**DFAIT Project MDE-2012-05**

**Final Report**
**March 31, 2012**

# COOKSTOVES LOWERING EMISSIONS IN THE WEST AFRICAN REGION (CLEAR) PROJECT

*Prepared for:*

Climate Change and Energy (MDC)| Department of Foreign Affairs & International Trade (DFAIT) Canada

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## Executive Summary:

In West Africa, the majority of rural populations' energy requirements are currently met with wood which is commonly burned in three-stone open fires that are inefficient and emit a significant amount of smoke. Furthermore, the dependence on fuel wood is exacerbating ecological decline in the form of deforestation and soil erosion. The Cookstoves Lowering Emissions in the West African Region (CLEAR) Project has demonstrated that a promising solution is to disseminate improved wood stoves and clean burning non-wood stoves that use locally available materials. The CLEAR project focused on implementing two stoves in Sénégal and The Gambia: the Mayon Turbo Stove (MTS) and the 'No-Fly' Clay-Brick Stove.

This document is the final project report for the CLEAR Project which ran from February 1 – March 31, 2012 with funding from the Department of Foreign Affairs and International Trade (DFAIT) in Canada. Project implementing partners included: Resource Efficient Agricultural Production (REAP) Canada, the Njawara Agricultural Training Centre (NATC) in The Gambia, and *Cadre Locale de Concertation des Organizstion de Producteurs* (CLCOP) Wack Ngouna, in Sénégal. The project objective was to successfully produce and distribute 4000 improved MTS and 2000 improved clay brick stoves in at least 40 communities in The Gambia and Sénégal. The two stoves required very different approaches and consequently met different challenges.

The presence of the MTS in West Africa was significantly enlarged during this project. The project developed and enhanced the capacity of five metal workshops in The Gambia and Sénégal to manufacture the target of 4000 MTS. Two principle obstacles were encountered that delayed stove production and assembly from the outset. The first obstacle was the run-up and aftermath of the Sénégalese election which made it very difficult to travel within the country and to engage CLCOP and the metal fabrication workshop partners. This delayed project activities in Sénégal and caused us to scale-back their stove targets. The second challenge was with material availability and more specifically, the inability to source appropriate equipment (i.e. sheet rollers and drill presses) and adequate supplies of sheet metal which also delayed production. Despite these set-backs, the five commercial workshops have done an exceptional job in producing quality stoves. Overall, production targets are on track and will be met fully by the end of June, 2012. The workshops have all the materials necessary to accomplish this goal and will continue to be monitored closely by partner staff. In total to date there are 644 fully assembled MTS and 1300 unassembled awaiting final assembly. All the workshops have reached a production efficiency of 100 stoves per week and will have no problem reaching the target output of 4000 MTS in the coming weeks. On the distribution side, marketing efforts are well underway in both The Gambia and Sénégal. To date, there have been 16 MTS cooking demonstrations with approximately 533 participants from over 92 villages. This has already resulted in recorded MTS demand for over 1550 stoves. The marketing and distribution efforts will continue alongside production.

Through the CLEAR project, REAP was able to further develop a new clay brick based stove entitled the 'No-Fly' Stove. The name 'No-Fly' is a West African expression, understood across many local dialects as 'no problem'. The projected target was 2500 'No-Fly' stoves. The overall objective was to create a low priced stove made from local materials that could reduce fuelwood consumption and indoor air pollution while also improving cooking convenience and safety. The project engaged local masons and communities to produce the clay bricks and stoves at the village-level. To date, over 52,450 unfired bricks and 6,700 fired bricks have been produced (enough for almost 800 stoves). Because the ''No-Fly'' stove has to be produced in situ, as opposed to a central production site like the MTS, its production, marketing and distribution required a vastly different strategy than that of the MTS. The 'No-Fly' installation required a well coordinated series of activities including: community sensitization, mason training, transporting bricks to communities for the construction of a prototype in the village leader's compound (household), stove demonstration training, collection of subsequent demand, coordination and transportation of bricks and materials to the community, and monitoring and evaluation to ensure quality control. Over 90 villages have had sensitization on the 'No-Fly' stove. There have been 5 mason trainings conducted with a total of 72 Masons trained from 34 communities. Things in Sénégal were slightly later to start but staff have identified several communities and 8 masons. There have been over 40 stoves built in communities to date. There are already over 500 'No-Fly' orders to date and this number will increase as more demonstrations are conducted in the coming weeks.

The CLEAR project also established 5 community kilns in The Gambia and Sénégal. These kilns will support the continuation of 'No-Fly' stove production and ultimately, allow the price of the inner fired bricks to be reduced. Currently all the inner bricks for the stoves are coming from the two commercial enterprises but with their own kilns these villages can fire their own bricks, and produce bricks for other purposes such as housing construction and for construction of more kilns in neighboring villages.

The CLEAR project was designed to bring about lasting and continuing impacts long after the project is complete. The short term impacts are reductions to regional deforestation and improvements to the lives of women living in these environmentally degraded environments. However, the transfer of the skills and knowledge around the 'No-Fly' stove to local masons and communities has ensured the continued income generation from the stoves and environmental improvements for the long-term. Furthermore, communities will continue to benefit from the 'Fund for Revolving Economic Empowerment' (FREE) created by the partners from the project stove sales. The fund will provide start-up capital for furthering stove production which will continue to support the livelihoods of the fired and unfired brick producers from the CLEAR project. The most important thing about the fund however, is that it maintain the access to 'No-Fly' stoves.

In only two short months the CLEAR project has overcome some remarkable obstacles but has finished with appreciable success. The project will undoubtedly leave a legacy of environmental, social and economic benefits to the Sénégalese and Gambian communities it touched and has established a solid sustainability plan that will continue to support rural livelihoods in these areas well into the future.

Thank you, Merci & Jerrejef!

*The CLEAR Project Team*

## Project Proponents:

**Resource Efficient Agricultural Production (R.E.A.P.) - Canada**
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REAP - Canada is an independent, not-for-profit research and development organization with over 20 years experience working with farmers, scientists and the private sector to develop and commercialize sustainable agricultural solutions for fuel, fibre and food needs. Since 1991, REAP-Canada has been a global technology leader in the research and development of heat related energy applications from clean burning agricultural biomass resources. REAP has been working since 1997 in developing countries to develop and introduce leading innovations in rural household clean cooking technologies including biogas, solar and biomass (wood and non-wood) cookstoves. In a recent EPA supported emission evaluation of globally important cookstoves for the Global Alliance of Clean Cookstoves, REAP was the only Canadian agency requested to submit a cooking appliance in the 22 stove study. REAP also has developed a strong working relationship with the Canadian International Development Agency (CIDA) and has successfully implemented seven projects that integrated a cookstove component.

**Njawara Agricultural Training Centre (NATC)**
*Njawara Village, North Bank Division, The Gambia*
*Badarra Jobe (Director); E-mail: natcfarm@yahoo.co.uk*
*Tel. (Office) (+220) 5720 131; Mobile (+220) 9905 749/7073 755*
NATC is a non-profit community based organization established by farmers in the village of Njawara to support sustainable natural resource management as a means to limit rural-urban migration away from their village. Since 1990, NATC has focused on training farmers in sustainable agriculture and agroforestry techniques to improve local farm production and profitability. They are now one of the leaders in agricultural development in the country and region, and their relevant participatory research and training program allows them direct, on-the-ground access to beneficiaries and community members alike. NATC has a strong record in project management and financial reporting to external donor agencies such as UNDP, Concern Universal and Oxfam-America and is able to effectively monitor and facilitate activities on the ground. Financial reporting with international donors including CIDA has previously been handled proficiently and transparently and they have a finance director and full-time bookkeeper on staff.

**Cadre Locale de Concertation des Organisation de Producteurs (CLCOP)**
*Siège de la Communauté Rurale de Wack Ngouna, Kaolack, Sénégal*
*Elhagie Diop (Director); E-mail: elhadji97@yahoo.fr*
*Tel. (Mobile) (+221) 77 534 90 02*
Since its formation in 2002, the CLCOP-Wack Ngouna has supported the development needs of local producer organizations. It is a farmers alliance organization that provides services to support 75 members organizations representing 3500 farmers in the Nioro du Drip district (Kaolak Region). Its primary activities are to facilitate the development of small farmers organizations to accelerate agricultural development and capacity building in the region. CLCOP Wack Ngouna's primary interests include strengthening farmers access to improving farming knowledge, supporting institution building processes of organizations, helping farmers access appropriate tools and seeds for local conditions. CLCOP Wack Ngouna provides support services in a number of ways to local producers including providing a regional storage centre for improved seeds and farming tools. They also have a strong gender orientation as they specifically address the needs of women farmers in all of their activities.

## Project Management & Staff:

The CLEAR project was managed and implemented jointly with staff from the three project partner organizations: REAP-Canada, NATC and CLCOP. At the outset of the project, roles were delineated and appropriate staff was recruited to fit each of these roles (see Table 1 for a summary of all project staff). The three organizations worked together to develop the two-month workplan for the project. This workplan identified detailed project activities, roles and responsibilities, and timelines.

