FUEL EFFICIENT STOVE PROGRAMS IN IDP SETTINGS – SUMMARY EVALUATION REPORT, UGANDA

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1. Introduction: Evaluation Objectives

Around the world, conflict and natural disasters have displaced millions of people. Displaced populations fleeing to settlement camps and seeking safety in host villages often put great stress on natural resources, leading to environmental degradation and conflict with local populations. One of the greatest needs of all people affected by crisis, be they displaced, settled or on the move, is firewood or other types of fuel to heat their homes, cook their food, and treat water for drinking and food preparation. The risks endured (especially by women and children) collecting sometimes scarce wood resources constitute some of the most challenging and serious protection concerns both in IDP camps and in villages where the conflict over resources is high.

USAID's Office of Foreign Disaster Assistance (OFDA) has been one of the key US Government funders of humanitarian agencies implementing fuel-efficient stove (FES) programs in IDP settings. The FES programs are intended to help the agencies accomplish various goals, such as improve food security or decrease deforestation, by reducing fuel consumption. However, the large number of implementers, their varying motives and degrees of expertise, and differing conditions within and among IDP communities have made it difficult for OFDA to determine the relative efficacy of the FES interventions and provide guidelines for USAID-funded entities working in IDP settings.

Therefore, OFDA enlisted the assistance of the USAID Energy Team to undertake a multi-phase evaluation in order to derive "best practices" for future FES interventions. While the primary purpose of this evaluation is to provide guidance to USAID-funded organizations, USAID hopes to inform the broader humanitarian community by sharing the results of the evaluation with them as well. Eventually, the best practices will be developed into a series of recommendations and toolkits for use by NGOs, donors, and other groups operating FES programs in IDP settings.

Phase I of the evaluation process (November 2006) was a desk study of recent FES projects in refugee and IDP settings. Based on the Desk Study findings, Phase II (December 2006) entailed the development of a methodology for conducting the evaluation fieldwork. Phase III consisted of on-site research in IDP camps in Northern Uganda and is the subject of this report. A second field test is planned for Darfur, Sudan. Phase IV will entail the development of appropriate methodologies for future FES interventions and will be completed after the fieldwork.

The Phase III field research was carried out through a two-week data-collection mission in January/February 2007, and a 12-day verification mission in March/April, which included additional data collection where required. The evaluation team consisted of Ugandan and international experts in household energy, humanitarian, and gender issues, as well as USAID staff. During the two missions the evaluators investigated the FES programs of four NGOs in Gulu, Kitgum and Lira districts. Two of the NGOs had received funding from USAID. The NGOs are not named in this report and are identified only as NGO A, B, C and D.

The evaluation methodology incorporated a number of different tools in order to collect both quantitative and qualitative data on the FES programs. The underlying objectives were to determine 1) if the FES interventions were meeting their fuel saving goals, and 2) why or why not.

Specific areas examined included:

- Cooking technologies
- User outreach and education programs
- Stove production and dissemination strategies
- FES project monitoring and evaluation (M&E) frameworks

This summary report consolidates the findings from the programs that were evaluated and presents OFDA with preliminary recommendations designed to improve the impact and quality of its future support to FES activities in IDP situations. Final recommendations and "lessons learned" will be developed after the Sudan evaluation is completed.

2. Executive Summary

Fuel-efficient stoves (FES) may deliver numerous benefits to households in developing countries, including fuel and time savings, reduced exposure to smoke, and less danger from fire and burns. Programs promoting FES may therefore seem well-suited to IDP settings, where such multi-sectoral benefits typically are urgently needed. But moving a project forward from a proposal to one capable of realizing verifiable benefits can be a complex undertaking.

To better understand FES program drivers and outcomes, the USAID evaluation in Northern Uganda examined three types of FES being promoted by four different non-government organizations (NGOs), to ascertain whether the stoves were indeed reducing fuel consumption. In addition, the evaluation team sought to identify behavioral and programmatic factors that influenced the likelihood of the FES programs meeting their fuel savings and other goals. The evaluation revealed that not all stoves being promoted in Northern Uganda were appropriate, nor were all improved stove programs being implemented appropriately. Key findings of the evaluation include:

- Field staff work in extremely difficult conditions, and face considerable pressure to deliver results quickly. All of the NGOs examined had succeeded in disseminating stoves to large numbers of camp residents.
- Stove efficiency tests conducted by the evaluation team could not verify fuel saving claims reported by the evaluated NGOs. Some of the stoves tested consumed more fuel than the open fire.
- Implementing NGOs had insufficient quality control systems in place to guide their programs. Few NGOs had collected baseline data, monitoring and evaluation procedures were weak, and too much emphasis was placed on quantity, rather than quality, of stoves produced.
- Many field staff are overburdened, and lack the requisite time and technical expertise to successfully implement FES programs. Headquarters support was largely non-existent, especially for programs in which FES were just one component of a broader strategy (i.e., food security, livelihoods).
- NGOs that sought to standardize stove production, via paid specialist staff or mass production techniques, were better able to maintain design parameters critical for efficient combustion than NGOs that relied on beneficiaries to build their own stoves.
- Implementing NGOs need to spend more time on enduser education, to ensure behavior change messages are transmitted effectively and that beneficiaries know how to use their stoves to obtain maximum benefits.

Focus group discussions and one-on-one interviews revealed that IDPs in Northern Uganda are very interested in new cooking technologies, and especially welcome benefits that improve their overall quality of life (such as keeping ashes contained and soot out of the food). The evaluation team concludes that the promotion of FES remains a valid intervention for humanitarian assistance programs, but recommends that donors set specific minimum standards to increase the likelihood that FES programs will obtain their objectives. In particular, FES programs should first demonstrate the capacity of particular stoves to reduce energy consumption in the camps in which they are to be promoted BEFORE they are produced and disseminated on a large scale.

This will require the application of certain technical standards and realistic testing protocols, as well as the appropriate staff composition at the NGO level. Measures to monitor and improve quality control of stove production should also be incorporated into all FES programs.

Finally, there are other technologies that can help conserve energy in addition to stoves, and the team recommends that donors and implementing NGOs consider integrated methods to minimize fuel consumption and maximize time savings. In areas like Northern Uganda where the prevailing diet includes slow-cooking foods such as beans, introduction of retained heat cookers may be a worthwhile addition to FES programs.

3. Northern Uganda

3.1 Introduction

Over the past 20 years, Northern Uganda has suffered from a series of conflicts between the government and various rebel movements, the most prominent and long-running of which has been with the Lord's Resistance Army (LRA). The LRA began an insurgency in Acholi-land in 1987 and this spread to Lango and Teso in 2003[1].

