Evaluating implementation of an improved stove project in an Eritrean IDP camp

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ABSTRACT

This article describes our experience evaluating and monitoring an improved cookstove project in an Internally Displaced Persons (IDP) camp in Eritrea, East Africa. In the camp and Eritrea generally, cookstoves play a key role in overall energy use while the choice of wood as a cooking fuel affects deforestation, carbon emissions, and indoor air pollution which causes respiratory disease. Though implementation proved sufficiently complex to defy a straightforward or simplistic evaluation of success, unexpected positive factors help the program pay for itself both in terms of financial benefits to participating households and global environmental benefits (carbon emissions savings). Evaluating project performance at different organizational scales and comparing information from multiple perspectives yielded meaningful calculations of program benefits despite uncertainties in our data. In the future we hope to see improvements in project implementation efficiency, stove adoption and utilization rates, and in the persistence of the effective use of improved stoves.

Overview

Our evaluation exercise sought to determine how well an improved cookstove project in an IDP camp in Eritrea satisfied the goal of reducing stove-based wood consumption by one-half and to understand

how project performance can be improved. This project is part of Eritrea's national improved stove program, whose long term goal is to decrease household energy use by one-half and acute respiratory disease (caused by indoor air pollution) by more than twenty percent.

In Eritrea, as in other developing countries, severe resource limitations challenge any project's ability to provide benefits, and to meaningfully evaluate project performance, in a cost-effective way. So do the inevitable unexpected snafus—the effects of Murphy's law. We found these threats to the success of the cookstove project to be counterbalanced by unexpected positive factors. One is the ability of project beneficiaries to adapt when things do not go as planned: while many stoves were distributed but left unbuilt or unused, many families share those stoves that do work. A second is that the improved cookstove designs are inherently robust: many are not installed according to design specifications but still perform quite well, while properly installed stoves appear to exceed initial performance expectations.

The improved stove project implementation process proved sufficiently complex to defy a straightforward or simplistic evaluation of success. When data obtained in different ways seemed inconsistent, our strategy of comparing information from multiple sources and perspectives served us well, providing enough context to allow plausible interpretative decisions. Despite the uncertainty imposed by realities in the field, we are confident that the results of our calculations are meaningful and a reasonable basis for decisions about how to proceed with improving cookstoves in Eritrea.

We found that while only thirty percent of the households which received improved stove materials are using properly built improved stoves, average per-household fuel savings exceed initial project expectations by twenty percent. Annual household economic return on development investment is about 200%, meaning that for every dollar of improved stove parts purchased by the stove project, the average household realized more than two dollars of economic benefit per year. And, we estimate the total carbon benefit from the program to be 7500 tonnes of net sequestered CO_2, for a total undiscounted social and environmental benefit-to-cost ratio of 7.8 : 1 over the next three years. Overall, then, the project must be judged a success. Even so, in the future we hope to see improvements in project implementation efficiency and stove adoption and utilization rates, and evaluation of questions such as the persistence of effective use of improved stoves.

Evalution information from this study is likely to be applied by the International Committee of the Red Cross in Eritrea in deciding how to best improve, expand or phase out future implementation of the improved stove project with efficient deployment of scarce development resources. And as the national improved stove project expands in scale and coverage, hands-on village-level implementation will give way to national program policies that allocate incentives and support based on project performance.

This project evaluation was carried out as a cooperative effort between three entities:

- the Energy Research and Training Center (ERTC) of the Eritrean Department of Energy,
- the International Committee for the Red Cross (ICRC), and
- the Eritrea Technical Exchange (ETE), a project of the International Collaborative for Science Education and the Environment (ICSEE), a U.S. non-profit NGO which has been working closely with the ERTC on stove efficiency research and evaluation since 1995.

Project Background

Enjera (or *injera*, the individual loaves or pancakes of which are called *taita*), is the staple bread of Eritrea, Ethiopia, and parts of the Sudan, and is a major element of the diet and household energy use in this region (Van Buskirk, Teclai, and Negusse 1998). The stove on which *enjera* is cooked is called the *mogogo*. Besides *enjera*, Eritrean households cook *qiCa* on a stove called the *moqlo.* The vast majority of Eritreans live in rural areas where the fuels used for cooking are wood, dried animal

dung, and agricultural residue.

