field, a challenge of administering the survey was working with the Mama Bongisa, many of whom were not highly literate. Some Mama Bongisa were better at delivering the survey than others and it was hard to ensure methodological rigor, especially because the surveys were administered in the local language, thus it was difficult to supervise. This weakness was accounted for by reviewing and visually checking the completed surveys to note if there were any trends to indicate the surveys were filled out incorrectly. It was during this check it became clear that the question about the number of people in the household was consistently incorrectly recorded. This was probably due to poor wording of the question and failure to communicate the format of this question well in training with the Mama

Bongisa. These numbers were corrected when the two research assistants went back to each house to verify the household responses. There were, however, several other missing responses in the surveys that weakened the results of the study. This perhaps could have been corrected if more training had been conducted with the Mama Bongisa.

One other limitation involved in the data analysis was that the data were recorded first on paper then reentered into the computer, opening up possibility for recording error. A second round of data entry was conducted to verify responses and during the clean up and analysis the data was routinely checked to monitor for possible entry errors. Ideally the Mama Bongisa would have used electronic devices while conducting the surveys, however with limited resources, such technology was not available and administering the survey on paper, then entering the data by hand was the only option. Needing to translate the survey and the responses into different languages added another challenge to the data preparation, extending the length of analysis.

Chapter 4: Results

Introduction

The TLUD clean cookstove study conducted in Mokali was designed to meet several research objectives: to understand household experience with the TLUD stove, to determine possible barriers and incentives to household using the stove, and to investigate household willingness to pay for the stove. The qualitative focus group discussions were designed to understand the context of household experience with the stove, while the quantitative survey was designed to evaluate trends in stove and fuel use among households as well as quantify the strength of household preferences for the stove. The following results are a combination of the qualitative and quantitative analyses.

As explained in the literature review, the use and adoption of stoves generally depends on a multitude of factors, both external and internal. In this case there were a number of variables affecting household use, experience, and reaction to the TLUD stove including household and stove user characteristics, characteristics of the fuel market environment, and stove design. Stemming from these contextual factors, the crux of household experience with the stove centered on household ability to purchase the right kind of wood for their stove, their ability to effectively use and understand the technology, and stove design. It became clear from analysis of the focus group discussions that reactions to the stove were two fold. The Mama Bongisa had an overall positive experience with the stove, while many of the other women from the sampled households had overall negative experiences. The reasons for these reactions will be further explored in the results below.

The following results will first outline the general characteristics of the forty households that received the stove. Next, this section will describe contextual factors that affected fueling and use of the stove. Following that the findings will discuss household experience with the stove, particularly the design. Finally, the findings will cover outcomes of stove use and experiences culminating in household feelings on willingness to pay for the stove after having some time to use it.

Findings:

Characteristics of study population

The following statistics were drawn from the forty household surveys. While the Mama Bongisa were not a part of this sample, they also live in the neighborhood and thus these statistical trends may speak to their experiences as well. Of the forty households surveyed, the majority of household participants interviewed were women. Surveyors were asked specifically to survey women in the household as it was expected they had the most experience with the stove and would have the most to say regarding the technology. Households had an average of 7.48 members, the largest household consisting of 15 members and the smallest 5. Of all the income generating activities listed by households, over 80% of income generators were engaged in either shop keeping or wage labor, 10% were engaged in farming, and the rest in carpentry or other activities. Among household members listed as income generators, 79% were men and 21% women. When asked about the highest level of education a member of their household had received, 35% of households responded that they had a household member that had attended university, 52.5% responded having a household member that had attended secondary school, 10%

responded having a household member that had attended primary school, and 2.5% responded having no household members that had attended school.

Figure 4.1 Percentage of households with certain material goods

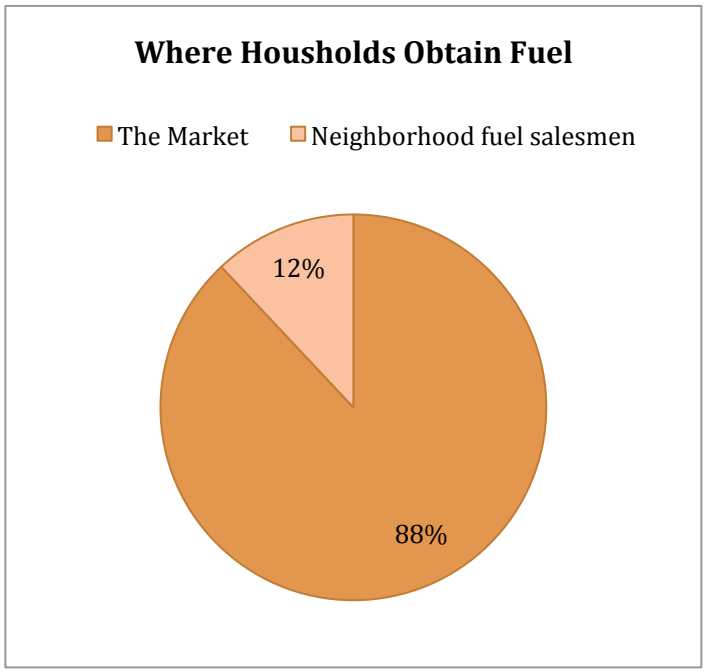
HH has electricity	72%	N – 26 Total -36
HH has TV	66.7%	N – 29 Total 39
HH has cell phone	60%	N – 24 Total 40
HH has radio	58%	N – 22 Total 38
Member of HH has watch	45%	N- 18 Total 40
HH has refrigerator	15.4%	N – 6 Total 49
HH has bank account	5%	N – 6 Total 39
HH has car	2.6%	N – 3 Total 39

It was not possible to directly measure household income since household members would not have been able to easily answer this question and likely been unwilling to do so. Instead the survey tool measured household ownership of certain material goods with the expectation this would provide an approximate idea of household wealth. As seen in the Figure 4.1, 72% of households cited having electricity (as least intermittently), and approximately 60% of households cited having a TV, a radio, or at least one member of their household who owned a cell phone. These results provide an idea of the general financial circumstances of Mokali. While these percentages are higher averages compared to data from the DHS conducted in 2007 this is no surprise as Congo's economy has increased drastically since 2007 (Ministère du Plan, 2007). Especially since certain technologies like TV's or phones are some of the first consumer goods households are usually interested in buying. Still Mokali is a relatively low-income neighborhood and is known as such in the city.

Factors contributing to the experience of the TLUD stove

The fuel market environment: Household difficulty finding the right kind of wood

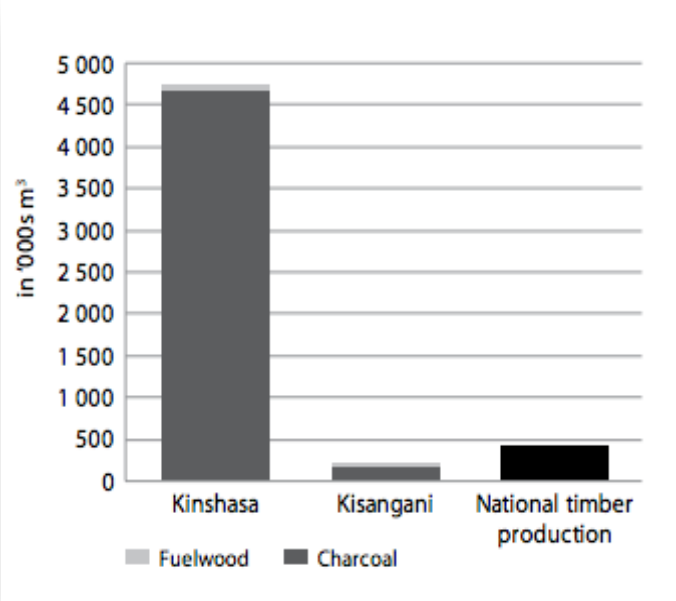
Figure 4.2 Location where households obtain fuel



The TLUD stove is fueled by wood. Understanding household experience fueling the stove is essential for understanding household's overall experience with the stove. Results from the focus group discussions and the results from the survey indicate that the availability of wood, accessibility to the right kind of wood, and affordability of wood were all essential factors to successfully fueling the stove. As seen in Figure 4.2, the majority of households buy their fuel, wood, charcoal, kerosene, etc. at the market. A small portion will get their fuel from salesmen who come into the neighborhood. Most households cited that on average they take 25 minutes to get fuel for their stove. Many households mentioned that it was difficult to find wood for the TLUD stove. Of the 40 households surveyed, 67.5% of households said it was difficult to find wood in the market. This is no surprise considering the deforestation surrounding the city of Kinshasa. Figure 4.3 depicts the results from a study conducted by the Center for International Forestry Research (CIFOR), which found that the majority of the fuel flowing into Kinshasa is charcoal and only a

fraction of the fuel imported to the city is regular firewood. The lack of avaliability of fuelwood in the Kinshasa market became an issue for the Mokali household stove users.

<u>Figure 4.3</u> Wood and Charcoal brought into DRC cities in '000s m³ compared to national timber production



Not using firewood is an obstacle to having a positive experience with the TLUD stove. In the focus group disucssions it became clear that fuelwood is not plentiful in the market, and even among the limited wood available fuelwood is less accessible to households compared to poor quality construction wood. If households do not use firewood, (which is hard and dense) and instead use construction wood, which tends to be much lower quality wood, the stove will not burn for long or perform very well. As one focus group participant stated, *"When you use lighter wood (in the TLUD stove) it dissipates and quickly turns to ash, but when the wood is heavy and hard, the fire lasts a long time and forms charcoal" (Women, FG 1).* Not only does the stove not burn for very long with construction wood, it also fails to produce the added benefit of charcoal. The TLUD stove works much better with firewood, but firewood is difficult to find in the market compared to construction wood. The Mama Bongisa elaborated on this in their focus group discussion. "*I must go farther in the market because nowadays, people use construction wood a lot more often than firewood. And when firewood can be found in the market, the mamas*

who make chikwangue (a fermented manioc dish) move quickly to buy it and empty out our stock for the day" (Mama Bongisa FG). The difficulty of finding firewood in the market negatively impacts households' experience cooking with the TLUD stove.

In addition to requiring the right quality wood, the TLUD stove only performs well if the wood used to fuel the stove is completely dry. If the wood is not dry the stove is hard to light, generates a lot of smoke, and does not produce a strong flame. Many users of the stove brought up the difficulty of finding dry wood. Some mentioned that it is a challenge to find dry wood when there is already such a shortage of wood in the market. This problem is further complicated by the rainy season, which annually occurs every September to May, making it difficult for both sellers and consumers of wood to keep wood dry. As Kinshasa is such an urban area and selling fuel can be lucrative, a large amount of deforestation has taken place in the city and in the surrounding countryside. When trees do grow they are often cut down at a young age and sold quickly, meaning they are green, and too wet for cooking. This again points to the general lack of availability and accessibility of the right kind of wood for stove users in Mokali.

Finally, a third factor that impacted households ability to acquire the right kind of fuel for the TLUD stove was affordability of wood, linked to the realities of household financial resources. Most households spend money for fuel on a day-to-day basis, only buying the amount of fuel they can afford for one day's worth of cooking. In the focus groups it was suggested that high quality firewood is more expensive to buy than construction wood in terms of upfront cost because firewood has to be bought in bulk. The Mama Bongisa who were well trained on the operation of the stove knew that investing in firewood was worth the expense, and were willing to spend more money up front.

However, most households only spent money on construction wood. This choice meant that the majority of households bought construction wood and were less satisfied with the stove because their wood burned out quickly and sometimes they were required to go back to the market the same day to buy more.

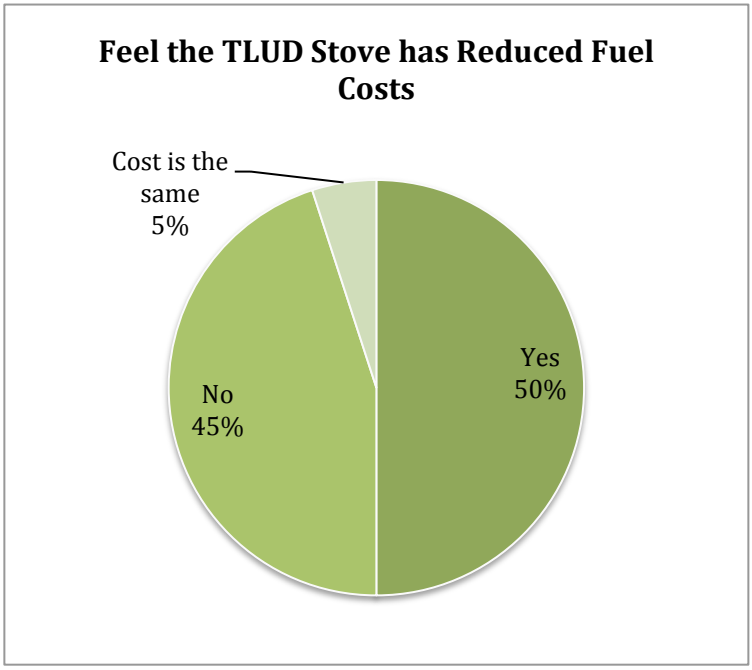
Cost and smoke were two major issues raised in the focus group discussions. Both of these issues were discussed in relation to the difficulty of finding and using the appropriate wood to fuel the TLUD. The Mama Bongisa who seemed to have more knowledge on the right kind of wood to buy, had less issues with smoke, and thought the stove saved them money. Other households who did not seem to have the same knowledge, often found fueling the stove expensive, and frequently spoke of issues with smoke. The next two sections cover some of the experiences of households with the TLUD stove regarding cost and smoke.