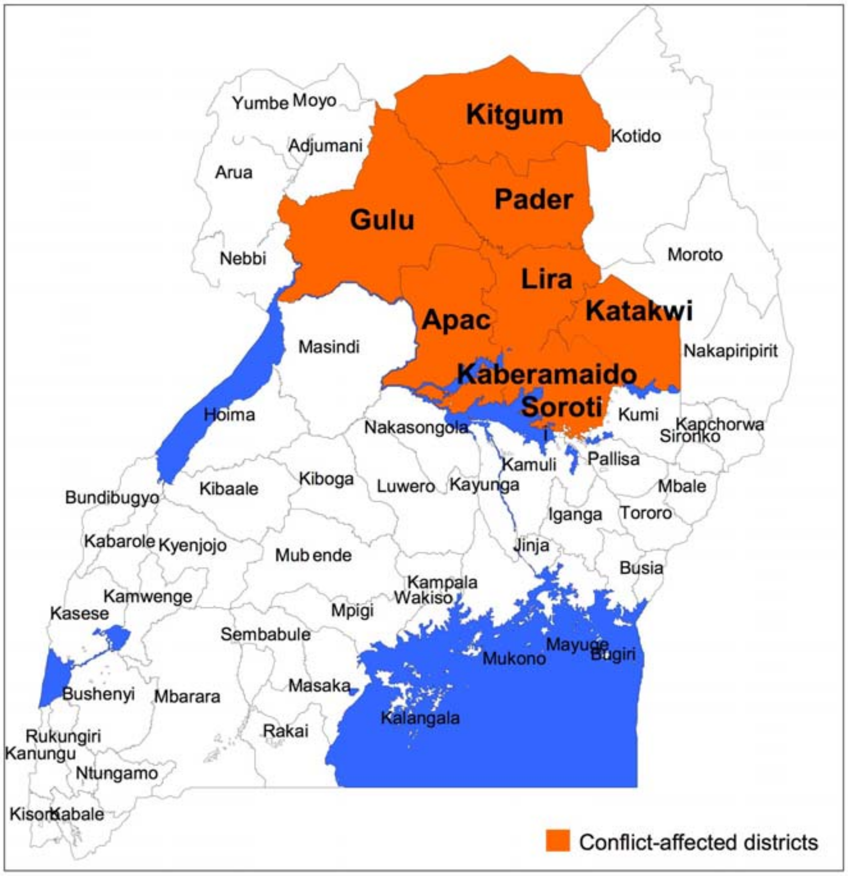

Figure 1: Conflict-affected districts, Northern Uganda

At its peak, the conflict with the LRA resulted in the displacement of 1.6 million people across the region, most of whom took refuge in IDP camps. Since the LRA entered into peace talks with the Ugandan government and agreed to a ceasefire in September 2006, there has been an improvement in the regional security situation and in some districts a significant percentage of camp residents have returned home or are in the process of doing so.

Throughout the crisis, USAID has supported a number of NGOs to provide humanitarian assistance to the IDPs. In several cases this assistance has included the promotion of FES.

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[1] Acholiland covers mainly Gulu, Kitgum and Pader Districts; Lango covers Lira and Apac; Teso covers Katakwi, Kaberamaido and Soroti.

3.2 Camp Situation

The IDP camps fall under Ugandan government jurisdiction, but each has its own internal management structure. NGOs operating in the camps have also set up extension systems for the implementation of IDP support programs, which typically focus upon food security, water supply, sanitation, health care, education, and income-generating activities.

The evaluation team visited camps housing IDPs from both the Acholi and Lang'i ethnic groups and found great similarity between the building styles, diets, traditions and cultures of these communities, which are both part of the wider Luo ethnic group that dominates northern Uganda.

In all camps the houses generally are circular and built using mud bricks or wooden poles, which are then plastered with mud and cow dung. They have grass-thatched roofs that are conical in shape with a central supporting pole. In Kitgum, the roofs are free-standing on a wooden frame that is placed outside the brick walls, which gives the huts eaves that allow for better ventilation and some removal of smoke.

Huts in the camps are positioned very close together with no physical divisions or defined household plots. This increases the risk of fire spreading rapidly and the burned remains of huts can be observed in some camps. Depending on a household's size and economic status, one hut may serve as both a kitchen and sleeping shelter, or there may be a separate hut used specifically for cooking.

Figure 2: Typical camp scene, Kitgum District

The IDPs survive on a combination of rations distributed by the World Food Program (WFP) and crops which they are able to grow themselves when the security situation permits. Traditional staples include sorghum, millet, beans, cassava and sweet potato. Distributed rations typically include a monthly (or less frequent) allocation of beans, maize, sorghum and cooking oil.

The displacement situation is not conducive to the establishment of stable livelihoods, and most IDPs obtain cash opportunistically, by (e.g.) selling some of their food rations or engaging in small enterprises such as commercial firewood collection (mainly women), charcoal making (men), transporting firewood and charcoal to urban markets (mainly men, using bicycles), brick-burning (men), food selling (mostly women), and brewing beer and spirits[2] (women).

Household surveys conducted by the evaluation team found an average of 7.7 persons per household in the camps, averaging 4.4 children younger than 12 years old, 1.5 children between 12 and 16 years, and 1.8 adults. These household sizes were slightly larger than those recorded in official statistics, perhaps because some families divided themselves into several units for registration purposes in order to receive more non-food items, as these tend to be allocated on a household (rather than per capita) basis. In Lira, half of the households were female-headed; in Gulu and Kitgum, 20 to 25 percent of households were headed by women.

Two of the camps visited contained perhaps 25-50 percent of the inhabitants they held at their peak, as the IDPs had begun moving to satellite camps or back to their home areas as the security situation improved. The gradual depopulation of the camps could affect the evaluation results as greater freedom of movement and lower population pressure may give the remaining IDPs less motivation to conserve fuelwood or change traditional cooking behaviors. At the time of the site visits, the camp in Gulu was largely intact, with nearly 4,000 households, while the camps in Lira and Kitgum contained approximately 2,300 and 1,500 families, respectively.

The principal source of cooking energy in the IDP camps is firewood, freely collected from the surrounding areas. Firewood harvesting is mostly the responsibility of women and, to a lesser extent, girls. It is laborious and in the past was also potentially risky, given the poor security situation.

The evaluators' household surveys suggest that firewood is gathered roughly every 4 days (1.6 to 1.8 times per week on average, with 35% of sampled households reporting they gather once a week, 47% twice a week, and the remainder more often). The cook is normally the person who gathers the wood. The average round-trip time per fuel-gathering trip is estimated at 5 hours, based on survey feedback. Firewood bundles weighed by the team averaged about 25 kg in Kitgum and Lira and almost 43 kg in Gulu. There is no clear explanation for this difference; perhaps, since Gulu is much more forested than the other two areas, households there collect more green wood (which is heavier than dry wood), accounting for the difference.

Wealthier households use charcoal for certain cooking tasks, particularly in camps located on main roads or close to towns where urban influences prevail. The use of charcoal is likely increasing as a result of the improved security situation, since charcoal production can now take place more easily and disposable incomes may be rising as the economy becomes more stable.

The household survey shows that there are on average 1.7 stoves per household; during random walkabouts it was confirmed that many households have more than one type of stove, probably because cooks prefer to use specific stoves for specific tasks. Similarly, households have an average of 3.9 cooking pots, varying in size and type. Clay pots typically are used for slower cooking foods (such as beans) while metal saucepans are preferred for rapid boiling and faster cooking dishes. Brewing of alcohol is widespread and takes place outdoors using open fires or trench stoves (see photos below) and large metal pots.

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[2] *Kong'o* and *Arege,* respectively.

3.3 Cookstove Programs

NGOs, some of them working with USAID funding, have promoted in the IDP camps a number of stoves designed to reduce fuel consumption compared to the traditional open fire. Three of the four FES interventions examined (including the two supported by USAID) were part of broader food security and livelihoods programs and were add-on activities managed by agriculture and food security technicians. The fourth was a stand-alone initiative implemented by an organization with some technical specialization in stoves and energy conservation.

The NGOs have various motivations for including FES in their programs, including reducing the gender-based violence and insecurity associated with fuel gathering; freeing up fuel gatherers/cooks' time for income-generating activities such as farming and small enterprise; improving food security; and reducing environmental degradation. At the heart of each program is the assumption that reducing fuel consumption will help attain those goals. The evaluation did not seek to test this logic and focused on whether the FES were actually saving fuel. A separate study would be necessary to ascertain and understand the relationships between FES programs and the broader impacts fuel savings might engender.

The NGOs promoting FES in the IDP camps are working under the common assumptions that improved stoves should:
1) be made from free or low-cost, locally-available materials;
2) be distributed at no cost (other than unpaid labor); and
3) achieve rapid, widespread penetration.

The result is a set of fairly basic stove designs with varying levels of efficiency, but there were still significant differences in technology and dissemination approaches among the NGOs evaluated.

