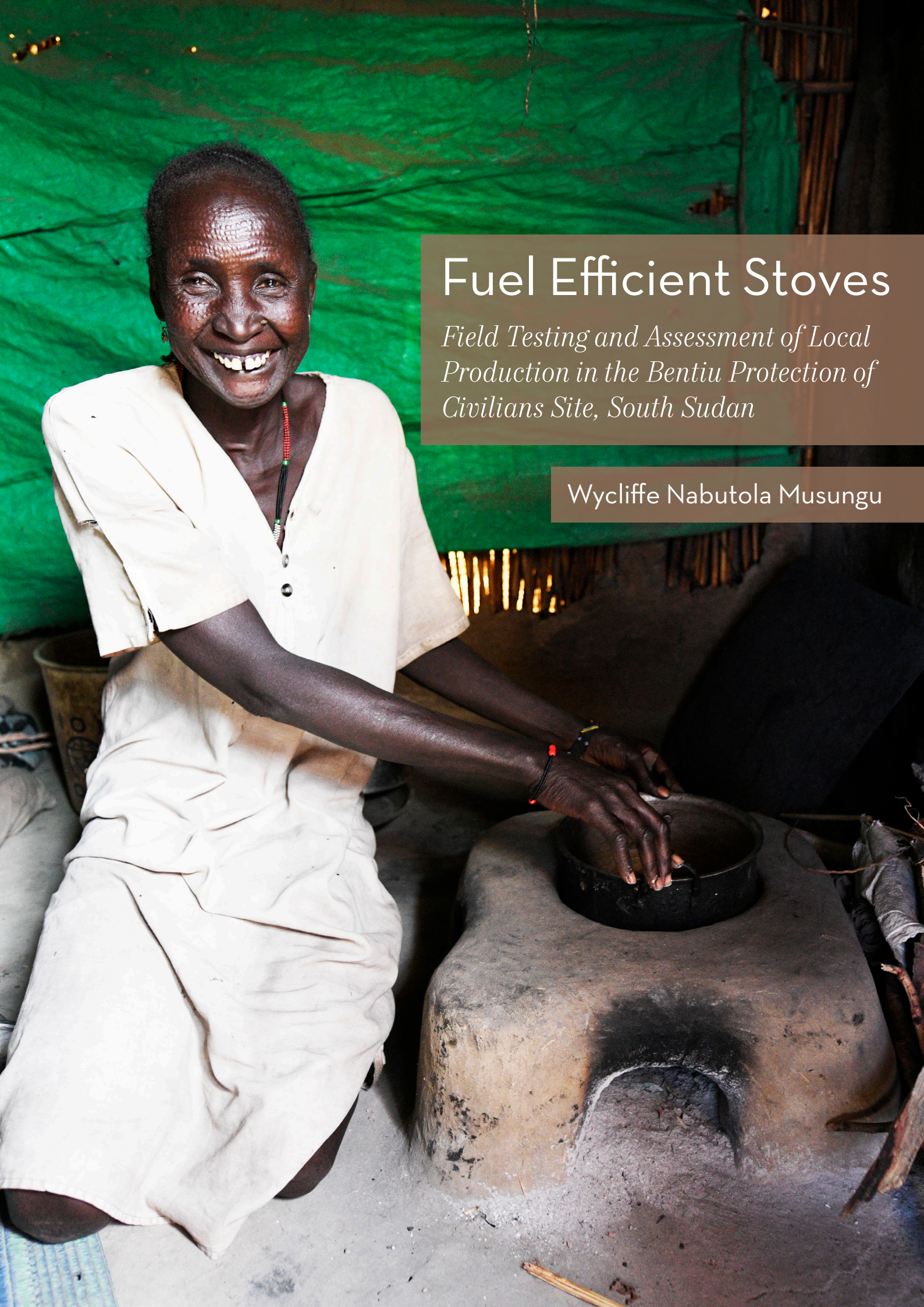

Fuel Efficient Stoves

Field Testing and Assessment of Local Production in the Bentiu Protection of Civilians Site, South Sudan

Wycliffe Nabutola Musungu

Contents

Executive Summary

In 2017 the International Organization for Migration (IOM) in South Sudan conducted a survey on fuel-efficient stoves and methods of their use and production. The survey and testing was set against a backdrop of continued crisis in South Sudan which has caused over 270,000 internally displaced persons to seek protection in displacement sites in proximity to bases of the United Nations Mission in South Sudan.

As the crisis continues into its fifth year, PoC sites are continuously maintained and sustained through immense efforts of the humanitarian community. Particularly women and girls suffer in conditions of displacement that place them at heightened risk of becoming victims to gender- and sexually based violence in and outside the Protection of Civilians sites. In order to reduce the risk of exposure to gender-and sexually based violence as they search for firewood outside the Protection of Civilians sites, IOM investigated into possibilities of introducing fuel efficient stoves to address several aspects of internally displaced persons' lives in the PoC sites such as protection issues, socio-economic aspects, health, and environmental sustainability.

The survey and testing found that internally displaced persons recognize the benefits of the FES particularly as regards to reduced risk-exposure for women and girls, reduced risk for children to burn while playing in the cooking area, reduced costs for firewood, and the overall improvement of the wellbeing of household members. The survey and testing concludes that of the seven fuel-efficient stoves tested two are recommendable for introduction in the Protection of Civilians sites.

Acronyms and Abbreviations

BDS	Business Development Skills
CHC	Community High Committee
CWG	Community Watch Group
FES	Fuel-efficient stove
FGD	Focus Group Discussion
GBV	Gender-based violence
IDP	Internally displaced person
IDPs	Internally displaced persons
IMDRM	Informal Mitigation and Dispute Resolution Mechanism
IOM	International Organization for Migration
ICC	Inter-Church Committee
NGO	Non-governmental organization
PoC	Protection of Civilians site
UNMISS	United Nations Mission in South Sudan
WRC	Women's Refugee Commission

Introduction

The majority of the world's refugees and internally displaced populations are struggling to find reliable and sustainable energy sources, forcing them to rely on traditional modes of lighting and heating. This presents social and economic challenges for both affected populations and host communities. Women and girls are particularly affected as they traditionally carry out the overwhelming majority of household chores, including the collection of cooking fuel and meal preparation.

In displacement camps and camp-like settings, often characterized by a relatively large population relying on a limited supply of natural resources, the burden of collecting cooking fuel and providing food for the family is associated with a number of negative consequences that disproportionally affect women and girls. This includes having to spend a considerable amount of time outside of the camp, which exposes them to increased risks of gender-based violence and sexual assault, as well as in the kitchen area, where they are exposed to health adverse smoke inhalation. Furthermore, confined to these activities, women are deprived of opportunities to actively participate in camp life – inevitably leading to further marginalization.

A study conducted in 2016 by the International Organization for Migration (IOM) in collaboration with the Women's Refugee Commission (WRC) in the Bentiu Protection of Civilians (PoC) site in South Sudan showed that women's perception of their participation in camp life is often limited to domestic chores, with a strong emphasis on the collection of firewood which is seen both as a "barrier to participate and a major safety concern".

In response to the outcome of this report, IOM implemented a pilot project in the Bentiu Protection of Civilians (PoC) site from June to July 2017. The project aimed at identifying viable ways of reducing the amount of time women spend on cooking related activities. The intervention consisted of distribution of different types of fuel efficient stoves (FES) that were subsequently tested for:

- Effects on cooking fuel consumption
- Perceived effects on health
- Community acceptance
- Prospects of long-term usage
- Potential for local production

While high levels of fuel-efficiency constituted a key objective, it was equally important that the affected population showed that they were willing to use the new technology and that it was well adapted to their cooking traditions. As demonstrated by previous FES distributions in the Bentiu PoC site, failing to do so would at best generate short-term usage of the stoves and would not lead to a sustainable reduction in time spent collecting firewood or preparing meals.

This report presents and analyses the findings of the pilot study and concludes with a set of recommendations for optional future construction, production, and distribution of fuel-efficient stoves in the Bentiu PoC site and its surroundings.

