CLIMATE ACTION MODEL VILLAGE PROJECT (CAM-PROJECT)

IMPROVED ROCKET LORENA STOVE CONSTRUCTION MANUAL

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ABOUT CAM PROJECT

The living situation of people in Nebbi and Pakwach districts is characterized by extreme poverty due to a high dependence on traditional subsistence agriculture that has high susceptibility to climate change. The high pressure on natural resources resulted into enormous environmental degradation (only 3.3% of the land is now forested). This situation was exacerbated by the COVID-19 pandemic as many households (58%) reported a decline in income they spent their savings (37%) and depleted their assets. Together, these factors have reduced the resilience of many households to climate, health, and economic shocks.

In order to strengthen the resilience of communities to climate, health and economic shocks, AFARD in partnership with AWO International secured EUR 913,400 from the German Federal Ministry for Economic Cooperation and Development (BMZ) to implement a 3.5-year (Oct. 2022 – March 2026) Climate Action Model Village (CAM) Project in Nebbi and Pakwach districts targeting directly 3,190 people (60% female and at least 10% individuals with special needs) composed of vulnerable smallholder farmers; primary school pupils (P5-7) and their teachers and management committees; district and sub county local government officials; traditional, religious and opinion leaders; and AFARD staffs.

The overall project goal is, “Communities in Nebbi and Pakwach Districts are resilient to climate change, health and economic shocks.” The project specific objective is, “Targeted communities in Nebbi and Pakwach districts have food and income security and serve as replicable examples for Climate Active Model Village March 2026” and this will lead to the following positive gains: 75% of target households are food secure; 65% of target households are income secure to withstand climate, health, and economic shocks; 45% of households plan their family size; Disaster preparedness interventions of CSCGs and SHECs have resulted in a 25% decline of infectious and vector-borne diseases (malaria, covid-19, cholera, diarrhea, and gastrointestinal worms; Residents of the climate action model villages use the forest planted on 15 acres for their own food (e.g., mangoes and oranges), food preparation (firewood), and health (shade, and utilization of the bark, sap, or leaves for medicines); and 08 climate action villages serve as models for replication through knowledge sharing with local governments, networks of AFARD, universities & partners of AWO International in Uganda.

PROJECT APPROACH

The CAM Project is planned to empower the population of at least ten villages in Nyaravur and Alwi sub counties to transform their villages into Climate Active Model Villages through:

1) the establishment of 15 Climate Smart Champion Groups (CSCGs) and 05 School Health and Environment Club (SHEC); and 2) capacity development of these civil society structures on sustainable agricultural intensification, income generation and management, gender equality, sexual and reproductive health and rights, preventive public health, environmental conservation, biodiversity and climate change mitigation. A cooperative will be formed to drive inclusive and sustainable value-added market participation. To attain these results, the project will use a 4-pronged approach:

1. Increasing agricultural production and productivity through intensification of production, technologies used and practices using improved agricultural inputs (seeds, livestock and ox teams) and training in climate-smart agricultural skills (using the resilience design approach) and value addition.

2. Livelihood diversification for alternative income generation through promotion of VSLA, IGA-SPM and financial literacy trainings to target households to enable them to save, identify locally viable investment opportunities, take necessary loans and start/build businesses to generate alternative income for food security and health service utilization among others.

3. Promote public health and prevent preventable diseases in schools and target communities for reduced student absenteeism and increased adult labour productivity.

4. Preserving the environment and biodiversity by changing awareness on the one hand and creating access to sustainable forest and non-timber products on the other, enabling communities to value an intact environment, take action against environmental degradation, green their villages and thus protect the climate.

The purpose of this manual is to provide a practical tool to be used in the construction of the improved Rocket Lorena Stove.

Objectives:

- Participants understand what cook stove is/are.
- Participants understand what materials are used for construction.
- Participants understand how to construct improved Rocket Lorena Stove and its usage.
- Participants understand and appreciate the benefits of using improved Rocket Lorena Stove.
- Participants understand the different types of improved cook stoves available.

COOK STOVE DEFINED

A cook stove is a stove that is heated by burning wood, charcoal, animal dung or crop residue. Cook stoves are the most common way of cooking and heating food in developing countries.

Type of cook stove

Shielded Fire Stove

This is a one saucepan/pot rest stove made using mixture of active anthill soil/clay and insulative materials such as dry chopped grass/saw dust/rice husks/dry banana leaves which are very good in retaining extra heat for cooking. This type of stove uses both firewood and charcoal/biomass briquettes and it is movable. It has one firewood chamber, air inlet with no chimney.

Improved Rocket Lorena Stove

This is a two saucepan/pot rest stove that uses one firewood chamber, air inlet and chimney. This type of stove is also made using mixture of active anthill soil/clay and insulative materials such as dry chopped grass/saw dust/rice husks/dry banana leaves which are very good in retaining extra heat for cooking.

Metal cladded Stove

This is a one saucepan/pot rest stove that is made using a mixture of clay, mica, and fine saw dust. Here, a stove liner is first molded, left to dry under the shade for about three days before firing in the kiln. Later on a preferred metallic stove jacket is made for fixing the fired liner to make a complete metal cladded stove. Cladding is a material used to provide a decorative and protective layer on a particular surface.

Institutional Rocket Stove

This is a stove where fuel is burned in a simple combustion chamber containing an insulated vertical chimney, which ensures almost complete combustion prior to the flames reaching the cooking surface.

This type of stove is mainly used in schools, hospitals, prisons and other institutions. This stove is also made using selected bricks, fire bricks, fire clay-bricks, cable cover, cement, ankle line, squared bar, flat bar, pit sand, terrazzo stones, insulators, chimney pipe, red oxide, and tiles among others.

Benefits of Improved Rocket Lorena Stoves/Shielded Fire Stoves

- **Fuel savings:** An Improved Rocket Lorena Stoves/Shielded Fire Stoves saves more firewood than a three stone fire stove, by about 50%.
- **Cooks faster;** An Improved Rocket Lorena Stoves/shielded Fire Stoves produces more heat than a traditional three fire cooking stoves and therefore cooks food faster and saves time spent on cooking compared to the traditional three fire cooking stones.
- **Less Smoke:** Improved Rocket Lorena Stove/Shielded Fire Stove produce almost no smoke if well used especially with well dried firewood.

- **Easy to use;** Improved Rocket Lorena Stoves/Shielded Fire Stoves are very easy to use. Once lit, the stove will not go out unless the user stops adding firewood. There is also no need to blow at the flames to keep the fire alight as compared to the three fire cooking stones.
- **Safe to use;** Improved Rocket Lorena Stove/Shield Fire Stove are safer to use because the fire is shielded, and the stove is well balanced. There is therefore less likelihood of burns by women and children.
- **Affordability:** Improved Rocket Lorena Stoves/Shielded Fire Stoves are constructed with locally available materials such as active Anthill soil/clay, soft pit sand, dry chopped grass/fine dry saw dust/dry banana leaves among others, for insulation and protection against unnecessary cracking.
- **Environmental benefits e.g. Reduced Global emissions:** Cooking is responsible for around 5% of all greenhouse-gas emissions worldwide, an equivalent of about 2 billion tons of carbon dioxide (CO2) emissions per year. Biomass fuel cooking, particularly the three-stone fire contributes more than three quarters of this. Improved energy cooking stoves therefore reduce greenhouse-gas emissions significantly at a net economic benefit or low cost. In addition, improved designs of energy saving stoves can significantly reduce emission of different global warming agents such as methane (CH4), Nitrous oxide (N2O), carbon monoxide (CO), non-methane hydrocarbons (NMHCs) and the especially health damaging black or elemental carbon (EC) particulate matter and thereby avoid risks for the environment.
- **Deforestation:** Globally, deforestation contributes to the build-up of harmful Green House Gases (GHG) in the atmosphere, and thus to global warming. Locally, deforestation can generate soil erosion, pollution of streams with sediments, loss of biodiversity and desertification (UNEP 2005). The wide dissemination of improved cook stoves could help to slow down deforestation.
- **Health:** Inefficient and poorly ventilated stoves burning biomass fuels such as wood, crop wastes and dung cause significant indoor air pollution, which causes deaths of an estimated 1.6 million people annually (WHO, 2002). The smoke emitted during combustion contains thousands of health damaging substances. Improved stoves can avoid or at least reduce the amount of smoke generated during combustion through more efficient combustion processes or chimneys leading the smoke outside.