4. Evaluation Approach

The following seven tools were developed (or adapted) for the evaluation of the FES programs:

Type of Tool	Description	Purpose
Contextual	Camp Survey	To gather background information on the camps and the regional and local situation (environmental, institutional, socio-economic, security, etc.)
	Programmatic Survey	To gather information on the NGOs and the specific details of their FES programs (justification, objectives, activities, indicators, M&E systems, resources, etc)
Quantitative	Water Boiling Tests	To provide technical data on the performance of stoves in the camps
	Controlled Cooking Tests	
	Household Energy Survey	To provide statistical information and gauge attitudes of the FES programs' beneficiaries; 25 per camp
Qualitative	Focus Group Discussions	To provide supplementary data to complement the household survey findings and cooking tests and investigate interesting issues in greater depth
	Random Walkabouts/Interviews	To gather anecdotal information, make informal observations and seek confirmation of the findings of the household survey, cooking tests and focus group discussions

5. Cooking Technologies

5.1 Traditional Cookstove Designs

Cookstoves generally fall into two categories: traditional and "improved" (with the latter typically referring to more fuel-efficient stoves). Traditional stoves tend to be made of locally-obtained materials such as stones or stones plus clay soil. They generally are non-portable and are built *in situ* by the user with little or no training.

The dominant traditional cooking system in developing countries is known as the "3-stone fire". This is one of the simplest forms of cooking technology and is highly adaptable, as it can use many types of fuel (firewood, crop residues, dung, leaves) and any type or size of cooking pot (metal or clay, flat- or round-bottomed). The 3-stone fire consists of a cooking pot resting upon three stones or bricks which surround an open flame. It is free to build, simple to use and can serve various non-cooking functions (such as provide a social gathering point). However, depending upon the cook's skill, the 3-stone fire may require a lot of fuel, generate a lot of smoke, and present considerable safety risks from fires or burns. In IDP situations, where natural resources (such as wood) may be scarce, respiratory illness common and living quarters cramped and highly flammable, these are serious concerns.

Figure 3: 3-stone fire

In Northern Uganda, users of 3-stone fires have introduced various methods to increase fuel efficiency and safety while retaining the flexibility they desire. Typically, the hearth is enclosed by building a mud wall around the stones (see Figure 4), or the combustion chamber is submerged in a hole or trench (see Figure 5). Such modifications are common, especially in areas of fuel shortage where people have to be economical in their use of energy.

Figure 4: Traditional Luo mud-stove in Northern Uganda IDP camp

Figure 5: Trench fire, also known as the “Bylaw” stove[3], in Northern Uganda IDP camp

Charcoal use is slowly penetrating the IDP camps. Unlike firewood, charcoal cannot burn directly on the ground and needs to be elevated by a grate on which charcoal lumps burn and glow. Often these stoves are made by the owner taking a traditional firewood stove and adding his or her own metal grate. In Northern Uganda, a bicycle sprocket (*Nang’a*) frequently serves as the grate, inserted into a traditional mud stove to convert it to charcoal use (see Figure 6).

[3] So-called because in some districts, such as Gulu, local government legislation (Bylaw) was introduced stating that all households should have an improved stove.


Figure 6: Nang'a charcoal stove (at right)

5.2 Improved Stove Technologies

Fuel-efficient stoves usually are made with more sophisticated materials such as metal, fired bricks or combinations of clay soil plus straw, cow dung, sawdust or rice husk to give better insulating properties and to improve durability. FES are often portable and some designs incorporate features for smoke removal. Some have complex design features and must be made by specialists, while others can be built by endusers themselves with appropriate training. Regardless of who makes the stove, users generally will need guidance to operate an FES properly and obtain the maximum benefits possible.

The evaluation team examined three FES models: a multi-pot "Lorena" stove, a 1-pot molded mud-stove, and a single-pot stove made of six bricks. NGOs A and B promote Lorena stoves independently of each other, although the original design was shared informally a few years ago. NGO C promotes the molded mud-stove in the same camp as NGO B, while NGO D has introduced a free-standing stove made of six fired bricks, plastered with mud during installation.

5.2.1 Lorena stove

The Lorena stove, which is promoted by the two NGOs funded by USAID (NGOs A and B), is a large, user-built mud stove that comes in two- and three-pot versions. The Lorena was developed by the Aprovecho Research Center (USA) for use in Guatemala during the 1980s. It uses a single combustion chamber and can heat several pots simultaneously as the hot gasses pass through internal heat distribution tunnels. It often incorporates a chimney. The original Lorena was designed for use in mountainous areas to simultaneously satisfy daytime cooking and night-time space heating needs, making use of stored heat re-radiated at night from the large body of the stove.

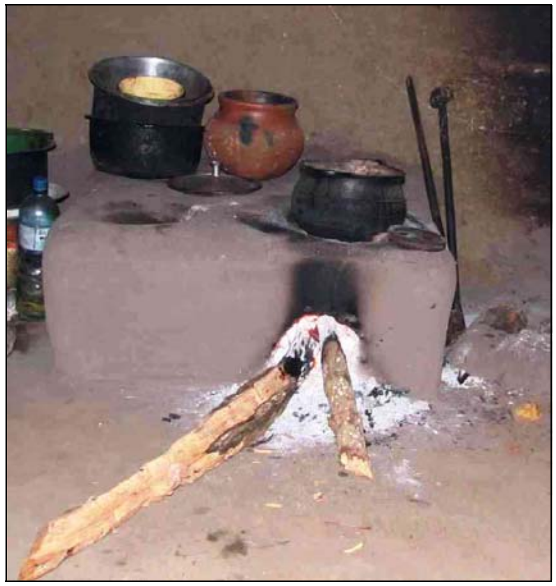

Figure 7: Typical 2-pot Lorena stove in a Ugandan IDP camp

Although the Lorena stove has not been widely promoted in Africa, it was taken up in Uganda by NGOs during the 1990s. In fact, it has been the dominant firewood stove promoted in the country over the last 15 years and even figures in educational programs in schools. The word "lorena" is now often used in Uganda as a generic term to describe a fuel-saving stove, irrespective of the design.

The Lorena stove is made from mud (clay), sometimes mixed with straw or anthill soil, that is found within the vicinity of the camp. Although the construction instructions specify the sizes for the outer dimensions and pot holes in order to maximize stove efficiency, users in the camps visited had sometimes modified these dimensions for their own convenience, to fit their particular cooking pots, or through lack of proper guidance. According to the recommended design, pots should sit on top of the pot holes without a gap and hot smoke should be removed by the chimney. In many cases, however, the gap was not closed off by the pot, releasing smoke into the room and thereby reducing the effectiveness of the chimney.

5.2.2 Molded 1-pot mud stove

NGO C, not funded by USAID, has developed a single-pot molded mud stove that it promotes in Gulu and Kitgum. This stove, designed by GTZ's Energy Advisory Project in the Ministry of Energy and Mineral Development (MoE), is based on "rocket" principles[4] and is constructed of anthill soil and straw. Once the mud dries out, the stove is attached to the floor of the hut. The stove body is constructed with a metal mold (an innovation of NGO C), which preserves stove dimensions and gives the stove a smooth finish (see Figure 8). Pots are normally expected to sink into the stove unless they are too large and must rest on the top, in which case they sit on three small stones on the rim of the stove to allow the hot air and smoke to exit (see also Figure 10).

[4] Rocket stoves feature an insulated, short chimney (the combustion chamber) that is located above the fire. The mixing of hot gases, flame, and air in the short chimney reduces harmful emissions and forces the hot gases to directly contact the pot, lowering fuel use.

In addition to its one-pot mud stove, NGO C promotes a two-pot stove referred to as a "Rocket Lorena," also designed by GTZ's Energy Advisory Project. This stove was developed due to reservations about the suitability and efficiency of the original Lorena, and incorporates rocket principles into the basic Lorena shape. Camp residents are free to select between the 1-pot molded stove and the 2-pot Rocket Lorena; at the time of the evaluation, 262 one-pot stoves had been disseminated, compared to only 6 two-pot stoves. This disproportionate response likely reflects user preference for smaller stoves that take up less room in cramped huts.