Main findings of this report indicate that:

- The Rubkona Rocket stove is a versatile, fuel-efficient stove, made out of locally available materials. The Rubkona Rocket stove can save up to 60 per cent of the firewood as compared to the traditional three-stone stove that is currently used by the majority of the households in the Bentiu PoC site;
- The Rubkona Rocket stove achieved high levels of user acceptance;
- Production and construction of the Rubkona Rocket stove provides opportunities for skills and vocational training that can support income generation among the affected population;
- To ensure sustainability, any intervention aimed at promoting fuel-efficient stoves should take local availability of materials and skills into consideration; and
- The Jiko Kisasa stove may also be considered for local production, however, requiring increased technical expertise.

Methodology

The methodology for testing the stoves was based on direct observation, qualitative, in-depth interviews to map-out user preferences, and quantitative surveys to capture impact on firewood consumption.

Data was collected by ten data collection assistants from 20 randomly selected households that voluntarily tested three imported fuel-efficient stoves (FES), two traditional FES that can be produced locally, and three rudimentary local stoves that are being used for cooking by the vast majority of households in the Bentiu PoC site.

The data collection was followed by focus group discussions (FGDs) during which participants were able to share their experience of using the various stoves.

- Selection of stoves: each household was supplied with the same type of stove to use; these stoves were:
    - The traditional stoves (the "Wire stove", the "All Metal stove", and the "Three-Stone stove"); these are stoves that were already used by a majority of HHs in the Bentiu PoC site; they formed the baseline of the testing for comparison purposes;
    - Two locally produced improved stove designs, the "Rubkona Rocket stove", with bricks and without bricks;
    - Three imported mobile stoves: Jiko Kisasa, EcoZoom and Kuni Okoa.
- Every household used the same one type of stove for three days.
- Every household was allowed to cook whatever meals they wished to prepare.
- The firewood was weighed on a daily basis before starting the fire, and again weight every evening after having finished cooking.
- To ensure the households did not use a traditional stove, or any other stove not designated during the study, monitors were placed in the household to observe the cooking process.
- At the end of each individual stove testing, a discussion and debriefing with the individual woman/stove user was conducted to get their perception on the stove in terms of ease of use, firewood consumption, speed of cooking, ease of lighting, safety, and health aspects of the stove.

As the data collection would require a person to sit in the kitchen to make observations and interview the cook, who in these cases were all women, it was decided that only women should be recruited as data collection assistants. The interviews were done in local languages.

Training of the data collection team in the Bentiu PoC

The data collection team getting to know the imported FES designs

Background

In July 2016, IOM in collaboration with the WRC conducted a study in the Bentiu PoC site in Unity state, South Sudan to find out more about women's participation in camp life and camp governance structures and how these might contribute to improving the safety of certain groups, such as women and girls.

A total of 158 persons were interviewed to identify contributing factors and barriers to women's participation in camp governance structures and activities as well as to assess their perceived level of exposure to safety concerns relating to gender-based violence (GBV). The purpose of this information is to initiate interventions that will increase women's participation in decision-making processes and camp governance, and management of the camp. Participation in camp management requires planning and resources and dedicated public communal space where individuals and groups from the displaced community identify and express their own views and needs. It is a process where decisions are made and action is taken together to contribute to solutions. When applied to all sectors involved in a camp's life cycle, community participation will reduce dependency and vulnerability of those living in the camp.

Governance Structure

- The United Nations Mission in South Sudan (UNMISS) and other humanitarian partners. The population is represented at three levels, namely by the Community High Committees (CHC) at camp level, and additional internally displaced persons' (IDPs) leaders at sector and block levels.

- Additional governance structures gather people in the PoC according to their places of origin, such as the different County Solidarity Associations, or according to their religious denomination, in the Inter-Church Committee (ICC).

- Dispute resolution and the resolution of minor security issues are respectively supported by the Informal Mitigation and Dispute Resolution Mechanism (IMDRM) as well as the Community Watch Groups (CWG). While the non-governmental organizations (NGOs) are the decision makers with the capacity to influence the living conditions in the Bentiu PoC site.

- They refer mainly to external stakeholders in relation to service provision, the CHC, CWG and ICC in relation to conflict mediation and security. IDP leaders are also identified as the liaison with external actors/ service providers, voicing the community's concerns.

Women's Participation in Camp Life

Despite their representation in governance structures, there is a general feeling among the IDP population that women do not have the capacity to make decisions. Either because they are "not good at making decisions" (male perceptions) or because of other barriers (female perceptions). Women believe that they have limited opportunities to share their views meaningfully. With one woman in a focus group discussion stating: "NGOs first consult men … whether we are educated or not, they don't want to involve the women".

Women's perceptions of their participation is often limited to domestic chores, with a strong emphasis on the collection of firewood which is both seen as a barrier to participate and a major safety concern. While most women living in the Bentiu PoC feel safest in their respective block, they do not feel safe anywhere in general, not even in their shelter at night. Therefore, efforts to ensure women's and girl's participation in camp life are an urgent protection priority, and can contribute significantly to improving their life.

Current Cooking and Firewood Collection Habits

Culturally, cooking is a task for women and girls and goes together with the collection of firewood and the preparation of meals for the family. This consumes a substantial part of women's time and often makes them miss out on opportunities to participate in other activities. During the process of firewood collection, many women and girls are exposed to gender-based violence, risk of snake bites and severe physical strain as they are forced to carry heavy weights (up to 50 kg) over long distances. Hence, reducing the amount of firewood needed for cooking will also reduce the amount of time women and girls are obliged to spend outside of the camp and their exposure to associated risks. Another issue exacerbated by inefficient cooking methods is an accelerating pace of deforestation. As the average distance to the forest or woodland increases, households, i.e. women and girls, spend more time collecting firewood and are forced to venture further and further away from the relative security in the Bentiu PoC site. Those who are unable to travel far enough often switch to lower quality wood fuel, which, although decreasing collection time, also reduces cooking efficiency and increases the adverse health effects from smoke pollution.

Apart from the widely used three-stone method of cooking (placing a pot on three stones surrounding an open fire) there are a few different types of stoves presently in use in the PoC and in neighboring villages and towns (see pictures below). All of them are rudimentary stoves consuming large amounts of fuel. These stoves are also made out of metal and have no insulation, increasing the risk of fire and making them unsafe for children.

The cooking culture necessitates the use of more than one stove per household. Different stoves are used for different pot sizes to allow variety of meals to be cooked. It is not uncommon for households to have three small stoves. Charcoal is the most commonly used fuel in towns such as Bentiu, while firewood is more commonly used in rural areas or during emergency displacement. Nevertheless, charcoal use is on the rise in the PoC as deadwood is getting scarce and women and girls are forced to venture further and further out to collect it

The Three-stone Iron stove for water and food

The Wire Charcoal stove

The Institutional All Metal Charcoal stove

The Institutional All Metal stove in use

Effects on Household Economy

Those who are unable or unwilling to collect firewood for their own consumption often acquire cooking fuel from the local market in the PoC. It is estimated that households which do so spend up to 60 per cent of their total household income for this purpose. This forces households to prioritize cooking fuel over other basic needs. Conversely, there are also households which cover their basic needs by selling firewood to other members of the community.

This dynamic reveals a simultaneous need of reducing households' expenses on cooking fuel while also providing alternatives for those who are collecting firewood as an income generating activity.

Firewood for sale in the Bentiu PoC site

The Stoves, the Testing, and the Results

Previous attempts at distributing fuel-efficient stoves in Bentiu PoC site have not been able to achieve a sustainable behavior change among the affected population. Arguably, this is due to a failure of humanitarian actors to adequately consider the local cooking culture.

Equally, distributions of firewood or charcoal have been done, however, this can only be considered as a short-term solution, as it creates dependency of the population on the distribution and does not secure a durable self-reliant sourcing of the fuel. Additionally, mere distributions do not help to reduce consumption. Fuel distributions also do not have much mitigation effect against GBV, as women and girls will continue to go out to supplement the rations or get firewood to sell it unless they are involved in other income-generating activities.

A total of seven stoves were tested as part of this study:

- Two traditional stoves with ad hoc improvements;
- Two locally produced fuel-efficient stoves;
- Three imported fuel-efficient stoves.

Traditional Stoves with ad-hoc Improvements

The following section provides a brief technical description of each individual stove. While all traditional stoves proved to be highly fuel inefficient, as well as hazardous to their users, the fact that they are widely used for cooking throughout the PoC site justified an attempt at modifying the stoves for better performance. Of the two local stoves, the wire stove proved to be the easiest to modify.