Materials used in constructing the improved Rocket Lorena Stove

S/NO	MATERIALS	QUANTITY FOR IMPROVED ROCKET LORENA STOVE
1	Active Anthill soil or clay.	12 basins (4 wheel barrows).
2	Dry chopped grass/saw dust/rice husk/dry banana leaves.	6 basins (2 wheel barrows).
3	Soft pit sand from the compound.	2 basins ONLY applicable for Nebbi and Zombo excluding Pakwach District due to the sandiness of the soil in that area.
4	Water	Add as you mix continuously.

NB: *Before adding sand, test the anthill soil or clay for the quantity of sand in it by compressing and throwing on the ground. If it scatters, do not add more sand, otherwise add sand if it does not scatter.*

Tools required for construction of improved Rocket Lorena Stoves/ Shielded Fire Stove

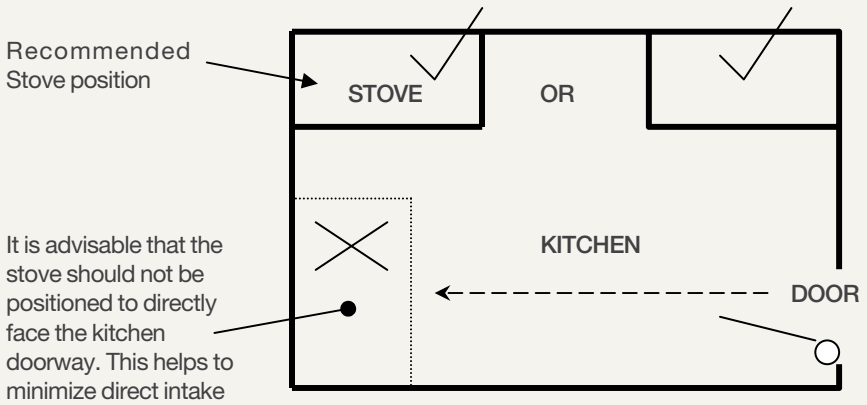
S/NO	TOOL	PURPOSE
1	Hoe	Digging base and mixing of assorted materials
2	Shovel or spade	Mixing of assorted materials
3	Jerrycan	Fetching and storing of water
4	Trowel/Knife/blunt machete	Smoothing plaster/stove finishing
5	Panga	Cutting and sizing grass, banana stems and stove body
6	Wheel barrow	Carrying assorted construction materials to the site
7	Basin	Measuring materials
8	Metallic mold or banana stem	For creating the combustion chamber, firewood inlet and air inlet
9	Sack and rope	For protecting the stove during curing processes
10	Saucepan	For molding the saucepan stands
11	Spirit level (optional)	Inspecting horizontal level of the stove base and body
12	Plumb line (optional)	Inspecting vertical alignment of the stove
13	Try square (optional)	Inspecting right angle of the stove
14	Tape measure (optional)	Taking accurate measurements

Recommended safety Gear

S/N	DEVICE	PURPOSE
1	Nose Mask	Protection against inhaling dust during construction.
2	Overalls/work clothes	Protection of clothes during construction.
3	First aid Kit	Treatment in case of injuries.

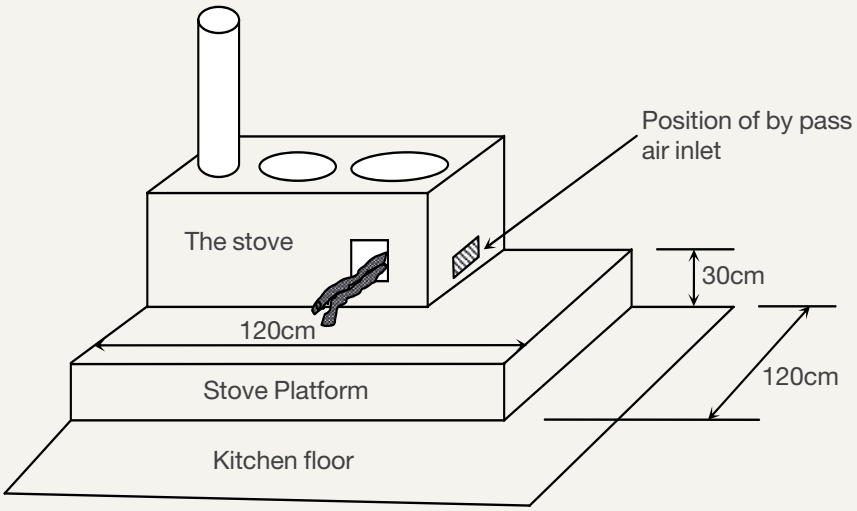
Mapping out the stove position in the kitchen

Choose a corner in the kitchento be occupied by the stove. Ths will saveitfrom accidental damage and it will also be useful in minimizing direct intske of cold air.



NOTE:

It is advisable that one week prior to stove construction, a 120 cm X 120 cm X 30 cm high platform be built in the kitchen corner that will be occupied by the stove. On this platform, the stove will be constructed. This will help to keep the stove out of reach for very young children.



Material preparation

Prepare construction materials, early enough before the time for stove construction. The preparation procedure will depend on the materials combination chosen as described below;

- Use Panga to chop the dry grass/dry banana leaves (6 basins/2wheelbarrow) into small pieces of approximate length of 1cm, this should be done carefully to avoid injuries. One can also use dry soft saw dust/dry rice husk so as to save time compared to cutting dry grass. They all equally work well. Dry hooped grass/dry banana leaves/ soft dry saw dust/rice husk makes the stove more durable and retain extra heat that can be used even if the fire wood/charcoal/briquettes have lost their heat among others.

- Crash active anthill sol or clay (12 basins/4 wheelbarrows) into smaller granules/particles, and sort it to eliminate stones, sticks and other unwanted materials. Using active anthill soil enables one to build Improved Rocket Lorena Stoves/Shieded fire Stoves that can last longer (about 10 years for active anthill soil and 15 years for clay soil) if built and maintained well. Crushing the active anthill soil/clay makes it very easy to mixt and bake.