Figure 8: Molded 1-pot mud stove, promoted by NGO C in Gulu and Kitgum

5.2.3 The 6-brick stove

NGO D's 6-brick stove design was developed with the technical input of the Aprovecho Research Center, and also incorporates "rocket" design principles. NGO D sets up brick production facilities close to its target population. Local clay is mixed with rice husks (to provide insulating properties), molded into specially-shaped bricks, and fired with wood logs using traditional clamp kilns. The use of this low-tech, temporary kiln means that production can be moved to a new location as local stove demand is saturated. The NGO is also considering using rice husks for firing of the kilns to cut down on the use of wood (for the firing process, large logs are needed that are usually extracted from the local woodland). The quantity of wood used for firing a brick is quite small: 0.3 kg of wood per brick, or 1.6 kg for the whole stove, compared to typical firewood consumption of 4-8 kg per household per day for this type of stove.

The brickmakers bind the fired bricks together in clusters of six using thick wire. One brick is cut in half to make an opening for feeding fuel. This basic stove body can be installed in a kitchen by fixing it upright to the ground and plastering it with mud. Women can choose to build up thicker stove walls if they want greater strength and stability. Mass production of the bricks helps ensure that their size and shape are uniform, thereby maintaining each stove's combustion chamber dimensions. Initially, NGO D incorporated a metal grate to raise the fuelwood off the ground and promote airflow, but discontinued this practice because the low-grade metal wore out quickly. In addition, the protective mud/clay covering (the "elbow") that attaches to the stove body and encloses the fuelwood had also been discarded. Pots rest on three small stones placed at the top of the stove to allow for improved air circulation.

Figure 9: 6-brick stove assembled and awaiting collection

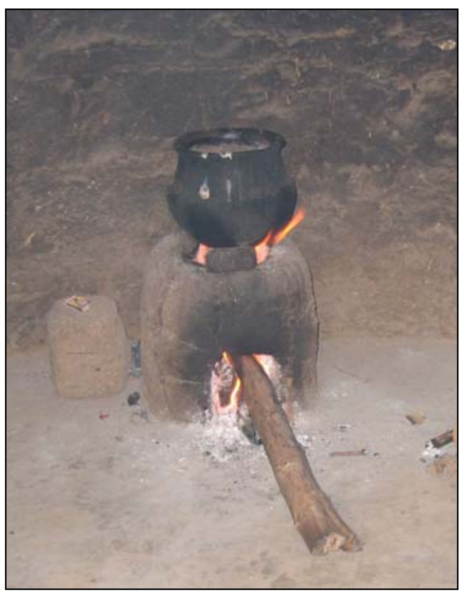

Figure 10: 6-brick stove plastered and installed in an IDP kitchen

6. Stove Penetration and Enduser Attitudes

All of the NGOs evaluated had succeeded in distributing large numbers of stoves in a relatively short period of time. Over a period of approximately two years, NGO A had disseminated the Lorena stove to virtually all 4,000 households in the camp.

NGOs B and C operated in the same camp in Kitgum. NGO B had been promoting the Lorena stove for approximately three years and had disseminated 2,000-3,000 units in Kitgum district, but did not have an exact figure for the camp in question. NGO C had been promoting FES for six months and in that time had disseminated 268 stoves in the camp (6 two-pot stoves and 262 single-pot molded mudstoves), out of 1,500 households. Between them, the two NGOs had succeeded in reaching the majority of residents, though the camp's size has dwindled considerably since its peak.

NGO D had been operating in Lira District for three years and had covered eight camps and three local communities. In the camp surveyed by the evaluation team, NGO D had been active for only two months but in that time had reached almost all of the 2,300 households still present.

When asked during the household survey what they liked about their new stoves, the IDPs cited time and fuel savings, smoke reduction, and safety and cleanliness (see Table 1).

Table 1: Household Survey Results: Appreciation of New Stove

What do you like about your new stove?	Gulu	Kitgum*	Lira	Average
saves fuel	29%	26%	25%	27%
saves time	28%	17%	21%	22%
removes smoke from house	19%	18%	6%	15%
safer	4%	15%	6%	9%
cleaner	6%	4%	16%	8%
easy	6%	3%	11%	6%
requires less supervision when cooking	3%	10%	6%	6%
modern	4%	6%	3%	4%
remains hot overnight	1%	1%	5%	2%

* Kitgum responses are for the Lorena stove promoted by NGO B.

Aspects of the new stoves that were disliked were more difficult to categorize and varied with the type of stove. In Lira only 3 of 18 households registered complaints, with one each noting that the 6-brick stove was difficult to light, created smoke during the start-up stage, or was difficult to use to prepare *posho* (local maize meal porridge), presumably due to stability problems encountered when stirring vigorously. In Kitgum, 12 responses were given and suggested that the Lorena was difficult to light or wore out the bottom of the cooking pot (three responses each); was difficult to use for making *posho*; burned food; or made the house very hot (two responses each). In Gulu the most responses were provided (29), of which 13 said the Lorena stove quickly wore out the bottom of the pot, 7 said it made the house very hot, 4 that it produced smoke during lighting, and 5 that it had various other problems. The fact that Lorena stove users voiced higher rates of complaint is in line with the team's findings about stove performance from other survey tools, but may also reflect the newness of the 6-brick stove in the target population (e.g. stove shortcomings might not yet have become apparent).

Observations by the team revealed that the one-pot molded stove and six-brick stove, promoted by NGOs C and D respectively, did indeed emit much less smoke than the average 3-stone fire or Lorena, despite their lack of external chimney (smoke was observed only during the lighting period, before the fire was very hot). All of the stoves, by virtue of enclosing the fire, also appeared safer and cleaner than an open fire. Beneficiary claims about significant time and fuel savings, however, could not be substantiated by the evaluation team for several of the stoves.

7. Fuel Efficiency Basics

7.1 Overview

A stove's fuel consumption can be influenced by a number of factors, including altitude, climate, and cooking method (e.g., frying vs. boiling). All of these factors must be taken into consideration when designing or selecting the appropriate FES for a given population. Generally speaking, the key factors that determine fuel consumption include:

(a) *Fuel type and characteristics*
The combustion qualities of a fuel are affected both by its inherent physical properties and the way in which it is prepared. Some fuels simply contain more energy than others (LPG, for example, contains much more energy per unit of mass than wood). In the case of wood, variables that may affect its quality (hence consumption) include moisture content, density, and oil content.

(b) *Combustion efficiency*
The amount of energy obtained from the fuel by burning it is known as combustion efficiency and will vary depending upon the design features of a given stove. Stoves that achieve high combustion efficiencies should require less fuel than those with lower efficiencies. Hot fires burn more cleanly and efficiently; so maximizing combustion efficiency requires finding the right mixture of fuel, air and spark that will more completely burn the gases emitted from the hot wood. Accordingly, factors that affect heat containment and airflow (e.g. insulation) can be adjusted in stove designs to boost combustion efficiency.

(c) *Heat transfer efficiency*
The transfer of heat/gases created by combustion to the pot is another important feature of stove design. Improved heat transfer (i.e., keeping hot gases in direct contact with the cooking surface and preventing leakage) should reduce fuel consumption.

(d) *Behavior of the cook*
The cook's skill in preparing the food and fuel, tending the fire, and using the stove can have a major impact on fuel consumption.

In order to obtain objective, quantitative data on the performance of the stoves studied in Uganda, the team undertook a number of different tests to gauge their thermal efficiency (i.e., the combined combustion and heat transfer efficiencies). The tests also permitted the team to observe the behavior of the cooks and to follow up on their observations during focus groups and one-on-one conversations.

7.2 Verification of Stove Efficiency

While there is no foolproof method for measuring cookstove efficiency, over the years researchers and stove designers have developed several protocols that provide a rational basis with which to test and compare stoves. The evaluation team utilized two different protocols in order to gain a broad perspective and test the applicability and utility of the protocols in humanitarian settings, which pose unique challenges due to access and security constraints. The results of these tests are summarized below.

7.2.1 Water Boiling Tests (WBT)

Water boiling tests (WBTs) can provide reliable information to stove designers about the performance of different wood-burning stove designs by standardizing as many variables (such as type and amount of fuel used and climatic conditions) as possible. The evaluation team decided to undertake WBTs to gain a better understanding of the stove designs being promoted in the camps, and to ascertain whether the WBT would be a useful tool for NGOs in the field. The test is a simplified version of the University of California Berkeley (UCB)/Shell Foundation revision of the 1985 VITA International Standard Water Boiling Test.