The Wire Charcoal Stove

The Wire Charcoal stove is made out of flexible iron wire that is collected from scrap heaps or, more frequently, from fences surrounding public and private areas in Bentiu town and Rubkona town. The first improvement to the Wire Charcoal stove was to remove the four lines which form the grate at the base to ensure the ash falls through without the need of shaking the stove.

The second improvement involved introduction of pot rests to enable free access of secondary air for efficient combustion. After the three adjustments had been identified local stove producers received training on how to perform the upgrades.

The Wire Charcoal Stove with an additional wire mesh.

Stove maker trained on adjustment of the Wire Charcoal stove.

Stove producers trained in the adjustment of the stove.

The All Metal Stove

The All Metal stove is made out of various forms of scrap metal that can be found in the Bentiu PoC site as well as in the nearby towns of Bentiu and Rubkona. Two improvements were made to the All Metal Stove, the first was to enlarge the grate holes (see picture below) to allow for the ash to fall through, and the second one was to introduce a pot rest to avoid putting the pot directly on the charcoal which will reduce fuel efficiency.

The metal stove before opening the grate holes to allow ash to fall through.

The metal stove after opening the grate holes to allow ashes to fall through.

Summary of the Wire Charcoal Stove and All Metal Stove Improvements

Stove name	Adjustment	Results	User opinion
Wire stove	Opening of the hole at the base of the stove	• Ash falls through without need for shaking	Very nice.
Wire stove	Use of handles as pot rests.	• The pot allows for secondary air to enter the combustion zone to allow for a higher temperature and also complete combustion	Nice but not very stable for the cooking pot. Pot could easily fall off.
Wire stove	Fabrication of pot rests	• Enables the use of different pot sizes on the stove • The pot is stable enough	Very nice.
Wire stove (later)	Insert ceramic liner	• The heat will be kept in the stove and directed to the pot for cooking only	Fuel saving improved and burns reduced
Metal stove	Enlarging the grate holes	• Ash falls through without stove shaking	Very nice.
Metal stove	Pot rests installed	• Cooking pot allows for secondary air to enter combustion chamber • The stove attains higher temperatures and also allows for complete combustion with a lower particulate matter emitted • The cook can stay in the house while the stove is cooking • Visible smoke has reduced	Very nice.
Metal stove (later)	Insert ceramic liner	• The heat will be kept in the stove and directed to the pot for cooking only	Fuel saving improved and burns reduced

Locally produced Fuel Efficient Stoves: the "Rubkona Rocket Stove"

As additional immediate improvement of the cooking and fuel situation, a new design of fuel efficient stove was introduced to the community and tested. The new design can be produced locally, using local materials and resources. The new design FES does not require a high financial investment, as opposed to the industrially manufactured and imported mobile fuel efficient stoves, further described in the next chapter "Imported Fuel Efficient Stoves".

The decision to test local fuel-efficient stoves alongside imported and at prima facie more fuel-efficient equivalents was made based on the following considerations:

- Stove construction material is readily available in Bentiu and surrounding areas.
- Construction does not require a highly educated labor force and members of the affected population could easily be trained to build the stove.
- Testing of similar stove models in Kenya has generated results showing a 50 per cent firewood reduction and significant reduction in smoke emission.
- The skills gained on how to build, maintain and repair this stove can be used by women and men as an income generating activity.
- Depending on how one cares for their stove and the quality of the construction materials, the stove can be in service for up to 5 years. This stove can accommodate different pot sizes depending on the pot size used when constructing the stove.

The Rubkona Rocket Stove with Bricks

The Rubkona Rocket Brick stove is based on traditional fuel-efficient stove designs and can be constructed from clay, cow dung and red clay bricks. The stove takes between one to two days to build from scratch and must then be left to dry for a period of at least 10 days before any cooking activities can commence.

The Rubkona Rocket stove construction at the Bentiu PoC Youth Center

Rubkona Rocket stove construction in the shade in the PoC site. A total of four stoves were constructed.

The Rubkona Rocket Stove without Bricks

This stove was an initiative by community members who were trained in the construction of the Rubkona Rocket Stove – with bricks (it was built after the IOM consultant left the Bentiu PoC). The main construction material was clay soil and cow dung and no bricks were used. The main reason for excluding bricks was that the majority of the population in the Bentiu PoC would not be able to access nor afford this commodity.

Furthermore, considering the temporal nature of the Bentiu PoC site, it seemed like a good idea to have stoves made out of just clay and cow dung which can both be easily removed and reconstructed when it is time to close the camp.

Five mud stoves were built by individual community members and then subsequently tested over a period of three days using the same methodology as for the other stoves.

Trainees measuring the dimensions.

The body of the stove being built solely out of clay and cowdung

Construction of the Rubkona Rocket Stove without bricks finalized.

Imported Fuel-Efficient Stoves

The following section presents a description of the three different imported fuel-efficient stoves that were tested as part of the study.

Jiko Kisasa

This is a manually produced stove, which consists of a fired ceramic product as a fire chamber. On the outside, it is lined with a metallic cladding. It is a durable stove and can last up to five years if well looked after.

Kuni Okoa

This is an industry made stove produced in Kenya. The mechanization process makes the stove a good quality product. The stove attains about 50 per cent fuel wood saving and significant reductions in smoke and emissions. The stove has good insulation to retain the heat over a long period of time.

Jiko Kisasa

Kuni Okoa

EcoZoom 5000

The EcoZoom 5000 stove for firewood is imported from China and comes into Kenya as a flat pack for local assembly. It is a high quality product and very fuel-efficient. It also has a significant smoke and emission reduction effect.

EcoZoom 5000

The Test Results

The different stove types were tested in the below categories. A full set of the results per testing category can be found in Annex A.

- Firewood consumption
- Ease of use
- Preparation of the fuel
- Cleaning
- Safety
- Health-related observations
- Willingness to pay for the stove
- Willingness to learn how to make the stove

Comparison was made on a number of aspects that can contribute towards reducing the frequency of firewood collection, while other observations/comments were, in fact, a matter of opinions and perceptions of the users.

Table 2: Results per tested stove

Stove type	Frequency of stove use	Av. firewood consumption	Ease to light	Safety	Ease of cleaning	Firewood reduction*
Jiko Kisasa	51/178	3.24	43/51	24/51	42/51	11.3%
Ecozoom 5000	54/178	2.4	24/54	22/54	36/54	34.2%
Kuni Okoa	6/178	3.3	3/6	2/6	4/6	9.6%
Rubkona Rocket – with bricks	10/10	3	10/10	9/10	10/10	17.8%
Rubkona Rocket – without bricks	15	2.96	14/15	15/15	12/15	19%

* (compared to the Wire Charcoal and All Metal Stove)

After the results of the testing were collected and focus group discussions on user preferences completed, each stove type was scored and ranked. The evaluation scale ranges from 0 to 5, with 0 indicating 'very poor performance' and 5 indicating 'excellent performance'. The results are presented in the table below:

Table 3: Stove scores and ranking

Stove type	Insulation	Firewood consumption	Smoke reduction	Local production	Material availability	Total Score
Wire stove	0	0	0	3	3	6
Iron stove	0	0	0	3	3	6

Metal stove	0	0	0	3	3	6
Jiko Kisasa	1	2	1	2	2	8
Kuni Okoa	1	3	2	0	0	6
Eco Zoom 5000	1	3	2	0	0	6
Rubkona Rocket (with and without bricks)	4	3	1	4	4	16

Jiko Kisasa

Most households that used this stove found it very easy to use and easy to start the fire, especially using the elephant grass. The stove body is also safe for children as it does not get hot to the extent of being dangerous due to the insulation between the metal and the clay part. Most users did experience some degree of coughing, but far less experienced burns with this stove. Most of the users were not willing to pay for the stove due to lack of income, nonetheless expressed interest in learning how to construct the stove. This provides a good opportunity to initiate Jiko Kisasa production in Bentiu PoC.

However, setting up a Jiko Kisasa production is a fairly heavy investment and would be a long term investment. Given the temporal nature of the Bentiu PoC site, it is possible to consider establishing such a production center outside the PoC site in order to produce stoves which can be sold to the IDPs in the PoC site. This means stoves which are locally made, using local material that is available at an affordable cost. Although many households responded that they were not willing to buy the stove because of lack of financial resources, the reality of having to sell food received in general food distributions in order to buy firewood would greatly impact decisions to eventually pay for the stove. Further, when stoves are seen to come, have been constructed, from a member of the community, and households using the stoves report of their efficiency to neighbours etc. This investment could even be considered as an initiative with a peace-building component that would benefit both the residents inside and those living outside of the PoC site.