The project partners were in regular contact to monitor the project's overall progress and conduct strategic planning. REAP-Canada and local project managers were responsible for the overall direction, management and technical integrity of the project and activities. Staff from REAP-Canada included a senior technical specialist, a program coordinator, two research associates and four interns who all supported the management and production side of the project. Because of the magnitude of the project, REAP staff were continually on the ground. The REAP technical specialist, Roger Samson, made two trips to The Gambia and Sénégal and the project coordinator, Meredith Kushnir, made one trip in March. Staff members from NATC and CLCOP were responsible for the managing and coordinating the training and distribution side of the project.

Table 1: CLEAR Project Team Members

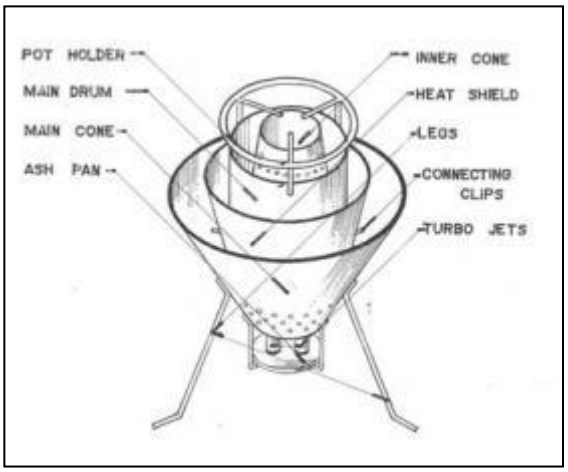
| Project Team | Team Members Position, Name, and Organization |
|---|---|
| REAP-Canada | Senior Technical Specialist – Roger Samson<br>Project Coordinator – Meredith Kushnir<br>Research Associates – Erik Delaquis, Claudia Ho Lem<br>Renewable Energy Interns - Audrey Yank, Benjamin Stevenson, Maxime Ouellet-Payeur<br>Ecological Farming Systems Intern – Sitelle Cheskey |
| NATC | Gambian Project Manager – Mama Manneh<br>Training Coordinator – Badarra Jobe<br>MTS Stove Marketing Coordinator - Musa Dampha<br>Clay Stove Marketing Coordinator – Haddy Fal<br>Stove Distribution Coordinator - Bala Drammeh<br>Clay Stove Technical Support - Babou Sisseh<br>Biomass Fuels Coordinator – Mesah Jobe<br>Finance Officer – Sainabou Panneh<br>Transportation / Drivers (2) – Mamoud Panneh, Nassirou Jallow |
| CLCOP | Sénégal Project Manager – Elhadji Nying<br>Sénégal Project Officer – Elhadji Diop<br>Sénégal Project Officer - Omar Ndiaye<br>Relais / Community Organizers - Samba Diallo, Djim Diallo, Modou Gueye, Omar Pane<br>Biomass Fuels Coordinator - Kebba Toure |

## Project Activities / Results:

The CLEAR project targeted 40 villages in Gambia and Sénégal for the distribution of 4000 Mayon Turbo Stoves (MTS) and installation of 2000 Clay Stoves. The two stoves required very different approaches and consequently met different challenges. The main goals of the project included:

- ✓ The manufacture & distributiondistribute 4000 MTS in Sénégal and The Gambia
- ✓ Installation of 2000 advanced clay brick stoves
- ✓ Expanded training efforts on stove production and use in 40 communities
- ✓ Developing and enhancing stove production capacity at 5 metal workshops
- ✓ Developing and enhancing clay brick and stove production in communities
- ✓ Expanding the agricultural fuel resources used in the stove

## 1. Mayon Turbo Stove (MTS)




The Mayon Turbo Stove (MTS) is a gravity fed conical stove with an advanced combustion design that enables it to cleanly burn a diversity of bulk porous agricultural fuels including rice hull, peanut shells, millet husk, and chopped grasses. The stove was developed by REAP in the Philippines in 2001 with support from CIDA. Approximately 6000 stoves have since been produced and distributed in the Philippines and in West Africa. The development of the MTS cooking system has seen several recent innovations that enable the stove to effectively meet the needs of West African households. The CLEAR project has significaintly upscaled the presence of the MTS in West Africa by developing and enhancing stove production capacity at 5 metal workshops, manufacturing and distributing 4000 MTS in Sénégal and The Gambia, expanding training efforts on stove production and use in 40 communities, and working towards expanding the agricultural fuel resources used in the stove.

While using an MTS each household uses approximately 1800 kg of agricultural fuel a year. This will displace the use of approximately 3 tonnes of fuelwood as used annually in 3 stone fire households. Therefore, 4000 MTS will displace up to 12,000 tonnes of annual fuelwood use. In addition to the environmental benefits associated with the stoves, there are also significant social, health and economic benefits for the project beneficiaries. The MTS has been independently tested in 3 separate evaluations and was found to reduce particulate matter emissions by 70%, as compared to traditional 3-stone fires. Notably, this is one of the highest ratings globally of any non-fan assisted biomass cookstove. This is relevant because decreasing exposure to smoke is critically important to prevent premature death in women. Also, many women in rural areas of the developing world spend a significant amount of time collecting fuel wood. The introduction of the MTS can relieve women from such a challenging labour requirement and allows women to devote more time to household management and income generation. Finally, the MTS also reduces annual household cooking costs which can free up household income for new livelihood opportunities.

### 1.1. Production

A production target of 4000 Mayon Turbo Stoves was determined at the outset of the project and it was determined that two sizes of the stove would be produced: the MTS 7000 for areas with predominant groundnut shell supplies and the MTS 7500 for areas with rice hull fuel sources. For example, Banjul has a surplus of groundnut shells and so it was logical to produce a smaller stove (MTS 7000) for the areas in and around the Banjul area that can access this fuel. The areas that have rice mills such as the North Bank Region, were supplied with MTS 7500.


**Unassembled components of MTS**

There were five metal workshop partners building MTS stoves located in: Kaolack, Njawara, Sukuta, Kaur, and Wack Ngouna [see Annex 4 for the location of workshops and Table 2 for a summary of the five workshops including production targets]. The Kaolack and Sukuta workshops were the most experienced workshops as both had previous experience fabricating the MTS through partnerships with REAP and NATC. However, in order to increase the production volume and to minimize transportation for distribution in each region, three additional metal production workshop partners were established in Sénégal and The Gambia. The strategy focused the distribution of the stoves in the region closest to each of the workshops.

Establishing five production workshops to produce and install 4000 Mayon Turbo stoves is no easy feat in West Africa. Two principal obstacles were encountered that delayed stove production and assembly from the outset. The first problem was the run-up and aftermath of the Sénégalese Election which was on February 26, 2012 with the runoff on March 25, 2012. The election made it very difficult to travel within Sénégal and engage CLCOP and the metal fabrication workshop partners. This made it necessary to scale back activities in Sénégal and to engage partners more actively after the Election. This is why the MTS production and distribution numbers in Senegal were 1000 out of the 4000 overall target. The problem was particularly acute at the Wack Ngouna steel workshop as the owner was the local regionally elected official and associated with President Wade's party. As well, the situation in Dakar was deemed unsafe for travel and no equipment or steel purchases could be sourced from the city. Kaolack was also a hotbed of political unrest with riots and street demonstrations leading to several deaths in the city. As the pre-election political situation became heated the decision was made to avoid Sénégal until after the election and focus on stove efforts in Gambia.

The second challenge encountered with MTS production was material availability and more specifically the inability to source appropriate equipment (especially sheet rollers and drill presses) and adequate supplies of sheet metal. At the outset of the project it was assumed that sheet metal rollers could be sourced within the West African region. However, local equipment metal procurement specialists were not able to procure any new or used sheet metal rollers in Sénégal or Gambia. The decision was subsequently made to import rollers from Belgium but the purchased rollers did not arrive with the stated cargo shipment date of March 15. The shipment only made the subsequent scheduled cargo boat to arrive on April 15th. Thus the only sheet metal rollers available to roll sheet metal were the rollers at the Kaolack workshop in Sénégal. In Gambia only the Sukota workshop was successful in borrowing a roller from The Gambia Technical Training Institute when the students had a two week break. Manual hammering of sheets had to be implemented to help accelerate the development of fully assembled stoves but this delayed production and increased labour efforts. Large drill presses, needed to drill the approximate 80 holes per stove (ie 160,000 holes for 2000 stoves), were also not readily available locally for purchase. This led to an intensive effort within the region to buy used drill-presses, replace motors on exiting units and to use multiple drill presses at workshops to complete activities. Furthermore, there was a shortage in sheet metal in The Gambia. The entire country's stock of large sheet metal was procured in The Gambia by the project but some production delays resulted due to a lack of adequate and timely supply for all workshops.

Another challenge faced by all of the workshops was frequent power outages, sometimes for a large portion of the day. Traditionally, many of the shops have used manual labour for cutting, with hammer and chisel. The project introduced electric shears along with replacement blades which has increased the efficiency of the workshops and boosted productivity. However, in the event of power outages, several of the workshops would opt to cut the patterns by hand in order to keep the work moving. The finished edge was not quite as smooth as that produced by an electric shear, however the accuracy was still very good

Despite these significant set-backs, the five commercial workshops did an exceptional job in producing quality stoves. There were few quality issues experienced due to the presence of 4 technical specialists that were monitoring production and quality issues. These included 3 engineers from Canada (Audrey Yank, Maxime Ouellet-Payeur and Ben Stevenson) as well as REAP Canada's Executive Director, Roger Samson. REAP staff were primarily responsible for the production of the MTS. In particular, Benjamin Stevenson led the technical development of the three Gambian workshops while Maxime Ouellet-Payeur led the technical development of the two Sénégalese workshops. Roger Samson and REAP Intern, Sitelle Cheskey, led the material and equipment procurement activities for each workshop.