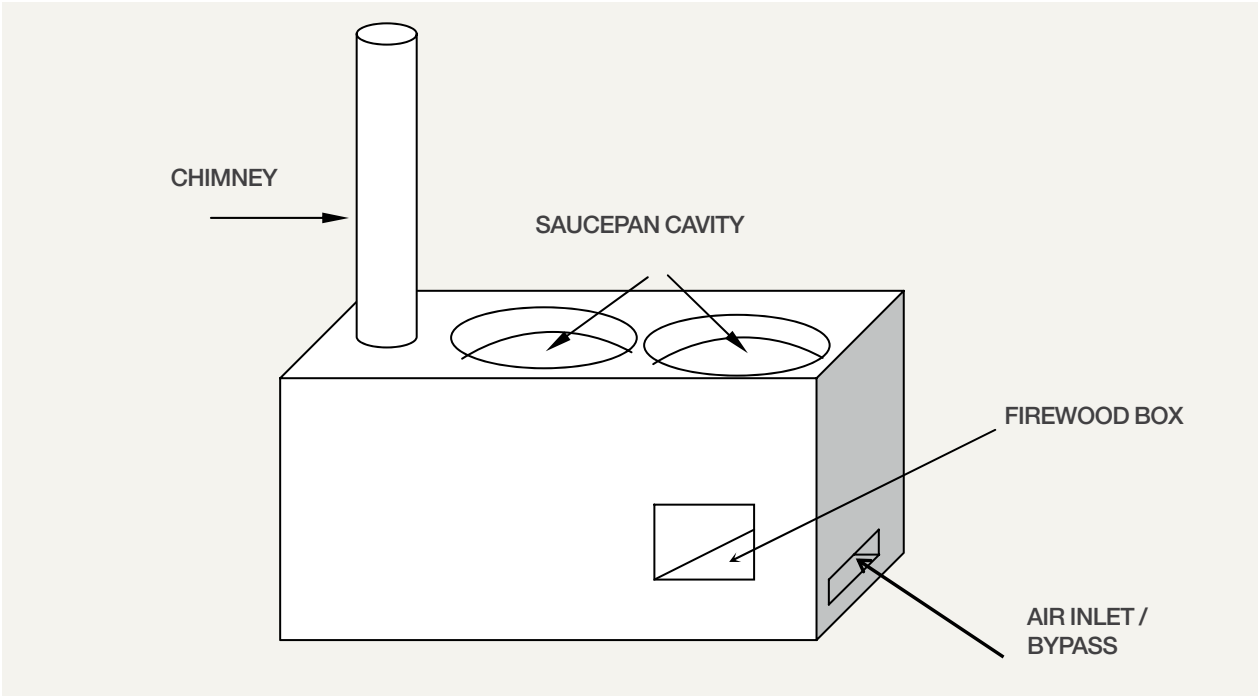
- Collect 2 basins of soft pit sand around the compound (ONLY applicable for Nebbi and Zombo excluding Pakwach District because of the sandiness of the soil in that area). The soil texture in most areas in Uganda and the rest of world do vary. The texture of the anthill soil/clay in Nebbi, Zombo and Pakwach are all different. No soft pit sand should be added when building the Improved Rocket Lore Stoves in Pakwach District because of the sandiness of the soil most of the areas. If one makes a mistake of adding soft pit sand to such materials, the compaction of stove body would not be possible. People coming from Nebbi and Zombo district can go ahead and add the recommended quantity of soft pit sand while preparing to build their stoves. Soft pit sand protects the stoves from unnecessary cracking and also helps in drying faster.

- Mix the chopped dry grass/soft dry saw dust/dry rice husk/dry banana leave/active anthill soil/clay and soft pit sand (ONLY applicable for Nebbi and Zombo excluding Pakwach District because of the sandiness of the soil in that area) in a volumetric of 12 basins of active anthill or clay soil (4 wheelbarrows) with 6basins (2 wheelbarrows) of dry chopped grass/fine saw dust/dry rice husk/dry banana leaves.

- Slowly add water to the mixture to make it moldable. One can use little amount of water during the wet season, and more during dry season. Water helps in softening the active anthill soil/clay soil for easy mixing with other assorted materials. Blend mixture using feet similar to the way the local mud bricks are prepared. Leave the mixture for at least 5 to 7 days (one week) to bake while fully covered with either grass/leaves/polythene bags to aid rain and direct sun from penetrating. This will also help the materials to bake very well and for the construction of the stoves.

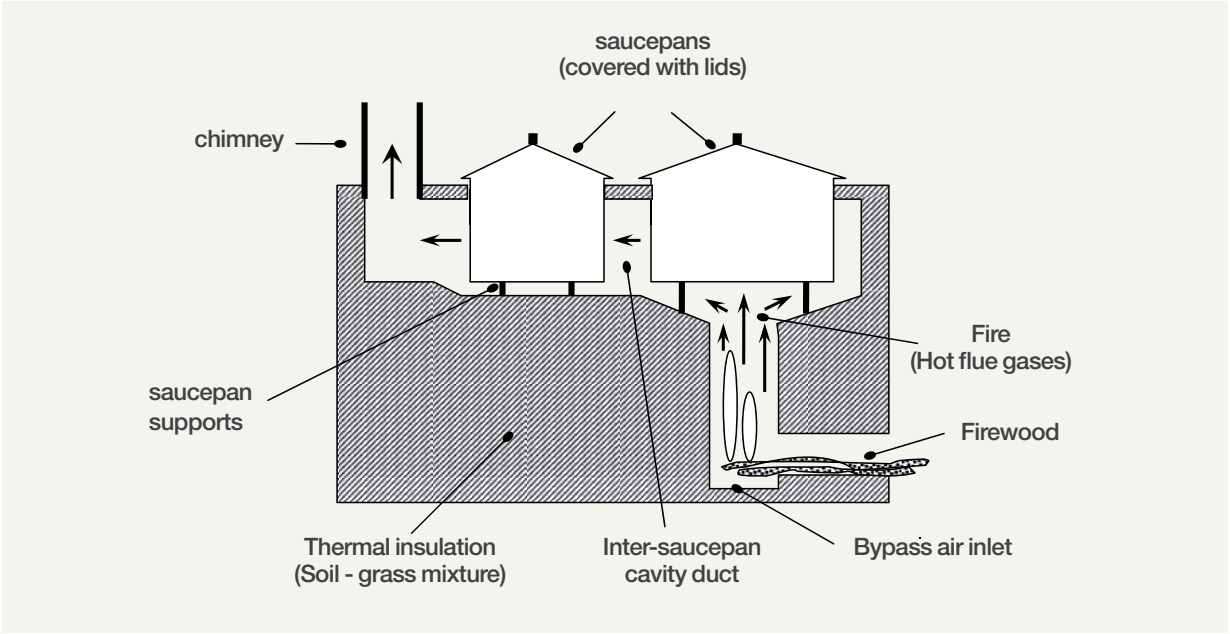
How to build the improved Rocket Lorena Stove

The size of the stove will depend on the size of the saucepan to be used in cooking with it. For a home that frequently uses a saucepan of capacity 3.5 liters and 2.5 liter and a diameter of 26cm (3.5 liters) and 23 (2.5 litters) cm respectively, the bigger saucepan should be positioned directly above the combustion chamber while the smaller one takes the other option. The size of the combustion chamber will be either 12cm*12cm (or circular option diameter of 13.5cm). The inner diameter of the chimney will also be 13.5cm as indicated in the illustration below.