The WBT consists of three phases that determine a stove's ability to:

- bring water to a boil from a cold start;
- bring water to a boil when the stove is hot; and
- maintain the water at simmering temperatures.

The amount of fuel and time needed for each of these different tasks is captured by the test. This data can enable a stove designer to gauge the efficiency of a particular design (and make changes), and makes it possible to compare stoves of different stove designs operated under similar conditions.

The WBT procedure is usually carried out by a laboratory technician or researcher under controlled conditions to reduce variability, and may not reflect stove performance under actual conditions. It was not possible to conduct laboratory tests in Uganda because many IDPs use large, self-built stoves that are permanently fixed in the kitchen. The evaluators were also looking for tools that could be locally applied with a minimum of complex equipment and technical experience. Therefore, a hybrid WBT method was employed, with testing taking place in IDPs' kitchens using normal cooks operating their own stoves, while supervision and recording of the observations was carried out by a specialist and an assistant. It is worth noting that stove efficiencies achieved in controlled laboratory settings are often higher than those attained in a real-life situation.

All stove models observed in the camps (except for the 1-pot molded stove promoted by NGO C) were subjected to the WBT. Two samples of each model were selected and 2-4 tests were carried out on each. It was necessary to balance the desire for large sample sizes, which help ensure accuracy (especially when stove dimensions are variable), against the need to test as many stove models as possible in the limited time available. The duration of the tests varied somewhat, from 1 hour for a hot-start test to over 4 hours when the stove was unable to bring water to a boil. An average test lasted less than 2 hours.

The results of the WBTs are summarized in Table 2. Given the relatively small sample sizes and lack of lab conditions, results should be considered indicative rather than definitive.

Table 2: Results of Water Boiling Tests: Average Stove Efficiencies

Stove type	No. of tests conducted	Thermal Efficiency			
		Cold start	Hot start	Simmering	*Average*
6-brick stove (NGO D)	8 tests, 4 stoves	13.6%	14.3%	15.4%	*14.4%*
Open fire	6 tests, 2 fires	13.7%	12.5%	15.5%	*13.9%*
Traditional mud stove	7 tests, 3 stoves	10.9%	9.3%	15.8%	*12.0%*
Trench stove	8 tests, 2 stoves	8.5%	10.1%	17.4%	*12.0%*
Lorena 2-pot (NGO B)	6 tests, 2 stoves	8.8%	7.5%	10.8%	*9.0%*
Lorena 2-pot (NGO A)	6 tests, 2 stoves	4.8%	4.5%	10.3%	*6.5%*

Note: Stoves are ranked by average efficiency over the three test phases.

The Lorena stoves had the lowest thermal efficiency ratings of the stoves that were tested, averaging 6.5% and 9.0% for the versions promoted by NGO A and NGO B respectively. Trench stoves and single-pot mud-stoves, both traditional user-built technologies, performed more efficiently (each averaging 12%). The traditional 3-stone fire out-performed most of the FES and achieved an average efficiency of 13.9%[5]. The most efficient stove tested was the 6-brick model promoted by NGO D, but only by an average margin of 0.5% over the open fire—a margin that statistically is not very significant.

The WBT protocol required the stove operator to bring the water to a boil using "maximum power" and this instruction was conveyed to the stove owners. The result was over-loading of the combustion chamber with large, crudely prepared pieces of wood, typical of actual cooking conditions observed in the camps. For comparative purposes, three stoves also were tested by asking the operator to boil the water in the most careful and efficient manner possible, with firewood cut into small, split pieces. The results of these optimally-managed tests are presented in Table 3.

Table 3: Results of Water Boiling Tests: Efficiencies Under Optimal Management

Stove Type	Thermal Efficiency				
	Cold start	Hot start	Simmering	*Ave. under optimal management*	*Ave. under normal operation*
6-brick stove	13.3%	16.6%	24.2%	*18.1%*	*14.4%*
Open fire	15.5%	17.8%	17.1%	*16.8%*	*13.9%*
Traditional mud stove	11.8%	15.6%	15.5%	*14.3%*	*12.0%*

This experiment was limited to just one test on three types of stove but the findings are nevertheless revealing. With an operator aiming to perform the WBT in the most efficient manner possible, the average efficiency across the three test phases went up by between 2.3 and

[5] Research cited by Aprovecho notes 3-stone fires have achieved thermal efficiency rates ranging from 5% to 30%, depending upon the characteristics of the wood, wind, and the cook's behavior.

3.7% for the stoves that were included, representing a 19 to 26% improvement over typical camp use. The efficiency ranking of the stoves relative to each other did not change, however.

These findings suggest that *user behavior can have a significant impact on a stove's performance*. Careful stove operation coupled with proper fuel preparation resulted in efficiency improvements of up to 26% over the same stoves over-stuffed with large pieces of firewood. The results nevertheless suggest that the stove technology itself remains important, in spite of the influence an operator may have, as the *relative* efficiencies of the three models tested were little changed from the original WBTs.

The final aspect considered in the WBTs was time taken to boil 3 liters of water. Results are summarized in Table 4.

Table 4: Results of Water Boiling Tests: Time Taken to Boil Water

Stove Type	**Average time to boil (mins)**	
	Cold start	**Hot start**
Open fire	17	16
Trench stove	22	21
Traditional mud stove	25	19
6-brick stove (NGO D)	28	23
Lorena 2-pot (NGO A)	51	34
Lorena 2-pot (NGO B)	56	52

Note: Stoves are ranked by cold start boiling time (3 liters of water in a flat-bottomed aluminum pot).

The open fire was able to boil water from a cold start in an average of just 17 minutes, probably because it does not restrict the amount of wood that an operator can use and absorbs no heat into a clay or ceramic surround. The NGO D 6-brick stove took 65% longer to boil water than the open fire. This may account for its lower-than-expected overall efficiency figure, because the bricks were probably absorbing much of the initial heat output of the fuel, rather than directing it to the pot. Another possible explanation for the slowness could be the stove's inadequate air flow, given the removal of the grate and elbow that are recommended in the true "rocket" design. If the time-to-boil of this stove could be reduced, it would probably give far more impressive results overall.

The two Lorena stove models promoted by NGO A and NGO B took 51 and 56 minutes respectively to boil water. This is probably due to a combination of inadequate airflow and the loss of initial heat from the firewood to the clay body of the stove rather than the pot. In three cases, the Lorena stoves selected for testing from NGO A were unable even to bring water to the local boiling temperature (96.3^{o}C) and the testing procedure had to be abandoned after the women operating the stoves had tried for at least one hour to boil 3 liters of water without success.

From the mission's point of view, it was surprising that user-built traditional stoves that pre-date the displacement situation were capable of achieving both faster water-boiling performance and higher thermal efficiencies than many of the stoves being promoted under the NGO programs. While the use of more careful cooking techniques led to useful efficiency improvements for the 6-brick stove, the same techniques resulted in comparable improvements for both the open fire and the trench stove, and thus do not represent an opportunity that is unique to improved stoves.

7.2.2 Controlled Cooking Tests (CCT)

In addition to the water boiling tests, the evaluation team also conducted controlled cooking tests (CCT) in the three camps visited. These tests were designed to simulate cooking of a typical IDP meal in a realistic kitchen setting. In each case, six women using different types of stoves were given 0.5 kg of beans and 0.5 kg of maize flour to prepare. Firewood was centrally purchased and issued to participants in bundles of approximately equal size and quality.

Each CCT included at least six stoves (usually two stoves each of three different models). In total, the team conducted six CCTs: one in Gulu, one in Lira and four in Kitgum, using a total of 36 stoves of seven different types. Because the team had more time in Kitgum, it was able to conduct two tests each with two different groups of stove users to improve the reliability of the test results. Nevertheless, the CCT findings also should be considered indicative rather than definitive.

Although the evaluation team aimed to replicate the same procedure in each test, the results showed considerable variation in cooking time from one CCT to another. While the average cooking time across all the tests was 180 minutes, there was a range between tests of 50 min and standard deviation of 12.5 min.