The major advances the technical team made in advancing production were the introduction of improved methods and production as well modernization of equipment used by the workshops [see Figure 2 next page]. All of the workshops received electric shears for cutting sheet metal, high quality rebar cutters for cutting steel rod, and rebar rollers for rapidly producing circular rings for the pot holders. High quality hand tools were also sourced to accelerate production alongside electric hand tools and welding machines on an as needed basis. Safety gear was provided to all workers including steel toe safety boots, welding masks and goggles, protective eyewear and gloves. By the end of April, all 5 workshops will be equipped with sheet metal rollers

that will greatly hasten their production and expand their shop capabilities in the future.

Some of the principle innovations to the MTS program that were introduced into the region included : the rebar rollers for producing pot holder rings with greater ease, and the production of 500 MTS7500 stoves which were designed to increase heat output for rice hull burning households. Finally the project also modified the stove design at the Sukuta workshop to burn groundnut shell with greater performance. The primary air was cut back by 25% and this reduced particulate load and provided better control over the combustion process. Another production innovation that the project team developed was the use of jigs to ease production and improve product quality. Jigs were made for each workshop for all complicated tasks including assembly of the pot holder, installation of the legs, installation of the ash pan, and installation of the centerpiece. Overall the workshops have appreciably developed their production skill capabilities and have the necessary equipment to further enhance stove production capabilities in the future.

FIGURE 2: LIST OF EQUIPMENT PROVIDED FOR WORKSHOPS

*Machinery*
- Sheet Rollers
- Electric Shears
- Re-bar Coiler
- Toolbox
- Drill Press
- Manual Re-bar cutter
- Bench Grinders
- Portable Grinders

*Measuring equipment*
- Calipers
- Measuring tapes
- Compasses
- Levels

*Hand Tools*
- Hammers
- Files
- Chisels
- Punches
- Hacksaws
- Quick clamps
- Vice grips
- Welding clamps
- Piece buckets
- Pliers
- Tin snips
- Drill bits

*Safety equipment*
- Work boots
- Safety glasses
- Welding goggles
- Gloves
- Ear protection

FIGURE 1: PHOTOS FROM 5 MTS WORKSHOPS

**Clockwise from top left: Rolling hoppers in Kaolack, Drill press in Sukuta, Hand tools in Wack Ngouna, MTS Jig in Wack Ngouna Rebar rolling in Farafeni, Fitting cones together Njawara.**

Overall, production targets are on track and will be fully met by the end of June, 2012. Because of some delays in material procurement and some key pieces of machinery (i.e. Metal Rollers) several of the workshops fell behind at first. However, to maximize efficiency, they have focused on producing component parts and will complete full assembly of the stoves when they receive the Rollers mid-April. The fully assembled MTS stoves produced to date have mostly been done by hand rolling which is considerably more difficult and time consuming. Nevertheless, the workshops are fully productive and on track to meet their production targets. Table 3 outlines the production numbers in each workshop to date. In total, there are 644 fully assembled MTS and 1300 unassembled waiting for final assembly. All the workshops have reached a production efficiency of 100 stoves per week and will have no problem reaching the target output of 4000 MTS in the coming weeks.

| Table 2: Descriptions of MTS Workshops | | | | | |
|---|---|---|---|---|---|
| Workshop | Stove type / description of production | Production Targets | Distribution region | Stove Technicians / Roles | Photos |
| Kaolack, Sénégal | Preassembly of 500 MTS 7500 centerpiece, hopper and cut metal for the ash pan | 500 | To the Njawara workshop | Modou Gambo – Manager<br>Abdoulie Cissey – Welder<br>Sarjo – Technician<br>Mamadou – Technician<br>Bala – Apprentice<br>Ablie – Apprentice<br>Ibou - Apprentice |  |
| Njawara, Gambia | Assembling MTS 7500 from Kaolack & adding ash pan, legs and pot holder | 500 | Central & Upper Baddibou, North Bank Region, The Gambia | Mbye Seck: Manager<br>Modou Gamu – Welder<br>Adama Jabo – Welder |  |
| Sukuta, Gambia | MTS 7000 – full assembly | 1100 | Banjul / South Bank, The Gambia | Ebrahima Jammeh – Manager<br>Amadou - Welder<br>Amadou Jallow - Technician<br>Fuday – Technician<br>Matar – Technician<br>Abdou – Apprentice<br>Sajosed – Apprentice |  |
| Farafeni, Gambia | MTS 7000 – full assembly | 1000 | Lower Baddibou & Central River District, The Gambia | Ebou Marika – Manager<br>Modou Joof – Welder<br>MoLamin Marika - Technician<br>Ibrahim Dabo – Technician<br>Malik Dumbaya – Technician<br>Mbemba Jaiteh – Apprentice<br>Bubacar Marika – Apprentice<br>Cerif Kamarah - Apprentice |  |
| Wack Ngouna, Sénégal | MTS 7000 – full assembly | 1400 | Koalack Region, Senegal | Daouda Dieng – Manager<br>Ndiaye Dieng – Welder<br>Souliman Sokhna – Apprentice<br>Ndiaye Biteye – Apprentice<br>Amath Sow – Apprentice<br>Mattar Kebe – Apprentice<br>Abdoulaye Wade – Apprentice<br>Ibrahima Dieng – Apprentice<br>Mbaye Lo – Apprentice |  |

| Table 3: Production numbers of MTS to date | | | | |
|---|---|---|---|---|
| **Country** | **Workshop** | **# fully assembled MTS to date** | **# of partially assembled MTS to date** | **Projected # by June 30** |
| The Gambia | Njawara | 138 | 200 | 500 |
| | Sukuta | 168 | 300 | 1100 |
| Sénégal | Farafeni | 0 | 400 | 1000 |
| | Wack Ngouna | 200 | 300 | 1400 |
| | Kaolack* | 138 | 100 | 500 |
| **Total MTS** | | **644** | **1300** | **4000** |

*Note: Njawara workshop is finishing the unassembled MTS from Kaolack; therefore the numbers are only counted once.

## 1.2. MTS Marketing / Distribution

NATC and CLCOP took the lead on marketing / distribution of the clay and metal stoves as well as collecting the reflows from stoves sales in their respective regions. The reflows will be an added ongoing benefit to partners and the community [see 'Project Sustainability' Section]. A stove marketing meeting was held at the beginning of the project to start this process and to develop an outline of the project strategy for the introduction of improved cookstoves into target communities. Importantly, the CLEAR project is not giving the stoves to communities. They are sold to interested women at a subsidized rate. The NATC and CLCOP set the MTS costs at about $5 which is an affordable rate according to many women in both Sénégal and Gambia. Local implementing partner staff were all trained on the function, benefits and parameters of the MTS. The metal stove coordinator, alongside the REAP interns, was responsible for delivering this training at the beginning of the project. This is an important strategy for ensuring that the communities receive a harmonized message about the environmental, social and economic benefits of the MTS as well as the function and operation of the stove.

The partner organizations strategically targeted communities for the marketing of the MTS or Clay Stoves based on pre-established criteria. For example, some of the criteria for targeting MTS marketing in a community include: the presence of large quantities of peanut shells and at least one other mixing fuel in the area (i.e. rice hulls, millet husk, etc) and a significant scarcity of fuel-wood or exorbitant fuel wood prices.

**Initial Stove Sensitization**

In order to effectively market the stoves, it was necessary to conduct cooking demonstrations in the villages. This was the only way for women to see the benefits of the stoves for themselves. Our history marketing stoves in the region has shown that photographs and word-of-mouth marketing alone are not enough to sell stoves. The most effective sales strategy is to demonstrate new technology in person. Community cooking demonstrations were organized in Gambia by the stove marketing coordinator from the NATC, Mrs. Hady Fal and in Sénégal by the project manager El Hadji Nying. Before the cooking demonstration however, marketing staff first had to visit a target community, and conduct a brief sensitization meeting about the stoves and initiate planning for a furture cooking demonstration. In the photo [right] Hady Fal is speaking to a group of women about the stoves.

To date in Gambia and Sénégal, 16 cooking demonstrations on the MTS have been conducted with approximately 533 participants from over 92 villages [See Table 4]. The marketing team decided to do demonstrations in 'clusters' in order to increase the efficiency of the marketing; women from the immediately surrounding communities to the demonstration site village would be invited to come to participate in the demonstration. A small meal would be provided to demonstrate actual cooking ability of the stove and to show

**MTS demonstration, The Gambia**

appreciation for the women's time to attend the demonstration. Materials used for fuel included groundnut shell, rice husk, millet stalks and some shrub branches. Positive responses were received from many of the women who made particular note of how quickly the stove boils water and their appreciation of being able to use groundnut shells to cook with. Many women also appreciate the speed of the stove and the fact that it alleviates the energy and time-consuming task of collecting fuel-wood in the mangroves. At the demonstrations, interested women recorded their name and telephone numbers.