Kuni Okoa

Kuni Okoa was tested by only six households, possibly because only these were in a position to buy and use charcoal during the time the study was done. Fuel consumption is not very different from Jiko Kisasa and most users found the stove ease to light and use. However, the cost of the stove at USD38 is high for most PoC residents. The stove requires and industrial setting for the production with heavy machinery. Considering the temporal nature of the PoC, this may not be very interesting especially taking the costs into account.

Ecozoom stove

This stove was the most fuel-efficient and would have the highest impact on the objective of reducing firewood collection for women. It also presents an opportunity to introduce a fuel-efficient stove in the PoC. The stove can be imported as knock-out kits and people are trained on how to assemble the stove. However, the cost of stove was considered too high. Due to lack of income generating activities for the IDPs in the PoC, it will be very challenging to introduce the new stoves unless it is distributed for free. Free stoves distribution is not encouraged as it takes away the responsibility to care for it.

Rubkona Rocket Stove with bricks

As mentioned before, this stove was introduced during the course of the FES testing period for consideration based on the experience from Kenya. The stove did get many positive reactions from the users who tested it. Firewood consumption is more or less as the Jiko Kisasa and was considered ease to light using the elephant grass. All the people who tested this stove confirmed it was very safe to use around children due to its clay body mass which does not get hot on the outside. This was the only fixed stove while the rest of the FES were portable stoves which has implications on stability when cooking on the stoves. Using clay fired bricks and clay soil to make this stove, it becomes fairly cheap in comparison to all the other three stoves discussed above.

The investment required to get this stove made for the PoC involves trained people on how to construct the stove since clay soil and fired clay bricks are easily available in Bentiu. There is no need for the establishment of a permanent structure to get production underway. Many users were willing to learn how to construct this stove. If acquired, such a skill can be used while an IDP lives in the PoC, and beyond this, when the IDP returns to his or her place of origin. Skills acquired could, in the future, contribute to the better reintegration of such individuals into their communities outside the PoC. Payment for this stove could come in many ways either as cash or in-kind payment by exchange of goods (for example, in-kind payment modalities for stoves are common in Kenya especially in areas where people cannot afford the cost of the stove).

Following focus group discussions with the households who were selected to participate in the FES and Rubkona stove testing and the data collection, Jiko Kisasa and Rubkona stove were preferred as they did not require a lot of change in the way of cooking. It must be mentioned that in principle Rubkona stove operations and performance does not differ much from Jiko Kisasa. Both stoves require basically good clay soil either as fired liner or fired clay bricks for construction.

Rubkona Rocket Stove without bricks

This stove is similar in almost every way with Rubkona brick stove with some disadvantages for the users. Having a stove wholly built out of mud/clay soil has one critical disadvantage: Observations have been made in Kenya when similar stove was being introduced and found out that every time firewood is put in the stove, it will often touch the back of the stove (as one pushes the firewood into the fire chamber). This will result into enlarging the fire chamber and naturally people will tend to put more firewood than necessary. The result is that more firewood will be used and therefore loose the saving potential.

The other important factor to be considered is the need for frequent maintenance of the stove. Since the stove is made out of clay/mud, every time water spills on it, it cracks especially when it is hot. This will need to be repaired by often smearing a mixture of soil and cow dung on the stove to keep it looking good. This can be perceived as creating more work for women and girls, and some users may not be very interested in regular maintenance. However, stove maintenance can also be offered as a service at a small fee.

All in all, the Rubkona stove seems to have made a good impression on those who used it. As this stove is made out of clay commonly available in Bentiu, it could also be considered for wider dissemination in the PoC. The approach would be the same as for the Rubkona brick stove, where people are trained on how construct and maintain the stove, with production and sale based on a small-business model.

Local Production of Improved Stove Designs: Rubkona Rocket Stove and Jiko Kisasa Stove

To allow continuation of the FES activities in the Bentiu PoC site it is important to assess the opportunities which exist to facilitate stove production locally given the circumstances. The need for the promotion of FES is evident to the population in the PoC, especially considering that household sometimes sell the food they receive through general food distributions to buy fuel to cook. This will be discussed from two perspectives, materials and skills that are locally available.

Material Availability

The following section presents a brief overview of the required materials for the production of fuel-efficient stoves and their availability in Bentiu and surrounding areas.

Metal

Rubkona town and Bentiu town have a good supply of waste metal from old oil drums that can be used for the cladding of Jiko Kisasa stoves. Interestingly, in Kenya the most durable Jiko Kisasa portable are cladded using the same material. Training will be required to equip laborers with the skills to cut and make the metal cladding. In the long run, readily available waste metal may become scares. Nonetheless, in the meantime, the commonly found scrap metal strewing the landscape, as seen in the photo below, can be used.

The Rubkona Rocket stove can also be produced either by using bricks or making a clay product called an insert which can be used to make the fire chamber in the Rubkona Rocket stove. The production process is similar to the Jiko Kisasa liner production, just with a different shape for the insert.

Old metal drums near Bentiu PoC

Waste oil drums for Jiko Kisasa stove cladding

To ensure good quality production for the liner for the Jiko Kisasa stove or insert for the Rubkona Rocket stove, a metal mold is required for making the shape and keeping the right dimensions.

Examples of molds for Jiko Kisasa stove

Installed Jiko Kisasa

Cow dung

Availability of cow dung presents an opportunity to consider the construction of a biogas plant with which the resulting gas could be used for cooking in domestic, and even institutions such as hospital and hotels. This is a technology and skill which can be carried back into the IDPs' communities when they return to their places of origin. The cow dung can also be used in mixing with the clay to improve its quality for brick and liner production.

Clay available in Bentiu and surroundings.

Clay

Clay is readily available and the areas are very expansive covering over 680 hectares. This presents an opportunity to consider production of the Jiko Kisasa stove in or outside the PoC. The fired ceramic products can then be used as fire chamber and the stove body constructed using bricks or appropriate red soil. The skills for the production of the ceramic lining element of the stove does not need skilled labour. People can be trained in a 12-day training to impart the skills for production, and a 9-day training on how to fire the stoves. The Jiko Kisasa can be used as a portable stove, therefore, a 6-day training on how to do metal cladding can be organized. Jiko Kisasa can also be installed directly in the kitchen as a permanent feature without needing the metal clad around it.

However, it must be mentioned that Jiko Kisasa production requires a centralized production setup, to go through the process of soil preparation, molding, drying the green liner and firing before the product is ready for installation as above, or ready for metal cladding.

If this stove should be considered, an immediate solution will be to initially import it from Kenya while setting up a production center in Bentiu. This should be considered as a long term investment beyond the camp life for the people of South Sudan.

Clay Bricks

Fired clay bricks and the appropriate technology for firing bricks is available, and IDPs can be trained in production. These bricks can be used for the construction of Rocket stoves as demonstrated by the Rubkona stove.

Brick making in Bentiu town

Availability of material locally makes the stoves easy to produce without much upfront cost. Based on experiences made in Kenya, construction of the Rocket stove does not require any mechanization, nor skilled labor, and no setting up of a production center.

Skills Availability

The making of clay fired bricks is well known in Bentiu town and its surroundings. A site that was originally used to produce bricks on a commercial scale is available and still functional. The owner of the site assured the IOM team that he is able to produce on average of 500 to 600 green bricks per person per day.

He, however, said he can only start that kind of production in November at the end of the rainy season. He also said that he owns the land where the brick production is located. And that it is more than 680 hectares. During the discussion with the brick producer, he calculated that he can reduce the price to SSP20 per brick, if ordered in large quantities, but for now he can only sell at SSP30 per brick. It is recommended that he however reduces the price even further should a higher number of bricks be in demand for a higher number of stoves being produced. That would make the Rubkona Rocket stove even cheaper and competitive with the other improved versions that are factory produced.

There is no need for special skills for the construction of the stoves requiring locally available materials such as the Jiko Kisasa or the Rubkona Rocket stoves. IDPs can easily be trained to undertake stove construction as an income generating activity.