The cost of fueling the TLUD stove

As stated earlier, households that bought construction wood were less satisfied with the stove because their wood burned out quickly. Participants in the focus groups spoke of having to buy extra wood to fuel their stoves and said some days they had to go back to the market to get more wood for cooking their meals. The need to buy so much wood elevated the cost of operating the stove. For several households that used the stove, especially in the focus groups with women, cost was noted as one of the biggest drawbacks to the TLUD stove. As one participant put it, *"Me personally, I have spent a lot because I could pay for charcoal at 300 to 500fc which I could use well in my old stove, but with this one, I pay for the wood 200-500fc and it is difficult for me to complete all of the meals of the day. I must spend at least 1000fc to cook with the improved stove" (Woman, FG 2).* Not all participants

however spoke so negatively of the cost of fueling the TLUD stove. Many of the Mama Bongisa in fact thought that using the TLUD stove saved them money. One Mama Bongisa said, *"In any case no, it does not take a lot of money to use. With 2000fc I can use my cut wood for at least 3 days, but with the same price for charcoal I can only pay for one day" (Mama Bongisa Focus Group).* While it is unclear how many people each of these two households cooked for, which would have determined the amount of money needed for fuel per day, notably, each woman had her own tone when it came to speaking about the cost of fueling the TLUD stove. The type of wood used and knowledge on how to use the stove may have determined the difference in experience.

Figure 4.4 Household Perception on whether the TLUD stove reduced fuel costs

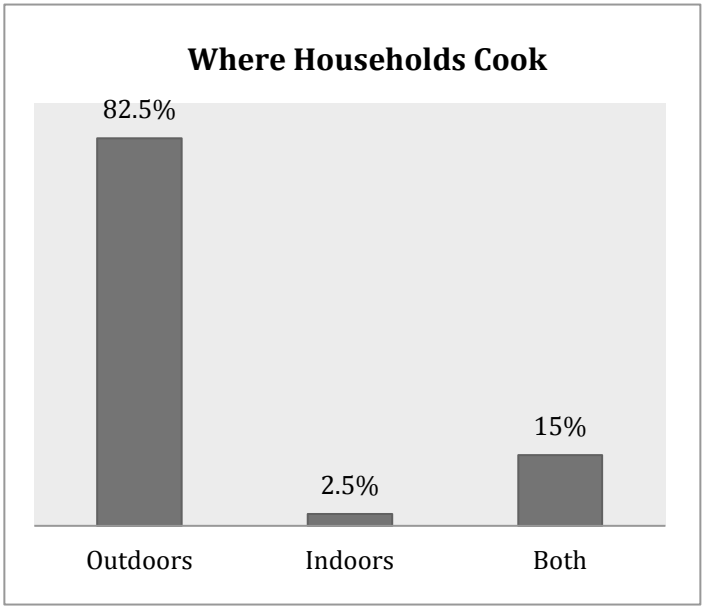


In addition to these findings the survey results shed some light on the cost of operating the TLUD stove compared to other charcoal, kerosene, and battery stoves. According to the survey, 50% of households using the TLUD stove thought it reduced fuel costs, 5% thought fueling the TLUD stove cost the same, and 45% did not think that they saved money (Figure 4.4). This difference in costs of using the stove likely centered on the type of wood households used to fuel the stove, whether they bought dry wood, and in general if they used the TLUD stove correctly.

Smoke from the TLUD Stove

Understanding household experience with smoke and the TLUD stove was another important part of this research since exposure to smoke and particulate matter is one of the major health risks the TLUD stove is designed to prevent. In this study, findings show that when households use wet wood to fuel the TLUD stove, the stove produces a lot of smoke, is difficult to light, and does not produce a good flame. When the stove is fueled with dry wood it runs well and without smoke. Before beginning this research there was concern that households would actually prefer smoke as studies in other regions of the world have found that households sometimes prefer smoke for the flavor it adds to food and its assistance in keeping bugs away. The households in this study, however, did not like smoke and all focus group participants spoke of how they don't appreciate the smell of smoke on their clothes, the taste of smoke in their food, or smoke blackening the bottoms of their pots. Women also mentioned how much they dislike smoke stinging and getting into their eyes as they cook. The majority of households surveyed said that they usually cook outdoors, likely because they like to keep the smell of smoke out of their homes (Figure 4.5). Also in the survey, when asked if smoke posed a risk to their household's health, 60% of

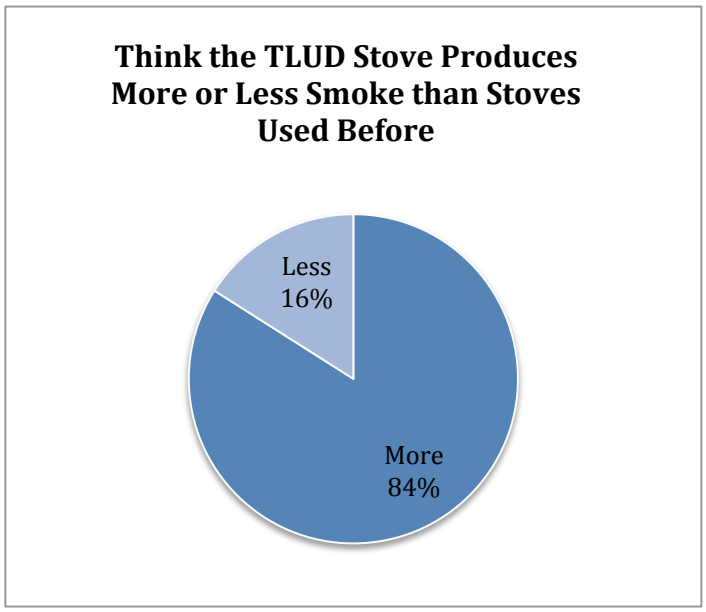
Figure 4.5 Locations where Households cook their meals



respondents thought it did while 40% percent did not.

Among the participants in the focus groups there were several different opinions on how much smoke the TLUD stove produced and whether or not it was a problem. The Mama Bongisa said that they experienced little smoke from the stove as long as they used dry wood. Some mentioned they thought it produced so little smoke it was comparable to using a gas stove. Other women from the sampled households found that the TLUD stove produced a lot of smoke and thought the smoke was an extreme nuisance. Focus group participants who "did not like the stove" were the most upset by the smoke from the TLUD and attributed smoke as their major reason for rejecting the stove. As one participant said, "*When we received the stove we were very happy, but when we actually began to cook with it we noted or saw that it let out a lot of smoke. It was after that that we decided to not use it*" (Did not like the stove FG). Some of this struggle with excess smoke can possibly be attributed to women not fully understanding the importance of using dry wood. Another likely factor affecting households' perception of the TLUD was their experience with other stove technologies before receiving the TLUD stove. Most households owned a charcoal stove before receiving the TLUD stove, which in general emits little smoke though

Figure 4.6 Household perception of smoke from the TLUD stove



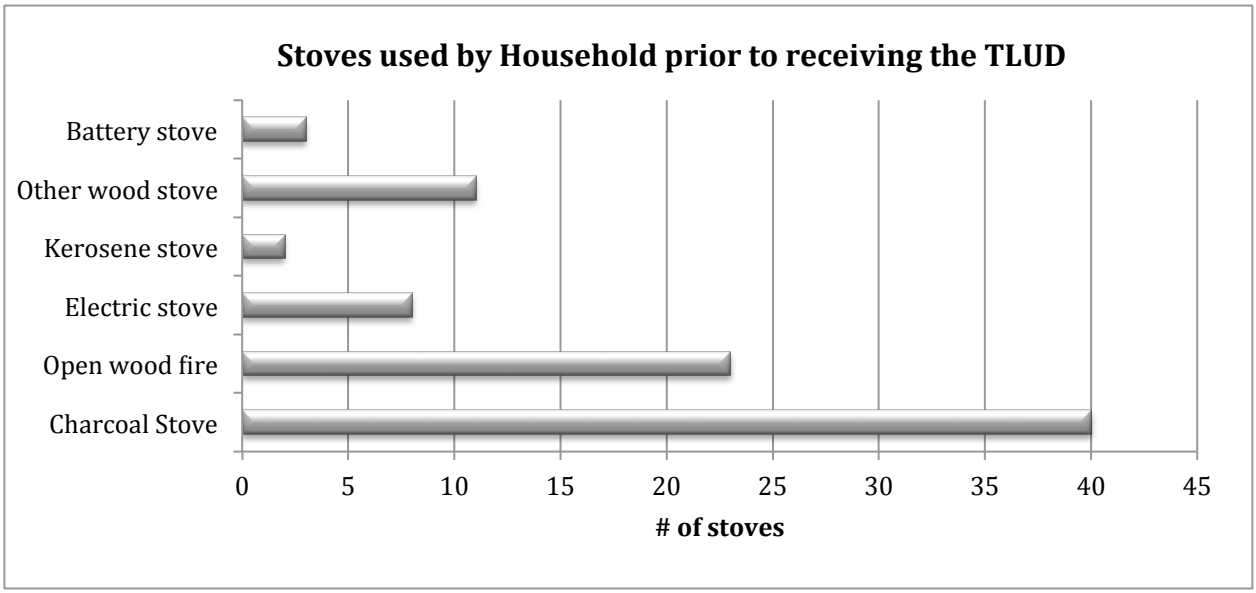
it releases carbon monoxide, a pollutant that stove users cannot easily see. Previous household experience with charcoal stoves and the use of wet wood, both likely contributed to the fact that when surveyed the majority of households thought that the TLUD stove produced more smoke than the stoves they used before with 84% saying that it produced more and 16% saying that it produced less (Figure 4.6). Also of note, however, is that if households used a wood stove before receiving the TLUD stove, they were more likely to look favorably on the TLUD stove and think that it produced less smoke. As one participant said, "*With our old wood stoves, when you cooked food and you lifted off the lid of the pan, all the smoke entered into the food, but with the improved stove there is not an odor of smoke in the food"* (Men's FG).

Stove Stacking

Another factor that contributed to household experience with the stove was stove stacking. Stove stacking is when households cook concurrently with multiple energy sources and stove technologies. It was clear from the survey results and focus group discussions that households using the TLUD stove were also continuing to use their charcoal stove and other stove varieties. The survey data revealed that even before receiving the TLUD stove, households were already using on average two stoves to do their cooking during the week. There may be several reasons for this practice: one household may prefer to be able to use different stoves depending on the amount of money they have for fuel on a particular day, another may prefer a stove with a more stable base or one that boils water faster. A household's use depends on need. As Figure 4.7 demonstrates, among those stoves already being used by households before receiving the TLUD, 40 of them were

charcoal and 23 were open fire wood stoves. Additionally, there were a few electric stoves, other wood stoves, and battery stoves.

Figure 4.7 Stoves used by Household Prior to Receiving the TLUD



The focus group discussions revealed that households expected to rely on the TLUD stove only as one stove among their repertoire. Some mentioned cooking on the TLUD stove to get a dish done quickly while cooking another dish on another stove. Another participant stated that when she has money to pay for wood she will use the TLUD stove, but when she does not have money she will use her charcoal one. Additionally, in the survey when households were asked how many times they used the TLUD stove per week after receiving it, 42.5% said that they used it everyday, 50% said several times a week, and 7.5% not all. This finding has implications for the future TLUD interventions and potential impact on reducing the effects of indoor air pollution. Moreover, household experience and interaction with other stoves affected household perception of the TLUD stove design and perhaps also willingness to pay.

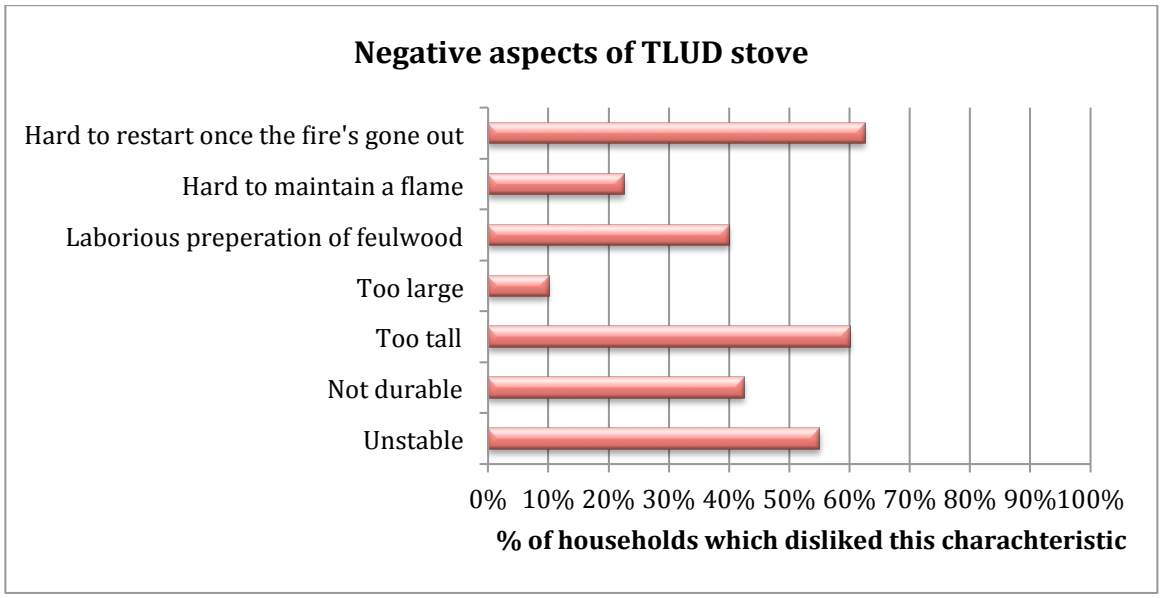
Household experience using the stove

Design

There are several design elements of the stove that influenced the experience of households. Some design elements are modifiable while others are unchangeable elements of the TLUD technology. There were a number of characteristics about the stove that households didn't like. For example, in all the focus group discussions participants asked that the stove be made of a heavier and more durable metal. They also asked that it have a stronger, more stable base. As one participant said, *"It only needs to be strengthened, in both its feet for support and the two handles that help in transporting it. Little by little as the fire heats up the metal deteriorates and because it's not a heavy metal it goes bad quick. And with a pot that weighs a lot, its feet for support will not hold well"* (Mama Bongisa FG). Households wanted the metal to be stronger so they could easily place big, heavy pots on top of it. They also wanted it to be stronger so that the stove would last longer. Finally, they wanted it to be stronger so that the stove would look more impressive to other family members and their neighbors. In the focus groups with participants who explicitly 'didn't like the stove' they mentioned often that they like battery fan stoves the most because the battery stove is made out of strong and durable metal. When asking for a more stable base, most participants mentioned that the stove TLUD rocks around a lot, particularly when they prepare the staple food *fufu* (a heavy, thick dish that requires a lot of stirring), therefore they wanted a more stable stove for cooking. One participant did admit, however, that their old charcoal stoves weren't necessarily that much better in terms of stability and durability.