Both the CLCOP and NATC have established solid distribution plans. When the construction of over 50 stoves is completed at a workshop, the workshop manager will notify the NATC or the CLCOP that the stoves are ready. Subsequently, stoves will be distributed based on the areas surrounding each workshop first, in order to minimize resources used for distribution. Over-supply in any area will be redistributed into regions with higher demand than their local workshop can supply. Because the marketing team will have recorded the demand during the demonstrations including customer's contact information, as soon as stoves are ready in an area these people can be contacted. The stoves will be kept in a central storage area for each workshop, where urban customers can come to pick up their stoves when they are ready. In rural areas, stoves will be delivered based on demand to a representative compound in the village which will act as a central distribution point for all stoves purchased by members of that village.

**Table 4: MTS / Clay Stove Demonstration Trainings**

| Country | Village | MTS | Clay | Date | # attendees | # of villages represented |
|---|---|---|---|---|---|---|
| Gambia | Daru Salam | ✓ | | 20/02/2012 | 35 | 1 |
| | Doobo | ✓ | ✓ | 24/03/2012 | 20 | 1 |
| | Noo Kunda | ✓ | ✓ | 02/04/2012 & 17/04/2012 | 40 | 7 |
| | Tallen Fula | ✓ | ✓ | 26/03/2012 | 20 | 2 |
| | Samba Musu | ✓ | ✓ | 26/03/2012 | 15 | 1 |
| | Njawara | ✓ | ✓ | 19/02/2012 & 12/04/2012 | 35 | 3 |
| | Ndungu Kebbeh | ✓ | ✓ | 28/03/2012 & 16/04/2012 | 30 | 11 |
| | Illiassa | ✓ | ✓ | 03/04/2012 & 23/04/2012 | 50 | 8 |
| | Kerr Jibell Satou | ✓ | ✓ | 26/03/2012 | 30 | 2 |
| | | | | **TOTAL Gambia** | **275** | **35** |
| Sénégal | Wack Ngouna | ✓ | ✓ | 31/03/2012 | 41 | 14 |
| | Keur Mady Yacine | ✓ | ✓ | 01/04/2012 | 35 | 14 |
| | Keur Yoro Khodia | ✓ | ✓ | 02/04/2012 | 38 | 14 |
| | Guine | ✓ | ✓ | 02/04/2012 | 50 | 1 |
| | Koutango | ✓ | ✓ | 03/04/2012 | 33 | 12 |
| | Ngueyene Djim | ✓ | ✓ | 03/04/2012 | 22 | 1 |
| | Nguer Babou | ✓ | ✓ | 03/04/2012 | 39 | 1 |
| | | | | **TOTAL Sénégal** | **258** | **57** |
| | | | | **GRAND Total** | **533** | **92** |

## 2. West African “‘No-Fly’” Clay Stove:

Through the CLEAR project, REAP was able to further develop an innovative clay brick based cooking system. The name “‘No-Fly’” is a local expression, understood across many local dialects as ‘no problem’ and generally insinuating that the user is enjoying themselves. The overall objective in designing the “‘No-Fly’” stove was to create a low priced stove made from local materials that could reduce fuelwood consumption and indoor air pollution while also improving cooking convenience and safety. The next section chronicles the evolution of the stove design. Several REAP-Canada renewable energy interns were involved in sourcing or developing early prototypes of clay stoves which helped contribute to the current 70 brick stove design. The design team was led by Roger Samson (REAP’s executive director) and was supported by REAP renewable energy interns including Leanne Robinson (2010-2011), Bhanu Duggirala (2010-2011), Thomas Blaine (2011), Audrey Yank (2011-2012), Maxime Ouellet-Payeur (2012) and Ben Stevenson (2012). Audrey Yank was largely responsible for fine tuning the final design and was instrumental in scaling up production.

During the CLEAR project, REAP worked with local masons and communities to produce the clay bricks and stoves at the village-level, building on existing local production initiatives of fired and sun-dried pressed clay bricks. The project also aimed to minimize the cost of the stove both to increase demand in the short term, but also to encourage long-term acceptability of the stove locally. Although originally estimated at a cost of $10 per stove it was possible to reduce the cost to $8 / stove and consequently install 500 more stoves than originally estimated. Cost savings included improved efficiencies of the brick masons, building kilns in communities to enable them to produce the inner bricks locally, and reducing the ratio of lime to clay. All in, the CLEAR project targeted 40 villages in Gambia and Sénégal to procure equipment, produce bricks and install 2500 advanced clay brick stoves.

### 2.1. Design Finalization

The first step for implementing the clay stoves was to finalize the design. REAP worked with local technical staff and communities to incrementally build upon previous experience and experimentation with improved clay wood-burning stoves. West African rural households have large family sizes, with an average of 12 people eating each meal. In Gambia, fuelwood is generally available locally from mangrove swamps, farmstead trees or gathered from the local bush. In project areas around Wack Ngouna, Sénégal, wood is much more scarce and burning of smaller shrubs and dung is much more common. Typical pots in the project areas of Sénégal and Gambia are quite large (often 32-33cm diameter) and heavy when loaded and require a relatively high heat demand to complete the cook in a reasonable amount of time.

REAP’s first attempt to introduce an improved wood stove was through the introduction of a bucket rocket stove 2005 -2010 and clay molded stoves in 2010-2011. The bucket rockets were generally well received but proved expensive to produce, were undersized for the heat demand of most households and had poor longevity. A hand molded clay fired stoves was tested in May 2010 but was deemed unsuitable as it was undersized for the average household cooking application and were prone to breakage by the daily placement of the cooking pot on the stove.

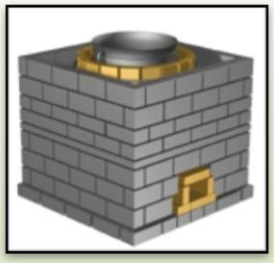
**Hand Molded Fired Stove**

**24 Brick Stove**

The most logical evolution for our improved wood stove program was to move ahead and use fired clay bricks to improve stove longevity and keep costs under control. The first effort with clay bricks was to build a 16 brick rocket stove. When construction efforts began in the village of Toro Tayam with the 16 brick rocket stove the local villagers deemed the stove combustion chamber too small to meet their cooking needs and an enlarged version was built that used approximately 24 bricks. The stove had secondary air holes put into the unit to promote better air mixing and adequate secondary air to more fully burn out-gases. Several 24 brick stoves were built with fired clay bricks and unfired mud bricks with this

design in villages in North Bank division including Toro Tayam, Njawara and Samba Musa. The stoves that were built with fired bricks and mortared with cement proved rather resilient and were in relatively good condition 12 months after installation. Locally built stoves that were copies of these stoves, made from mud, however were not useable and broke down within 3 months. One central problem was the constant outward pressure on the walls caused by heavy cooking pots which would eventually cause the outside wall to collapse. Furthermore, these stoves appeared to suffer from excess air as the square shaped combustion chamber allowed easy passage around the round cooking vessel into the corners. It was clear that while the 24-brick stove was resilient, there were improvements to be made. In particular, combustion emissions and heat transfer had to be improved. The next improved stoves that were examined were the Esperanza, the Lion and the Lion Cub stoves [photos left]. These stoves each included some or all of the following superior design features including reduced excess air, preheated and multiple entry sources for primary air. The stove that appeared the best sized for heat demand of West African households was the Esperanza stove. However it was deemed too big a cultural and technological leap from the stoves currently in use which largely were 3 stone fire or simple clay or metal framed fireboxes. The Esperanza looked to be a difficult/expensive design for rural households of West Africa. It required a large amount of detailed craftsmanship had complicated molds and was not considered user friendly as it was difficult to view the fire.

**Esperanza Stove**



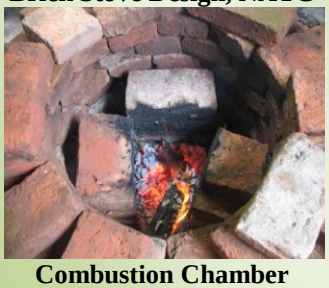
**Lion Stove**

**Lion Cub Stove**

For the purposes of the CLEAR project, the best approach was to design a simplified and inexpensive clay brick stove made from locally available materials and that incorporated some of the design features of the aforementioned stoves including: preheated combustion air, improved heat transfer to the pot, reduced excess air through the use of round walls and adding several entry points for primary and secondary air. Furthermore, in order to reduce the pressure on the outer walls of the stove and their eventual weakening, the notion of lowering the pot to sit inside the stove on fired inner bricks was invented. So in September 2011, two main features were incorporated into the improved brick stove design:

1. An improved combustion chamber that could also act as a pot support;
2. A round shroud of bricks for the outer wall that would help reduce excess air, improve heat transfer and reduce heat loss while also improving user safety from injury or accidental fire in the household.