The time variations did not appear to arise from significant differences between the stoves themselves, as the range of cooking times within any one test was rather small (standard deviations for the six tests of only 3.3 to 6.8 minutes). The speed variation instead arose from lack of common agreement over when the beans were cooked and ready to serve; this is a subjective assessment and difficult to standardize from one test to another. There was a tendency for women participating in a given CCT to decide that their beans were cooked at approximately the same time (all were cooking in physical proximity to each other, regardless of stove type), which might have been somewhat earlier or later than the average time of another group participating in a separate CCT.

In order to compare the findings between tests of different durations more reliably, it is instructive to consider the *rate* of fuel consumption for each CCT (in gms/minute). Table 5 provides a summary of these results.

Table 5: Results of Controlled Cooking Tests

Cooking system	Ave. fuel used for CCT (kg)	Ave. time taken (mins)	Rate of fuel consumption (gm/min)
6-brick stove (NGO D)	4.1	199	20.7
Open fire	4.3	188	22.9
1-pot molded mud stove (NGO C)	4.1	170	24.0
Lorena stove (NGO B)	4.7	180	26.2
Trench stove	5.6	177	31.3
Traditional mud stove	6.5	198	32.8
Lorena stove (NGO A)	7.0	178	39.2

Note: Stoves sorted by average rate of fuel consumption.

In most respects, the results of the CCTs parallel those of the WBTs. The worst performing stove in terms of fuel consumption rate was again the Lorena promoted by NGO A (wood consumption of 39 gm/min) and the best performing was again the NGO D 6-brick stove (21 gm/min). The 6-brick stove took much longer to cook the given foods than the other stoves tested, however, averaging 199 minutes to complete the two tasks. As mentioned above, if it could be re-engineered to bring water to the boil more quickly, its overall fuel consumption probably could be significantly lowered.

Open fires, trench stoves and traditional mud stoves once again demonstrated intermediate performance, in the same declining order as the WBTs, with firewood consumption ranging from 23 to 33 gm/min.

The single-pot molded mud stove promoted by NGO C was included in the CCT (but not in the WBT, as the team was unaware of its existence during its first trip and therefore had not scheduled enough time to test it). The stove demonstrated reasonable performance, matching the fuel consumption of the 6-brick stove and beating the 3-stone fire. But the CCTs in Kitgum were, on average, 22 minutes shorter than the tests conducted in Lira (where the 6-brick stove was tested). So although the NGO C 1-pot stove consumed relatively little fuel during the tests, its rate of consumption was actually 5% higher than the open fire and 16% higher than the 6-brick stove. Head to head in the same test with the same beans, the NGO C stove would probably have used significantly more fuel than the 6-brick. The molded stove's rate of fuel consumption was also slightly higher than the open fire's average rate of consumption.

The CCT produced a finding that contradicted the WBT for just one stove: the Lorena promoted in Kitgum by NGO B. While this stove fared poorly in the WBTs and achieved just 9% average efficiency, it performed better in the CCTs, using fuel more efficiently (26 gm of firewood/min.) than the trench fires and traditional mud stoves. However, it still used 14% more firewood overall than the open fire to complete the assigned cooking task.

The CCTs confirm the general finding of the WBTs, which is that several of the "fuel efficient" stoves promoted in the IDP camps consume more fuel to cook standard meals or conduct simple tasks (such as boiling water) than traditional open fires. The 6-brick stove was the only model that consistently performed better than the 3-stone fire in both tests, but by a far smaller margin than the implementing NGO had expected.

8. Stove Design Comparison

The stove tests, coupled with observations of the evaluation team, revealed various flaws that marred the performance of the FES evaluated. In some cases a problem may be inherent to the stove design itself; in others, the fault may stem from improper construction or use of the stove. The team noted the following shortcomings:

<u>Lorena stove</u>

- the stove combustion chamber is not insulated, resulting in heat loss to the mud surround;
- pot surfaces are largely (>80%) exposed to the air and not enclosed within the stove body, resulting in heat loss;
- the flue channel joining the first pot hole with the second is often positioned at the bottom of the combustion chamber[6], hence obstructing (rather than encouraging) the flow of hot air and flue gases; and
- Lorena stoves promoted by NGO A incorporate a chimney vent which is usually placed at ground level and is hence incapable of extracting smoke; in fact, the chimney often acts as an air *inlet*, resulting in smoky kitchens.

<u>6-brick stove</u>

- the bricks are quite fragile and break easily during transportation to the hut of the beneficiary; this arises in part from the use of rice husks as an insulating material, as the air gaps in the bricks tend to be too large and often link up to form lines of weakness;
- the elbow and grate that were included in the original “rocket” design have been lost; and
- pot rests are often missing so airflow is impeded.

<u>Molded one-pot stove</u>

- the stove easily accommodates only one size pot; a more innovative design of internal pot rests could allow a wider range of pot sizes to sink properly into the stove body; and
- the pot rests for those (large) pots that cannot sink into the stove are not an integral part of the design so users must place their own pebbles on top of the stove; not all do so and as a result air flow is often obstructed.

These weaknesses are bound to result in inconsistent stove performance which will hamper NGO efforts to achieve their programs’ desired energy savings. Although the NGOs all succeeded in finding technologies that could be built cheaply and relatively quickly in the IDP environment, their lack of awareness of (or in some cases the inability to respond to) the above shortcomings likely considerably reduced their programs’ impact.

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[6] Since hot air rises, the channel should be located near the top of the chamber.

9. Reconciling Performance Test and Household Survey Results

Most of the NGOs evaluated assess fuel savings achieved by their FES programs by surveying households about the frequency of their fuel foraging trips before and after receiving their new stove. Based upon this data, virtually all of the NGOs were claiming their programs had resulted in fuel savings of approximately 50 percent. However, the results of the WBT and CCT cast doubt on these figures, as well as the claims of fuel savings reported by the IDPs to the evaluation team in the household surveys.

There may be several reasons for these discrepancies:

- respondents may feel pressure to say positive things about NGO programs from which they hope to secure additional assistance or benefits;
- even if beneficiaries report they are collecting fewer bundles per week, the amount of wood collected could vary from bundle to bundle, making it impossible to gauge just how much fuel (if any) has been saved without more objective means of measurement; and
- IDPs may find it difficult to accurately gauge fuel consumption since many continue to use a traditional stove for various purposes even after they receive their improved stove.

The contradictory findings also beg the question, why might beneficiaries be satisfied with their new stoves, even if their fuel consumption may be no better (or even higher) than it would be with a traditional cooking system? One reason could be that appreciation is measured not only in terms of fuel consumption, but also in terms of other attributes such as smoke reduction, reduced risk of fire and burns, and prestige. These attributes may be so significant that they cancel out any negative observations regarding fuel consumption. Focus group discussions revealed that many women greatly appreciated the ability of their various improved stoves to reduce soot and ash production and lessen the risk of their children getting burned (since the fire and ashes are contained).

In at least one camp, however, IDPs displayed through action attitudes belied by their responses to the survey and interviews. The evaluation team observed that large numbers of households with NGO A Lorena stoves seemed to have abandoned them in favor of 3-stone fires or *Bylaw* trench stoves. The Lorena stoves remained intact inside the huts, but showed no evidence of recent use. Many were being used to store items.

Figure 11: Lorena stove being used for storage

The one feature of the Lorena that some users seem to appreciate is the second pot hole, on which they can pre-heat water for cooking or other purposes under certain conditions. But this feature is also allowed for in traditional cooking systems simply by placing one pot on top of another or at the side of the fire, and is not an attribute unique to the Lorena. Although Lorena stoves have a second and sometimes a third hole, these will be useful only if the first hole is completely covered or closed off by the pan, which did not seem to be the norm in the camps visited for the evaluation.

Users of NGO C's molded mud-stove found it to be strong and stable, with an attractive appearance. The NGO D 6-brick stove was liked for its appearance and ease of use, though some large families complained it was too small to accommodate large cooking pots. Nevertheless, the evaluation team witnessed that many IDPs were collecting 6-brick stoves to transport back to their home villages, indicating high satisfaction with the technology.