Economic Aspects of FES Construction

Any FES intervention by humanitarian actors should preferably also be seen from a private sector angle. Humanitarian actors planning programs and interventions surrounding fuel efficient stoves should consider these interventions as opportunities for employment and income generation at all levels of the product cycle (production, marketing, installation, and maintenance or repairs). Pricing should be left to those building the stove to decide. Income generation from stove work is one of the biggest motivators to continue doing this work. It is therefore important to give all the necessary support to ensure those interested can do it as a business.

There will be a need to have those interested in the production of the stoves trained not only in technical skills in making the stove but also in entrepreneurship skills to be able to consider this as opportunity for income generation. Women must be given the highest priority as they can easily influence other women to use the new types of stove. Experience from other countries indicates women have good skills in selling stoves to other women. This can be considered as an empowerment platform for women and give them the confidence to more pronouncedly take-part in public aspects of the camp life such as governance.

An intensive awareness creation campaign about the Rubkona Rocket stove was undertaken between September and November 2017. When planning for the introduction of FES, it must be considered that people in the PoC spend money to buy items they consider of value to their families. Currently, IDP households spend a substantial part of their financial resources to purchase charcoal or firewood. If they are aware of the possibility of saving on this expenditure by investing in a stove, the chances are that they will buy a stove.

Information from the Bentiu PoC site indicates the need for the construction of the Rubkona Rocket stove has increased tremendously. Therefore, it is recommended that the trained stove artisans soon embark on the construction of the Rocket stove to capitalize on the current good will.

The other stove which can to be made available to the population of the Bentiu PoC site is the Jiko Kisasa. As this requires centralized production and proximity to the source of clay, it can be produced outside the PoC, and the liners can be brought into the PoC for sale. This will require another group of people to be trained in the PoC to install/do metal cladding for the stoves. This can be taken up as an employment opportunity by IDPs. Metal fabrication workshops that are already operational in the Bentiu PoC site can be trained on mold fabrication as an additional income generating activity.

Electricity generator in workshops in Bentiu PoC site

Metal works in the market.

Cutting the metal plate using a cold chisel and a ball pain hammer to make the mold

The other recommendation is to train the artisans on business developments skills (BDS) and entrepreneurship. This training will enable the artisans to look at doing the production and installation from a commercial point of view. It will also encourage them to be entrepreneurs.

Considering this intervention as one geared towards supporting women, the selection of those who will be trained to do construction of Rubkona Rocket stove could give women a priority. This is important especially because women trust each other and consequently can sell products better to other women.

Conclusions

Throughout 2017 humanitarian needs in South Sudan have rapidly escalated reaching unprecedented levels, exhausting the coping capacities of those experiencing new and recurrent shocks. The number of individuals displaced has reached record levels, with nearly 4 million people uprooted by the end of October 2017 including more than 1.9 million internally displaced persons (IDPs) within South Sudan and more than 1.9 million people having fled the country, becoming refugees. More than 270,000 IDPs are currently seeking refuge at the Protection of Civilian (PoC) sites in Bentiu, Unity; Malakal, Upper Nile; Juba, Central Equatoria, and Wau in Western Bahr el Ghazal. Humanitarian partners are providing lifesaving humanitarian responses in the PoC sites. As the crisis continues, living conditions in PoC sites must be continuously maintained and sustained with great efforts from the humanitarian community. As the protracted conflict, in its fifth year, is not expected to subside soon, the living conditions of IDPs in the PoC sites have to be addressed in a more holistic manner taking into consideration not only short term immediate humanitarian assistance required to ensure the survival of the IDP population. The IOM initiative to investigate the possibilities of introducing fuel efficient stoves could address several aspects of IDPs' lives in the PoC sites such as protection issues, socio-economic aspects, health and environmental sustainability.

The systematic research conducted by IOM in 2017 shows that IDP households suffer great strains to regularly and continuously obtain the firewood required to prepare their daily meals. The unsustainable harvesting of firewood by the IDPs, particularly women and girls, causes them to leave the safety of the PoC sites which imposes great risks to their safety. Through this surveys on perceptions and experiences of IDPs with FES as well as the testing of the FES, it was possible to establish which of the seven (7) tested FES are most suitable to the conditions in the Bentiu (PoC). The survey and tests also established the means by which the FES can be produced locally and presented viable options for local manufacturing.

The survey and testing found IDPs recognize the benefits of the FES particularly as regards to reduced risk-exposure for women and girls, reduced risk for children to burn while playing in the cooking area, reduced costs for firewood, and the overall improvement of the wellbeing of household members, particularly women and girls.

The survey recommends the introduction of the Rubkona Rocket stove as it had the best results in regards to fuel efficiency, acceptance by IDP test users and can be efficiently produced locally. The second best results were found with the Jiko Kisasa stove. The survey and test results predict that the Jiko Kisasa stove can be similarly successful when introduced in the Bentiu PoC.

It is recommendable to set up a manufacturing, dissemination and education programme for the Rubkona Rocket stove, and optionally the Jiko Kisasa stove. This would initiate a testing of the roll out of such a wider effort that combines support to small scale business, training of craftsmen as well as encouraging IDP households to use these stoves.

Annex A

Full Testing Results and Findings per Tested Category

1) Full Results for Imported FES
2) Full Results for Rubkona Rocket Stove – with bricks
3) Full Results for Rubkona Rocket Stove – without bricks

1. Full Results for Imported FES

After the data collection, the data was cleaned and entered into Statistical Package for Social Sciences (SPSS). A total of twenty respondents were interviewed.

The distribution is based on the frequency of use of the stoves as shown in Table 1 below.

Type of cooking stove	Total	Percentage
Jiko Kisasa	51	30.91
All Metal Stove	22	13.33
Wire Stove	27	16.36
EcoZoom 5000	54	32.73
Three-stone Stove	5	3.03
Kuni Okoa	6	3.64
Total	178	100.00

Table 1: Frequency of stove use

Firewood Consumption

The preferred type of food of the majority of the respondent, therefore making it possible to estimate the fuel consumption. From the table below, Ecozoom stove recorded the lowest figure in firewood consumption in both cooking periods while three-stone stove respondents recorded the highest number of average weight of firewood at both times as shown in Table 2 below:

Type of cooking Stove	Average weight of firewood in (Kgs)		Average consumption
	in the morning	*in the evening*	
Jiko Kisasa	3.4	3.08	3.24
All Metal Stove	3.8	3.5	3.65
Wire Stove	3.3	3.16	3.25
EcoZoom 5000	2.4	2	2.2
Three-stone	3.9	3.5	4.7
Kuni Okoa	3.3	2.45	2.87

Table 2: Firewood consumption by different stoves

Ease of Use

To understand if the respondents were having difficulties in lighting the different types of stoves (starting/igniting the fire), the consultant asked the respondents whether it was easy or hard to light the stoves. The analysis indicates that Jiko Kisasa and Kuni Koa were the easiest to light of all the cooking stoves. The respondents indicated that Jiko Kisasa was easy because it only required elephant grass to light them and they can light even with a small amount of firewood. The process of starting the stove can easily influence the beneficiaries on whether they would like to use such a stove or not. Quick ignition is important for women as they have to deal with many other issues in the cooking process.

	Jiko Kisasa	Eco Zoom	Kuni Okoa	Total
Easy	43	24	3	70
Hard	8	30	3	41
Total	51	54	6	111

Table 3: Ease with which FES are ignited

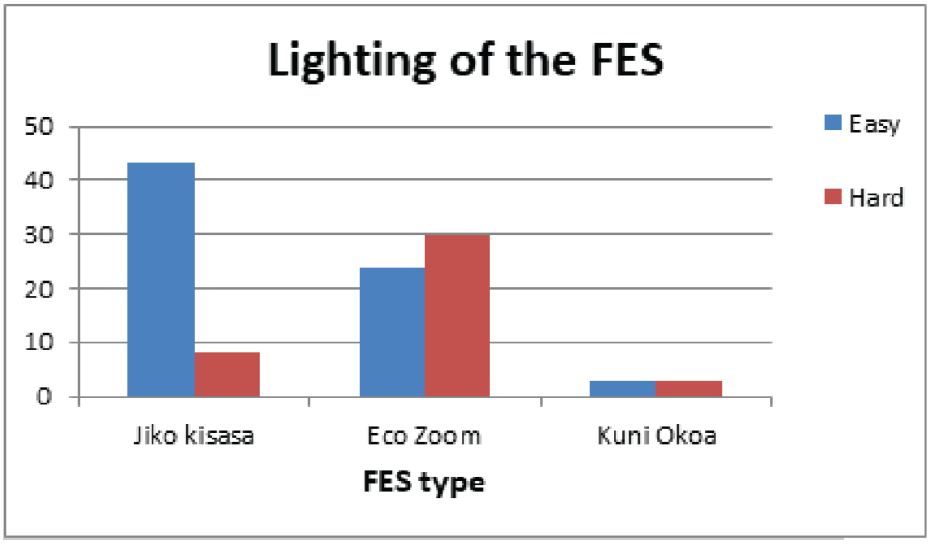

Figure 1: Ease of lighting/igniting the stove

In terms of adherence to the lighting/ignition process of the stoves, there was not much variance. Almost all the respondents, through reporting and observation, proved not to have major problems while lighting the stoves.