Figure 4.8 shows the TLUD stove characteristics households noted they didn't like derived from the survey. As just mentioned, instability and non-durability of the stove were elements of the stove households did not like. Another common dislike of the stove was its height. Over half of households (60%) thought the TLUD stove was too tall. The height of the stove was problematic for some households, because in order for the stove to work well and light well, it is best if the stove is densely packed with wood and filled to the very top. This means that the taller the stove, the more fuel it needs and the more expensive it is to operate. While many households thought the stove was too tall, very few households were

Figure 4.8 Negative aspects of TLUD stove



displeased with the size of the stove, suggesting the stove was of an appropriate width. Some participants mentioned in the focus groups that they like that the stove was wide enough to place their pots on top.

A further drawback of the stove design mentioned by participants was the somewhat laborious preparation of the wood. The pieces of wood to fuel the stove had to be cut into small pieces approximately 10 to 15 cm in length. One participant said*, "I*

encountered difficulties at this level, You must, in advance, cut pieces of wood that are well measured so that they can easily by put in the stove, while with the other wood stoves it was possible to slip in wood from outside the stove"(Woman FG 1). Some participants talked about difficulty finding a machete to properly cut the wood for the stove and said that firewood is harder to cut compared to construction wood because it is denser. However, survey participants did not list fuel preparation as much of a dislike as expected; only 40% households said it takes too long to prepare fuel.

Another drawback of the TULD stove related to the flame of the stove. On one hand, households appeared to have little problem keeping the flame going once the stove was started. In fact, many in the focus group discussions said they appreciated that they could leave the stove unattended and the flame would not go out. However, if the stoves flame did go out participants stated it was a hassle to restart. Several participants spoke of the nuisance of having wet wood or not having enough wood to fill the stove all the way and if the stove did not catch fire well women had to dump all the wood out, find dry wood or more wood, and start the process over again. Also, once the firing with the TLUD stove was done they could not simply add more wood into the stove and cook again if needed. Instead, they first needed to remove the coals left over and repack the stove. This was an obvious difficulty and according to the survey the least popular aspect of the stove as 63% of households said they did not like that the stove was so difficult to restart once it had gone out.

One final aspect of the stove that participants did not like was the stoves lack of holes for ventilation. Many participants thought that adding air vents would help with the stoves smoke problem. *"It lets out a lot of smoke because it doesn't have a hole to let out air.*

The smoke hurts our eyes and it costs us a lot of money"(Woman FG2). Others thought that placing vents in the stove would make the stove easier to use with less wood. *"As for me, I would have preferred that it had the vents to allow air to pass, thus even if there was not enough wood, the fire would continue to keep the flame going" (Woman FG1).* In reality, the TLUD stove would not be able to create biochar or be as energy efficient if vents were placed in the stove, but all participants including the Mama Bongisa and the men's focus groups asked for vents suggesting that there is a fundamental misunderstanding of the mechanics of the TLUD stove. This technology is completely different from the regular stoves that households have used in the past and this uniqueness sometimes serves as an obstacle for households to operate the TLUD stove properly.

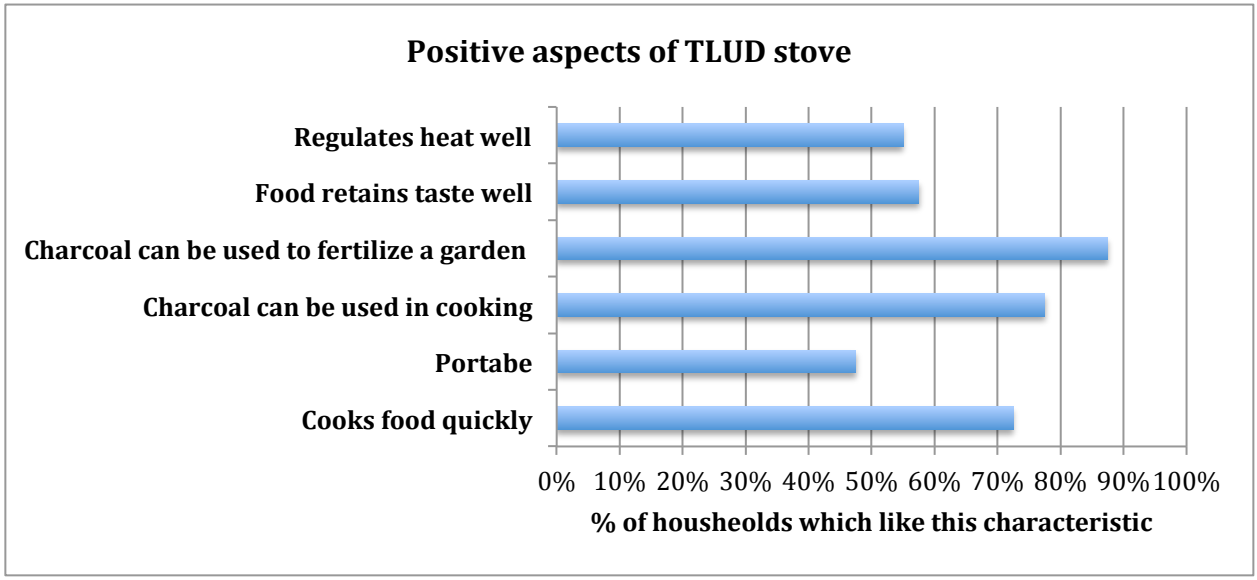
While there were many design elements of the stove that households did not like, there were also many design elements households appreciated about the TLUD stove. In Figure 5.9 you can see responses to three questions asked of households in the survey regarding what they think of the TLUD stove compared to their old stoves. In terms of whether the stove is easier to use the response was split, half thought it was easier, half thought it was harder. When asked if it takes longer or shorter to start the TLUD stove compared to the stoves they used previously most participants said that it takes less time to start the TLUD compared to their previous ones. Also the overwhelming majority said that their food took much less time to prepare on the TLUD stove. The fact that the TLUD stove cooks food quickly was the most commonly cited

<u>Figure 4.9</u> TLUD stove compared to stoves HH used before

TLUD harder or easier to use	52% easier 48% harder
TLUD takes longer or shorter to start	72.5% shorter 27.5% longer
TLUD takes longer or shorter to prepare food	87.5% shorter 10% longer 2.5% the same

benefit of the TLUD stove in the focus groups. Most participants talked about foods that usually take a long time to cook, such as beans, cooked much faster with the TLUD. One of the male participants said, *"The food (cooked on the TLUD stove) was delicious. Everything that she makes on it is good, even the beans that spend a long time on the fire do not take a long time to soften. It cooks the food well and we eat with much appetite and satisfaction" (Men's FG).* As seen in the graph below (Figure 4.10) the fact that the TLUD stove cooks food quickly was a popular benefit; 73% households said they liked that aspect of the stove.

Figure 4.10 Positive aspects of the TLUD stove



The other two most popular characteristics of the TLUD stove from the survey were the fact that the stove creates charcoal and that this charcoal can be used to fertilize the garden. Interestingly however, these two benefits of the stove were not often brought up in the focus group discussions and when they were mentioned it was most often by the Mama Bongisa group. There are several possible reasons for this, first, in general in critical discussions it is more common for people to focus on the negative rather than the positive when trying to see an object or situation improved. Additionally, the Mama Bongisa may

have had better success at getting charcoal because they tended to be better about using dense firewood. Also the other households may not have understood the full range of the use of the charcoal since they had only experienced one training session on the stove while the Mama Bongisa had several.

Other characteristics that households liked about the stove were that it was portable, regulated heat well, and cooked food well. In addition, several mentioned that it was nice that they did not need to stand by the fire to keep it going. As one participant said, *"There is a big difference for me because with my old wood stove, it was necessary to be beside the stove to slip in or add wood and fan the fire all the time. At the smallest distraction the fire would go out but with this one, when you load your stove only with wood, you can go ahead and occupy yourself with other things"* (Women FG1). Other women mentioned that they liked to be able to walk away and do other tasks while the fire cooked. Finally there was a question in the survey regarding whether participants like the appearance of the stove. Ninety percent said they liked it while 10% did not. It is likely that if fabricated with stainless steel metal the households would like the appearance even more.

Social perception of the design of the stove also played a large role in experience with the stove. Household and social perceptions of the TLUD stove were affected by many factors including stove performance and outward appearance. Depending on whether households could find firewood and dry wood influenced the cost of the TLUD stove and smoke from the stove. If the stove seemed expensive or too high maintenance with the amount of smoke it let off, the household and neighbors were not impressed. As one woman said, *"I did not like your stove. It lets off a lot of smoke and the children don't like it. They put themselves under shelter. Its legs for support are weak and not durable. Considering*

all these difficulties we were obligated to reject it. If you can, build for us stoves that are worthy of us mamas" (Don't like the stove FG). This request to build a stove "worthy of mama's" was brought up several times in the focus groups. In some ways stoves seem to be a social marker for households since they are used in outdoors spaces and thus viewed by the public. Households hoped when receiving the stove that the stoves would be modern, look nice, save them money, and be impressive to the neighbors. As another participant said*, "Me I would like for the metal to be fixed so that it is stronger, heavier, so that we have the appearance of benefit (l'air advantage)"(*Women FG1). It's clear from this quote that if the stove appears to be nicer than the average stoves used in the neighborhood that is an incentive for households to use the TLUD stove. Also, in regards to social perception many households discussed how much they liked the uniqueness of the TLUDs appearance and function. Some participants said that because the stove technology is something "new", which they'd never seen before, that's what would make them interested in buying it and using it.

Influence of gender on household use and experience with the TLUD stove

Participants use and experience of the TLUD stove differed by gender. As mentioned before, in the DRC women do the cooking in the households. The survey results confirmed this with 100% of households reporting that women do the cooking in their house. Another result from the survey found that the majority of households list men as their head of household. In one section of the survey respondents were asked who in the household makes the decision regarding certain purchases. Women were listed the majority of the time as the ones most responsible for the decision to buy fuel or stoves. Interestingly, men were listed by 50% of households as the one responsible for decisions

on food purchases, while 40% of households listed women as responsible for decisions on food. Only 10% of households listed men and women together as responsible for decisions on food. This perhaps explains this man's comment in a focus group discussion, *"What I like about the (TLUD) stove is that it doesn't make our food taste smoky. Except it uses a lot of money. You could leave money for 2 cups of flour, but when returning in the evening, be told that 1 cup of flour was bought because the rest was needed to add wood"* (Men's FG). This quote suggests that while women use the stove and purchase fuel for it, men monitor household expenses and purchases. The fact that a woman spent more money on wood for the fuel was something that this man noted.

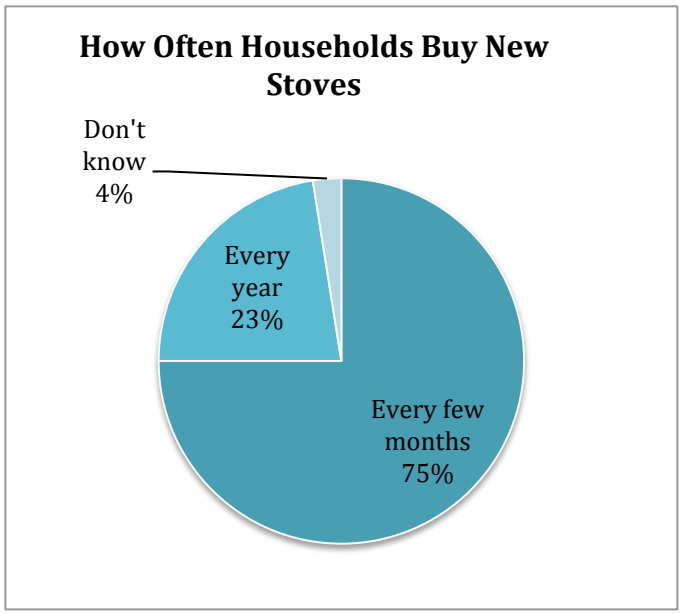
Willingness to pay and likelihood to adopt

Willingness to pay for the TLUD stove

Another objective of the research was to understand household willingness to pay for the TLUD. This question is important as it helps to gauge how much households value the TLUD as well as how much the stove could be sold for in future program interventions. Willingness to pay, however, is not an easy sentiment to measure. First, it helps to know the context of the stove market in Kinshasa. Most households buy inexpensive charcoal stoves, which are generally made out of poor material and must be replaced every few months. In response to the survey question, how often do you buy a new stove, 75% of respondents said every few months, 22% responded every year, and 3% responded as not knowing (Figure 4.11). This shows that in Kinshasa at least there is a high turnover when it comes to stove use and purchasing.