10. Program Management and Delivery

Stove design aside, some of the problems and constraints to achieving maximum fuel savings in the camps may be attributed to the implementation strategies of the NGOs and the lack of adequate oversight and support by head offices and donors. Few of the NGOs had technical expertise in-house, and most had under-estimated the amount of time and labor required to implement FES programs well (especially in the early stages of a project). Understandably, given the nature of the IDP crisis, all seemed focused primarily on meeting ambitious penetration targets (typically 100% of a camp) quickly.

With the exception of NGO D, the FES programs were implemented as sub-components of broader programs under the management of non-energy specialists. The main thrust of these broader programs, such as food security, etc., already requires considerable attention from the NGO staff members, who often are under pressure to achieve ambitious goals. The design of stoves, their promotion, and the monitoring of uptake and impact are technical activities not easily handled by generalists with limited training in this area, and who have little time to take on additional responsibilities. Nevertheless, the local NGO staff were enthusiastic and committed in their implementation of the FES add-on activities, and still committed significant time to them.

These staff members would have benefited greatly had the NGOs incorporated monitoring and evaluation measures into each phase of the project. However, as far as the team could determine, no baseline studies of energy consumption were carried out before commencement of the FES programs by any of the NGOs evaluated. Several of the programs also selected stove models without first soliciting the feedback of their proposed beneficiaries to ascertain the appropriateness of the technologies. Most monitoring conducted by the NGOs is aimed at collecting information on program impact, and not to inform program implementation.

All of the NGOs gathered their performance data by questioning a small sample of stove owners about time and fuel savings, which is a subjective and sometimes unreliable means of assessing impact. None of the NGOs (with the possible exception of NGO A) conducted stove efficiency tests to gather more objective, quantitative data on the performance of the stoves they were promoting. NGOs A and B report to USAID numbers of training sessions held and numbers of stoves built, but such indicators do not provide sufficient data to determine whether energy savings are being achieved, let alone delivering the wider programmatic benefits envisioned (such as reduced deforestation or gender-based violence).

10.1 Promotional Approaches

In addition to the management issues cited above, the FES production and distribution strategies of the implementing NGOs clearly have an impact on the NGOs' ability to obtain their fuel savings objectives. Broadly speaking, the evaluation team found that the NGOs employ two approaches to stove construction and dissemination: Training of Trainers (ToT) and use of specialist, paid extension workers.

10.1.1 Training of Trainers Approach

NGOs A and B have adopted a ToT approach for stove dissemination. Two extension agents in each camp are trained on stove construction (in this case the Lorena) and in turn train IDPs how to build and maintain the stoves. For this, they enlist the help of camp committees and sub-committees, organizing systematic, block-by-block training sessions. For one of the NGOs (A), the extension agents oversee the full range of the organization's activities at the camp level and do not specialize only in FES promotion.

IDPs are usually grouped together after the trainings and encouraged to help build each other's stoves, working together in each group member's house in turn. It was said by one NGO that this grouping helps bring active women together with those who may be less motivated and thereby achieves more rapid and widespread uptake. Stove construction is supposed to be supervised by the NGO extension staff to ensure that each stove is built according to the specified design parameters. If it is not, households are asked to demolish their stoves and re-build them.

This approach has the advantage of allowing field staff to double up on roles, which can be cost-effective and allows multiple ideas or technologies to be promoted through the same set of personnel. It also allows for synergies between the NGOs' various programs/activities. In theory, the IDPs trained to build stoves should also be able to use this knowledge when they return to their home villages, thereby extending the impact of the program.

However, considerable inconsistencies in stove appearance and operational performance suggest that the ToT process has not been effective in ensuring quality control and preserving optimal stove design parameters. Design changes observed by the team (such as NGO A's decision to increase the Lorena stove's height without adjusting other features accordingly) also suggest that the non-specialist program staff and camp-based extension agents have a poor understanding of combustion principles and are not well placed to provide technically sound advice on stove construction.

10.1.2 Modified ToT Approach

NGOs C and D rely upon paid employees to construct (or assist the IDPs to construct) the new stoves. This approach reduces the risk of design inconsistencies by limiting stove construction responsibility to closely monitored specialists. While it is possible such specialists may become stove-building entrepreneurs once the conflict is over and the camps disband, the rest of the camp population would be unable to reproduce their stoves upon returning home.

NGO C utilizes camp residents to promote and construct FES. These individuals have no other NGO responsibilities. Group trainings are still organized, as per NGOs A and B, but it is primarily the paid workers who supervise or conduct each stove installation, with less reliance on camp committees or IDPs at large.

The result, as observed by the evaluation team, was greater consistency in stove construction from one home to another; hence a higher likelihood of improved efficiency (and other) benefits being realized. One drawback of this approach, however, is the risk of favoritism on the part of stove promoters who have dissemination targets to meet and therefore may prioritize friends, family and the most innovative (hence probably wealthiest and least vulnerable) members of the IDP community, to ensure maximum uptake. There were also suggestions that corruption came into play in the selection of households for stove construction, given the great demand for stoves and relatively small number of trainers. Speed of stove dissemination was also limited by the small number of molds FES promoters had to work with.

Two NGOs (A and C) tried to incorporate a cooking pot in their stove dissemination strategy, the idea being that the stoves would be built to fit around the pots and hence would be more efficient. In both cases this plan went awry as the NGOs were unable to keep up with demand. Moreover, some people sold the pots and others had multiple family members sign up to get them. The process became onerous for the NGOs to manage and did not necessarily improve stove efficiency, since all households have multiple pots of different sizes.

10.1.3 "Come and Get It" Approach

In NGO D's program, camp residents are hired to make the bricks and also to train households how to mud them. Residents of the camp are invited to come to the brick production site and collect a stove on assigned days, by residential block. Households receive an explanation of how to mud the stove when they collect it from the production site, and the trainers (1 or 2 per camp) try to visit the households thereafter in their homes. Group-based training is not used. During the evaluation team's visit, 150 stoves were picked up in one day—a rate impossible for the small number of trainers to keep up with (though households indicated they would prefer more such visits).

10.2 End-User Outreach and Education

All four NGOs claimed they provided training to beneficiaries on energy saving practices and how to use the FES properly. However, observations by the evaluation team and responses in the household survey revealed that efforts in these areas have been insufficient (see question 6 in the Annex). In all camps team members witnessed endusers overstuffing stoves with wood, thereby greatly diminishing their stoves' ability to save fuel. Various reasons were offered for this behavior, including lack of knowledge of fuel-saving practices, lack of resources (i.e., axe) necessary to implement fuel-saving practices, and concerns about the amount of time needed to accommodate new cooking and fuel preparation practices.

Yet it is well-known (and confirmed by the mission's tests) that significant fuel savings are possible if the cook knows how to operate the stove properly. Practices that promote efficient use of wood for cooking include:

- drying wood;
- splitting wood into small and short pieces;
- using as little wood as necessary for the specific cooking task (as opposed to stuffing the combustion chamber);
- using a grate to raise wood as it is pushed into the combustion chamber and allow the entry of secondary air to make combustion more complete;

- pre-soaking beans; and
- using tenderizers.

To the extent that the NGOs tried to transfer any of these messages, their behavior change communication strategies showed little creativity. The evaluation team's controlled cooking tests generated great interest in the camps, attracting much attention from residents. Yet few if any of the NGOs had undertaken cooking demonstrations or competitions, or utilized materials common in FES programs in development contexts (such as photos, jingles or skits) to educate or enthuse their target population.

11. Recommendations

Improved stoves have the potential to deliver numerous benefits – including energy savings, pollution reduction, time savings, and reduced danger from fire and burns – that justify their continued promotion in IDP settings. The issue of cooking is of universal interest and the promotion of better stoves may provide humanitarian organizations with a useful entry point for other community assistance programs.