**First Prototype of Improved Brick Stove Design, NATC**

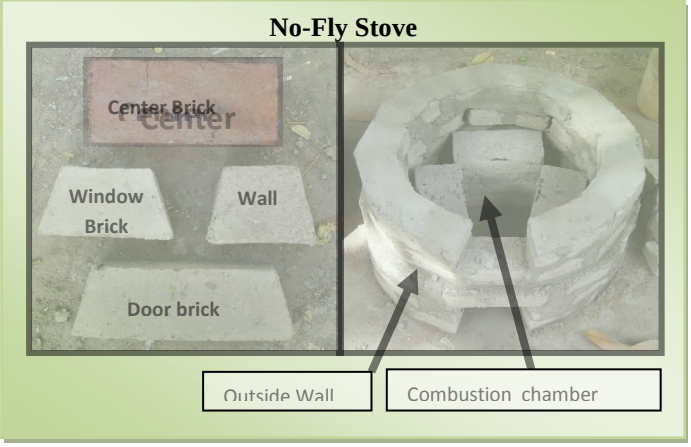


**Combustion Chamber**

The first stove of this design was built in the NATC kitchen in The Gambia in September 2011. The stove was brick intensive as it used large bricks and was built for a commercial cooking pot. However, the performance of the stove appeared excellent and the design was well understood and appreciated by local villagers who saw it in operation. Subsequently in December 2011 several smaller units of the same design were assembled. These prototypes made it evident that for the typical rice and sauce aluminum cooking pots used in local households (mainly 32-33 cm in diameter and molded from aluminum) the combustion chamber would have to be reduced by building smaller combustion chamber bricks to enable an air gap between the inner combustion chamber and the shroud. The bricks were also aligned to minimize the entry of air via the front door air to try and prevent cold air from entering into the combustion chamber while practically being large enough to allow moderately sized fuelwood entry.

Prototypes of the household-sized advanced clay brick stove were built in early February 2012 using hand sawn “green clay” or wet unfired bricks and several efforts were made to create custom made bricks of various sizes to build the combustion chamber and shroud of the stove. The current width of

brick was deemed appropriate to provide sufficient stability. Also while longer outside wall bricks would be cheaper and more convenient to make, transport and mortar, the round shape of the stove was somewhat compromised if the brick wall was made octagonal in shape. In the end the design that evolved was to reduce the number of bricks in the top two rows to provide a desired gap between the wall and the cooking pot while also allowing the bottom bricks to have an air gap from the combustion chamber to enable air preheating to the central combustion chamber. Four entry points for primary air were established and the main entry point was the front fuel loading door. It was designed to use moderately sized fuel wood to minimize cold air entry and prevent excess air problems. The remaining three primary air entry points were placed behind one of the three centre combustion chamber bricks to force air to travel around the bricks and warm prior to entry into the central combustion chamber. The central combustion chamber was built to a height of approximately 20cm to enable the flames to develop sufficiently within the refractory chamber. The secondary air holes were put around the 4th layer of bricks to promote further gas burning and to help air mixing. A fire viewing window was put into the 5th layer to help improve user convenience to manage the fire. Finally the majority of local aluminum pots have legs of approximately 4 cm in length. Hacksaws were used to reduce this to 2 cm to improve heat transfer, pot stability and to reduce the potential for fracturing the combustion chamber bricks.




In terms of materials it was necessary to use fired bricks from high quality clay resources for the centre combustion chamber bricks to improve resilience to heat. For the outside bricks of the outer wall or shroud it was faster and cheaper to mix local lime (from oyster shells) with local clay to make a resilient brick without the need for firing large quantities of bricks for the outer wall. Along the coastal area of Sénégal it was a longstanding practice to make household bricks from mixing local clay with lime made from fired oyster shells. In all the project areas local lime could be sourced and transported to villages for approximately $4USD per 50 kg bag or about $80/tonne. In other areas of West Africa without local lime resources it may be necessary to fire at least the upper two rows of bricks where higher surface temperatures are reached as the fire travels around the pot against these upper two rows. All the lower rows remain quite cool as the centre chamber bears almost all the heat.

Overall, all aspects of the ‘‘No-Fly’’ Stove look quite promising. The stove is able to boil 5 liters of water in 17-20 minutes. The stove saves appreciable amounts of fuel (this is still being quantified). The stove tends to perform very well in the simmering phase and requires little fuel to sustain the cook. Local masons appear to be able to learn the construction of the stove relatively quickly and it requires limited training in its use as it is very similar to a traditional 3 stone fire in its operations. The stove is also quite affordable and it is projected production costs could be dropped from $8/stove stove to $5/stove as improved production methodologies and materials are developed. The ‘No-Fly’ resembles an improved 3-stone fire with a round wall of bricks. Its cultural acceptance is high due to its simple design that is based on the ancient art of cooking on a 3-stone fire.

FIGURE 3: SUMMARY OF IMPROVED STOVE DESIGN FEATURES INTRODUCED INTO THE 'NO-FLY'

1. Reduced excess air: with smaller entry points for primary air and making a round shroud that is adjusted to fit to local pot size (the pot plugs the hole that creates excess drafts in most stoves)
2. Primary air restricted & diversified: 3 of the 4 entry points aren't aligned with the combustion chamber
3. Preheated air: cool outside air is drawn in and along the narrow gap between the inner combustion chamber and outside walls where it preheats
4. High temperature combustion: the central combustion chamber has preheated air and a defined combustion chamber with 20cm brick walls that radiate back heat.
5. Secondary air: the stove is equipped with 4 entry points for secondary air in the 4$^{th}$ layer of bricks
6. Improved heat transfer: the central combustion chamber directs hot flames under the pot and then allows them to pass through the narrow gap along the outside of the pot and the outer wall. The shroud also protects the pot from cooling wind.
7. Stove safety: the 'No-Fly' is amongst the world's safest stoves. It protects the home from fire with its outer wall and protects infants from falling or crawling onto the fire. There is no risk of an adult or child knocking over a boiling pot.
8. Cleanliness: the stove has reduced smoke emissions and keeps ash confined in the central combustion chamber; it is also easy to clean.
9. Convenience: the exposed central combustion chamber allows an easy start to the fire and the fire viewing window makes it easy to maintain. It operates as simply as a 3 stone fire but it is more convenient as both fire starting and boiling are fast and it is relatively effortless to simmer.
10. Minimized material consumption: Stove built largely of local natural materials and custom brick designed round shape minimizes both resource consumption and costs for production and transport.

### 2.2. Overall Strategy for Up-Scaling the 'No-Fly' Stove

Because the 'No-Fly' stove has to be produced in situ, as opposed to a central production site like the MTS, its production, marketing and distribution required a vastly different strategy than that of the MTS. Although the project staff was divided into six teams each with a specific set of responsibilities, the work of each team was interlinked and required exceptional communication and coordination for success. The six teams were:

1- Marketing Team
2- Transportation Team
3- Stove Construction Team
4- Building Team (masons)
5- Demonstration Team
6- Monitoring and Evaluation Team

Generally, it was determined that the marketing team would have the first contact with the communities. Using photos of the stove, they would sensitize the communities to the idea of the 'No-Fly' to determine the interest level in the community. If adequate interest existed, the community would identify two masons to attend the stove training in the adjacent village. In order to fully market the stoves to women in rural communities, they needed to actually see the physical stove in a demonstration. Consequently, the strategy was to build a 'No-Fly' in each village president's compound in order to have a prototype stove within the community for the women to see. Once the masons were trained on stove construction, the bricks were transported and the masons built a stove in each village leader's compound. After three days of drying, the marketing team returns to do full stove user training and demonstration to sensitize the remaining women in the community. The demonstrations played a key role in raising demand numbers. Once the demand was known in a community, subsequent transportation of bricks to that community followed. The monitoring team then continued to monitor for stove quality.

## 2.3. Production

After design finalization, the next step was to develop brick production sites in appropriate communities. As previously mentioned fired bricks are used for the center of the stove to provide stronger support for heavy pots and to better resist the heat of the fire. Unfired clay bricks are used for the rest of the stove. See Table 5 for a summary of the brick production sites.

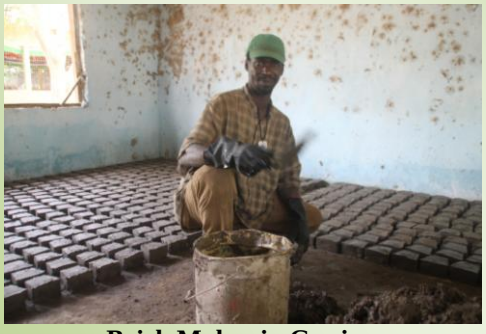
**Babou Sisseh and Brick Mason with Fired Bricks in Samé**

**Fired Bricks**: For the inner bricks, two commercial production sites were chosen; one in Farafenni and one in Samé. The two sites were chosen on the basis of existing expertise in firing bricks as well as their location. Strategically it made sense to choose two sites that were set geographically apart in order to supply different regions during the construction of the stove (See Annex 4 for site locations). Project staff worked with the workers at the firing sites to increase brick quality. To this end the workers were provided with a cement slab (bottom flat surface), trowels (to fill the molds and even the clay in the mold), a plastic tarp (to prevent the bricks from drying in the direct sun and to reduce cracking), shovels and barrels (to ease the clay mixing), water buckets, pick-axels (to ease clay digging), and wheel barrows (for brick handling). To date, 6700 fired bricks have been made at these two sites and distributed.