When asked in the survey how much the respondent would be willing to sell the TLUD stove for, the average price was 1,769 Congolese francs (Fc), which translates to 1.92 USD. The minimum price they'd be willing to sell the stove at was 1000 Fc while the maximum price was 5000 Fc. When asked in the survey what was the highest the respondent was willing to pay for the TLUD stove, the average price was 2,066 Fc, the equivalent of 2.25 USD. The minimum price a household offered to pay was 500 Fc while the maximum was again 5000 Fc. In the focus groups participants were asked how much they'd be willing to pay for the TLUD stove if offered and many said that a fair price would be around 1500 Fc because that is on average what they pay for new stoves now. Also in the focus groups no one at any point ever offered a price above 5,000 Fc even if they really liked the TLUD stove.

Figure 4.11 How Often Households Buy New Stoves



In both the focus groups and the survey, participants were asked how they felt about paying 10,000 Fc for the stove, a price that IMA World Health determined would cover the cost of producing the TLUD. In the survey, 100% of respondents said they would not pay 10,000 francs for the stove. In the focus groups there was consistently a huge reaction from participants whenever 10,000 francs was suggested as a price. No one thought that was a reasonable price to pay for a stove, especially considering the stove's

weaknesses in terms of smoke and weak metal. As one of the male respondents put it, *"In any case, I would prefer to stock up on my old stoves rather than buy a stove for 10,000 francs"* (Men's FG). The price ceiling of around 5,000 francs is something important to consider when marketing the TLUD stove. It is also important to put this number into perspective. According to The World Bank the gross national income per capita in the DRC is 212,098 francs per year. According to this reference, paying even 5,000 francs for a stove equates to 8 days worth of an individual's annual budget (The World Bank, 2012).

When asked in the survey if households would be willing to pay more if the stove was on credit, 54% said yes. It was surprising to see this response considering some of the previous literature suggesting that offering the stove on credit can help households be more willing to pay. When asked if households would be willing to pay more if the stove had a more stable base, 51% said yes. The reaction to the question of whether households would be willing to pay more for the stove if it was a made out of a stronger metal had the most positive reaction, as 60% of respondents said yes (Figure 4.12).

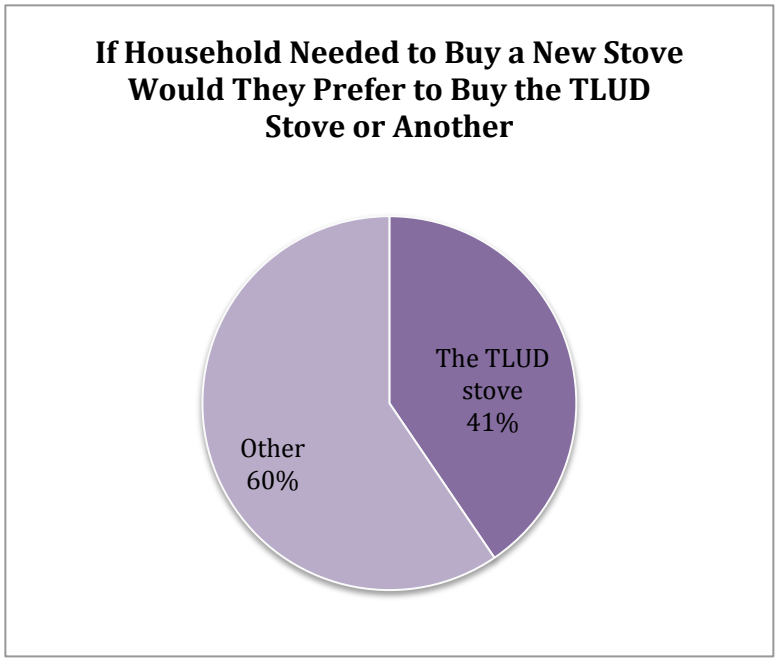
Figure 4.12 Willingness to pay more if certain stove features are changed

Willing to pay more for stove if bought on credit	54% yes
Willing to pay more for stove if it had a stable base	51% yes
Willing to pay more for stove if made out of stronger metal	60% yes

This suggests that changing the quality of the metal of the stove is perhaps the most effective way to improve household willingness to pay. The weak metal of the stove was an issue for many households, even the Mama Bongisa, who generally were more positive about the stove. One Mama Bongisa said, *"For me something that can prevent me*

*from buying it is its sheet metal, if you could fix it because it is too light. Make it more hard and thick. We use very heavy pots which weigh a lot…if you could improve the aspect of its metal so that it is more attractive in the sense that if someone saw it for the first time it would be something they'd be interested in… this is what would prevent me from buying it"(*Mama Bongisa).

Figure 4.13 Do Households want to buy the TLUD stove or another



Another theme that emerged in the focus group discussions regarding willingness to pay for the stove related to household financial circumstances. Within the neighborhood, household financial circumstances can vary widely and this will greatly affect willingness to pay. There is no one size fits all model and approach to selling the stove. One woman said that even if the strength or design of the stove were changed, if households have no money they will not be able to pay. Another question to ask then is, even if households have money, would they then buy the TLUD stove? When asked in the survey if they would prefer to buy the TLUD stove or another stove when the time came for the households to buy a new stove, 60% of respondents said that they would prefer to buy another stove, 40% said they would prefer to buy the TLUD (Figure 4.13). This response does not include the opinion of the Mama Bongisa who in

general has a more positive experience with the TLUD stove.

Chapter 5: Discussion and Conclusion

Principal findings

Household experiences with the TLUD stove were complex, influenced by multiple factors including the fuel market, knowledge of the appropriate type of wood to use and ways to operate the stove, stove cost and smoke, stove design, and social perception of the stove. Willingness to pay for the stove, regardless of experience, was quite low. In the focus group discussions it appeared that the Mama Bongisa had an overall positive experience with the stove while other households had more negative experiences. The experience of the Mama Bongisas was likely due to their knowledge of the right wood to use for fuel and how to operate the stove, meaning they experienced little to no smoke with the stove, saved money, and had charcoal left over. Other households seemed to experience more smoke and greater cost. When it came to the design of the stove, households thought that the stove needed to be more stable, strong, and durable. Survey and focus group respondents also disliked its height, thought it produced more smoke than other stoves they had used before, and was laborious to restart. Households liked, however, that the stove cooked food quickly, could be left unattended, was portable, and produced leftover charcoal which could be reused and put in the garden as fertilizer.

Strengths and weaknesses of the study

This study conducted in Mokali, Kinshasa, DRC had several strengths and limitations. A major strength of the study was that it employed mixed methods allowing for methodological triangulation to determine results. The focus groups provided a nuanced

understanding of households' use of the stove and the physical, natural, and cultural environment in which household stove, fuel, and energy decisions are situated. The survey data, which was informed by the focus groups, was able to quantify the strength of household perceptions and reactions to their experiences with the stove and the stove design. Employing both methods highlighted certain aspects of household experience, perception, and willingness to pay for the stove, which would have been unclear or unknown only employing one method.

A limitation of this study was that it was conducted through several languages, which complicated data collection, preparation, and analysis. Particularly with the focus groups data, the translation of the focus group transcripts from Lingala, to French, to English may have influenced the ability to find more nuance in the data. Another limitation was that the research assistants and survey enumerators were new to qualitative methods and rigorous survey data collection. This sometimes affected the quality of data collected in both the focus groups and surveys. An interesting methodological choice in the study that perhaps was both a strength and limitation was the last minute decision to include the Mama Bongisa in a focus group. The Mama Bongisa inclusion is a strength of the study because it allowed for a more comprehensive picture of household experience with the stove and revealed findings that would not have been apparent otherwise. However, because the Mama Bongisa were not included in the survey, the findings were not as clear and representative as they could have been otherwise.

This study compared to others in the literature

This study contributes to the literature on clean cookstoves for several reasons. First, as mentioned in the literature review, to date little research has been done examining household receptivity to biomass clean cookstoves, particularly the TLUD stove. Additionally, little to no research on clean cookstoves has been conducted in the DRC so this study provides new information on factors affecting household adoption of biomass stoves and receptivity to clean cookstoves in general in the DRC. Additionally, there have been few mixed method studies conducted to examine household experience and receptivity to a clean cookstove technology so this study helps provide new information on household receptivity to the TLUD biomass stove using a different methodological approach.

This study corroborates several findings from other studies in the literature, which show that factors contributing to household adoption of stoves are complex and multidimensional. As the Risseeuw study (2012) found in Mozambique, both endogenous and exogenous factors can affect household fuel decisions and options. In this particular study the availability, accessibility, and affordability of fuel and internal household preferences and knowledge regarding fuel both played a role in household fuel choices. This study also shows that financial incentives play a major role in determining a household's ability to buy clean cookstove technologies, but beyond that there are other stove characteristics that affect adoption of new stoves including the stove design, social perception of the stove, and knowledge. Additionally, this study corroborates that it is challenging for households to change energy technologies, as there usually are cogent reasons why households use the stoves they do and even if households do adopt a new

stove, stove stacking is common. This study also matched the El Tayeb Muneer findings from Ethiopia (2003), showing that women are the main purchasers of stoves and are the most important target group for facilitating stove adoption. Though as demonstrated in the results, women can have varied opinions on stove technology and convincing one group of women to invest in the stove technology does not mean that others will follow suit.

One finding that was not consistent with the other findings in the literature was the reluctance of households to increase willingness to pay for the stove even when offered on credit, which varied from results in the Uganda study (Levine, 2013). Household reluctance to increase willingness to pay for the stove may have differed from the Uganda study since the Uganda scenario was hypothetical and households had already been given a chance to use the stove for free.

Meaning of the study: Public health implications and recommendations

- This study has shown how many factors can contribute to household reaction to clean cookstoves. In this particular case, household reaction to the TLUD stove was determined not just by economics of the stove, but also the fuel market environment, household contextual factors and preferences as well as user knowledge. This speaks to the necessity of conducting a thorough investigation of household receptivity to a technology before going to scale with the technology as a public health intervention.
- In order to make the TLUD stove more appealing to users, at least in Kinshasa DRC, there are a few design characteristics that could be modified: reduce the stove's

height, improve the quality of the metal and develop a stronger base or foundation for the stove.

- Characteristics of the TLUD stove that were liked by users that should be stressed when trying to promote the stove include: speed for cooking, relative ease of use, ability to make charcoal that can used again in another stove or in the garden, and if used with the right kind of wood, less smoke. Promoting these aspects of the stove could be helpful in marketing the technology.
- This study demonstrated the importance of communicating to household stove users how to use the stove and the right kind of wood to use to fuel it. Perhaps if all households had been given the same amount of information on the stove they would have had more positive experiences with it. It is important to communicate well how to use the TLUD stove before disseminating it.
- Social perception of the stove also needs to be taken into account. If the stove does not seem like a technology that will impress neighbors or family, and may in fact draw criticism, it is less appealing to users.
- When distributing the stove gender sensitivity is key. In Kinshasa, and likely in many other regions, women will be the users and purchasers of stoves so they are the target group to convince to buy the stove and will need to be well informed on how to use it. Men, however, also need to be included in the processes as they are no doubt involved in other household finances and they will notice the stove and how the new stove impacts finances and their meals.

- The TLUD stove was not always guaranteed to produce less smoke as it was often used incorrectly with wet wood. This interferes with the effectiveness of the stove as a good public health solution to indoor air pollution.
- When disseminating the TLUD stove it is important to take into account stove stacking. Even if households adopt the TLUD they may be using other stoves concurrently in the week, which will impact effectiveness of the TLUD stove on reducing indoor air pollution.
- The demand for new stove technologies was not as high as expected and this was possibly reflected in low willingness to pay. Investigating possible subsidy and credit models will be important for future stove programs and should be incorporated into any future community trial.

Unanswered questions and future research

There are several unanswered questions that deserve future research before going to scale with introduction of TLUD stoves in Kinshasa. First, it would be good to conduct a similar study to investigate how the TLUD stove is received in rural DRC where the stove and fuel environment differs greatly from Kinshasa. Second, how might households react to the stove if some of the simple design flaws were changed such as the strength and durability of the metal of the stove as well as the stability of the base? Finally, how might household experience with the stove differ when households receive more than one training session on how to use the stove and have increased knowledge of the kind wood needed to fuel the stove properly? In general, it would be valuable to conduct further community trials with improved versions of the TLUD stove in other regions of the DRC to

see how household experience and reaction to the stove changes depending on environment, knowledge, and stove characteristic's.