Preparation of Fuel

The work load related to firewood preparation prior to using a stove is a decisive factor. If the stove requires smaller pieces of wood than is normally used in traditional stoves, it results in more work for the women and girls as they have to chop down the wood to the appropriate size. This alone can easily put off a potential user. It is important that the new stove does not add more work for the women and girls. The respondents reported that there was no major challenge when it comes to the preparation of the firewood to be used during cooking. The major challenge is finding the firewood to be used. They indicated that the major source was purchasing from local traders. This was a challenge because they did not have any sources of income.

FES Type	Yes	No	Total
Jiko Kisasa	16	35	51
Eco Zoom	23	31	54
Kuni Okoa	2	4	6
Total	65	113	111

Table 4: Respondents experiencing an increase in fuelwood preparation workload:

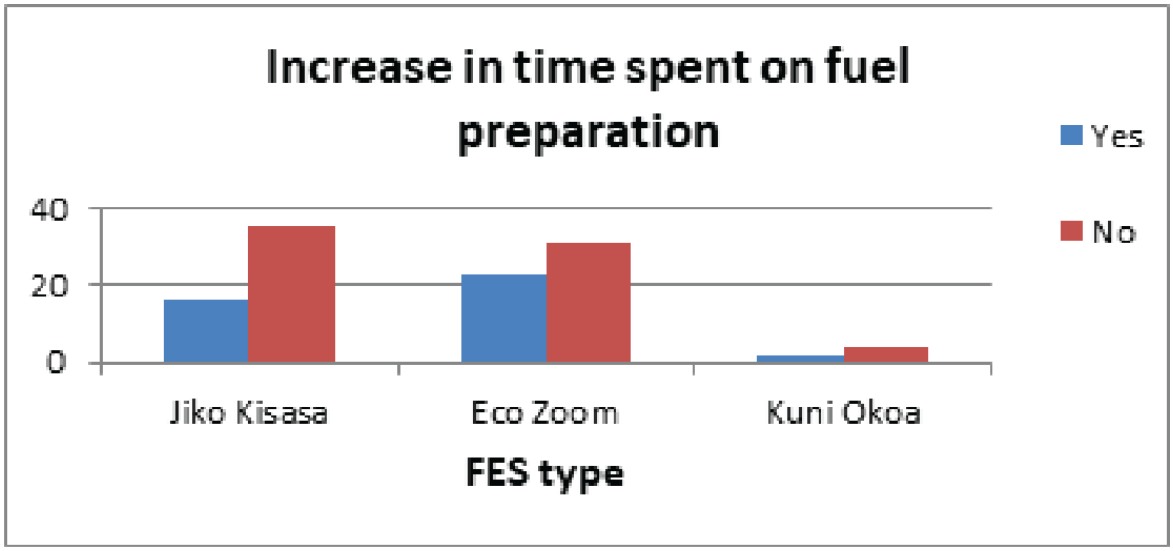

Figure 2: Time spent on fuel preparation

Cleaning

Ease of cleaning the stove was also discussed with stove users. The respondents were asked whether it was hard or easy to clean the stove. Ecozoom, Jiko Kisasa, Kuni Okoa and the Wire stoves were found easy to clean. Out of the four, the analysis indicated that the Wire stove was easiest to clean, followed by Jiko Kisasa. The ease of cleaning, according to the respondents, was because these stoves did not produce a lot of smoke, hence less soot. They only used a piece of cloth to wipe the stove after cooking.

FES Type	Hard	Easy	Total
Jiko Kisasa	9	42	51
Eco Zoom	18	36	54
Kuni Okoa	2	4	6
Total	29	82	111

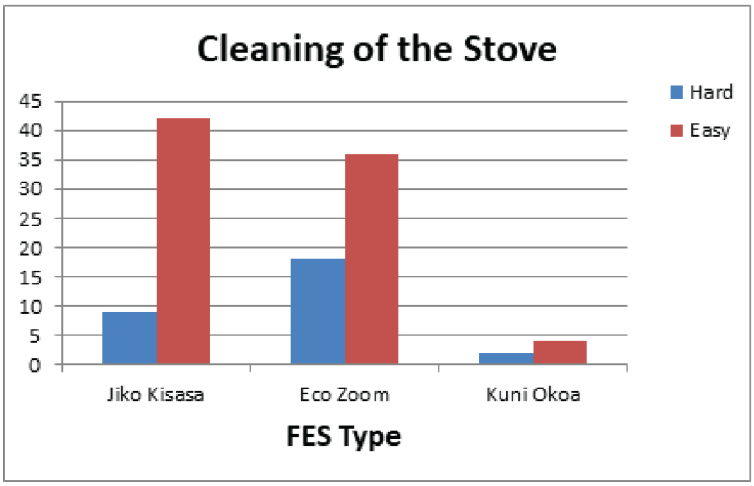

Figure 3: Ease of cleaning the stove.

Safety

Often when mothers are cooking, children play around the fire place/kitchen. The safety of children is an important factor in making the decision on which stove type to use. Therefore, it is important that the stove must be well insulated to ensure that the stove body temperature is not dangerous to children around and that the stove does not easily topple and spill the food. All cooking stoves were found to pose a danger to children if left alone. The three–tone stove posed the greatest danger. The respondents indicated that most cooking stoves produced a lot of heat hence are dangerous to children. In fact, the observation by the research assistant showed the same results.

Children in the cooking area

Although Ecozoom scored higher as a safer stove as compared to the other stoves, most respondents preferred the Jiko Kisasa stove. The major contributing factor to this preference is that the stove has an inner layer of clay which acts as an insulation and directs most of the heat towards the cooking pot, consequently the stove exterior does not get hot enough to cause burns. The stove is also heavy, giving it greater stability when cooking. Observation indicated that the respondents were at ease when they were cooking with the Jiko Kisasa while children were playing around the stove since it seems to be more stable than Ecozoom.

FES Type	FES endangering children?		Total
	yes	*no*	
Jiko Kisasa	27	24	51
Eco Zoom	32	22	54
Kuni Okoa	4	2	6
Total	63	48	111

Table 6: Children in the cooking area

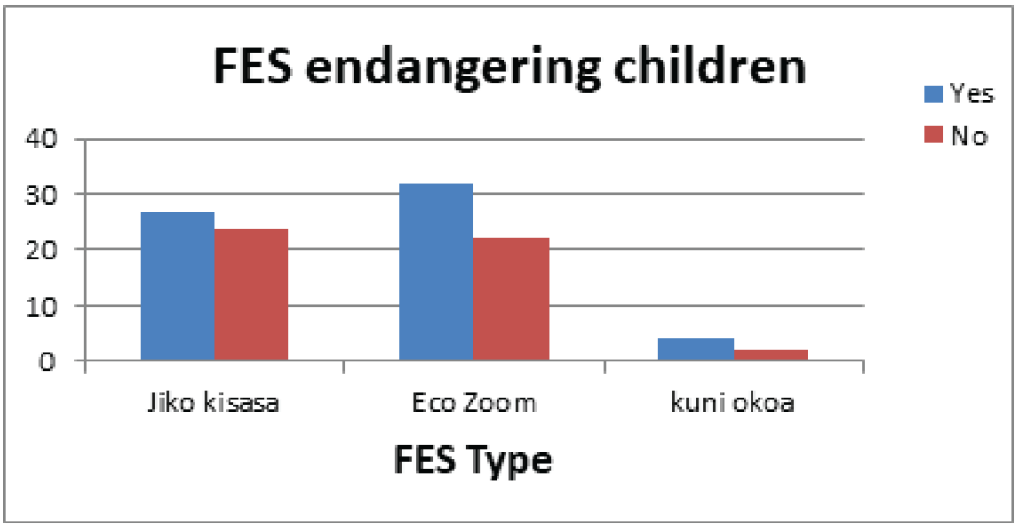

Figure 4: Safety of the stove

Health-related Observations

The respondents were asked if they experienced any problems with regards to coughing, eye problems and burns from using any of the stoves. Most of the respondents indicated that they did not cough after having used the different types. However, this cannot be ruled out since smoke emissions also depend on how dry/ wet the firewood is and the type of wood used. From all the three FES tested, Jiko Kisasa scored well in all three aspects with fewer problems reported than the other stoves.