The ICRC improved stove project is part of a national effort by the Eritrean Department of Energy called the Eritrea Dissemination of Improved Stoves Program (EDISP). EDISP has its roots in stove efficiency research conducted during the Eritrean independence struggle (1962-1991) by liberation fighters. Striving to systematically bring use of every resource down to an absolute minimum, the fighters reduced the fuel wood requirements of cooking for their forces by designing improved stoves.

In 1995, the Eritrean Department of Energy's ERTC began stove efficiency research, investigating first electric and later biomass *mogogo*'s. This research revealed iron-plate designs to be about twice as efficient as traditional clay plate designs. Subsequently, a design adapted from "the field" (i.e., the independence struggle) proved to be two to three times as efficient as traditional stoves, even when using clay cooking plates.

A pilot project conducted in *damba* village in 1999 was expanded to a dozen villages with support from ETE/ICSEE in 2000 and 2001. During this time, the ERTC worked with the home economics department of the Ministry of Agriculture to train several staff in the improved stove designs.

War broke out between Eritrea and Ethiopia in 1999, and lasted into 2000. As a result, Internally Displaced Person (IDP) camps were set up in Eritrea, and the presence of these relatively large, concentrated communities led to critical fuel shortages and deforestation. In response, the ICRC decided to mount improved stove programs in the IDP camps. The ICRC began planning this effort in early 2003 as part of a general fuel assistance program for the IDPs that included the distribution of kerosene fuel. Initial efforts focused on camps in *meTera*, *may wuray*, and *`adi qexi* with materials for 300, 300, and 2500 stoves distributed respectively by about March 2004.

Project impact evaluation for the first phase of the stove projects began in late 2003 and early 2004. In December 2003, ERTC and ICRC staff worked together conducting household interviews to help collect data for carbon emissions reductions credits that the Eritrean Department of Energy sells to Future Forests (1) to fund EDISP.

In January 2004 ETE/ICSEE performed a carbon credit emissions evaluation for the *`adi qexi* IDP camp, and found substantially less fuel and carbon emissions reduction savings than what we expected based on earlier ICRC project interviews and ERTC stove project evaluations in other villages. The evaluation showed only about twenty percent fuel savings obtained by the improved stoves against an expected savings of fifty percent. This disappointing performance was attributed to errors in stove construction—about half of stoves had the fire grate installed upside-down—and the heavy use of the kerosene which ICRC distributed for free to the IDPs at the time.

ETE/ICSEE described the preliminary results in an email to ERTC and the ICRC in January 2004, and completed the more detailed carbon credit verification report at the end of March. In response to ETE's problematic findings as well as to a heavy load of other projects, ICRC agreed to shift responsibility for implementing the next phase of the stove project to the ERTC. This was expressed in a memorandum of understanding (MOU) signed by the ICRC and the ERTC in March 2004. The MOU indicated that 400, 400, 400, 100, and 200 new improved stoves were to be installed in the IDP camps of *korekon*, *kotebya*, *`adi qexi*, *afoma* and *meTera* respectively.

At the end of May 2004, when ETE/ICSEE returned to Eritrea to continue evaluation of EDISP projects, ERTC and ICRC agreed that ETE/ICSEE should evaluate the *`adi qexi* IDP camp to gather information on the performance of the project and the MOU.

Structure of the Evaluation Process

In Eritrea, ETE has approximately five years' experience in monitoring and evaluating village-level improved stove projects for social acceptance, economic benefits, and physical resource impacts. We have learned that development projects—like many human endeavors—suffer from both Murphy's law and shortages of time, money, and resources, making it important to measure and evaluate

progress in the course of the project implementation cycle, so as to diagnose and correct problems and improve project effectiveness.

The present project evaluation focuses on the performance of the improved stove projects implemented in the internally displaced person (IDP) camp of `*adi qexi,* whose primary goals are to decrease wood use, decrease deforestation pressures, and save fuel expenses and collection time for IDP households.

In performing the evaluation, we used a four-step framework for project production and impacts that captures the flow of project resources and information from project inputs to final outcomes.