Conclusion

The complex relationships of factors affecting stove experience and likeliness of adoption point to the necessity of understanding the context of household energy and fuel environments as well as household preferences. Household willingness to adopt clean cookstove technology extends far beyond the economics of fueling and purchasing. There are a constellation of social, economic, and technological factors that must be dealt with in future design and rollout if TLUD is able to meet its potential as a potent public health intervention.

References

Adkins, E., Tyler, E., Wang, J., Siriri, D., & Modi, V. (2010). Field testing and survey evaluation of household biomass cookstoves in rural sub-Saharan Africa. *Energy for Sustainable Development, 14*(3), 172-185. doi: http://dx.doi.org/10.1016/j.esd.2010.07.003

Bailis, R., Cowan, A., Berrueta, V., & Masera, O. (2009). Arresting the Killer in the Kitchen: The Promises and Pitfalls of Commercializing Improved Cookstoves. *World Development, 37*(10), 1694-1705. doi: http://dx.doi.org/10.1016/j.worlddev.2009.03.004

Berkeley Air Monitoring Group. (2012). Stove Performance Inventory Report.

Carter, S., & Shackley, D. S. (2011). *Biochar Stoves: an innovation studies perspective*. UK Biochar Research Center

University of Edinburgh.

CDC. (2012). CDC in DR of Congo: Factsheet.

CIFOR. (2011). Woodfuels for Urban Centers i nthe Democratic Republic of Congo: Center for International Forestry Research.

El Tayeb Muneer, S., & Mukhtar Mohamed el, W. (2003). Adoption of biomass improved cookstoves in a patriarchal society: an example from Sudan. *Sci Total Environ, 307*(1-3), 259-266.

Gifford, M. L. (2010). *A Global Review of Cookstove Programs.* Berkeley.

Global Alliance for Clean Cookstoves. (2011). Igniting Change: A Strategy for Universal Adoption of Clean Cookstoves and Fuels: The Global Alliance for Clean Cookstoves.

Global Alliance for Clean Cookstoves. (2012). Uganda: Draft Market Assessment Executive Summary: The Global Alliance for Clean Cookstoves.

Global Alliance for Clean Cookstoves. (2013). Scaling Adoption of Clean Cooking Solutions through Women's Empowerment: Global Alliance for Clean Cookstoves.

Global Alliance for Clean Cookstoves. (2014). November 2013, from http://www.cleancookstove.org

Haines, A., McMichael, A. J., Smith, K. R., Roberts, I., Woodcock, J., Markandya, A., . . . Wilkinson, P. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. *The Lancet, 374*(9707), 2104-2114.

Herrin, W. E., Amaral, M. M., & Balihuta, A. M. (2013). The relationships between housing quality and occupant health in Uganda. *Social science & medicine (1982), 81*, 115-122.

International Biochar Intiative. (2014). Frequently Asked Questions about Biochar (Vol. 2014).

International Energy Agency. (2010). World Energy Outlook 2010: IEA.

Kadir, M. M., McClure, E. M., Goudar, S. S., Garces, A. L., Moore, J., Onyamboko, M., . . . Goldenberg, R. L. (2010). Exposure of pregnant women to indoor air pollution: a study from nine low and middle income countries. *Acta Obstet Gynecol Scand, 89*(4), 540-548. doi: 10.3109/00016340903473566

Kshirsagar, M. P., & Kalamkar, V. R. (2014). A comprehensive review on biomass cookstoves and a systematic approach for modern cookstove design. *Renewable and*

Sustainable Energy Reviews, 30(0), 580-603. doi: http://dx.doi.org/10.1016/j.rser.2013.10.039

Lambe, F., & Atteridge, A. (2012). Putting the Cook Before the Stove: a User-Centred Approach to Understanding Household Energy Decision-Making: Stockholm Environment Institute.

Levine, D. I., Beltramo, T., Blalock, G., & Cotterman, C. (2013). What Impedes Efficient Adoption of Products? Evidence from Randomized Variation in Sales Offers for Improved Cookstoves in Uganda.

Lewis, J. J., & Pattanayak, S. K. (2012). Who adopts improved fuels and cookstoves? A systematic review. *Environ Health Perspect, 120*(5), 637-645. doi: 10.1289/ehp.1104194

Martin, S., Arney, J., Mueller, L., Kumakech, E., Walugembe, F., & Mugisha, E. (2013). Using Formative Research to Design a Behavior Change Strategy to Increase the Use of Improved Cookstoves in Peri-Urban Kampala, Uganda. *International Journal of Environmental Research and Public Health, 10*(12), 6920-6938.

Ministère du Plan. (2007). Enquête Démographique et de Santé République Démocratique du Congo.

Mobarak, A. M., Dwivedi, P., Bailis, R., Hildemann, L., & Miller, G. (2012). Low demand for nontraditional cookstove technologies. *Proceedings of the National Academy of Sciences, 109*(27), 10815-10820. doi: 10.1073/pnas.1115571109

Mobarak, M., & Miller, G. (2013). *Learning about new Technologies through Opinion Leaders and Social Networks: Experimental Evidence On Non-Traditional Stoves in Rural Bangladesh*. Paper. Yale: School of Management. Retrieved from http://faculty.som.yale.edu/mushfiqmobarak/stove_MS.pdf

Perez-Padilla, R., Schilmann, A., & Riojas-Rodriguez, H. (2010). Respiratory health effects of indoor air pollution. *Int J Tuberc Lung Dis, 14*(9), 1079-1086.

Puzzolo, E., Stanistreet, D., Pope, D., Bruce, N., & Rehfuess, E. (2013). Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies: Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre).

Risseeuw, N. (2012). *Household Energy in Mozambique: A study on the socioeconomic and cultural determinants of stove and fuel transitions.* Vrije Universiteit. (2507180)

Ruiz-Mercado, I., Masera, O., Zamora, H., & Smith, K. R. (2011). Adoption and sustained use of improved cookstoves. *Energy Policy, 39*, 7557-7566.

Sesan, T. (2014). Global imperatives, local contingencies: An analysis of divergent priorities and dominant perspectives in stove development from the 1970s to date. *Progress in Development Studies, 14*(1), 3-20. doi: http://dx.doi.org/10.1177/1464993413504345

Smith, K. R., McCracken, J. P., Weber, M. W., Hubbard, A., Jenny, A., Thompson, L. M., . . . Bruce, N. (2011). Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): a randomised controlled trial. *The Lancet, 378*(9804), 1717-1726.

Smith, K. R., Shuhua, G., Kun, H., & Daxiong, Q. (1993). One hundred million improved cookstoves in China: how was it done? *World Development (Oxford), 21*(6), 941-961. doi: 10.1016/0305-750X(93)90053-C

The World Bank. (2011). Household Cookstoves, Environment, Health, and Climate Change: A new look at an old problem.

The World Bank. (2012). Congo, Dem. Rep., from http://data.worldbank.org/country/congo-dem-rep - cp_wdi

Thurber, M. C., Warner, C., Platt, L., Slaski, A., Gupta, R., & Miller, G. (2013). To promote adoption of household health technologies, think beyond health. *Am J Public Health, 103*(10), 1736-1740. doi: 10.2105/ajph.2013.301367

van der Kroon, B., Brouwer, R., & van Beukering, P. J. H. (2013). The energy ladder: Theoretical myth or empirical truth? Results from a meta-analysis. *Renewable and Sustainable Energy Reviews, 20*(0), 504-513. doi: http://dx.doi.org/10.1016/j.rser.2012.11.045

World Health Organization. (2012). World Health Statistics 2012.

(Appendix A) Focus group guides

Qualitative Questionnaire guide for Women's Focus Groups

Introduction

Hello and thank you for being willing to participate in this focus group. My name is _____ and I am going to be the moderator of this discussion. This is _____ he/she will be taking notes. A number of weeks ago, all of you received Peko Pe stoves from IMA. I am here, on behalf of IMA, to learn more about your thoughts and opinions on the stove. IMA is interested in knowing more about whether the Peko Pe stove has met you cooking needs, what specific attributes you like or dislike about the stove, and whether the stove is economical to use. For the next hour we will be discussing together your opinions on the stove. Your opinions will greatly help IMA better inform its program with the stoves in the future.

Again thank you for giving up some of your valuable time. Before we begin the discussion lets lay some ground rules for the group. I am very interested in getting all of your opinions. It's all right if you disagree with one another so don't be afraid to share your perspective even if it's not the same as many others. There are no right or wrong answers to these questions, in fact we are trying to get a diversity of opinions on the this subject so don't be shy. No one needs to speak in order, but it important that everyone take turns speaking loudly so we can be sure to hear one another. Please be respectful of each other throughout the course of the discussion.

Everything you say in this discussion will remain anonymous. If at any point you feel uncomfortable or would like to leave you may do so. To be sure that we do not miss anything important that is said we would like to record this discussion with this device here (show the recorder). Do I have your permission to record the discussion?

(Wait for everyone's consent)

Thank you! Do you have any questions for me at this point? ……..

Lets start first by going around and doing introductions. If you would like, please share your name and maybe also share one thing you really like about cooking with the Peko Pe stove.

Questions on whether the TLUD stove meets women's basic needs and preferences

1) Before receiving the TLUD stove, were you ever dissatisfied with your old stove?
   [Probe: Why or why not? If so, specific characteristics that annoyed you?]

2) What did you think of the TLUD stove when it was presented to you?
   [Probe: Why?]

3) What are some of the differences between cooking with your old cook stove and cooking with TLUD?

4) What are some of the specific characteristics you like about the TLUD stove?
[Probe: portability, appearance, durability, size, heat regulation, length to heat, general cooking speed]

5) Have you experienced any problems cooking with the TLUD stove? Are there aspects of the stove you don't like?
[Probe: portability, appearance, durability, size, heat regulation, length to heat, general cooking speed] [How important is that concern?]

6) What do you think of the taste of food cooked on the TLUD stove?
[Probe: Notice a difference? What kind of difference? Negative or positive feelings about it?]

7) Do you find that the TLUD stove produces less smoke compared to your old stove? If so, is that a change you like about the TLUD stove?
[Probe: Why or why not?]

8) How has using the TLUD stove affected your everyday cooking routines or practices? [Probe: expand on that, give an example.]

9) Does the stove meet your basic cooking needs?

Questions about fuel and economics of stove

10) How do you feel about using wood to fuel the TLUD stove?
[Probe: Is it easier or harder to fuel the TLUD stove compared to fueling your previous stove? More work to fuel with wood? More or less expensive? More or less time consuming?]

11) What are the expenses of using the TLUD stove?
[Probe: Noticeable difference in saving time and money?]

12) If you did not already have the TLUD stove, and it was on sale for 10,000 cfa (Congolese francs), would you be willing to pay for it?
[Probe: What makes it too expensive/not worth it? Or what makes it worth it? Would you be willing to buy it for less? If they think it's worth buying, does the rest of their family (particularly husband) feel the same way?]

13) Are there any factors besides price that might prevent you from choosing to buy and use the TLUD stove?

Questions on social reaction to stove and wrap up questions preference or adoption of stove

14) Has the rest of your family noticed that you have switched to using a new kind of stove? If so what have been their comments and reactions?
[Probe: Positive, Negative?]

15) Would you recommend the TLUD stove to other people in your community?
[Probe: What would you say exactly to recommend it?]

16) If you could make any changes to the TLUD stove to improve it, what would you change?

17) This brings us close to the end of the discussion. Is there anything else you'd like to share regarding your experience with the TLUD stove? Things you liked or disliked about it?

Closing remarks
And that concludes my questions. Thank you so much for your time and the wonderful discussion. I hope you enjoyed the hour. If you have any questions for me feel free to come talk to me I will be here for a little while longer.

<u>Qualitative Questionnaire guide for Men's Focus Groups</u> (Assume that they have never used the stove)

Introduction:
•Present interviews/note takers •Establish focus group ground rules •Assure anonymity and right to leave •Ask for permission to record •Do group introductions

Questions on whether the TLUD stove meets women's basic needs and preferences

1) What did you think of the stove your household used previously before receiving the TLUD stove?
[Probe: Why or why not? If so, specific characteristics that annoyed you?]

2) When the TLUD stove was presented to you did it seem like something you wanted adopt?
[Probe: Why?]

3) What are some of the difference between cooking with your household's previous stove and cooking with TLUD?

4) What are the things you like about the TLUD stove?
[Probe: portability, appearance, durability, size, heat regulation, length to heat, general cooking speed]

5) Have you noted any difficulties cooking with the TLUD stove?
[Probe: Do you dislike any aspects of the stove? portability, appearance, durability, size, heat regulation, length to heat, general cooking speed]

6) What do you think of the taste of food cooked on the TLUD stove?
[Probe: Notice a difference? What kind of difference? Negative or positive feelings about it?]

7) Do you find that the TLUD stove produces less smoke compared to your old stove? If so, is that a change you like about the TLUD stove?
[Probe: Why or why not?]

8) How has using the TLUD stove affeected everyday cooking routines or practices?

Questions about fuel and economics of stove

9) How do you feel about using wood to fuel the TLUD stove?
[Probe: Is it easier or harder to fuel the TLUD stove compared to fueling your households previous stove? More work to fuel with wood? More or less expensive? More or less time consuming?]

10) What are the expenses of using the TLUD stove?
[Probe: Noticeable difference in saving time and money?]

11) If you did not already have the TLUD stove, and it was on sale for 10,000 cfr (Congolese francs), would you be willing to pay for it?

[Probe: What makes it too expensive/not worth it? Or what makes it worth it? Would you be willing to buy it for less? If they think it's worth buying does the rest of their family (particularly wife) feel the same way?]