There were some concerns around the quality of the bricks produced in Farafenni because at first, the surfaces were not entirely flat. However, this issue has been resolved through additional training with the brick producer on the importance of removing extra clay and maintaining a flat top. Some concerns still remain around the quality of the firing in that the temperatures were too low during firing (probably because of the scarcity of wood in the area). There have been discussions with the producer that we need the blocks to undergo full firing and that they should appear red in a sign of complete heat treatment of the clay.

**Sun-dried Pressed Bricks:** There were six sites chosen for outer brick production: Gunjur, Njawara, Banni, Noo Kunda, Ndubu Kebbeh and Samba Musu [see map]. These sites were chosen according to the clay resource quality and quantity. Some of the sites such as Gunjur and Ndubu Kebbeh already had significant past experience working with clay to make pottery. Gunjur has the best quality clay of any of the sites and consequently doesn't require any additives. The clay from the other sites is mixed with lime to increase the strength (a 4:1 ratio of clay to lime). Community groups were encouraged to involve a diversity of people from their villages including women and youth. There were some challenges in the organizations of the workers but the best scenario was achieved when a team leader was assigned to deal with the workers (payment, quality control on brick production, material distribution). Each community assembled teams of brick makers and in the case of Njawara and Nduggu Kebbeh, youth and individual contractors were hired. The involvement of youth in this new income generating activity will help to prevent the rural exodus trend by providing local employment and transferring skills to youth. By paying the brick makers 1 Dalasi / brick, we were able to achieve a high production of blocks rapidly.

**Brick Maker in Njawara**



**Brick Maker in Gunjur**

Quality control and monitoring was necessary to avoid mistakes such as an unleveled top surface, improperly filled corners, and holes on the sides of the bricks. Project staff worked with the brick workers to maintain quality control and to come up with solutions to the challenges faced by the workers. Some solutions that were implemented include: reminding workers to fill the mold properly by pushing the clay down the mold with the trowel, improved mixing techniques of the clay and lime, and providing the brick makers with smaller trowels that are more suitable to fill the small molds

Safety equipment was also distributed to reduce reaction to the lime which may create irritation in the long term (rubber gloves, glasses). Furthermore, to increase the speed of production we provide workers with double molds (two molds welded together).

**Table 5: Brick Production Sites**

| Production Site | Brick Type | Target # to produce | # Produced to Date | Distribution Region | # of workers | Equipment provided |
|---|---|---|---|---|---|---|
| Farafeni | Fired | 6,000 | 2,000 | UBR | 3 | Metal molds (10x20x6cm); shovels; Pic-axes; Cement slab; gloves; safety glasses; trowels; buckets; wheelbarrow |
| Samé | Fired | 12,000 | 4,700 | NBR; CRD | 7 | |
| Kuer Yoro Khodia | Fired | 4,500 | 0 | Ndiedieng, Sénégal | 3 | |
| **TOTAL** | | **22,500** | **6,700** | | | |
| Nduggu Kebbe | unfired | 50,000 | 28,050 | NBR; CRD | 12 | Metal molds; Shovels; Buckets Wheelbarrow; Pic axels; Plastic tarps; Trowels; Gloves; Safety glasses |
| Gunjur | unfired | 10,000 | 3,100 | UBD, CRD | 20 | |
| Njawara | unfired | 40,000 | 19,500 | NBR | 8 | |
| Noo Kunda | unfired | 17,000 | 300 | UBD | 10 | |
| Samba Musu | unfired | 5,000 | 1,500 | NBR,CRD | 12 | |
| Koutango | unfired | 10,300 | 0 | Ndiedieng | 6 | |
| Wack Ngouna | unfired | 10,100 | 0 | Ndiedieng | 6 | |
| Kuer Mady Yacine | unfired | 10,100 | 0 | Ndiedieng | 6 | |
| **TOTAL** | | **152,500** | **52,450** | | | |

## 2.4. Training

### 2.4.1. Stove technician / mason training

In order to transfer the skills around building the 'No-Fly' stoves and meet the eventual demand, it was first necessary to organize trainings for the stove masons. This was conceived as a way to jump start demand as the masons would be in a position to facilitate marketing in their respective communities. To date in Gambia alone, there have been five mason trainings conducted with a total of 72 Masons trained from 34 communities [see Annex 3]. Sénégal was slightly later to start but staff have identified several communities and the masons to conduct the trainings with. Overall, these trainings have been incredibly successful and we continue to receive requests for stove trainings.

**Mason Training / Demo, Wack Ngouna**

**Constructing 'No-Fly' Stoves at a Mason Training, Njawara**

In general, the trainings followed a pre-set agenda [Figure 4: next page] to ensure that the trainings were harmonized in their approach. The trainings combined theory and practice allowing enough time for the Masons to build a practice stove. Project staff would

work alongside the Masons to point out any mistakes in the stove building. Common mistakes included putting the door frame on the fourth row instead of on the 3rd row, producing a rectangular combustion chamber instead of triangular one. However, in general the masons picked up the construction of the stoves very quickly. After the training, the masons return to their villages and build one 'No-Fly' in the Lady President's compound. This stove would be examined by project staff to ensure quality before the masons are allowed to continue building stoves in their communities.

FIGURE 4: STOVE TECHNICIAN / MASON TRAINING AGENDA

1. Presentation of the rationale of the project / clay stove to:
   i. Reduce deforestation
   ii. Improve community livelihoods
   iii. Improve women's health
2. Overview of environmental degradation in the Gambia
3. Objective of the workshop
   a. Train masons on the construction of the 'nofly' stove
   b. Transfer knowledge to masons and build on their skills
   c. Understand the combustion principle of the stove
4. Project expectations for each masons:
   i. Build a stove in their women president's compound
   ii. Contribute to increase the demand in their village
   iii. Transfer the knowledge to other masons
   iv. Guide the women on how to use the stove with care
5. Advantages of the 'No-Fly' stove
6. Recommendation for stove care and stove use for the women
7. Construction of one Stove Sample (with full explanation of the concepts behind it and technical aspects behind it)
8. Practical session (each team of 2-3 masons build one stove )

### 2.4.2. Stove user Training / Marketing

In order to market the 'No-Fly' to a community, some of the criteria considered by the partner organizations included: experiencing deforestation and a need to conserve wood in the community, proximity to clay brick producing communities, and the type of cooking pot used (metal or clay). Similar to the MTS, in order to market the 'No-Fly' it was deemed necessary to conduct a cooking demonstration. However, unlike the MTS, a demonstration clay stove cannot just be picked up and transported from village to village. Consequently, the strategy was to build a ''No-Fly'' in each village president's compound in order to have a prototype stove within the community for the women to see. Once the masons were trained on stove construction, the bricks were transported and the masons built a stove in the Lady President's compound. After three days of drying, the marketing team returns to do full stove user training and demonstration to sensitize the remaining women in the community. The demonstrations have played a key role in raising demand numbers. See Table 4 for a summary of clay stove user demonstrations.

**"No-Fly" Stove User Demo, Keur Yoro Khodia, Sénégal**

During the demonstrations, the women were sensitized on the background and rationale behind the 'No-Fly'. The training team grasped the opportunity to provide discussions are around the following points during each training:

1) Review of environmental issues (deforestation, tree felling, bush fires, etc)
2) Explanation of the stove (advantages)
3) Stove user principles
4) Cooking Demonstration
5) Stove maintenance (to increase longevity)

### 2.5. Kilns

The CLEAR project also established 5 community kilns in The Gambia and Sénégal. In The Gambia, kiln construction is underway in Njawara, Same, and Gunjur and in Sénégal, kilns will be built in Kutango and Kerr Yoro Khodia. These villages are large enough to support 1000-brick kilns, and will be able to produce quality fired bricks to support the continuation of 'No-Fly' stove production. This will also allow the price of the inner fired bricks to be reduced. Currently, all the inner bricks for the stoves are coming from the two commercial enterprises but with their own kilns these villages can fire their own bricks, and produce bricks for other purposes such as housing construction and for construction of more kilns in neighboring villages. The design will be further adapted for a smaller kilns in other villages. The materials and design are simple, so that the kilns can be easily understood and replicated by local masons in the future. This design is also versatile, and could be used for firing pottery as a future income-generating possibility.

In order to determine the ideal kiln size, shape and design, Babu Kebbeh and Benjamin Stevenson visited two of Gambia's top stove experts, each with decades of field experience. Alhagi Gaye has two kilns designed for pottery in Kanifeng. For firing bricks, he recommended a square shaped kiln, using the clamp method (bricks stacked in alternating rows from above the combustion chamber, to the top of the kiln). He suggested a firing temperature of between 600 to 900 C, and bringing the temperature up slowly, over the course of a day. Mr. Gaye suggested that a top is not necessary, and that the clamping method will retain enough heat due to the close spacing of the bricks being fired. Alex Ayisi of the Abuko Resource Center was also consulted. Mr. Ayisi operates a large pottery kiln for a variety of products. He suggested a down-draft design, which incorporates a double wall. The hot air rises in the outside chamber, then is forced downward through the clamp of bricks, and pulled back up through a chimney which collects the air from a trough at the bottom of the kiln.

Though the down-draft kiln may be very efficient, the complexity and cost of the design would be beyond the scope of this project. The simple square design was selected, with a roof and small chimney to ensure efficient use of fuelwood. Small kiln sizes were explored, for firing around 100 bricks. However, smaller kilns are known to be less efficient, and local kilns in Gambia tend to fire around 2000 bricks at a time. Our design fires up to 1000 bricks at once. This allows us to obtain a reasonable efficiency, without aiming to compete with a commercial sized kiln.