Figure 1 illustrates the general form of this framework with a simple flow diagram:

Input ® Output ® Intermediate Outcome ® Final Outcome

Figure 1: Flow diagram of four-step evaluation framework

We define the framework components this way:

- *Inputs* are resources that are used to design and implement the project: staff members, stove parts, transportation services, funding, and so on.
- *Outputs* are tangible products that projects generate. For improved stove projects, outputs are usually physical in nature: number of installed stoves, their condition, and the mode and frequency of use.
- *Intermediate Outcomes* are observable and measurable changes that result from the existence of Outputs: less wood consumption, lower energy expenditures, less time spend gathering fuel for cooking.
- *Final Outcomes* are the ways people experience changes in their material lives because of Intermediate Outcomes: sick less frequently from cooking smoke, more free time, enhanced opportunity and greater available choices because less time and money is spent on collecting or paying for cooking fuel.

Final outcomes can take years of study and research to measure reliably. Given the very limited evaluation time and resources available, we are obliged for now to focus on the first three elements of the project production framework.

For the specific application of stove projects, we can define different levels of household involvement or project penetration. Mapping these into the flow diagram, as in Figure 2 below, gives a sense of how the project works. We have two data sources here: the ICRC's list of households and persons to whom non-food items are distributed in the IDP camp (equivalent to a list of everyone resident there), and the ICRC's record of those households it thinks received parts for improved stoves.

Input	®	Output	®	Intermediate Outcome
total number of households per ICRC		constructed stoves (may or may not be well-built or used by the household)		Fuel savings (measurable through household surveys and stove cooking tests)
houses on the ICRC stove list				Decreased indoor air pollution
stove materials				

Figure 2: Evaluation framework flow diagram with project penetration levels mapped in

Going further, we incorporate data from the field—now the flow diagram begins to reflect project production. We now supplementing the data from the ICRC lists with results from a stove counting survey we performed to measure project penetration at different levels.

We can define an "implementation efficiency" for each step of the stove program process. Each level of project penetration has its own efficiency factor. These factors help us see where efficiency must improve if our project is to help make high efficiency stoves the norm in Eritrean households. The resulting flow diagram appears in Figure 3 below.

Input	efficiency factor	value	®	**Output**	efficiency factor	value	®	**Intermediate Outcome**
1. households/ persons exist per ICRC	n/a	5115		1. new stove is built	installation efficiency	76% of Input 3		Fuel savings
2. households on ICRC stove list	sign-up efficiency	2500, or 49% of Input 1		2. new stove is used	utilization fraction	78% of Output 1		Decreased indoor air pollution
3. household members have materials for new stove, per ETE survey	sharing factor	85% of respond-ents, or 173% of Input 2		3. new stove is well-built	design compliance efficiency	58% of Output 2		
				4. new stove is improperly built	n/a	42% of Output 2		

Figure 3: Evaluation framework flow diagram with field data and efficiency factors

At this point, the flow diagram highlights an apparent discrepancy: the ICRC recorded that 49% of the total number of households in the camp received parts for improved stoves, while in our stove counting survey we found that 85% of households we could physically locate told us that they had received the materials for the new stoves. This probably happened because people sharing the same *mogogo* may not all be from households recorded by ICRC as receiving improved stove parts. When interviewed directly by ETE, people may say that they have received improved stove parts because they are using an improved mogogo whether it's in their own immediate household or not; they may be sharing a *mogogo* with close relatives, for example, who live in different households.

Later, when all of our data are in and we perform the calculation of project impact, the result will be a value for the Intermediate Outcome of fuel savings. The Intermediate Outcome of decreased indoor air pollution is outside the scope of this project evaluation.

Evaluation Activities

We wanted our evaluation process to account for project project performance at different organizational scales and levels. To accomplish this, we designed four types of evaluation activities:

1. a project implementer meeting with the Barentu office of the ICRC
2. a meeting with members of the women's committee
3. interviews with households, accompanied by stove counting surveys
4. cooking tests to measure actual fuel savings and cooking efficiencies for stoves used in the IDP camp.