12) What factors besides price might prevent you from choosing to buy and use the TLUD stove?

Questions on social reaction to stove and wrap up questions preference or adoption of stove

13) Has the family noticed that you have switched to using a new kind of stove? If so, what have been their comments and reactions?

[Probe: Positive, Negative?]

14) Would you recommend the TLUD stove to neighbors and other people in your community?

15) If you could make any changes to the TLUD stove to improve it, what would you change?

16) Is there anything else you'd like to share about your experience with the TLUD stove? Things you liked or disliked about it?

Closing remarks
•Assurances of de-identification •Acknowledgement of time given • Thanks

Qualitative Questionnaire for those that did not like the stove

Introduction

Bonjour et Merci beaucoup pour votre participation dans ce groupe de discussion. Je m'appelle ___(Nom)_____ et je serai la/le modératrice/modérateur de cette discussion. Je vous présente ____(nom)_____ . Il/elle va prendre des notes pendant notre discussion. Il y a quelques semaines passées que votre femme a reçu le foyer amélioré TLUD de PPEJ/PCUSA. Je suis envoyé pour animer cette discussion parce que le PPEJ/PCUSA voudrait savoir si le foyer amélioré TLUD répondait aux besoins culinaires de votre épouse ; s'il y a des caractéristiques spécifiques du foyer qu'elle a aimées ou n'a pas appréciées et aussi s'il est économique d'utiliser le foyer. Pendant une heure et demie, nous discuterons ensemble sur vos opinions du foyer amélioré. Vos opinons sont importantes et aideront le PPEJ/PCUSA à améliorer ses programmes dans l'avenir et plus particulièrement le foyer amélioré.

Avant de commencer, il est important que nous établissions des règles de bases pour le groupe.
Premièrement, tout le monde doit se sentir à l'aise et doit exprimer librement son avis avec respect des autres participants. Ne vous inquiétez pas si vous n'êtes pas d'accords avec les opinions des autres participants. Nous souhaitons recevoir les perspectives diverses, donc c'est nécessaire que tout le monde puisse s'exprimer. En plus souvenez-vous qu'aucune de ces questions ont une réponse correcte ou incorrecte. Tout le monde peut prendre la parole à tour de rôle sans nécessairement suivre l'ordre de siège. Aussi, il est important de parler à haute voix pour être écouté et aussi permettre un bon enregistrement de la discussion.

Tout ce qui sera dit dans cette discussion restera anonyme et ne sera utilisé que pour la recherche. Si vous n'êtes pas à l'aise avec cette discussion, vous pourrez partir à tout monde si vous le souhaitez. Nous procéderons à l'enregistrement de la discussion pour être sûr que toutes les déclarations sont bien recueillies. Lors de l'analyse des données, les noms des participants ne seront pas utilisés.

Est-ce que vous donnez votre accord pour participer dans cette discussion et de l'enregistrer?

Merci !

D'abord nous allons commencer avec des questions sur les types des foyers utilisés **ici dans votre communaut**é, **ensuite nous demander vos préférences et besoins par rapports aux foyers.**

1) Quels sont des types des foyers que vous utilisez habituellement ?

2) D'après vous pourquoi les gens préfèrent ils ces foyers?

3) Pourquoi est-ce que beaucoup des gens utilisent plus d'un type de foyer dans leurs maisons ?
[Sondage : Est-ce que les foyers servent pour des fonctions différentes ?

4) Quelles sont les caractéristiques spécifiques du foyer que vous utilisez en ce moment, que vous appréciez?

5) Parmi les caractéristiques des foyers que vous utilisez, lesquelles n'appréciez-vous pas ? (pas le foyer amélioré)? Pourquoi ?

Parmi vous, plusieurs personnes ont reçu le foyer amélioré mais ne l'ont pas aimé. Nous voulons comprendre pourquoi vous ne l'avez pas aimé et quelles améliorations au foyer vous pensez sont nécessaires?

6) Pourquoi avez-vous rejeté le foyer ?

7) Quelles caractéristiques spécifiques du foyer amélioré n'avez-vous pas aimé?

5) Quels types des changements souhaiterez-vous qu'il soit fait au nouveau foyer pour le rendre plus utile à vous ou pour que vous puissiez l'utiliser ?

8) Que pensez vous du manque de la fumée avec le foyer améliorer ? Pensez vous que c'est une bonne ou mauvaise chose de réduire la fumée ?

Maintenant nous voulons poser des questions par rapport à des circonstances économiques et sociales qui peuvent influencer votre utilisation du foyer et des combustibles.

9) Quelles étaient les réactions des membres de votre famille (mari, enfants, etc.) suite à l'adoption du foyer amélioré ?
[Sondage : Est-ce qu'ils aiment le foyer ou non?]

10) Est-ce que vous serez plus intéressé à utiliser le foyer amélioré si un(e) ami(e) ou un membre de la famille vous dit que le foyer était très utile pour lui et l'a aide à épargner de l'argent ?

11) A ce moment, à votre avis quel est le foyer le moins cher à utiliser?

12) Si vous pourriez créer le foyer parfait, quelles sont les caractéristiques spécifiques vous voudriez voir dans ce foyer pour correspondre

(Appendix B) Survey

Enquête: Culturale, sociale, et économique sur les facteurs qui influence l'adoption par les ménages de foyer biomasse TLUD de combustible-efficace à Kinshasa, D.R.C.

Date ……..
Nom d'Intervieweur ……
 # & Nom de rue/ave .....
Cartier ……..
Commune ……
Ville .....
 # téléphone ……..

INTRODUCTION
Que l'intervieweur lise l'introduction qui suit au répondant:

Mon nom est …….. et je travail avec PPEJ/PCUSA et nous sommes en train de faire une enquête pour mieux comprendre comment une famille normale à Kinshasa fait la cuisson avec son foyer.

Nous voulons aussi avoir votre avis sur le foyer amélioré TLUD, que PPEJ/PCUSA voudrait donner à votre ménage, par rapport à votre foyer existant. L'information de cette étude sera utilisé pour aider PPEJ/PCUSA à mieux comprendre ce qui droit être encore fait pour améliorer le foyer et ainsi fabriquer plus de foyer amélioré comme apport dans son program de santé.
S.V.P. soyez complètement honnêtes avec vos réponses. Vos avis et pensées sur votre foyer existant et le foyer amélioré TLUD de PPEJ/PCUSA nous intéressent beaucoup. L'enquête prendra plus ou moins 20 minutes. Votre participation est tout à fait volontaire et l'information que vous donnez sera gardée en confiance.

Vous n'êtes pas obligé à répondre à une question pour laquelle vous n'êtes pas à l'aise et à tout moment vous pouvez arrêter l'enquête.

Si vous acceptez de faire parti de cette étude et vous prenez le TLUD foyer amélioré de PPEJ/PCUSA, vous acceptez de participer dans les focus groupes qui vont avoir lieu dans plus ou moins un mois. A la fin de focus groupes vous pouvez garder le foyer amélioré.

Est-ce que vous donnez votre accorde de participer dans cette enquête /et étude?

Je le soussigné(e) donne mon
accorde, ……

L'heure du début de l'enquête …… : …… (Exemple 14 :15)

<table>
<tr><td colspan="4">First, I'd like to ask you a few questions about you and your household.</td></tr>
<tr><td>What is your age?</td><td colspan="3">_____ _____</td></tr>
<tr><td>Note the respondent's gender.</td><td colspan="3">☐ Male ☐ Female</td></tr>
<tr><td rowspan="2">How many children, men, and women are a part of your household.

Children are 18 years and younger.
A household member is defined as an individual who sleeps in the house and regularly eats with the household.</td><td>Children</td><td>Men</td><td>Women</td></tr>
<tr><td>_____ _____</td><td>_____ _____</td><td>_____ _____</td></tr>
<tr><td rowspan="4">Who provides income for your household and what is their gender?

What are their income generating activities?

You may list more than one person.</td><td>Gender</td><td colspan="2">Primary income generating activity</td></tr>
<tr><td>☐ Male
☐ Female</td><td colspan="2">☐ Wage labor only
☐ Farming only
☐ Farming and Wage labor
☐ Shop keeping
☐ Other _____</td></tr>
<tr><td>☐ Male
☐ Female</td><td colspan="2">☐ Wage labor only
☐ Farming only
☐ Farming and Wage labor
☐ Shop keeping
☐ Other _____</td></tr>
<tr><td>☐ Male
☐ Female</td><td colspan="2">☐ Wage labor only
☐ Farming only
☐ Farming and Wage labor
☐ Shop keeping
☐ Other _____</td></tr>
</table>

	☐ Male ☐ Female	☐ Wage labor only ☐ Farming only ☐ Farming and Wage labor ☐ Shop keeping ☐ Other _____
Who is your head of household? Note their gender	☐ Male ☐ Female	
What is your highest level of education?	☐ No formal schooling ☐ Primary school ☐ Secondary school ☐ Higher education	
What is the highest level of education of someone else in your family?	☐ No formal schooling ☐ Primary school ☐ Secondary school ☐ Higher education	
Does your household have….	Electricity	☐ Yes ☐ No
	A radio	☐ Yes ☐ No
	A television	☐ Yes ☐ No
	A mobile phone	☐ Yes ☐ No
	A refrigerator	☐ Yes ☐ No
Does any member of this household own…	A watch	☐ Yes ☐ No
	A bicycle	☐ Yes ☐ No
	A motorcycle	☐ Yes ☐ No
	A car or truck	☐ Yes ☐ No
Does this household own livestock, or chickens?	☐ Yes ☐ No	

How many of the following animals does this household own?..	Cows	
	Goats	
	Sheep	
	Chickens	
Does any member of this household own a bank account?	☐ Yes ☐ No	
Who makes decisions in your household when it comes to buying…	Food	☐ Man ☐ Woman ☐ Joint decision
	Clothes	☐ Man ☐ Woman ☐ Joint decision
	Phone Credits	☐ Man ☐ Woman ☐ Joint decision
	Fuel	☐ Man ☐ Woman ☐ Joint decision
	Stove	☐ Man ☐ Woman ☐ Joint decision
	Large appliances (fridge, TV, radio)	☐ Man ☐ Woman ☐ Joint decision

Now I'm going to ask you some questions about your stove use and the new stove you received.	
Who is mainly responsible for cooking in your household?	☐ Male ☐ Female
How many hot meals does you household consume per day?	☐ 1 ☐ 2 ☐ 3 ☐ 4

<table>
<tr><td>Do you think that smoke from cooking affects the health of your household?</td><td colspan="2">☐ Yes ☐ No</td></tr>
<tr><td rowspan="9">Please list the type of stove or stoves you had in your household before receiving the TLUD?

What kind of fuel does the stove or stoves use?</td><td>Type of stove</td><td>Fuel Type</td></tr>
<tr><td colspan="2">1st Stove</td></tr>
<tr><td>☐ Open fire
☐ Charcoal stove
☐ Wood stove
☐ Kerosene stove
☐ Electric stove
☐ Other
_____</td><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td></tr>
<tr><td colspan="2">2nd Stove</td></tr>
<tr><td>☐ Open fire
☐ Charcoal stove
☐ Wood stove
☐ Kerosene stove
☐ Electric stove
☐ Other
_____</td><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td></tr>
<tr><td colspan="2">3rd Stove</td></tr>
<tr><td>☐ Open fire
☐ Charcoal stove
☐ Wood stove
☐ Kerosene stove
☐ Electric stove
☐ Other
_____</td><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td></tr>
<tr><td colspan="2">4th Stove</td></tr>
<tr><td>☐ Open fire
☐ Charcoal stove
☐ Wood stove
☐ Kerosene stove
☐ Electric stove
☐ Other
_____</td><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td></tr>
</table>

Before you received the TLUD stove, how often were you using the previous stove or stoves?	☐ Everyday ☐ Several times a week ☐ Once a week ☐ Less than once a week
Since receiving the TLUD stove, how often have you used your previous stove(s)?	☐ Everyday ☐ Several times a week ☐ Once a week ☐ Less than once a week
Do you cook with the TLUD stove indoors outdoors or both?	☐ Indoors ☐ Outdoors ☐ Both
Does the TLUD stove produce more or less smoke than the one you used before?	☐ More ☐ Less ☐ The same
Is it easier or harder to cook with the TLUD stove compared to your previous one?	☐ Easier ☐ Harder ☐ The same
Does it take longer or shorter to start this stove compared to your previous one?	☐ Longer ☐ Shorter ☐ The same ☐ I don't know
Does it take longer or shorter to prepare food with this stove compared to your previous one?	☐ Longer ☐ Shorter ☐ The same ☐ I don't know
What do you think of the size of the TLUD stove?	☐ Too tall ☐ Too small ☐ Too short ☐ Good size
Do you like the appearance of the TLUD stove? If not what do you not like about it?	☐ Yes ☐ No _____
Is there anything you dislike about the stove?	☐ Not stable enough

	☐ Not durable enough ☐ Too tall ☐ It's not large enough ☐ It lets off too much smoke when the wood is wet ☐ Not easy to find wood in the market ☐ The flames burn the pot ☐ It takes longer to prepare the wood for fuel ☐ It's hard to keep the flame going ☐ Hard to restart once you start it ☐ Other _____
What are the greatest benefits of the stove?	☐ It cooks food quicker ☐ Less smoke when the wood is dry ☐ It's portable ☐ Can reuse the charcoal for other cooking ☐ Can use the charcoal to fertilize garden ☐ Food retains taste better ☐ It's less expensive to fuel ☐ It regulates heat well ☐ Other _____

Now I'm going ask you some questions about finances related to the stove.	
Where did you buy your previous stove or stoves?	☐ In the market ☐ From a store ☐ From a neighbor ☐ I made my stove ☐ I don't know
Who in your family usually buy's your stoves? Note their gender.	☐ Male ☐ It depends ☐ Female ☐ We don't buy our stoves

How often do you purchase a new stove?	☐ Every few months ☐ Every year ☐ Every 2-5 years ☐ Every 5-10 years ☐ I don't know		
If you needed to buy a new stove. Would you prefer to buy the TLUD stove over others?	☐ Yes ☐ No		
If you were trying to sell the stove to someone else. How much would you ask for it?	_____ _____ _____ ____ fr		
Would you be willing to pay 10,000 fr for the stove?	☐ Yes	Would you be willing to pay 12,000 cfr?	☐ Yes
			☐ No
	☐ No	Would you be willing to pay 8,000 cfr	☐ Yes
			☐ No
What is the highest you would be willing to pay for the TLUD stove?	_____ _____ _____ ____ fr		
If you could pay for the stove in incremental funding every few weeks. Would you be willing to pay more?	☐ Yes ☐ No		
Would you pay more for the TLUD stove if it had a more stable base?	☐ Yes ☐ No		
Would you pay more for the TLUD stove if it was made from a stronger metal?	☐ Yes ☐ No		

Now I'm going to ask you some questions about your fuel use			
What kind of cooking fuel do you gather to	Type of fuel	Location	Minutes to obtain
	1st Stove		

<table>
<tr><td rowspan="6">fuel your stoves (including the TLUD stove) in your household?