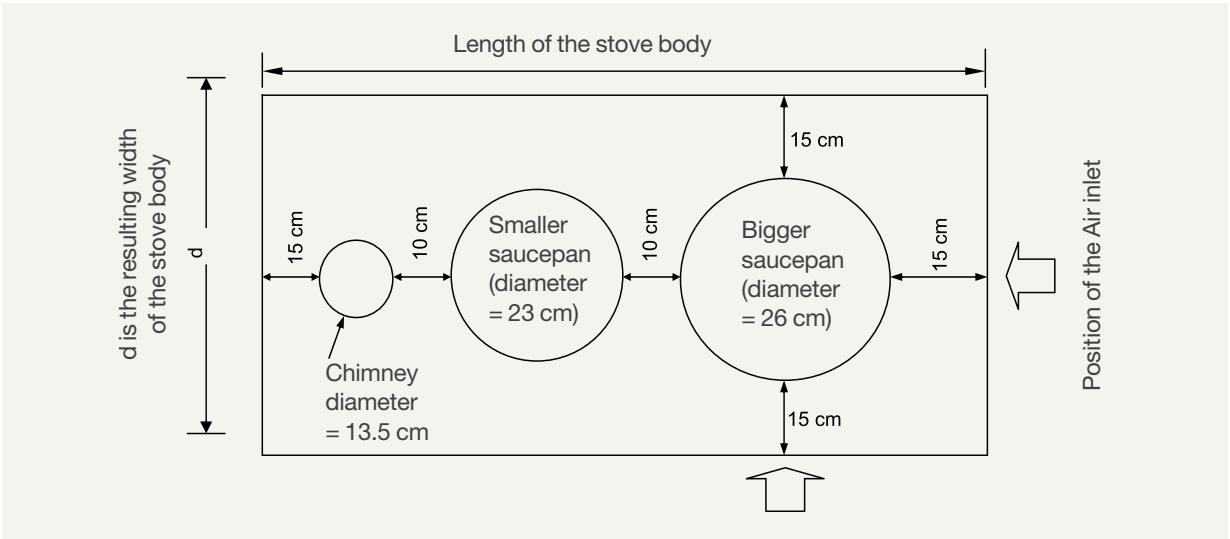


Below is a sectioned view of how the Improved Rocket Lorena Stoves works. Note that the saucepan cavity is deep enough to have the whole saucepan sub merged into the saucepan's hot gas passage. This increases the surface area of the saucepan being exposed to the fire (hot flue gas), resulting into increased heat transfer to the saucepan.

This stove uses the rocket elbow combustion chamber for improved combustion efficiency and these results into an almost smokeless environment. Furthermore, the design has an inlet for air flow, improving the fuel to air ratio. The thermal insulation required to minimize heat loss is ensured by an adequate mixing ratio of the grass to soil.



For example, the stove design for 3.5 litter of water (bigger saucepan) and 2.5 litter of water (smaller saucepan) will have the resulting outer dimensions of about 107cm * 56 cm as shown below;



Draw the outline of the Improved Rocket Lorena Stove foundation on a flat surface as illustrated in the figure above. The bigger saucepan should be positioned directly above the combustion chamber while the smaller one takes the other position. In the event that a measuring tape is not available, use your palm width. The width of your palm approximates 10cm and 15cm measurements.

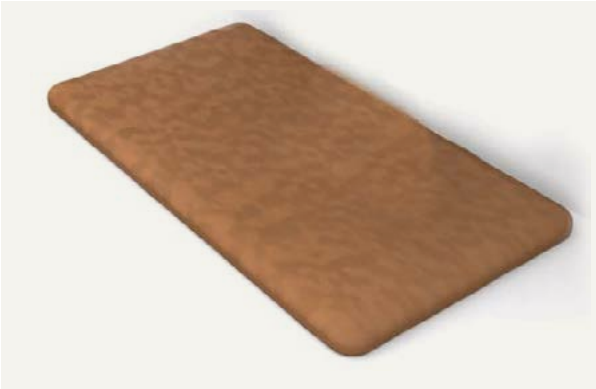
You will need some materials (Metallic Mold/Wet Banana Stem) to mold the combustion chamber shape during stove construction. In order to build the combustion chamber of 12*12cm for support, for option of a circular combustion chamber use diameter of 13.5 cm and 11*11cm for combustion chamber of 12.5cm.

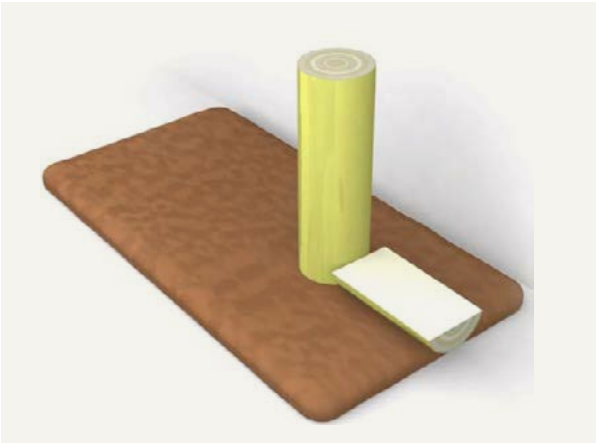
Measurement of the combustion chamber.

For example

- Using a 26cm diameter saucepan combustion chamber = 12.5cm wide, H= 30cm; which implies that;
- The length of the vertical banana stem is 30cm.
- The stove width is 30cm.
- The sgtove width is (26+30) = 56cm = d.
- Therefore ½ d= ½ *d = ½ * 56= 28 cm
- The length of the horizontal stem then becomes 28 + 10= 38cm.
- After measuring off the horizontal length (38cm) and diameter (13.5cm) of the horizontal stem, using a measuring tape, read off one third (4.5cm) of the diameter. Using a machete/Panga, split the stem to obtain two pieces. The smaller piece (4.5cm) will form mold for the air inlet while the bigger one (9cm) will form mold for firewood inlet as illustrated in Place the smaller (4.5cm thick) banana stem at the base perpendicular to the vertical one in the direction of air inlet with the flat surface facing up.

Wet the marked out position of the stove to be built. Lay down a 6cm high base for the stove, bordered by the marked out line.





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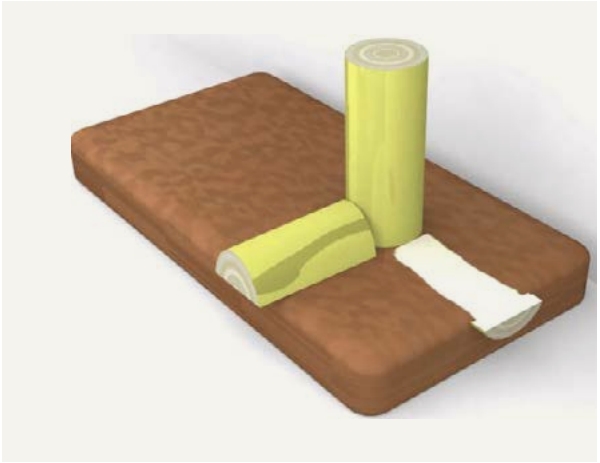
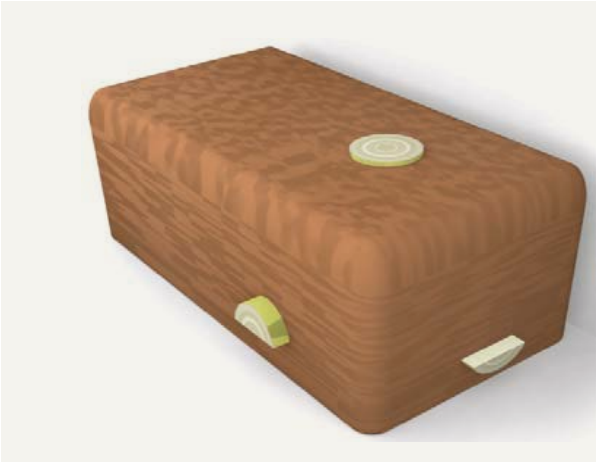
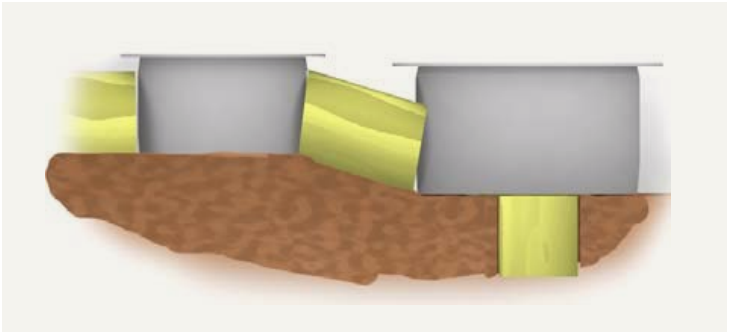