Each evaluation activity provides different views and measurements of project performance, and carries a different cost in the time and effort of project staff and IDP camp residents. These are summarized in Table 1 below.

evaluation activity	**objective**	**human resource requirements**		
		staff	**time**	**comment**
project implementer meeting	understand organizational dynamics of the implementer who provides the support and incentives that help drive the project	2-3 project implementers	2-3 hours	some useful information can also be obtained through conversations in the course of other project activities
meeting with the women's committee members	gain insight into the organization of the stove project training and installation labor and activities	at least 5 women organizers, and project staff	two hours of time from each	

evaluation activity	objective	human resource requirements		
		staff	time	comment
household interviews	obtain information on household economics, demographics, and perceived stove project impacts	one to several household members, and two project staff	0.5 - 1 hour of time from each, per interview	a minimum of 20 interviews typically need to be made for a project evaluation exercise, so this costs typically 30 project staff hours and a similar number of household interviewee hours
stove counting surveys	assess degree to which the dissemination, installation, and utilization of the stove parts and stoves has covered all households in the camp	two project staff	one household for every 1-2 minutes	a sample of approximately 100 data points requires only about 5 person-hours of staff labor
cooking tests	obtain reasonably accurate information on actual stove performance in the household cooking setting	at least 2 project staff, and one householder	1-2 hours from each, for each test	

Table 1. Evaluation activity objectives and requirements

A detailed look at what was communicated in the various meetings provides a glimpse of the human and organizational dynamics that are key to project performance.

Project Implementer Meeting

This largely unstructured interview revealed that from the perspective of the regional ICRC office, the improved stove project was a high priority component of household energy assistance to the *`adi qexi* IDP camp throughout 2003. However, after distributing parts for improved stoves to 2500 of the 5115 registered households in *`adi qexi*, the project's efforts to install more improved stoves there stalled in 2004. At about the same time, improved stove projects were initiated at two other IDP camps in the region (*kotebya* and *korekon*).

Regional ICRC staff partly attributed the difficulty in 2004 installations to the MOU between the ERTC and the ICRC. In March 2004 the MOU had transferred implementation responsibility from the ICRC to the ERTC, which is based more than a day's drive from the IDP camps, in Asmara, the Eritrean capital. Despite the MOU and heavy commitments from other program responsibilities, the regional

ICRC office managed to work with the ERTC and the regional Ministry of Agriculture Home Economics Department to launch the improved stove project in the *kotebya* and *korekon* IDP camps.

Local Organizer Meeting

This semi-structured interview with women's representatives of the *`adi qexi* IDP camp posed five key questions:

1. What has been the time line of activities for the project?
2. How many stoves of each type have been built?
3. What fraction are in use?
4. What are some of the problems with the stove and the stove program?
5. What fraction of people in the community really want the new stove?

The meeting began by rehashing the timeline of project implementation as summarized below.

- The improved stove project began in May 2003 with a visit by two trainers of the Ministry of Agriculture (MoA) Home Economics Department, who had attended a 10-day training session at the ERTC. These MoA staff trained a total of 45 local women from the six villages of the IDP camp (the IDP camp is organized in six sub-communities called 'villages'). During the course of the training a total of 80 improved stoves were constructed. Then, in the first phase of the program 910 additional stoves were installed in the six villages as shown in Table 2 below.

Village	**Number of Stoves**
`adi SeSe	200
xelalo	200
mukuti	150
xexebit	150
`adi hakim	110
may qobah	100
Total	910

Table 2: Phase I Improved Stove Distribution

- Phase I of the project began in June 2003 and was completed in August 2003.

- In Phase II 1500 stoves were installed beginning in November 2003. All requisite materials have been distributed for both phases but the stove construction remains incomplete for about ten percent of the households, according to the organizers' estimate. Two factors are thought to be responsible for the shortfall: first, a persistent rumour that part of the camp will be moved to another location, and second, that some householders are traveling to care for cattle or crops in remote parts of the countryside.

- For the third phase of the project, the materials for 400 stoves have been gathered in a central store-house, and there has been a training meeting, but no stoves have been installed.