Where do you obtain each type of fuel?

How many minutes must you travel to obtain these fuel sources?</td><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td><td>☐ Neighborhood Market
☐ Door to door service
☐ From the surrounding yard
☐ Nearby trees/forest
☐ Other
_____</td><td>_____
_____</td></tr>
<tr><td colspan="3">2nd Stove</td></tr>
<tr><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td><td>☐ Neighborhood Market
☐ Door to door service
☐ From the surrounding yard
☐ Nearby trees/forest
☐ Other
_____</td><td>_____
_____</td></tr>
<tr><td colspan="3">3rd Stove</td></tr>
<tr><td>☐ Wood
☐ Charcoal
☐ Kerosene
☐ Electricity
☐ Other
_____</td><td>☐ Neighborhood Market
☐ Door to door service
☐ From the surrounding yard
☐ Nearby trees/forest
☐ Other
_____</td><td>_____
_____</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="4">Who obtains the cooking fuel you use in your household and what is/are their gender(s) age(s)</td><td>Gender</td><td>Age</td></tr>
<tr><td>☐ Male
☐ Female</td><td>_____ _____</td></tr>
<tr><td>☐ Male
☐ Female</td><td>_____ _____</td></tr>
<tr><td>☐ Male
☐ Female</td><td>_____ _____</td></tr>
<tr><td>How easy is it to find fuel for the TLUD stove compared to you other one?</td><td colspan="2">☐ Easier ☐ Harder ☐ The same</td></tr>
</table>

Do you feel that using the TLUD stove has reduced your household fuel costs?	☐ Easier ☐ Harder ☐ The same
Since receiving the TLUD stove, how much fuel (in gallons, kilograms, bags) had your household consumed per week?	_____ _____ _____ Unit _____
Since receiving the TLUD stove how, many francs has your household spent on fuel per week?	_____ _____ _____ _____ CFA
If you could cook with any kind of fuel what would you prefer to use?	☐ Wood ☐ Charcoal ☐ Kerosene ☐ Electricity ☐ Other _____

(Appendix C) Codebook

Code Name	Question	English Code	Lingala Code	# Number	Data Results
survey_ID				1-40	
intvr_ID:			Lulendo-Rose	1	
			Dikoko-Marie	2	
			Kipasa-Odette	3	
			Bambi-Helene	4	
			Mitungu-Justine	5	
			Lunduata-Marie-Claire	6	
			Ngoy-Helene	7	
			Mutukulu-Julienne	8	
			Mwika-Victorinne	9	
age	What is your age?	_____	_____	_____	
sex_infrmt	Note the respondent's gender	Men	Mobali	1	
		Woman	Muasi	2	
nbre_HH	How many members are a part of your household?	_____	_____	_____	
contributer_sex_1	Who provides income for your household? what is their gender?	Men	Mobali	1	
		Woman	Muasi	2	
work_1	What are their income generating activities?	Shop-Keeping	Koteka	1	
		Wage labor only	Lifuti ya suka ya sanza	2	
		Other	Misusu	3	
		Farming only	Bilanga	4	
		Carpenter	Menuisier	5	
		Hair dresser	Tresseuse de cheveux	6	
contributer_sex_2	Who provides income for your household? what is their gender?	Men	Mobali	1	
		Woman	Muasi	2	
work_2	What are their income generating activities?	Shop-Keeping	Koteka	1	
		Wage labor only	Lifuti ya suka ya sanza	2	
		Other	Misusu	3	
		Farming only	Bilanga	4	
		Carpenter	Menuisier	5	
		Hair dresser	Tresseuse de cheveux	6	
contributer	Who provides	Men	Mobali	1	

_sex_3	income for your household? what is their gender?	Woman	Muasi	2	
work_3	What are their income generating activities?	Shop-Keeping	Koteka	1	
		Wage labor only	Lifuti ya suka ya sanza	2	
		Other	Misusu	3	
		Farming only	Bilanga	4	
		Carpenter	Menuisier	5	
		Hair dresser	Tresseuse de cheveux	6	
total_nbr_contributers		_____	_____	_____	
head_HH	Who is your head of household? Note their gender	Man	Mobali	1	
		Woman	Muasi	2	
infrmt_edu_level	What is your highest level of education?	No schooling	Atanga-te	1	
		Primary school	Ecole-Primaire	2	
		Secondary school	Ecole-Secondaire	3	
		Higher education	Niveau-Superieur	4	
highest_edu_level	What is the highest level of education of someone else in your family?	No schooling	Atanga-te	1	
		Primary school	Ecole-Primaire	2	
		Secondary school	Ecole-Secondaire	3	
		Higher education	Niveau-Superieur	4	
courant	Does your household have electricity?	Yes	Iyo	1	
		No	Te	2	
radio	Does your household have a radio?	Yes	Iyo	1	
		No	Te	2	
tv	Does your household have a tv?	Yes	Iyo	1	
		No	Te	2	
phone	Does your household have a telephone?	Yes	Iyo	1	
		No	Te	2	
frigo	Does your household have a refrigerator?	Yes	Iyo	1	
		No	Te	2	
montre	Does someone in your household have a watch?	Yes	Iyo	1	
		No	Te	2	
velo	Does someone in your household have a bike?	Yes	Iyo	1	
		No	Te	2	
car	Does someone in	Yes	Iyo	1	

	your household have a car?	No	Te	2	
bnk_account	Does anyone in your family own a bank account?	Yes	Iyo	1	
		No	Te	2	
dec_food	Who makes decisions in your household when it comes to buying food?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
dec_habits	Who makes decisions in your household when it comes to buying clothes?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
dec_units	Who makes decisions in your household when it comes to buying phone credits?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
dec_fuel	Who makes decisions in your household when it comes to buying fuel?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
dec_stove	Who makes decisions in your household when it comes to buying stoves?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
dec_equip	Who makes decisions in your household when it comes to buying large appliances?	Man	Mobali	1	
		Woman	Muasi	2	
		Both		3	
sex_cook	Who is mainly responsible for cooking in your household?	Man	Mobali	1	
		Woman	Muasi	2	
selection_nbre	How many hot meals does you household consume per day?	_____	_____	_____	
fumee	Do you think that smoke from cooking affects the health of your household?	Yes	Iyo	1	
		No	Te	2	
stove_1	Type of stove or stoves you had in your household				
		Charcoal stove	Mbabola	2	
		Open fire	Moto-ya-koni	3	

	before receiving the TLUD.	Electric stove	Rechaud-ya-courant	5	
		Kerosene stove	Rechaud-ya-petrol	6	
		Wood stove	Lituka-ya-poussiers	7	
		Batteries	Piles	8	
fuel_1	What kind of fuel does the stove or stoves use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust stove	Poussieres ya makala	6	
		Wood dust stove	Poussiere ya koni	7	
		Batteries	Piles	8	
stove_2	Type of stove or stoves you had in your household before receiving the TLUD.				
		Charcoal stove	Mbabola	2	
		Open fire	Moto-ya-koni	3	
		Electric stove	Rechaud-ya-courant	5	
		Kerosene stove	Rechaud-ya-petrol	6	
		Wood stove	Lituka-ya-poussiers	7	
		Batteries	Piles	8	
fuel_2	What kind of fuel does the stove or stoves use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust stove	Poussieres ya makala	6	
		Wood dust stove	Poussiere ya koni	7	
		Batteries	Piles	8	
stove_3	Type of stove or stoves you had in your household before receiving the TLUD.				
		Charcoal stove	Mbabola	2	
		Open fire	Moto-ya-koni	3	
		Electric stove	Rechaud-ya-courant	5	
		Kerosene stove	Rechaud-ya-petrol	6	
		Wood stove	Lituka-ya-poussiers	7	
		Batteries	Piles	8	
fuel_3	What kind of fuel does the stove or stoves use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya	6	

		stove	makala		
		Wood dust stove	Poussiere ya koni	7	
		Batteries	Piles	8	
stove_4	Type of stove or stoves you had in your household before receiving the TLUD.				
		Charcoal stove	Mbabola	2	
		Open fire	Moto-ya-koni	3	
		Electric stove	Rechaud-ya-courant	5	
		Kerosene stove	Rechaud-ya-petrol	6	
		Wood stove	Lituka-ya-poussiers	7	
		Batteries	Piles	8	
fuel_4	What kind of fuel does the stove or stoves use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust stove	Poussieres ya makala	6	
		Wood dust stove	Poussiere ya koni	7	
		Batteries	Piles	8	
Petrol	Use of petrol for non-petrol stove purposes	----------	----------	1	
nbre_debut	Before you received the TLUD stove, how often were you using the previous stove or stoves?	Everyday	Mikolo-nionso	1	
		Several times a week	Mbala-ebele-na-poso	2	
nbre_semaine	Since receiving the TLUD stove, how often have you used your previous stove(s)?	Everyday	Mikolo-nionso		
		Several times a week	Mbala-ebele		
lieu_usage	Do you cook with the TLUD stove indoors outdoors or both?	Indoors	Na-kati	1	
		Outdoors	Na-libanda	2	
		Both	Kisika-nionso-mibale	3	
quantite_fumee	Does the TLUD stove produce more or less smoke than the one you used before?	More	Ebele	1	
		Less	Muke	2	
		The same	Ndenge moko	3	
difficulte	Is it easier or	Harder	Pasi	1	

	harder to cook with the TLUD stove compared to your previous one?	Easier	Pete	2	
allumage	Does it take longer or shorter to start this stove compared to your previous one?	Shorter	Ngonga-mukuse	1	
		The same	Ndenge-moko	2	
		Longer	Ngonga-ebele	3	
duree	Does it take longer or shorter to prepare food with this stove compared to your previous one?	Shorter	Ngonga-muke	1	
		The same	Ndenge-moko	2	
		Longer	Ngonga-ebele	3	
grandeur	What do you think of the size of the TLUD stove?	Too tall	Eleki-molayi	1	
		Good size	Eza-bien-bongo	2	
		Too small	Eleki-muke	3	
appreciation	Do you like the appearance of the TLUD stove?	Yes	Iyo	1	
		No	Te	2	
dislike_pamba	Ezo-ningana-pamba-pamba	Yes	Iyo	1	
		No	Te	2	
dislike_ebele	Ezo-sala-milinga-ebele	Yes	Iyo	1	
		No	Te	2	
dislike_beba	Ezo-wumela-te-na-ko-beba	Yes	Iyo	1	
		No	Te	2	
dislike_molayi	Eleki-molayi	Yes	Iyo	1	
		No	Te	2	
dislike_muke	Eleki-muke	Yes	Iyo	1	
		No	Te	2	
dislike_wenze	Eza-pasi-ko-zua-koni-na-wenze	Yes	Iyo	1	
		No	Te	2	
dislike_nzungu	Milinga-nango-ezo-bebisa-ba-nzungu	Yes	Iyo	1	
		No	Te	2	
dislike_mike	Ezo-zua-ngonga-ebele-pona-ko-kata-koni-mike-mike	Yes	Iyo	1	
		No	Te	2	
dislike_pela	Eza-pasi-pona-ko-batela-moto-ya-ko-pela	Yes	Iyo	1	
		No	Te	2	
dislike_lamba	Eza-pasi-pona-ko-pelisa-lisusu-moto-soki-ya-	Yes	Iyo	1	
		No	Te	2	

	liboso-ekufi-tango-ozo-lamba				
benefits_noki	Makusa-ekomi-noki-noki	Yes	Iyo	1	
		No	Te	2	
benefits_kawuka	Ezo-sala-milinga-muke-soki-koni-eza-ya-ko-kawuka	Yes	Iyo	1	
		No	Te	2	
benefits_ememeli	Ememeli-nango-eza-pasi-te	Yes	Iyo	1	
		No	Te	2	
benefits_makala	Okoki-ko-salela-makala-nango-pona-leyisa-mabele-ya-bilanga	Yes	Iyo	1	
		No	Te	2	
benefits_misusu	Ezo-pesa-makala-oyo-okoki-ko-lambela-biloko-misusu	Yes	Iyo	1	
		No	Te	2	
benefits_nango	Bileyi-ezo-batela-elengi-nango	Yes	Iyo	1	
		No	Te	2	
benefits_salela	Ezo-sena-koni-ebele-te-pona-ko-salel	Yes	Iyo	1	
		No	Te	2	
benefits_moto	Ezo-batela-moto-malamu	Yes	Iyo	1	
		No	Te	2	
qui_achete	Who in your family usually buy's your stoves? Note their gender.	Man	Mobali	1	
		Woman	Muasi	2	
		It depends	Ekipaka-mutu-te	3	
temps_achat	How often do you purchase a new stove?	Every few months	Sima-ya-mua-ba-sanza	1	
		Every year	Sima-ya-mbula-moko	2	
		I don't know	Na-yabi-te	3	
achat_suivant	If you needed to buy a new stove. Would you prefer to buy the TLUD stove over others?	The TLUD stove	Lituka TLUD	1	
		Another stove	Lituka mususu	2	
prix_tlud	If you were trying to sell the stove to someone else. How much would you ask for it?	_____	_____	_____	
cout_10	Would you be willing to pay	Yes	Iyo	1	
		No	Te	2	