Type of stove	Coughing Problems		Problems with Eyes		Any Burns	
	yes	*no*	*yes*	*no*	*yes*	*no*
Jiko Kisasa	12	39	9	42	2	49
Eco Zoom	15	39	41	13	18	36
Kuni Okoa	1	5	2	4	0	6
Total	28	83	52	59	20	91

Table 7: Health-related observations

Willingness to Purchase the Stove

Willingness to pay, means one has attached a value to the product and will take care of it. The vast majority of the internally displaced persons (IDPs) in the Protection of Civilians (PoC) sites regularly receive food and non-food items. However, often IDPs sell the food they receive through the general food distributions to get money to buy firewood and a variety of other items. Taking this into consideration, IDPs may consider purchasing fuel efficient stoves (FES) as they may appreciate the stoves' efficiency in contributing to saving on food and fuel, consequently on the households' financial resources.

As shown in table below, the majority of the respondents, though, are not willing to purchase the stove. The vast majority of IDPs have no sources of income and are unemployed. The respondents were interested and willing to buy the stove but lack of money was the major challenge. Nonetheless, the free distribution of stoves should be avoided so as to encourage ownership and sustainability. Other options like constructing a stove and purchase for barter can be explored. In Kenya for example, old women who cannot afford to pay

for stoves, pay in terms of a chicken, a tin of maize or beans. This can be an option for payment for those who may engage in stove construction for business.

Type of FES	Willingness to purchase FES		Total
	yes	*no*	
Jiko Kisasa	15	36	51
Eco Zoom	10	44	54
Kuni Okoa	1	5	6
Total	26	85	111

Table 8: Willingness to purchase the stoves.

Willingness to learn how to make the stove

The majority of the respondents, 61 per cent, reported that they were willing to participate in the production of the stoves, whereas 39 per cent were not willing to participate. This indicates that there is a potential opportunity to produce the stoves locally in the PoC sites stove production using the available labor force and compensate by paying producers for each unit constructed.

Willingness to learn how to make the stove		
	frequency	*percent*
yes	68	61.3
no	43	38.7
Total	111	100.0

Table 9: Willingness to learn how to make the stove

2. Full Results for Rubkona Rocket Stove (with bricks)

The exercise to test the Rubkona Rocket Stove – with bricks, was done after finalizing the imported FES testing. Feedback from the Rubkona Rocket Stove testing does not represent statistical significance due to the very small sample (total of 10 households used the stove) and therefore only general feedback can be given on the Rubkona Rocket Stove from a user's perspective:

Firewood Consumption

The majority of the respondents used approximately 3kg of firewood during the preparation of their meals as shown in the table below.

Amount of firewood in Kgs used in the morning (after cooking)		**Amount of firewood in Kgs used in the evening (after cooking)**	
weight after cooking	*frequency*	*weight after cooking*	*frequency*
3	5	3	5
3.9	1	3.9	1
1.1	2	1.4	1
1	1	0.6	2
1.2	1	1.5	1
Total	10		10

Table 10: Amount of firewood used among Rubkona Rocket stove users

Ease of Use

All the respondents acknowledged that lighting the stove is easy. They attributed this to the large opening (fire chamber) which creates enough space for the fire to light and in addition, they indicated that the presence of elephant grass makes it easy.

Ease of lighting the stove	
yes	*no*
10	0

Table 11: Lighting of the stove

Preparation of the Fuel

Most respondents did not experience any difficulties in the preparation of firewood to be used as shown in the table below.

Takes time	**Frequency**	**Percentage**
Yes	3	30.0
No	7	70.0
Total	10	100.0

Table 12: Firewood preparation

Cleaning

The majority of the respondents acknowledged that the cleaning of the stove is difficult. This attributed to the fact that the stove is too hot hence difficulties in cleaning. This response is subject to how the question was put across. However, it is natural that the stove will normally be cleaned when starting the fire and at that time the stove is often cold. Practically speaking this will pose no problem.

Cleaning of Rubkona Rocket	Frequency	Percentage
Hard	7	70.0
Easy	3	30.0
Total	10	100.0

Table 13: Cleaning of the FES

Safety

Nine out of 10 respondents indicated that the stove did not pose any danger to children. This is because the energy is not transmitted to the outer side of the stove, as a result children playing around it are less at risk of harm. This is due to the body mass of the stove which is made of clay and does not heat easily hence it is safe even when the children are in the kitchen when cooking since the stove does not become hot on the surface.

Dangerous to children	Frequency	Percentage
Yes	1	10.0
No	9	90.0
Total	10	100.0

Table 14: Safety for children

Health-related Observations

The Rubkona Rocket Stove – with bricks, as shown in the following table did not have major health problems on regard to coughing, problems with eyes and burns. This is mainly because of the big fire chamber which creates enough space for proper combustion to take place and therefore reduce the amount of smoke emitted. Consequently, less smoke means fewer problems for the eyes, and less coughing. The body mass of the stove does not heat fast therefore the risk of uncontrolled fire is reduced.

	Coughing problem		Problem with eyes		Any burns	
	yes	*no*	*yes*	*no*	*yes*	*no*
	1	9	4	6	1	9
Total	10		10		10	

Table 15: Health-related observations.

Willingness to Purchase

All the respondents were not willing to purchase the stove. This is because they did not have any source of income in form of employment. This is well understood given their situation in PoC. However, this situation

in a way presents an opportunity for those who may be willing to engage in stove construction to use this as an income generating opportunity. Doing stove work as business creates opportunity.

Able to purchase	Frequency	Percentage
No	10	100
Total	10	

Table 16: Willingness to purchase the Rubkona Rocket – with bricks.

Willingness to Participate in the Production of the Rubkona Rocket Stove with bricks

All the respondents interviewed were willing to participate in the mass manufacture of the stove as shown in the table below. This indicates a high level of acceptance of the Rubkona stove, as respondents would be happy to be associated with this activity.

Willing to manufacture	Frequency	Percentage
Yes	10	100
Total	10	

Table 17: Willingness to participate in mass manufacturing of the Rubkona Rocket Stove – with bricks

3. Full Results for Rubkona Rocket Stove (without bricks)

For the Rubkona Rocket stove – without bricks, additional categories were tested. These are the following:

Firewood consumption

Weight in the morning	Frequency	Percentage	Weight in the evening	Frequency	Percentage
1.9	2	13.3	1.9	1	6.7
2.1	2	13.3	2	1	6.7
2.2	1	6.7	2.5	1	6.7
2.5	1	6.7	3	2	13.5
2.9	1	6.7	3.1	3	20
3.2	1	6.7	3.2	2	13.5
3.9	1	6.7	3.9	2	13.5
4	1	6.7	4	2	13.5
2	2	13.3	5	1	6.7
3.1	3	20.0	-	-	-
Total	15	100.0			100

Table 18: Weight of the firewood the morning after cooking – distributed by frequency of use.

73 per cent percent of the respondents said that they are using less firewood compared to their initial stove they were using, whereas 27 per cent said that the consumption is not less. The big fire chamber and sufficient inflow of air create a good combustion and are able to make use of the heat since the pot sits directly on the fire chamber. This minimize wastage as compared to traditional stoves.

Firewood used	Frequency	Percentage
Less	11	73.3
Same	4	26.7
Total	15	100.0

Table 19: Amount of firewood used compared to initial cooking stove

Ease of use

The majority of the respondents, 93 per cent, indicted that lighting the stove was easy. This is because it only needs a piece of paper or elephant grass to ignite the fire; the firewood used was dry; and the fact that it is hard for wind to enter the stove due to the way it is constructed. The stove is basically shielded from all sides with except for the small door/opening through which firewood is placed into the stove. This ensures that when starting the fire, no wind can below the fire away. The respondents who indicated that it was hard to lighten the stove stated that this was because the stove was still wet. Normally, after construction, the stove needs up to three weeks to dry properly (possibly less depending on the time of the year). Otherwise the stove will be too cold inside when wet to allow fire to light easily.