- At the meeting, the trainers demonstrated a more comprehensive improved stove design integrating a *mogogo* (a stove for cooking *injera*), a *moqlo* (a stove for cooking *qiCa*), and a sauce stove. This stove featured an easier-to-contruct firebox with sides made of custom-designed ceramic bricks rather than flat stones. The women's organizers requested that at least some of these integrated triple stoves be constructed.

- When asked about problems with the stoves and the program, the organizers cited few if any problems with the stove (except that they should have access to the better design), and focused on needs not being met by the project implementers. The women's organizers made three requests of the project implementers:

    - Payment of a per-diem stipend to women organizers who assist individual households in constructing their improved stoves.

    - That the project provide materials for an upgraded stove design including the hollow ceramic bricks for constructing the stove firebox, and for constructing a double stove that includes both the *mogogo* (for the *taita* bread) and the *moqlo* (for the *qiCa* bread), and

    - That households receive a tarp for protecting the mogogo during the rainy season.

- Of the three requests, the per-diem for local project organizers and implementers was the most strongly emphasized. In quite a bit of back and forth, the ICRC and the ERTC took the position that the local community should contribute this portion of the project, while the organizers emphasized the hard labor required for stove construction and the need for some payment to enable them to reach all households.

Household Interviews

Three sets of household interviews were conducted in the course of project evaluation. The first, in December 2003, provided good initial information although the interview form lacked a degree of clarity in some of the more detailed questions. The second, conducted in January 2004 as part of a carbon credit verification process, featured a more carefully structured interview form and supervision by an international expert. The third, in June 2004, was part of a follow-up study of problems and issues noted in the January 2004 carbon credit verification evaluation. The interview form appears at the end of this section, as Figure 4.

The different sets of household interviews produced consistent data about some measured quantities, yet were inconsistent with respect to average fuel use estimates. Changing conditions of energy demand between the study periods may be responsible for this inconsistency. Results of the

interviews appear in Table 3 below.

Quantity	Dec. '03	Jan. '04	June '04
Household size	5.6	6.1	5.8
taita consumption (#/cap/week)	7.8	6.5	5.4
Wood per *taita*, improved stove (kg/*taita*)	0.35	0.42	0.22 0.36
Wood per *taita*, unimproved stove (kg/*taita*)	0.83	0.51	0.74
Wood per *qiCa* (kg/*qiCa*)	3.6	3.5	2.7

Table 3: Household interview results

Results from the three sets of evaluation studies showed good consistency on two points: household size and a downward trend in *taita* consumption (perhaps explained by seasonal effects, namely warmer temperatures leading to lower caloric intake). However, fuel use measurement of improved stoves varied up to about thirty percent, and the January measurement of fuel use for unimproved stoves showed an even larger discrepancy. For the *qiCa* fuel use, this discrepancy appears between the June and the December/January results.

The discrepancy between the January *taita* fuel use for the unimproved mogogo and the fuel use for the other evaluation periods is likely due to the impact of subsidized kerosene. In virtually all interviews, households reported using kerosene to light the fuel for cooking *taita*. In January the ICRC was distributing five liters/month of free kerosene per household. At more than 35 MJ/liter, one liter of kerosene has about the same energy content as two kilograms of wood. In addition, using kerosene to start the fire may substantially increase the efficiency of combustion by causing fuel temperature in a shorter span of time. In June, although households reported using kerosene to initiate fires for *taita* cooking, this was not observed in cooking tests, and one household confidentially told evaluation staff that households were reporting frequent kerosene use in the hopes of obtaining subsidized kerosene again.

Count of Installed Stoves

For the stove count evaluation, seven groups of ten houses semi-randomly distributed throughout the camp were surveyed quickly to answer four questions:

1. Did the household receive materials for the improved mogogo?

2. Did it construct the improved mogogo?

3. Was it using the improved mogogo?

4. Was the improved mogogo installed correctly (i.e., with the clay grate in the correct position)?

The results of this quick survey appear in Table 4 below.