Compact mixture up to the level of the air inlet mold. Put the fire magazine mold face down and continue compacting the entire stove body up to the height of the middle mold (combustion chamber).

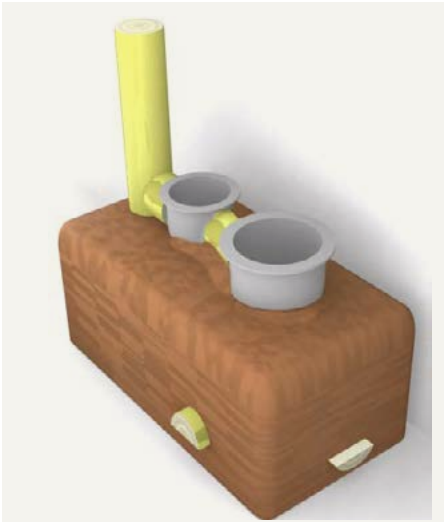


Level the compacted materials to make a flat base again.

Continue constructing the stove body up to the level at which the vertical banana/metallic mod (combustion chamber) stem just gets covered as in the figure above.
Measure out the positions of the saucepans, the chimney and the 10cm gaps between, them.Position the big saucepan such that the centre of its bottom sits at the centre of the vertical banana stem/metallic mold. Raise the adjacent space for the smaller saucepan using the insulation mixtue to get level at the top of the saucepans.Then put the smaller saucepan (about 23cm and with capacity of about 2.5 litters of water) in the other posititon (as shown) and check for top level of two saucepans. Place the horizontal banana stem segments and chimney position. One can also compact all the saucepans to their rims and use hands to create holes in between the two saucepans (10cm).

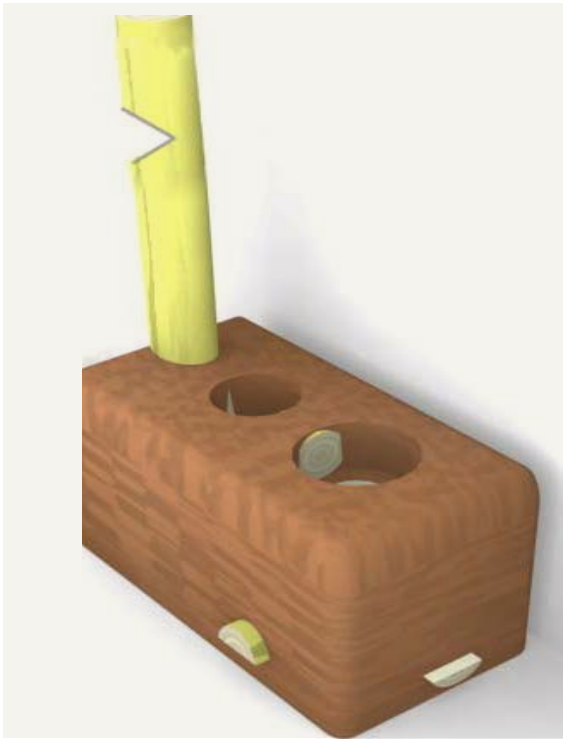


Wet the bigger saucepan with diameter about 26cm (with capacity of about 3.5 litters of water) and position it directly above and place it on top of the middle mold (combustion chamber). Place the smaller saucepan with about 23 diameter (with about 2.5 litters of water) while a space of 10cm between the two saucepans .Compact the saucepan with the available mixture up to the height of the saucepan's rims. Level the compacted material to the saucepan's rims and trim the sides and insert a chimney of about13.5cm wide and 45cm 60cm (2feet) below the roof level. In case the kitchen wall is short, adjustments maybe made but it is recommended that the distance between the chimney exit and the roof should not be less than 45cm (about 1.5feet).



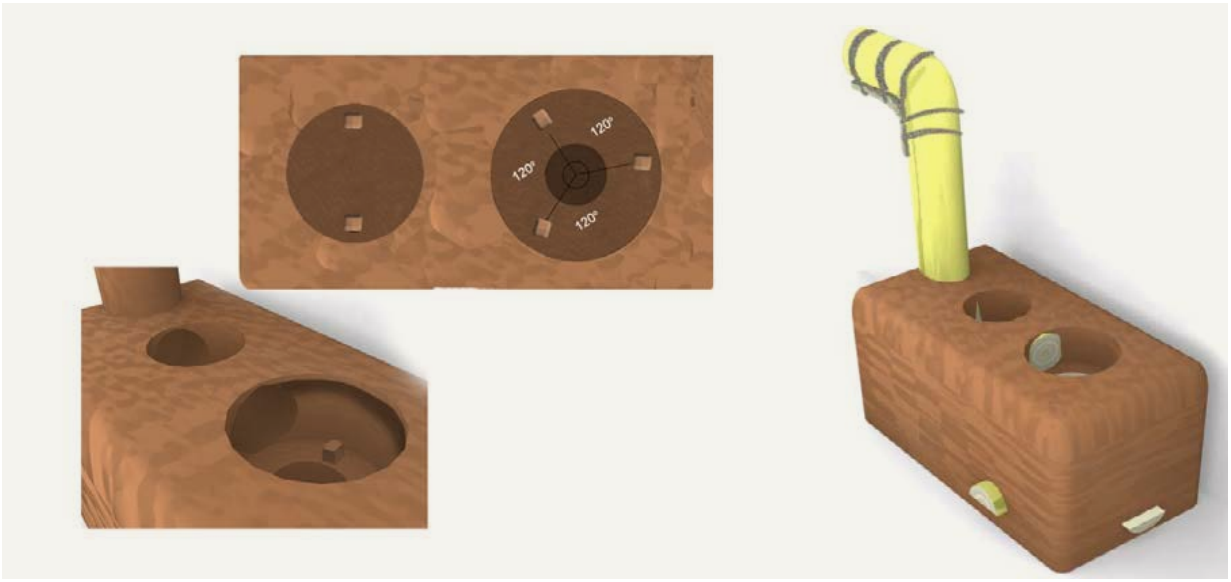
Place some pieces of the mixed active anthill soil/clay in the two saucepans to hold them in position incase bricks are not available, as shown below and fill the spaces around the saucepans with the insulation mixture.