Lighting of the Stove	Frequency	Percentage
Easy	14	93.3
Hard	1	6.7
Total	15	100.0

Table 20: Lighting of the Rubkona Rocket stove – without bricks

Explanation of ease of use	Frequency	Percentage
Only needs elephant grass/piece of paper	9	60.0
Firewood is dry	3	20.0
No entry of wind	2	13.3
Still wet	1	6.7
Total	15	100.0

Table 21: Explanation for ease of use

Preparation of Fuel

The respondents reported that they need less time in the preparation of firewood to be used for this type of stove. 80 per cent said that they are using less time, whereas 2 per cent said that they are not using less time. The reason why they were requiring less time was because a fire can be ignited in the stove with any size of firewood, if there is elephant grass or piece of paper start the fire. The design of the Rubkona stove enables it to cook a meal with even the smallest pieces of firewood because the fire is concentrated to go directly under the pot and is not carried away by the wind since the stove is shielded all round except at the door/opening.

	Frequency	Percentage
Yes	12	80.0
No	3	20.0
Total	15	100.0

Table 22: Less time in firewood preparation

Cleaning of the Rubkona Rocket Stove without bricks

80 per cent of the respondents indicated that the cleaning of the stove is easy, whereas only three respondents, representing 20 per cent of the overall responses, said that it was difficult. In their opinion, the respondents indicated that they only remove the ashes after some time. The removal of ashes is easy as compared to their usual cooking stoves. Those who said that it was hard did so because the stove is made from mud and as a result is hard to clean. Drawing from these responses, it is important to teach the women how to clean this make of stove. The producers of the stoves could be oriented in how to transfer the knowledge of how to correctly and easily clean the stove to their clients.

Ease of cleaning	Frequency	Percentage
Easy	12	80.0
Hard	3	20.0
Total	15	100.0

Table 23: Cleaning of the Rubkona Rocket Stove – without bricks

Safety

All respondents indicated that the stove is safe for their children. Children can even play around the stove. The major reason why it is secure according to the respondents is because of the mud insulation. This ensures that the heat is not transmitted to the outer side of the stove. In addition, it is secure because the cooking pot

is stable when placed on the stove and does not pose any challenge to children when they are playing around it. The pot will often sink inside the stove, making it stable and reducing the likelihood of the stove easily toppling.

Safe for children	Frequency	Percentage
Yes	15	100.0

Table 24: safety to children

Health-related Observations

The respondents indicated that the stove poses less health problems to the users. There were minimal cases of coughing and eye problems. In terms of smoke levels, the respondents said that they experience less smoke as compared to the usual cooking stoves. The Rubkona Rocket stove has enough space for the fire chamber to allow proper combustion to take place and therefore reduces the amount of smoke and subsequently reduces the irritation of the eyes and coughing. The clay mass body insulates the stove making it safe and there was no case of burns reported during the testing period.

	Coughing		Problem with eyes		Any burns	
	yes	*no*	*yes*	*no*	*yes*	*no*
	3	12	4	11	0	15
Total	15	15	15			

Table 25: Health-related observations

Willingness to Purchase

Only one respondent was willing to purchase the stove. Those who were not willing either stated that they did not have money or the stove had already been installed in their household (no need of constructing another one). The lack of financial means to purchase a stove expected given their situation in the camp. The same observation was made for all stoves.

Willingness to Purchase	Frequency	Valid Percent
Yes	1	6.7
No	14	93.3
Total	15	100.0

Table 26: Willingness to purchase the stove

Why not willing to purchase	Frequency	Percentage
Already installed	6	42.9
No money to pay	8	57.1
Total	14	100.0

Table 27: Reason for not willing to purchase

Willingness to Participate in the Production of the Rubkona Rocket Stove without bricks

The majority of the respondents were willing to participate in the mass production of the stove. The stove does not need highly skilled workers to construct, however, it is important to provide training to people to ensure proper construction to get the benefits from the stoves.

Willing	Frequency	Valid Percent
Yes	11	73.3
No	4	26.7
Total	15	100.0

Table 28: Willing to participate in the production.

Addendum to the above categories/ additional tested categories for the Rubkona Rocket Stove – without bricks

Time used in cooking compared to initial cooking stove:

The majority of the respondents, 53 per cent, reported that they are using less time for cooking as compared to their usual cooking stoves. Twenty-seven percent said that they are using the same amount of time in cooking, whereas, 20 per cent reported using more time. Those who reported using less time stated that the stove cooks faster than what their usual stoves.

Time used in cooking	Frequency	Percent
Less	8	53.3
Same	4	26.7
More	3	20.0
Total	15	100.0

Table 29: Time used in cooking

Source of firewood

67 per cent of the respondents purchased the firewood they were using, whereas, 3 per cent fetch firewood from the forest. With the majority of people purchasing firewood from the market, this is one aspect which can be used to demonstrate how much money a household can save if it buys an improved stove. The money saved could then be used to cover other family needs. Also, families saving on financial resources because of reduced fuel consumption of the new stoves, could be less inclined to sell the food they receive through the general food distributions. Consequently, the households' nutrition status could also benefit from the introduction of the fuel-efficient stoves (FES).

Source of Firewood	Frequency	Percentage
Forest	5	33.3
Purchasing	10	66.7
Total	15	100.0

Table 30: Source of firewood

Time used to fetch the firewood

The respondents were asked to estimate the time they need for one trip to the forest. Eighty percent stated that they required between 4 to 6 hours, whereas 20 per cent, require 7 to 9 hours. The use of the improved stove will reduce the amount of firewood and consequently reduce the frequency of firewood collection. Women will have more time to engage in other activities.

Time Used	Frequency	Valid Percent
4-6 hrs	4	80.0
7-9hrs	1	20.0
Total	5	100.0

Table 31: Time used for the trip to fetch firewood

Number of days that one trip firewood collection lasts the household

All the respondents (five) who sourced the firewood from the forest reported that the firewood from one trip lasts for about 1 to 3 days. Meaning they will go at least twice a week for collection. This can go down most probably to one trip when using an improved stove.

Number of Days	Frequency	Valid Percent
1-3 days	5	100.0
Total	5	100.0

Table 32: Days the firewood lasts for household

Risks of fetching firewood from the forest

All the respondents reported that there are risks in sourcing firewood from the forest. The risks are shown in the table below. It is clear that the respondents are aware of the dangers awaiting them while collecting firewood. However, the call for family survival is far bigger and forces them to take the risk every time they go to forage for firewood. This risk can be reduced by reducing the frequency of going out in the forest. One useful intervention could be to encourage the PoC residents to plant fast growing trees in their own compounds or on dedicated space in the nearby surroundings of the PoC as is done in other camp settings around the world. Firewood, or cow peas which is also grown for food, could be planted as both have but the plant can be an excellent source of firewood. This intervention will have no negative effect, rather the effect would be sustainable and would even be environmentally beneficial.

The Risks	Frequency	Percentage
Sexual assault	3	60.0
Snakes	1	20.0
There are criminals in the forest	1	20.0
Total	5	100.0

Table 33: Risks during firewood collection

General Satisfaction with the Rubkona Rocket Stove without bricks

The majority of the respondents, that is 60 per cent, indicated that they were satisfied with the Rubkona Rocket Stove – without bricks. 20 per cent were fairly satisfied, and fairly unsatisfied respectively.

Level of satisfaction	Frequency	Percentage
Very satisfied	9	60.0
Fairly satisfied	3	20.0
Fairly unsatisfied	3	20.0
Total	15	100.0

Table 34: Satisfaction with the Rubkona stove

Recommendation to Others

87 per cent of the respondents were willing to recommend the stove to a friend or neighbor, whereas 13 per cent would not recommend the new stove. Realizing the benefit of the new stove, could be a reason why the vast majority of the respondents would recommend the stove to other households. This indicates a high level of acceptance of the new stove.

Reccomendation to Others	Frequency	Percentage
Yes	13	86.7
No	2	13.3
Total	15	100.0

Table 35: Recommendation to others