House Group	Parts Received	Installed	Actively Used	Correctly Installed
Group A	9/10	8/10	5/10	4/10
Group B	10/10	7/10	4/10	4/10
Group C	9/10	9/10	8/10	6/10
Group D	7/10	5/10	5/10	1.5/10
Group E	5/10	2/10	2/10	0/10
Group F	9.5/10	8/10	5/10	3/10
Group G	8/10	6/10	6/10	6/10

Table 4: Stove count quick survey results

The stove count evaluation revealed that of households receiving stove parts, some had not yet installed the improved stove, some were actively using it, and not all improved stoves were installed according to design specifications. These results imply a need to focus additional resources on the installation and utilization steps of improved stove dissemination, in addition to the parts distribution step which has been the primary focus of the stove program so far.

Whether a household participates successfully in the improved stove program appears to depend partly on its location in the camp. The cluster of households with the lowest participation rate was located a significant distance from the main pathways, on a windy and dusty patch of sloping ground. During the stove count several families reported that because they had ongoing work in their original home villages, they lacked sufficient time to complete the stove installation. Rumours about the relocation of some camp residents apparently prevented some installations from being completed. And, evaluators noted that some households in the stove count survey were unoccupied at the time. We might expect, then, to find the efficiency connecting the parts distribution step and final stove utilization to be greater in the more cohesive communities.

Cooking Tests

To verify the fuel use data from the household surveys, six field cooking tests were conducted in the `*adi qexi* camp. The results from these tests are summarized in Table 5 below.

Cooking Test	Mogogo Type	*taita* mass (kg)	# of *taita*	Wood Consumed (kg)	Wood Intensity (kg/*taita*)	HH Interview Wood Intensity (kg/*taita*)
Test A	Improved, Unclogged Grate	4.2	8	1.53	0.19	0.22
Test B	Improved, Unclogged Grate	8.0	14.5	1.74	0.12	0.22
Test C	Improved, Unclogged Grate	8.2	19	2.07	0.11	0.22
Test D	Improved, Clogged Grate	4.9	9	3.3	0.37	0.36
Test E	Improved, Clogged Grate	8.1	15	2.7	0.18	0.36
Test F	Traditional	5.6	8	4.12	0.52	0.72

Table 5: Cooking test results

These results largely correlate with energy use estimates derived from the June 2004 household interviews. Average fuel intensities from the cooking tests are about one-third lower than the fuel intensities indicated from the household interviews. This may indicate that households being interviewed tend to overestimate cooking fuel use. The tests also appear to confirm that even an improperly installed improved stove (i.e., one with an upside-down grate which consequently becomes clogged) uses about one-half the fuel used by an unimproved stove. A properly installed improved stove appears to need less than one-third the amount of fuel required by an unimproved stove.

HOUSEHOLD INTERVIEW FORM FOR
Stove Project Evaluation
JANUARY, 2004

Date: _____
Interviewer Initials: _____
Village or location _____
Family name _____

Number of persons in the family:
number of adult males _____,
number of adult females _____,
number of boys under 16 _____,
number of girls under 16 _____,

How many people have had a cold or a cough in the last two weeks?
number of adult males _____,
number of adult females _____,
number of boys under 16 _____,
number of girls under 16 _____,

Which types of stoves do you use?
1. Traditional Mogogo ( ) Improved Mogogo ( ) No Mogogo ( )
2. Traditional Mokulo ( ) Improved Mokulo ( ) No Mokulo ( )

Do you have a second mogogo? Yes ( ) No ( )

If yes, what type is the second mogogo?
Traditional ( ) Electric ( ) LPG ( ) Improved ( )

1. For cooking taita:

How many times do you cook taita in a week? _____ times/week

If you have both traditional and improved mogogo, how often do you use each type?
_____times/week for improved mogogo
_____times/week for traditional mogogo

How many taita do you cook per session? _____

Do you cook Kicha when you cook taita? Yes ( ) No ( )
If yes, how many? _____

How long does it take to cook taita (and Kicha)? _____hrs

How much of each kind of fuel do you use?
(if there are both types of mogogo, put amounts for
traditional mogogo in parentheses)

_____kg wood, _____kg sticks, _____kg Kindling (gifgaf encheyti),

_____kg Dung Patties (Kubo), _____kg Loose Dung (gifgaf Kubo)

_____kg other types: grass( ) sawdust( ) agricultural residue( )

Do you add kerosene to start the fire? Yes ( ) No ( )

How much charcoal is left after cooking taita? _____kg dry charcoal

2. For cooking kicha separately from taita:

How often do you cook kicha separately from taita? _____ times/week

How many kicha do you cook per session? _____

How long does it take to cook kicha? _____hrs

Do you use the mogogo or the mokulo? Mogogo ( ) Mokulo ( )

How much of each kind of fuel do you use?