When all of the saucepan cavity is covered by the mixed active anthill soil/clay, carefully remove the saucepans carefully by rotating back and forth while lifting them out.

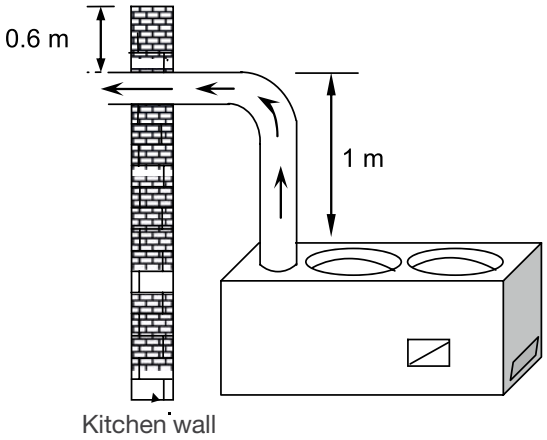


Cut out a 15cm thickness of the layer off the saucepan cavity to enlarge it and give room for the fire (flue gas) to flow around the saucepan cavity during stove use in future. Smoothen all the surfaces (firewood box, air inlet, combustion chamber and saucepan seat) with a knife or a flat metal piece or smooth stone. Use the right quantity of water where necessary. Measure out the position of the chimney (10cm from the small saucepan to the chimney and 15cm from chimney to the kitchen wall).

To enable the stove also use charcoal or briquette, cut out 2cm thick by 2cm deep at the bottom of the saucepan seat and smoothen the surface. Make a clay slate (chapatti like base) the size that can sit at the second base of the charcoal/briquette part and cut out small holes on it to allow air to flow in it when in use. On the saucepan seat, build 3 saucepan supports of equal distance from the center of the combustion chamber with a uniform angular spacing of 120 degrees. These will hold the saucepan high enough to allow the fire (hot blue gases) to flow from the bottom to the sides of the saucepan during stove use in future.

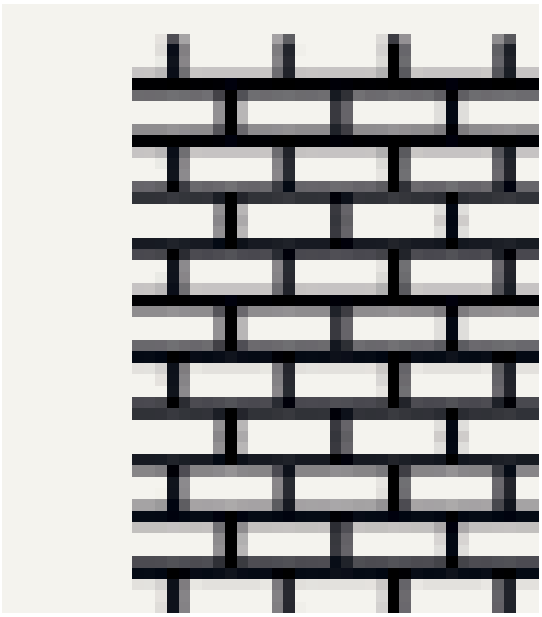


Use the banana fibers or sisal strings to fasten the bent stem to form a corner in the chimney mould. Determine the chimney exit position on the kitchen wall. It is recommended that this position is at least 60cm (2 ft.) below the roof level. In case the kitchen wall is short, adjustments may be made but it is recommended that the distance between the chimney exit and the roof should not be less than 45cm (1.5 ft).Make a hole in the wall and direct the banana stem though it as shown in the diagram.

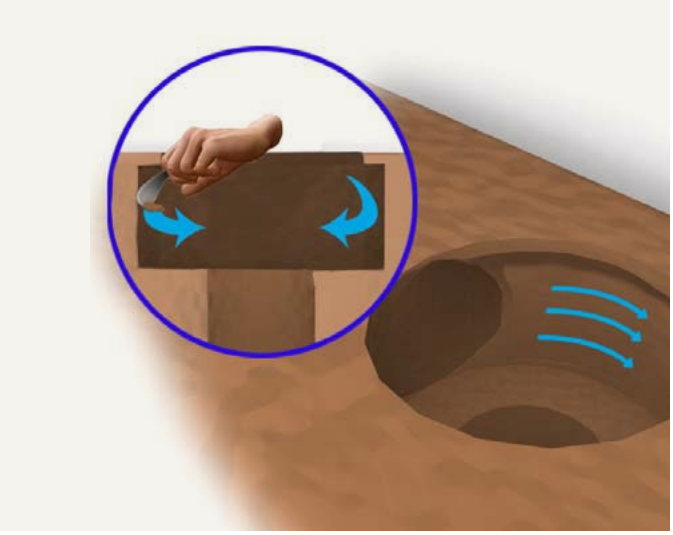


Roll some of the insulation mixture in your palms and begin to build them, coiling out on the banana stem as shown below:

Smooth out the ridges in the chimney tower to get a regular shaped chimney as shown below:



Continue shaping the saucepan cavities for abut after 6- 7 days of drying. Use a measuring tape, measure off 2.5cm of the saucepan cavity. You can also use a spoon to scoop out a saucepan thickness of 2.5 cm to create the saucepan ring as shown below.



Using the insulation mixture, build an all-round saucepan supports of 2.5cm high , inside the bigger saucepan seat and the smaller one as well. These are done to enable the stoves to also use charcoal and briquettes made from assorted agricultural wastes (such as dry banana stems/ fibers/peelings, coffee husks, rice husks, cotton stems, maize cobs among others).

Plaster the stove body to give it a good finish. You may use any of the materials such Micah, loam soil mixed with cassava porridge, cow dung and water among others. This is also done to prevent the stoves from unnecessary cracking. Use the wet fingers; wet trowel layers of a cut banana stem to smooth without cracks are also some good innovations to embrace.

Cover the stoves tight enough with polythene bag to avoid direct sunlight/heat and rain from penetrating the stove and Leave it to cure (wet dry) for at least one month (4weeks) before use.

Note:

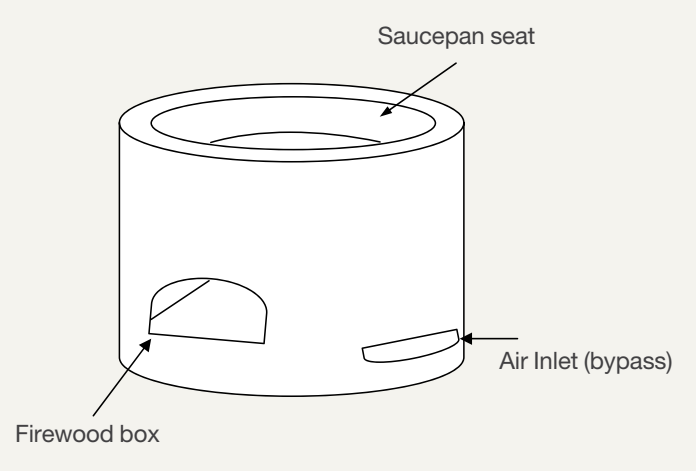
- Do not let the fire magazine face the direction where wind can blow directly into the stove so as to avoid cold wind entering and may hinder with its efficiency.
- Monitor the stove on a daily basis for any cracks and repair to ensure quality. Where there are cracks, use a knife to fill the crack with same mixture and smoothen with little water and cover it back.
- After 4 weeks of drying, smoothen the fire passage including combustion chamber and air inlet using wet hands.
- When the stove has fully dried, smear the stove with a mixture of soil for smearing houses and cassava porridge or potatoes vine to preserve it.