	10,000 fr for the stove?				
cout_achat	What is the highest you would be willing to pay for the TLUD stove?	_____	_____	_____	
payment	If you could pay for the stove in incremental funding every few weeks. Would you be willing to pay more?	Yes	Iyo	1	
		No	Te	2	
achat_eleve	Would you pay more for the TLUD stove if it had a more stable base?	Yes	Iyo	1	
		No	Te	2	
achat_metal	Would you pay more for the TLUD stove if it was made from a stronger metal?	Yes	Iyo	1	
		No	Te	2	
type_feul_1	What kind of cooking fuel do you gather to fuel your stoves (including the TLUD stove) in your household?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	
lieu_1	Where do you obtain each type of fuel?	The Market	Wenze	1	
		Door to door service	Batu-ba-lekaka-na-ba-ndaku	2	
time_fuel_1	How many minutes must you travel to obtain these fuel sources?	_____	_____	_____	
type_feul_2	What kind of cooking fuel do you gather to fuel your stoves (including the TLUD stove) in your household?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	
lieu_2	Where do you obtain each type		Wenze	1	
			Batu-ba-lekaka-	2	

	of fuel?		na-ba-ndaku		
time_fuel_2	How many minutes must you travel to obtain these fuel sources?	_____	_____	_____	
type_feul_3	What kind of cooking fuel do you gather to fuel your stoves (including the TLUD stove) in your household?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	
lieu_3	Where do you obtain each type of fuel?	The market	Wenze	1	
		Door to door service	Batu-ba-lekaka-na-ba-ndaku	2	
time_fuel_3	How many minutes must you travel to obtain these fuel sources?	_____	_____	_____	
qui_apporte_1	Who obtains the cooking fuel you use in your household and what is/are their gender(s) age(s)	Man	Mobali	1	
		Woman	Muasi	2	
		It depends	Ekipaka-mutu-te	3	
qui_apporte_2	Who obtains the cooking fuel you use in your household and what is/are their gender(s) age(s)	Man	Mobali	1	
		Woman	Muasi	2	
		It depends	Ekipaka-mutu-te	3	
qui_apporte_3	Who obtains the cooking fuel you use in your household and what is/are their gender(s) age(s)	Man	Mobali	1	
		Woman	Muasi	2	
		It depends	Ekipaka-mutu-te	3	
outillage	How easy is it to find fuel for the TLUD stove compared to you other one?	Easier	Pasi	1	
		Harder	Pete	2	
		The same	Ndenge moko	3	
economie	Do you feel that using the TLUD stove has reduced your household fuel costs?	Yes	Iyo	1	
		No	Te	2	
		The same	Ndenge moko	3	
quantite	Since receiving	_____	_____	_____	

	the TLUD stove, how much fuel (in gallons, kilograms, bags) had your household consumed per week?				
sortie					
montant					
materiel_1	If you could cook with any kind of fuel what would you prefer to use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	
materiel_2	If you could cook with any kind of fuel what would you prefer to use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	
materiel_3	If you could cook with any kind of fuel what would you prefer to use?	Wood	Koni	1	
		Charcoal	Makala	2	
		Kerosene	Petrol	3	
		Electricity	Courant	4	
		Other	Misusu	5	
		Charcoal dust	Poussieres ya makala	6	
		Wood dust	Poussiere ya koni	7	

Appendix D: Summary of survey results

Age of respondents
38 responses
Average age: 46.97
Maximum age: 80
Minimum age: 20

Gender of respondents
38 responses
2 men – 5.2%
36 women – 94.7%

Number of members of household
40 responses
Average #: 7.48
Maximum #: 15
Minimum #: 5

Gender of members that provide income to the household
54 total income providers listed
33 men - 61%
21 women - 39%

Types of income generating activities
50 types of income generating activities listed
25 said shop keeping – 50%
16 said wage labor – 32%
1 said other – 2%
5 said farming only – 10%
3 said carpenter – 6%

Average number of contributors to each household
1.35
1-3 contributors

Gender of head of household
38 responses
30 men – 79%
8 women – 21%

Interviewee highest level of education
40 responses
4 no schooling – 10%

12 primary school – 30%
17 secondary school – 42.5%
7 higher education – 17.5%

Highest level of education among members in the household
40 responses
1 no schooling – 2.5%
4 primary school – 10%
21 secondary school – 52.5%
14 higher education – 35%

Household has electricity
36 responses
26 yes – 72%
10 no – 28%

Household has radio
38 responses
22 yes – 58%
16 no – 42%

Household has tv
39 responses
26 yes – 66.7%
13 no - 33.3%

Household has phone
40 responses
24 yes - 60%
16 no - 40%

Household has refrigerator
39 responses
6 yes – 15.4%
33 no – 84.6%

Household has watch
40 responses
18 yes – 45%
22 no – 55%

Household has bike
38 responses
0 yes – 0%
38 no – 100%

Household has car
39 responses
1 yes – 2.6%
38 no – 97.4%

Household has a bank account
39 responses
2 yes – 5%
37 no – 95%

What is the gender of the person in the household that makes the decision about purchasing food
39 responses
19 men – 49%
15 women – 38%
5 both – 13%

What is the gender of the person in the household that makes the decision about purchasing clothes
38 responses
20 men – 53%
14 women – 37%
4 both – 10%

What is the gender of the person in the household that makes the decision about purchasing phone units
28 responses
14 men – 50%
8 women – 29%
6 both – 21%

What is the gender of the person in the household that makes the decision about purchasing fuel
36 responses
2 men – 6%
31 women- 86%
3 both - 8%

What is the gender of the person in the household that makes the decision about purchasing stoves
36 responses
1 men – 3%
32 women – 89%
3 both – 8%

What is the gender of the person in the household that makes the decision about purchasing large hh equipment
27 responses
21 men – 78%
5 women – 18%
1 both – 4%

Gender of person who cooks in the household
100% women

How many hot meals do households consume per day
40 responses
10 eat 1 meal a day – 25%
30 eat 2 meals a day – 75%
Avg: 1.75 meals

How many think that smoke from cooking affects the health of household
40 responded
24 yes – 60%
16 no – 40%

What types of stoves did households use before receiving the TLUD stove
87 stoves listed
40 charcoal stoves – 46%
23 open fire/wood stove – 26.4%
8 electric stoves – 9.2%
2 kerosene stoves – 2.3%
11 wood stoves – 12.6%
3 battery stoves – 3.5%

What fuels did they use for these stoves
99 fuels listed
25 listed wood – 25.3%
39 listed charcoal – 39.4%
18 listed kerosene – 18.2%
8 listed electricity – 8.1%
0 listed other – 0%
8 listed charcoal dust - 8%
0 listed wood dust – 0%
1 listed batteries – 1%

Average # of stoves per household before receiving the TLUD
Average 2.2

How often households used previous stoves before receiving the TLUD
40 responses

40 said everyday – 100%

How often households used their previous stoves now that they have received the TLUD
37 responses
17 said every day – 46%
20 said several times a week – 54%

Where households cook with the TLUD stove
40 responses
1 said indoors – 2.5%
33 said outdoors – 82.5%
6 said both – 15%

Do household members think the TLUD stove produces more or less smoke than the stoves they used before
38 responses
32 said more – 84%
6 said less – 16%

Do household members think the TLUD stove is more or less difficult to use compared to the stoves they used before
40 responses
19 said it was harder – 48%
21 said easier – 52%

Do household members think the TLUD stove takes longer or shorter to start compared to the stoves they used before
40 responses
29 said shorter – 72.5%
11 said longer – 27.5%

Do household members think it takes longer or shorter to prepare food with this stove compared to the ones they used before
40 responses
35 said shorter – 87.5%
1 said the same – 2.5%
4 said longer – 10%

What interviewees think of the TLUD stove's size
40 responses
23 too tall – 57.5%
14 said good size – 35%
3 said too small – 7.5%

What interviewees think of the TLUD stove's appearance

40 responses
36 said yes they like it – 90%
4 said no – 10%

Did not think the stove was stable enough
40 responses
22 said that yes it was not stable enough – 55%
18 said no the stability was fine – 45%

Did not like the smoke when wet
40 responses
28 said it lets off too much smoke – 70%
12 didn't mind

Did not think it was durable enough
40 responses
17 said it was not durable enough – 42.5%

Thought it was too tall
40 responses
24 said it was too tall – 60%

Thought it was not large enough
40 responses
4 said it was not large enough – 10%

Thought it was not easy to find wood in the market
40 responses
27 said it was not easy to find wood in the market – 67.5%

Disliked that the flames burned the pot
40 responses
22 said that the flames burn the pot – 55%

Disliked that it took longer to prepare the wood for fuel
40 responses
16 said that it takes longer to prepare the wood for fuel – 40%

Disliked that it was hard to keep the flame going
40 responses
9 said that it was hard to keep the flames going – 22.5%

Disliked that it was hard to restart once it had been fired once
40 responses
25 said that it's hard to restart once you've already tried starting once – 62.5%

Liked that it cooked food quicker
40 responses
29 said it cooks food quicker – 72.5%

Liked that there was less smoke when the wood was dry
40 responses
24 less smoke when the wood is dry – 60%

Liked that it was portable
40 responses
19 it's portable – 47.5%

Like that you can reuse the charcoal for other cooking
40 responses
31 said they like that you can reuse the charcoal – 77.5%

Like that you can use the charcoal to fertilize the garden
40 responses
35 said they like that you can use it to fertilize the garden – 87.5%

Like that food retains taste better
40 responses
23 said that food retains taste better – 57.5%

Like that it's less expensive to fuel
40 responses
16 said that it is less expensive to fuel – 40%

Like that it regulates heat well
40 responses
22 said that it regulates heat well – 55%

Where households buy their stove?
100% the market

Who buys stoves?
40 responses
37 women – 92.5%
2 men – 5%
1 don't know- 2.5%

How often households purchase new stoves
40 responses
31 said every few months – 75%
8 said every year – 22.5%
1 said they don't know – 2.5%

If household needed to buy a new stove would they prefer to buy the TLUD stove or another
37 responses
15 said TLUD stove – 40.5%
22 said another stove – 59.5%

For how much would the interviewee sell the stove
39 responses
2 missing data
Avg. of 1,769.2 Fc
Max 5000
Min 1000
Mode: 1500

What's the highest they would be willing to pay for the TLUD stove
38 responses
2 missing data points
Avg. of 2,065.8 Fc
Max 5,000
Min 500
Mode: 2,000

Would they be willing to pay more if they could pay for the stove on credit
39 responses
21 responses – 54%
18 said no – 46%

Would they be willing to pay more if the stove had a more stable base
39 responses
20 said yes – 51%
19 said no – 49%

Would they be willing to pay more if the stove was made from a stronger metal
40 responses
24 said yes – 60%
16 said no – 40%

Kinds of cooking fuels households gather to fuel their stoves including the TLUD
68 responses
37 said wood – 54%
11 said charcoal - 16%
19 said kerosene – 28%

Where they obtain these fuels

58 responses
51 said the market – 88%
7 said "The people who pass by you or your house." – 12%

How many minutes they travel to obtain these fuels sources
38 responses
Avg. 25 minutes
Minimum 5 minutes
Maximum 105 minutes
Mode 15 minutes

(Removing 105 minutes, it's an average of 23 minutes and a maximum of 90 minutes)

Gender of the person who gathers the fuel
56 responses
5 men – 9%
51 women – 91%

Age of people who go collect the fuel
41 responses
Avg. 41.45
Minimum 10
Maximum 80

Ease of finding fuel for the TLUD stove compared to finding fuel for other stoves
40 responses
31 said it was easier to find fuel for this than the other stoves – 77.5%
8 said it was harder – 20%
1 said it was about the same – 2.5%

Feel that using the TLUD stove has reduced household fuel costs
40 responses
20 said yes - 50%
18 said no – 45%
2 said it's about the same – 5%

How much fuel in gallons, kilograms, bags had your household consumed per week?
39 responses
19 used 1 bag
14 used 2 bags

What fuel household members would prefer to use
87 responses
36 said wood

6 said charcoal
33 said kerosene
3 said electricity
8 said other / mainly matches