_____kg wood, _____kg sticks, _____kg Kindling (gifgaf encheyti),

_____kg Dung Patties (Kubo), _____kg Loose Dung (gifgaf Kubo)

_____kg other types: grass ( ) sawdust( ) agricultural residue ( )

Do you add kerosene to start the fire? Yes ( ) No ( )

How much charcoal is left after cooking kicha? _____kg dry charcoal

3. Diameter and weight of taita and kicha:

What is the diameter and weight of taita?

diameter of taita:_____cm, weight:_____kg

diameter of mogogo plate:_____cm

What is the diameter and weight of the kicha?

diameter:_____cm, weight:_____kg

diameter of mokulo plate:_____cm

3. For Improved Stoves (Mogogo and Mokulo)

Date of construction _____

Is the firebox built with stones or ceramic blocks?

Flat Stones ( ) Ceramic Blocks ( )

What fills the space inside the stones or blocks?

Ash ( ) Sand ( ) Air/Nothing ( ) Gravel ( )

Are the fire grate holes clear and open, or clogged with ash?
Open/Clear Holes ( ) Clogged with Ash ( )

Is there a chimney? Yes ( ) No ( )

Is there an air control valve for the chimney? Yes ( ) No ( )

What are the 3 principal benefits of using the improved stove?

1) _____

2) _____

3) _____

What are the 3 principal problems of using the improved stove?

1) _____

2) _____

3) _____

When you move next (change your house or return to your village) will you carry the new mogogo parts (grate and chimney) to your new house?

Yes ( ) No ( ) Comment _____

4. General questions

Who participates in cooking in your family? _____

Who buys or collects the fuel for cooking? _____

Do you collect or buy the fuel for cooking taita? Collect ( ) Buy ( )

If you buy, how much do you pay for fuel? _____ Nkfa per _____ (amount)

If you collect:

How many times a week do you collect fuel? _____ times/week

How long does it take you to collect fuel? _____ hrs/round trip

Comment_____

End of interview

Figure 4: Household interview form

Project Impact Calculations

To be able to calculate the average per stove project impact, we must first interpret the results of the evaluation studies to estimate or assume values for different impact factors.

Our assumed or estimated project impact factors are these:

- *Household Size* of 5.8 people/household
- *Per Capita taita Consumption* of 6.5/capita/week.
- *Fuel Intensity of taita Production* of:
    - 0.5 kg/*taita* for an unimproved stove
    - 0.25 kg/*taita* for an improved stove with a clogged grate, and
    - 0.17 kg/*taita* for an improved stove with an unclogged grate.

- *Fuel Price* of 25 Nakfa/donkey load of 25 kilograms, or one Nakfa/kg.
- *Biomass Lifetime in Ecosystem* of 7 years on average.
- *Below Ground Biomass* of 0.47 times above-ground biomass.
- *Carbon Content of Biomass* of 1.8 kg CO_2/kg Biomass
- *Project Implementation Efficiency:*
    - 76% of households that receive materials install stoves, and 78% of these are used, meaning (1-76%*78%) = 41% of households continue to use the traditional stove.
    - The 59% of participating households using improved stoves consist of one set of 34% using a well-built stove, and 25% of participating households using an improved stove with a clogged grate.

Now we can calculate the answers to the basic questions addressed by our project evaluation.