However, the evaluation revealed that some NGOs are relying on assumptions, rather than evidence-based data, to guide FES program implementation. FES programs are more complex than many organizations recognize, and require significant planning and staff time to implement well. Verification of a stove's capacity to reduce energy consumption in the relevant setting should be a *sine qua non* for all technologies that are to be promoted in an FES program. In addition, proposed FES programs should fulfill certain minimum conditions with respect to quality control, monitoring and evaluation, and beneficiary outreach.

The following recommendations are presented to USAID to help improve the impact of its funding of FES in IDP settings:

a. **Provide clear guidelines to applicants:** USAID should specify the qualities that it will be looking for in stove programs to ensure that funding applications are of a good technical standard. Evidence should be included in proposals of the following:

   (i) **Full baseline description:** The NGO requesting funding from USAID should provide a complete baseline description of the target IDP camp(s) and the prevailing security and household energy situation. The proposal for an FES program should clearly describe objectives and targets, define monitoring indicators, and set out the approach that will be followed to achieve meaningful results.

   (ii) **Appropriate staffing of the project team:** At least one expert in household energy and stoves should be part of the project staff, either at the headquarters to provide guidance to field staff, at the field office itself, or contracted on a consultant basis. The evaluation showed that simple mistakes (which effectively led to the failure of some programs) could have been avoided if such experts had been available. In addition, staff must have adequate time to design and implement FES programs, especially in the labor-intensive start-up stages.

   (iii) **Simplicity and functionality of stove design:** The selected stove model(s) should be simple and shown to be appropriate for the culture and diets of the IDPs concerned. Multi-pot stoves in particular should be rigorously assessed. The incorporation of multiple pot-holes makes stoves larger, harder to build, more difficult to standardize and potentially more wasteful of energy (if the second pot-hole becomes a heat escape rather than a cooking hole). In addition, users often like to convert the second pot-hole to a charcoal stove with the result that primary wood consumption is increased rather than decreased. Chimneys are also difficult to build well and may result in heat loss and present a fire risk under over-hanging thatch eaves, if not well constructed.

(iv) **Quality control systems in place:** Any FES program should institute a quality control system to ensure that design parameters are transferred consistently and efficiently. This can be achieved (e.g.) through the use of molds (for mud stoves) or standardized manufactured components (for ceramic or metal stoves). A stove that is entirely user-built with poor supervision is at risk of progressive deterioration of standards, with inevitable reductions in the maximum combustion efficiency that can be achieved.

(v) **Measurable energy savings from the stove in question:** Evidence should be provided by applicants that any stove to be promoted has been (or will be) thoroughly tested in the field, alongside cooking devices that IDPs are already using, to confirm how much fuel the proposed stove is likely to consume under real operational conditions. Assumptions of fuel savings should not be based solely on lab tests, second-hand reports from other programs, or potentially subjective feedback from beneficiaries of NGO support.

(vi) **Relevant monitoring indicators:** Monitoring indicators in FES programs should focus on how much energy is saved, rather than the number of people trained or the number of stoves constructed. Fuel savings are the underlying goal of USAID's support to FES programs and hence need to be rigorously confirmed. Other real or perceived benefits could also be identified and monitored, such as time savings and reduced fire hazard. Monitoring reports should include a description of the baseline situation and be updated regularly so that the findings can be used to fine-tune the program as it proceeds.

(vii) **Attention to fuel and stove management and behavior change:** User education should be emphasized in training and behavior change efforts. Education should provide practical hands-on demonstration of cooking techniques and fuel handling practices that promote the efficient use of wood. Adoption of such techniques should be actively monitored and an effort made by the implementing organization(s) to determine which practices are already being used, what effects they are having, and which others have the potential to be promoted.

b**. Promote other ideas or equipment to reduce the consumption of fuel:** Given the prevailing diet in IDP camps in Uganda, the introduction of hay boxes may be useful. Hay boxes are insulated containers in which food continues to cook without further fuel consumption once it has been brought to a boil on a stove. They can be manufactured locally and sometimes can be introduced as an income-generating activity. Hay boxes could be introduced simultaneously with FES or as a stand-alone activity (depending upon the capacity of the NGO).

c. **Increase donor coordination with NGOs:** USAID should request regular program updates from the implementing NGO throughout the life of the project. Such updates should include explanations of any incremental changes from the baseline situation, as well as updated performance indicators.

Annex: Summary of Household Survey Results

The evaluation team conducted random household surveys in all three districts in order to collect basic information on cooking practices, as well as to gauge beneficiary attitudes toward FES and FES program impact. The sample size in Kitgum and Gulu was 25 households, in Lira District 26 households were surveyed. Condensed results of the survey (containing those questions most relevant to fuel consumption and savings) are presented here. In general, and unless noted differently, a percentage of all responses for the particular camp are presented in all tables.

1. How many times per day do you cook or light the fire to boil water?

	Kitgum	Lira	Gulu
1 time	8%	54%	-
2 times	13%	38%	11%
3 times	50%	8%	43%
4 times	25%	-	30%
5 times	4%	-	16%

2. Do you use any energy saving practices when you are cooking? *(multiple responses)*

	Kitgum	Lira	Gulu
A: sieving cooking water thru ash	-	3%	-
B: presoaking of beans	68%	5%	96%
C: add soda ash (magadi)	4%	40%	20%
D: extinguish fire when cooking is done	40%	28%	16%
E: cut large pieces of wood into smaller ones	-	18%	-
F: dry wood	-	5%	-
G: cover the pans	-	3%	-

3. Why do you like your traditional stove?

	Kitgum	Lira	Gulu
1 tradition	15%	17%	22%
2 cheap	8%	22%	33%
3 simple	8%	22%	11%
4 best	0%	6%	11%
5 don’t know other stove types	31%	6%	0%
6 ignites easily	15%	17%	22%
7 uses wide variety of pot sizes	23%	6%	0%
8 no response	0%	4%	1%

4. What are the 4 main reasons why you like your improved stove?

	Kitgum	Lira	Gulu
1 modern	6%	3%	4%
2 easy	3%	11%	6%
3 saves time	17%	21%	28%
4 saves fuel	26%	25%	29%
5 safer	15%	6%	4%
6 cleaner	4%	17%	6%
7 remains hot overnight	1%	5%	1%
8 removes smoke from house	18%	6%	19%
9 requires less supervision when cooking	10%	6%	3%

5. What are the 4 main things that you dislike about your improved stove?

	Kitgum	Lira	Gulu
1 expensive	0%	0%	0%
2 difficult to light	12%	6%	3%
3 smokes when being ignited	0%	6%	15%
4 burns food	8%	0%	12%
5 makes house very hot	8%	0%	24%
6 wears out pot bottom quickly	12%	0%	34%
7 takes up much space in house	0%	0%	0%
8 difficult to prepare posho, millet meal	8%	6%	12%
9 can't think of any	52%	82%	0%

6. Did anyone teach you how to use your improved stove?

	Kitgum	Lira	Gulu
Yes	12%	81%	16%
No	72%	4%	72%
No reply	16%	15%	12%

7. Does the improved stove use more or less fuel than your traditional stove?

	Kitgum	Lira	Gulu
Less	100%	80%	100%
More		5%	
No reply		15%	

8. Have you ever heard of a Hay Box?

	Kitgum	Lira	Gulu
Yes			
No	100%	85%	92%
No reply		15%	8%

9. What do you normally use to start the fire?

	Kitgum	Lira	Gulu
B: Scrap paper			
C: Kerosene		8%	
D: Plastic bag			
E: Cloth			
F: Twigs, leaves		15%	
G: Grass	100%	77%	100%
H: No reply			

10. Do you dry the fuel you use at home?

	Kitgum	Lira	Gulu
A: only in the rainy season	68%	32%	71%
B: never	4%	0%	29%
C: always	28%	68%	0%

11. If you dry your fuel, how do you do this?

	Kitgum	Lira	Gulu
A: Always different method			
B: In the sun	96%	76%	64%
C: Outdoors, protected from rain			
D: Next to an open-fire/stove		12%	8%
E: In a closed shelter			
F: No response	4%	12%	28%