Efficient cooking practices

- Always use dry firewood split into small pieces. Wet firewood loses its heat value in driving off excess water. It also produces a lot of smoke.
- Always use a saucepan lid to cover food when cooking. This creates cooking pressure leading to faster cooking and saving fuel.
- Cut food into smaller pieces as it reduces the amount of energy required to cook.
- Soak the dry preserved food, beans, and peas, among others for at least 5 hours before cooking them. This cuts down the energy to cook such foods.
- Lit the fire with smoke and dangerous chemical free fire starter while preparing to cook.
- Boil water for drinking or put out the fire immediately after cooking to avoid firewood and energy wastage.
- Clean the stove often before setting fire to remove any accumulated ash that may block the air inlet.
- Keep your cooking environment clean at all times.

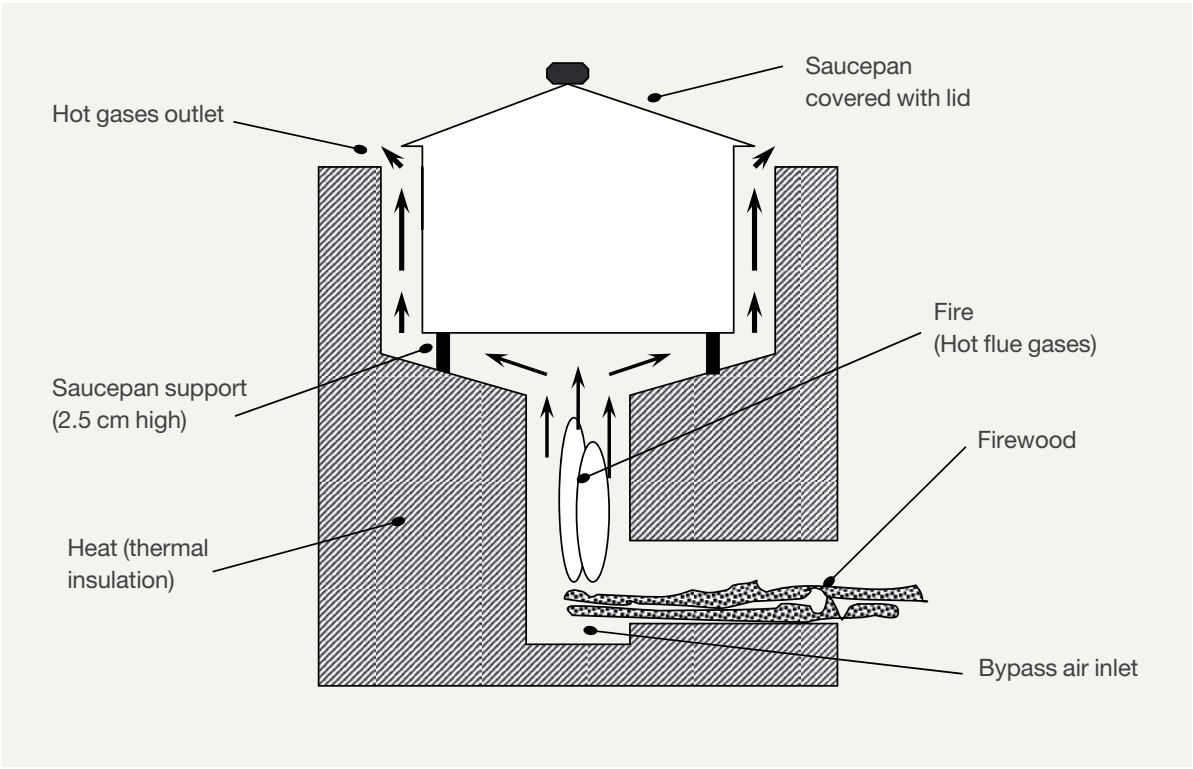
Shielded Fire Stove

This is a one saucepan/pot rest stove made using mixture of active anthill soil/ clay and insulative materials such as dry chopped grass/saw dust/rice husks/dry banana leaves which are very good in retaining extra heat for cooking. This type of stove uses both firewood and charcoal/biomass briquettes and it is movable. It has one firewood chamber, air inlet with no chimney.



How the Shielded Fire Stove works

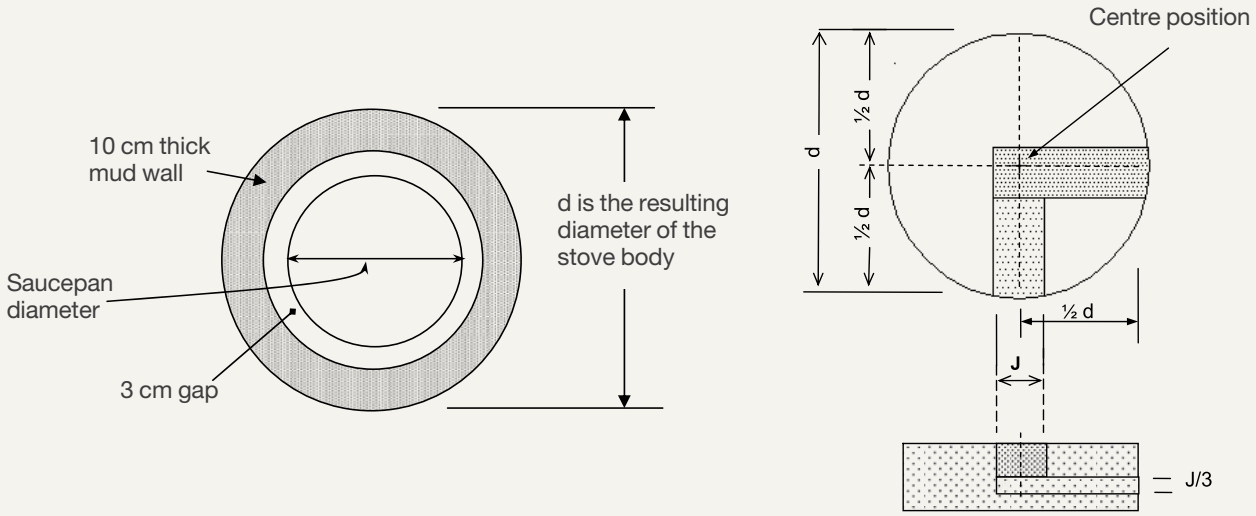
The saucepan seat should be deep enough to have 90% of the saucepan inserted into the stove's body. This increases heat transfer into the saucepan.



Building the shielded Fire Stove

The size of the stove depends on the volume (size) of the saucepan to be used. Stove sizes are therefore measured according to the saucepan's capacity.

Example: A home that uses a saucepan of about 26cm diameter(about 3.5 liters of water), the diameter of the saucepan is 26cm, the combustion chamber is 12cm by 12 cm (circular option diameter of 26cm). The stove designed for 26cn diameter will have a resulting circumference of 50 cm.



Setting the Combustion Chamber at the base

If the sauce pan diameter is D, the resulting stove base diameter is d = D + 24cm and combustion chamber width =J. For example, when using a saucepan of 26cm, the resulting stove diameter is d= 26+ 24= 50cm.

The combustion chamber width J= 12 for a squared chamber and 13.5 for a round shaped chamber. Refer to annex on the last page.

Construction of the Combustion Chamber.