- How much wood does a household using an improved stove use to cook a *taita*, compared with a household using an unimproved stove? In other words, how much wood per *taita* is saved by the improved stove?
    - On average a partipating household uses 0.41*0.5 + 0.25*0.25 + 0.34 * 0.17 = 0.33 kg wood/*taita*
    - On average, a non-participating household uses 0.5 kg wood/*taita*
    - Each improved stove saves, an average, 0.17 kg wood/taita
- Given these per-*taita* fuel savings, what is the average monthly fuel and monetary savings for households participating in the project?
    - For an average 5.8 people/household, and 6.5 *taita*/week and 4.3 weeks/month, the fuel savings per household per month is approximately 0.17 * 5.8 * 6.5 * 4.3 = 27 kg/month, which is valued at about 27 Nakfa/month.
- What is the payback time for the investment required to install an improved stove?
    - With the ICRC contribution per stove at about 159 Nakfa/household, the payback time in terms of average participating household savings is approximately six months.
- What are the environmental benefits provided by each improved stove?
    - In terms of CO_2 sequestration, the benefits of the program per household is the annual fuel savings plus the corresponding below-ground biomass fraction times the average biomass lifetime in the ecosystem times the carbon dioxide intensity of biomass.
    - This provides the result of 27 kg Biomass/month * 12 months/year * 1.47 * 7 years * 1.8 kg CO_2/kg Biomass = 6 tonnes CO_2 per participating household if the household continues to use the stove.
    - Assuming that at least half of households that start using the stoves continue using them indefinitely, then the CO_2 sequestration benefits are an average of about 3 tonnes per participating household. This has a current wholesale market value of about $6/tonne or $18/participating household.
    - If the exchange rate for Nakfa is 14 Nakfa/US$, then the global environmental benefits of the stoves are about 252 Nakfa per participating household.

Conclusion

Our evaluation and monitoring experience with an improved cookstove project in an Internally Displaced Persons (IDP) camp in the Gash-Barka (Western Lowlands) region of Eritrea, East Africa, has largely been a positive one. Challenges to the success of the cookstove project are counterbalanced by unexpected positive factors: while many stoves were distributed but left unbuilt or unused, many families share those stoves that do work; and the improved stove designs proved to be robust, exceeding initial performance expectations when installed properly and performing well even when they were not.

Though the improved stove project implementation process proved sufficiently complex to defy a straightforward or simplistic evaluation of success, our strategy of comparing information from multiple sources and perspectives provided enough context to allow plausible interpretative decisions. Despite the uncertainty imposed by realities in the field, we are confident that the results of our calculations are meaningful and a reasonable basis for decisions about how to proceed with improving cookstoves in Eritrea.

While only thirty percent of the households which received improved stove materials are using properly built improved stoves, average per-household fuel savings exceed initial project expectations by twenty percent. And annual household economic return on development investment is about 200%, meaning that for every dollar of improved stove parts purchased by the stove project, the average household realized more than two dollars of economic benefit per year. The improved stove program, then, pays for itself in terms of financial benefits to participating households. This is true in terms of global environmental benefits as well: assuming that half of households using the improved stove persist in doing so, the carbon emissions savings from the program is about three tonnes of CO_2 per participating household. The total estimated carbon benefit from the program in the `*adi qexi* IDP camp is thus approximately 3 * 2500 = 7500 tonnes of net sequestered CO_2. This gives an estimated total undiscounted social and environmental benefit-to-cost ratio for the program over the next three years of (3 * 12 * 27Nk + 252Nk)/156Nk = 7.8 : 1.

While the total social benefit from the improved stove project in the `*adi qexi* IDP camp is quite substantial, project implementation efficiency and stove adoption and utilization rates can still be improved. Evaluation to examine the effectiveness of any measures to achieve such improvements would be instructive. A persistence study to examine how long improved stoves continue to be utilized effectively by households could help in estimating long term environmental and economic impacts of the improved stove program. Refining our project impact estimates for the `*adi qexi* IDP camp through further detailed evaluations would probably not be cost-effective, given the many villages and camps in Eritrea that have yet to be evaluated.

Notes

1 Future Forests is, according to its website, “a UK-based company with a global vision: to protect the earth’s climate... to use a business structure ‘for good’ ...[and to] encourage practical action on climate change and sustainable carbon offset solutions.” See http://www.futureforests.com/ (accessed 20 December 2004).

References

Van Buskirk, Robert, Haile Teclai, and Ezana Negusse (1998) ‘The Effect of Clay and Iron Cooking Plates on *Mogogo* Efficiency and Energy Use: Experimental Results’, available at http://www.punchdown.org/rvb/mogogo/mogr0498b.html (accessed 20 December 2004).