**FIGURE 5: KILN DESIGN**

The design is 2 x 2 x 2m, and uses Gambia's own commercial Bonto bricks for the walls and floor [Figure 5]. The top will have a BRC (heavy duty metal grate), supporting a layer of smaller bricks to retain heat. We will also test the kilns without a top to study the difference in efficiency. The kilns will be built on concrete slabs, with a weather shelter over the top, made from corrugated steel. Along the base there will be 3 openings for wood insertion, and 3 smaller holes on the opposing side for additional air input.

# Project Sustainability

The CLEAR project was designed to bring about lasting and continuing impacts after the project was completed. The short term impacts will reduce regional deforestation and improve the lives of women living in environmentally degraded environments through the uptake of improved cooking systems. The transfer of the 'No-Fly' design concept and techniques to the local masons and communities ensures the continued production of the stoves and a source of income generation for the future. Furthermore, communities will continue to benefit from the local NGO partners' 'Fund for Revolving Economic Empowerment' (FREE) which deal with the reflows from the project stove sales.

One of the most important long-term contributions of the CLEAR project is the transfer of knowledge and skills around building the 'No-Fly' Stoves. For the 'No-Fly', more than 40 local masons now possess the knowledge, skills and experience necessary to build as well as to repair the 'No-Fly' stove well into the future. Furthermore, seven community groups have been equipped with the tools and knowledge to produce the outer bricks for the No-Fly and five communities have kilns to make the inner bricks. A central aspect of the mason training focused on communicating the importance of community 'turn-over' to the communities. In particular, the idea that the stove design and the skills learned are intended to stay within the community and eventually become an entirely community based venture was emphasized. The project has aimed to strengthen relations and ties between communities, local masons and brick production sites so that in the future, when women are demanding the stove, local masons will be able to source the materials and supply the demand on their own accord.

Another key part of the project sustainability is the development of agri-fuels for the region. The project had a biomass fuels coordinator in Sénégal and in Gambia who focused mainly on sourcing and nursing important tree seedlings for planting in the communities including: *Acacia melifera, Acacia leita, Acacia olo*. In time and with appropriate management these resources will become a sustainable source of agri-fuels to be used in the No-Fly stove thus further reducing the strain on the local fuelwood resource by ensuring a sustainable supply of fuelwood.

**Tree Nursery at the NATC**

The Fund for Revolving Economic Empowerment (FREE) has been developed in partnership with the local partners as a component of the CLEAR project to ensure long-term sustainability of efforts to decrease fuel wood consumption in the West African region. FREE will create one larger revolving fund which will be monitored by the NATC in Gambia and CLCOP in Sénégal. This fund will be used in two ways. First of all, part of the fund will be allocated to community organizations in the brick making communities who wish to continue constructing the No-Fly. The fund will provide start-up capital for furthering stove production which will continue to support the livelihood of the fired and unfired brick producers from the CLEAR project. The most important thing about the fund however, is that it increases the access of the 'No-Fly' stoves to users.

Second, the rest of the fund will be allocated to several community mico-financing funds. With the money, community based organization members will be able to take out short-term loans to purchase equipment, seeds, livestock or supplies to be used for revenue generation. As they make money, the funds will be paid back and recycled into the fund for further benefits to the community. In this way, this part of the fund will improve access to 'soft credit' for rural beneficiaries.

FREE will be created from reflow funds collected from stove sales at 150 Dalais each for both the Mayon Turbo Stove (MTS) and the No-fly (amounts to approximately $5 per stove) for a total of approximately $27,500 CAD. The funds in the FREE will be kept in local credit unions (one in Gambia and one in Sénégal).

The FREE microcredit programme will be co-managed by the local partners (NATC in Gambia and CLCOP in Sénégal) and five communities selected to participate. The management committee will be comprised of an NATC/CLCOP representative, a representative from each village, and a financial officer. As money is collected from stove purchases it will be put into this fund. New stoves produced after the project was completed are to be sold slightly above cost (5% probably) to maintain the fund into the future. Community organizations will be able to access credit and disburse it to their individual members who must present collateral to their organizations as a guarantee in case of default.

| ANNEX 1: Overall Project Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Activities* | February 2012 | | | | March 2012 | | | |
| | wk 1 | wk 2 | wk 3 | wk 4 | wk 5 | wk 6 | wk 7 | wk 8 |
| 1.1. Management | | | | | | | | |
| Local Staff Hiring / Determining R&R | x | x | | | | | | |
| Local Staff Training | x | x | | | | | | |
| 1.2. Production | | | | | | | | |
| Procurement of Equipment | x | x | | | | | | |
| Procurement of Materials | x | x | x | | | | | |
| Production | | x | x | x | x | x | x | x |
| Monitoring of Production | | x | x | x | x | x | x | x |
| 1.3. Distribution / Marketing | | | | | | | | |
| Marketing strategy developed | x | x | | | | | | |
| Community outreach and identification | x | x | x | | | | | |
| Public engagement / marketing in local markets, etc… | | x | x | x | x | x | x | x |
| 1.4. - Training | | | | | | | | |
| Developing training program and schedule | x | x | | | | | | |
| Delivering training to project staff on MTS demonstrations | | x | x | | | | | |
| 2.1. Management | | | | | | | | |
| Local Staff Hiring / Determining R&R | x | x | | | | | | |
| Local Staff Training | x | x | | | | | | |
| 2.2. Design Finalization | | | | | | | | |
| Procurement of material and equipment | x | x | | | | | | |
| Brick experimentation | x | x | x | | | | | |
| Construction of prototypes in communities | | x | x | | | | | |
| Testing and evaluation of prototypes by communities | | | x | | | | | |
| Refinement of design | | | | x | x | | | |
| Construction of remaining stoves in communities | | | | | x | x | x | x |
| 2.3. Production | | | | | | | | |
| Procurement of Equipment | x | x | | | | | | |
| Procurement of Materials | x | x | x | | | | | |
| Training of New Production Sites | | | | x | x | | | |
| Brick Production for 2000 Stoves | | | | x | x | x | x | x |
| Monitoring of Brick Production | | | | x | x | x | x | x |
| 2.4. Training / Distribution & Marketing | | | | | | | | |
| Training of stove trainers | | | x | x | | | | |
| Distribution of bricks and other material | | | | x | x | x | x | x |
| Stove marketing | | x | x | x | x | x | x | x |
| Training of end-users for stove construction | | | | | x | x | x | x |
| Stove construction | | | | | x | x | x | x |

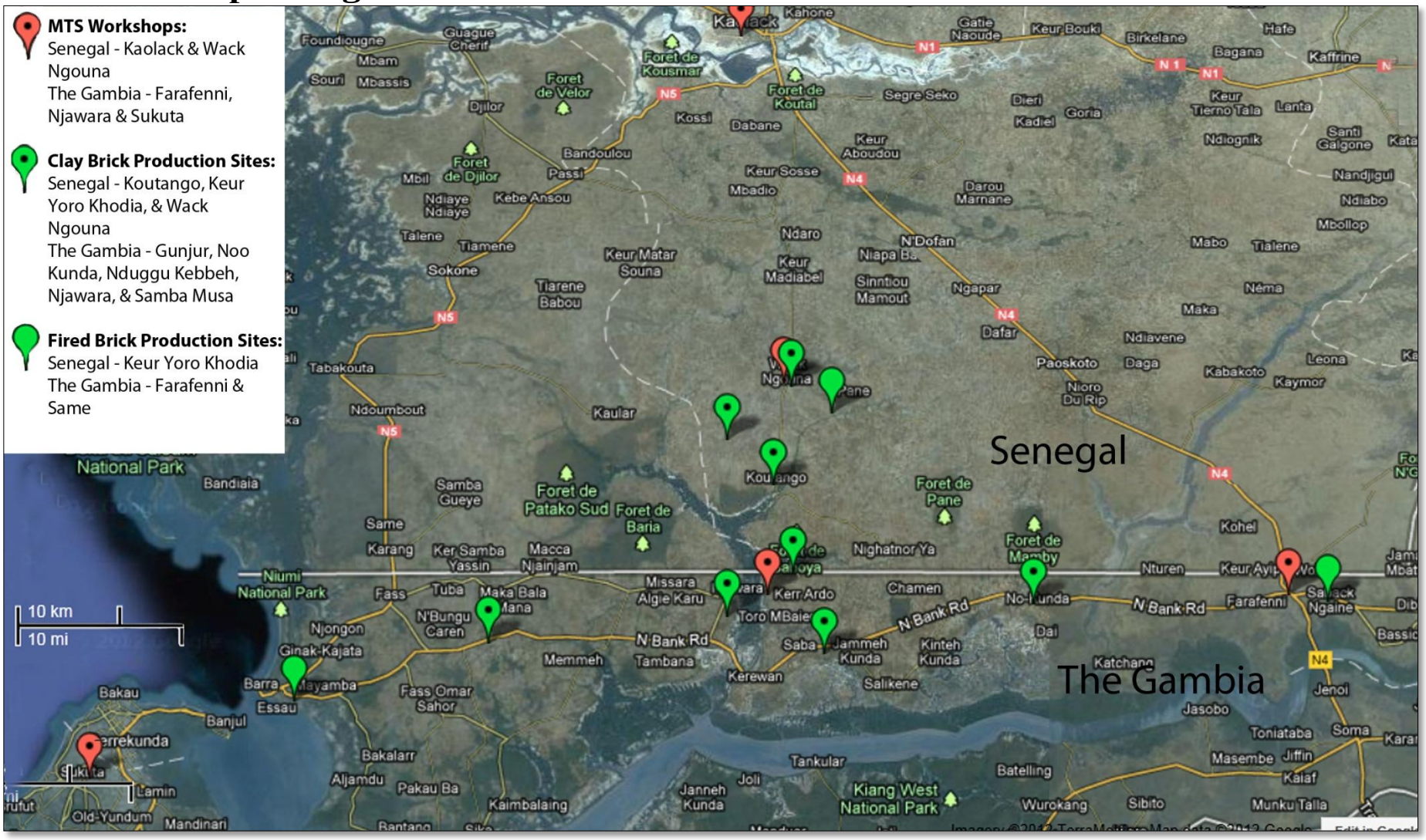
## ANNEX 2: Roles and Responsibilities for Project Activities:

| Activity | Roles and Responsibilities *(x = responsibility, xx =primary responsibility, ✓= participation)* | | | | |
|---|---|---|---|---|---|
| | **REAP** | **NATC** | **CLCOP** | **Workshops** | **Brick production sites** |
| **MTS METAL STOVES** | | | | | |
| 1.1. Management | | | | | |
| Local Staff Hiring / Determining R&R | ✓ | xx | xx | Xx | |
| Local Staff Training | X | xx | xx | Xx | |
| 1.2. Production | | | | | |
| Procurement of Equipment | xx | ✓ | ✓ | ✓ | |
| Procurement of Materials | x | | | xx | |
| Production | x | | | xx | |
| Monitoring of Production | Xx | ✓ | ✓ | ✓ | |
| 1.3. Distribution / Marketing | | | | | |
| Marketing strategy developed | ✓ | xx | xx | | |
| Community outreach and identification | ✓ | xx | xx | | |
| Public engagement / marketing in local markets, etc… | | xx | xx | | |
| 1.4. - Training | | | | | |
| Developing training program and schedule | xx | x | ✓ | | |
| Delivering training to project staff on MTS demonstrations | xx | | | | |
| **CLAY BRICK STOVES** | | | | | |
| 2.1. Management | | | | | |
| Local Staff Hiring / Determining R&R | ✓ | xx | xx | | xx |
| Local Staff Training | x | xx | xx | | xx |
| 2.2. Design Finalization | | | | | |
| Procurement of material and equipment | xx | x | | | x |
| Brick experimentation | xx | ✓ | | | |
| Construction of prototypes in communities | xx | x | x | | |
| Testing and evaluation of prototypes by communities | xx | x | x | | |
| Refinement of design | | | | | |
| Construction of remaining stoves in communities | xx | x | x | | |
| 2.3. Production | | | | | |
| Procurement of Equipment | xx | x | | | x |
| Procurement of Materials | xx | x | | | x |
| Training of New Production Sites | xx | | | | |
| Brick Production for 2000 Stoves | ✓ | ✓ | | | xx |
| Monitoring of Brick Production | xx | ✓ | | | ✓ |
| 2.4. Training / Distribution & Marketing | | | | | |
| Training of stove trainers | xx | x | x | | |
| Distribution of bricks and other material | x | xx | x | | x |
| Stove marketing | | xx | xx | | |
| Training of end-users for stove construction | xx | x | x | | |
| Stove construction | x | xx | xx | | |

| ANNEX 3: Stove Mason Trainings | | | | |
|---|---|---|---|---|
| **No.** | **Location** | **Date** | **Names of Participants** | **Village of Participants** |
| 1 | Summary: Training in Njawara - participation by 12 masons from 5 villages | | | |
| Njawara Village | | March 26, 2012 | Kebba Nyass | Wack Ngouna, Sénégal |
| | | | Babacarr Jallow | Wack Ngouna, Sénégal |
| | | | Kebba Jallow | Torro Bah |
| | | | Sulayman Gaye | Torro Bah |
| | | | Ousman Panneh | Panneh Ba |
| | | | Malick Jawara | Panneh Ba |
| | | | Joko Keita | Samba Musu |
| | | | Amadou Bah | Tallen Fula |
| | | | Amadou Fye | Njawara |
| | | | Abdoulie Bah | Doboo |
| | | | Ousman Bah | Doboo |
| | | | Baba Jatta | Kerrewan |
| | | | Babou Kebbeh | NATC, Njawara |
| | | | Bala Drammeh | NATC, Njawara |
| | | | Sitelle Cheskey | NATC, Njawara |
| | | | Audrey Yank | NATC, Njawara |
| | | | Maxime Oulette-Payeur | CLCOP, Wack Ngouna |
| | | | Meredith Kushnir | REAP, Njawara |
| 2 | Summary: Training in Ndungu Kebbeh - participation by 12 masons from 8 villages | | | |
| Ndungu Kebbeh | | March 28, 2012 | Ebou Njie | Ndungu Kebbeh |
| | | | Babou Njie | Ndungu Kebbeh |
| | | | Abdouaziz Njie | Samba Kala |
| | | | Dawda Bah | Sereh Bigi |
| | | | Sulayman Jallow | Sereh Bigi |
| | | | Aleu Ngum | Njoopen |
| | | | Ousman Nyang | Samba Kala |
| | | | Omar Gaye | Njoopen |
| | | | Allagie Jaw | Samba Njabeh |
| | | | Mamud Gaye | Ndungu Kebbeh |
| | | | Babou Kebbeh | Ndungu Kebbeh |
| | | | Balla Drammeh | NATC |
| | | | Audrey Yank | NATC |
| | | | Amadou Bala | Samba Njabeh |
| | | | Haddy Nying | NATC |
| | | | Katim Ceesay | Ndungu Kebbeh |
| 3 | Summary: Training in Kerromar Jawara 10 masons, 5 villages | | | |
| Kerromar Jawara | | March 29, 2012 | Alhagie Drammeh | Kerr Pateh Kala |
| | | | Ousainou Jeng | Kerr Pateh Kala |
| | | | Modou Sarr | Kerromar Jawara |
| | | | Masamba Ceesay | Lowen |
| | | | Ali Njie | Lowen |
| | | | Malick Jallow | Kerr Bohoum |
| | | | Abdoublie Jallow | Kerr Bohoum |

| | | | | |
|---|---|---|---|---|
| | | | Modou Manneh | Maka Balla Manneh |
| | | | Alhagie Manneh | Maka Balla Manneh |
| | | | Yunusa | Kerr Omar Jawara |
| 4 | Summary: Training in Noo Kunda with 16 masons from 7 villages | | | |
| Noo Kunda | | April 2, 2012 | Sambau jang Conteh | Conteh Kunda Sukoto |
| | | | Lang Camara | Conteh Kunda Sukoto |
| | | | Nfamara Nofana | Noo Kunda |
| | | | Lamin Sanko | Noo Kunda |
| | | | Karafa Dampha | Noo Kunda |
| | | | Kebba Jadama | Noo Kunda |
| | | | Lamin Suso | Conteh Kunda Nigi |
| | | | Musa Conteh | Conteh Kunda Nigi |
| | | | Almanmy Jammeh | Dai |
| | | | Ablie Jadama | Dai |
| | | | Omar Fofana | Buranya |
| | | | Malang Dibba | Buranya |
| | | | Alhagie Jammeh | Kekuta Kunda |
| | | | Topha Jammeh | Kekuta Kunda |
| | | | Abdoulie Bah | Chamaya |
| | | | Ebrima Bah | Chamaya |
| 5 | Summary: Training in Illiasa with 22 Masons from 9 Villages | | | |
| Illiasa | | April 3, 2012 | Mamodou Krubally | Alkali Kunda |
| | | | Salifu Camara | Alkali Kunda |
| | | | Kariga Wally | Katchang |
| | | | Alhagie Lang Janneh | Katchang |
| | | | Modou Fatty | Katchang |
| | | | Kebba Saikou Kassama | Katchang |
| | | | Babucar Bah | Chamen |
| | | | Lamin Camara | Chamen |
| | | | Babacarr jallow | Daru Barakatu |
| | | | Sailu Jallow | Daru Barakatu |
| | | | Ismaila Chanty | Jali Kunda |
| | | | Salifu Jallow | Yallal |
| | | | Musa Bah | Yallal |
| | | | Kabiro Marong | Jajary |
| | | | Sambou Dampha | Jajary |
| | | | Modou Dampha | Jajary |
| | | | Asumana Marong | India |
| | | | Jim Jallow | India |
| | | | Muhamed Jammeh | Illiassa |
| | | | Omar Jammeh | Illiassa |
| | | | Ebrima Yarbo | Illiassa |
| | | | Bakany Sali Kaddy | Illiassa |
| | | | | |

## ANNEX 4: Map of Region



## ANNEX 5: Mayon Turbo Stove (MTS) Manufacturing Manual

See Attached.

## ANNEX 6: 'No-Fly' Clay Stove Training Manual

See Attached.