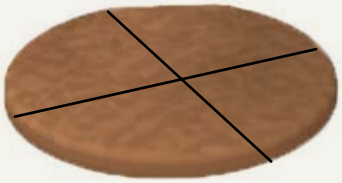
- Cut the wet banana stem, remove its outer layers to reduce its diameter to about 13.5 cm.
- Cut the wet banana stem into three segments, one of which is to be vertically positioned (combustion chamber, other two horizontally (fire magazine and air inlet).
- For example; using a saucepan of cooking capacity of about 3.5 liters of water (26cm in diameter) with a diameter 26cm, the combustion chamber will be 12cm wide and 30 cm high. This implies that J= 12cm and H= 30cm.
- Stove diameter, d- 50cm.
- Therefore ½ d= ½ x 50 cm= 25cm.
- The length of the horizontal stem then becomes 25cm + 10cm =35 cm.
- Using a measuring tape, read of one third (4.5cm) of the diameter of the horizontal stem.
- Using a Panga, split the stem to obtain two pieces; the smaller piece (4.5cm) will form the mold for the bypass air inlet while the bigger one (9cm) will form the mold for the firewood inlet. One can also use metallic mold if he/she can afford.

Building the Shielded Fire Stove

- Identify a flat surface preferably at the corners of your kitchen to ensure efficiency of stove being built. If it is not flat, you can first get level with sprit level or other tool that can be affordable before beginning building the stove.

- Spread your polythene bag/kavera on the flat safe and start compacting the flat base of about 6cm high as shown;

- Draw two perpendicular lines across the diameter of the stove foundation and mark their points of intersection. This will be the center if the stove as shown below;



- Place the vertical banana stem/metallic mold (combustion chamber) at the center of the stove foundation.

- At the stove foundation, the smaller piece of 4.5 cm thick banana stem to form mold (metallic mold) for the bypass air inlet at a right angle (900) to the vertical stem as shown below;

- Compact the mixture of active ant hill soil/clay around the banana stems (metallic molds) up to the level of the flat face of the inverted stem (metallic mold) as shown below;

- Position the bigger banana stem (metallic mold) (9cm thick) perpendicular to the bypass air inlet mold. Ensure that the surface faces downwards to form the mold for the firewood inlet as shown;

Constructing the stove body

Continue constructing the stove using the soil- grass mixture up to the height of the vertical banana stem. Level the top of the stove structure as below:

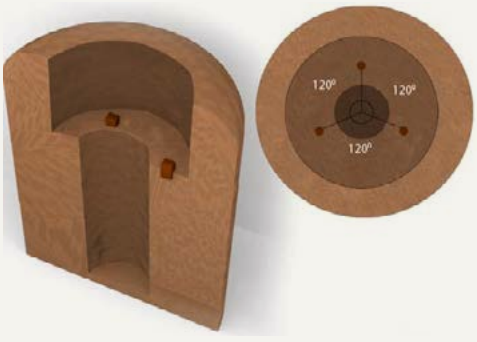
Constructing the saucepan cavity

- Wet the outside surface of the saucepan using a mixture of wood ash and water to ease its removal at a later stage.
- Position the saucepan such that the center of its bottom sits at the center of the vertical banana stem/met6allic mold (combustion chamber), and then place a piece of the mixture of active anthill soil/clay brick or stone to hold the saucepan in its position.
- Fill the space around the saucepan with the insulation mixture as shown in the figure 27 up to the height of the saucepan rim.

Remove the saucepan carefully by rotating back and forth while puloing it out.

- Cut out the mixture of the layer off the saucepan cavity to enlarge it and give room for the fire (blue gases) to flow around the saucepan cavity during stove use in future.

- Inside the sauce pan seat, build 3 saucepan supports equidistant from the center of the combustion chamber with a uniform angular spacing of 120 0 as shown in the figure.



Finishing the construction

- Plaster the stove body to give it a good finish. Use any of the materials that are used for plastering for example cow dung/ sand/ water, sap from sweet potato vines/ silt/ water. This helps prevent the stove body surface from developing cracks and also makes it fairly tight.
- Use wet fingers, a wet trowel, banana stem cuttings to smooth the finish such that the stove completely without cracks.
- Ensure that the stoves top surface is uniformly horizontal. Use the spirit level if available.
- Leave the stove block to dry for 4 weeks, while covered with watertight material for example polythene sheet or banana leaves.
- Protect the stove from sunshine and against damage resulting from children and animals.

***NOTE:** Restrict children and animals for accessing the stove during the drying process.*

Drying/curing of the Shielded Fire Stove

- Smooth the fire (hit flue gases) passage including the combustion chamber and air inlet using wet hands and other available materials.

***NOTE:** By This time the cracks could have formed during the drying process, seal the cracks using the original form mixture that was used in stove construction.*

Using the shielded Fire Stove

This stove can be used for cooking common types of food including bananas (matooke), potatoes, cassava, beans, posho among other food items. It is advisable to use the small amount of dry split firewood and always observe the following recommendations. It also use uses charcoal and briquettes made from assorted agricultural wastes such as dry banana leave/stems/peelings, maize cobs/stems, coffee husks/rice husks, cotton stem among others.

Efficient cooking practices

- Always use well dried firewood split into smaller pieces. Wet firewood loses its heat value in driving off excess water. It also produces a lot of polluting smoke.
- Always use a saucepan lid to cover food when cooking. This creates cooking pressure leading to faster softening of food and saving fuel.
- Cut the food into smaller pieces. The technique reduces the amount of energy required to cook.
- Soak the dry-preserved foods (beans, peas, among others) for at least 5 hours, before starting to cook. This cuts down the amount of energy to cook such kind of food.
- Avoid filling too much water in the saucepan. It takes a lot of energy to boil it, hence fuel wastage.
- Light the fire after preparing food for cooking
- Put out the fire after cooking to avoid firewood wastage

Cleaning the stove

- The stove should be cleaned only when it is not in use, that is, when cold.

Saucepan seats and fire passages

- Use a soft broom or bundles soft grass to sweep out the soot and ash from the saucepan seats at least after every cooking.

Combustion Chamber

- Use a scooper or small stick to remove the wood ash from the firewood feed chamber through the air inlet (by pass). This should always be done before lighting the fire.

Air passage/ inlet

- This should be handled before lighting the fire. All ash and wood pieces should be removed using a scooper or a small stick.

Relationship between saucepan / pot diameter and combustion chamber

Pot Diameter D (cm)	Pot capacity (litres)	J (cm)	K = 1.5 X J (cm)	H=K+J (cm)	Banana stem diameter (cm)	Chamber Area (cm^2)	Chamber sizing
Up to 20	Up to 2.7	11	16.5	27.5	12.4	121	11 x 11 cm
21 - 27	2.7-7.5	12	18.0	30.0	13.5	144	12 x 12 cm
28 - 30	7.5-9.8	13	19.5	32.5	14.7	169	13 x 13 cm
31 - 35	9.8-15.7	14	21.0	35.0	15.8	196	14 x 14 cm
36 - 40	15.7-24	15	22.5	37.5	17.0	225	15 x 15 cm
41 -45	24-35	16	24.0	40.0	18.0	256	16 x 16 cm
46 - 50	35-47	18	27.0	45	20.3	324	18 x 18 cm

References.

MEMD – PREEEP, 2008. Construction manual for firewood saving household stoves. The rocket Lorena & shielded fire stoves; with the support of the GIZ.