IMPROVED COOKING STOVES FOR DEVELOPING COUNTRIES

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ABSTRACT: The STOws-cooker article deals with improved stoves in developing countries. Indeed, in nearly all developing countries Biomass represents about 80% of the energy balance used for cooking purposes. This Biomass is used in very inefficient stove and wasting a lot of energy. This fact contributes to the continuing process of deforestation in developing countries. Purpose of the article is to explain and analyze the improved stoves concept in developing countries. The research and developing process of improved stoves, the production process and the distribution process will be the main parts of the article. The objective is to explain the whole supply chain of improved stoves where the sustainability of the cycle is the key point. This sustainability is only achievable if a fair profit for all actors of the production and distribution chain is guaranteed.
Key Words: Improved cook stove, Indoor Air Pollution, Developing countries.

1 IMPORTANCE OF IMPROVED STOVES

1.1 Cooking context in developing countries

In developing countries, the big majority of the energy that is needed for cooking purposes comes from biomass (mainly wood and charcoal). In some countries it is easily up to 90%. In theses countries, the stoves that are used for cooking are usually very bad from an energetic point of view. Indeed, the traditional stoves in developing countries waste a lot of biomass, mainly because of an inefficient heat transfer. A difference has to be made between urban and rural areas. Indeed, in urban areas, the local population prefers usually to use charcoal as cooking fuel because it is easier to stock, to use and produces nearly no smoke so that cooking inside is possible. There is a tendency in several countries to use liquid gas (LPG), which gives even a cleaner combustion. In urban areas the population lives in houses where the use firewood is partially difficult because of the smoke in the houses and because it is not always possible to cook outside in the street and yards. However, wood is also used in cities for household needs but also for productive uses such as bakeries or, in some countries, beer breweries. In rural areas, it is clearly wood that represents the biggest part of biomass consumption. Fuels such as dung can also be used but this is only the case in very desert areas or inside very poor population groups (Rural poor). In rural areas, it is usually the 3-Stonefire that is used. A good manipulated 3-Stonefire is not so bad (about 20% of efficiency), but still a lot of energy is wasted. Because of growing population in developing countries and the inefficient use of biomass, the pressure on the forest resources become more and more crucial. More and more trees disappear for the landscape and are not replaced. Senegal looses for example every year some 45,000 hectares of forest areas [1]. Other fuels such as gas, petroleum or electricity are too expensive for the biggest part of household in developing countries. Moreover, because of the price increase of such fuels on the international market, it is and will become more and more difficult to cook with theses fuels even for the wealthier part of the population. All theses factors explain to some extent the ongoing process of deforestation in developing countries and the phenomenon will increase in future if nothing will be done. The massive introduction of improved cook stoves is on part of the solution. Good forest management, development of alternatives fuels, etc. are also part of the solution.

1.2 Definition of an improved cook stove

An improved cooking stove is a stove that needs far less biomass to cook the same amount of food than a traditional one and consequently produces also far less smoke than a traditional stove. There is no international definition for the exact fuel savings that are necessary that a stove can be considered as an improved stove. However, it is usually admitted that an improved stove should save about 50% of the biomass in field test (different from laboratory ones) and/or reduce considerably the phenomenon of Indoor Air Pollution due to bad combustion (production of smoke).

The smoke is a product of incomplete combustion in the stove. Improved cook stoves reduce considerably the smoke, either by having a far better combustion or by have an excess of air or with a combination of both. The phenomenon of Indoor Air Pollution causes the death of about 1.5 million people every year according to the World Health Organisation [2]. The massive health problems created from Indoor Air Pollution are also underlined by the important number of people who suffer all live long from lung cancer or other diseases. A lot of people suffer from respiratory problems all their life long because since they are babies, they inhale smoke from inefficient cook stoves in their dwelling. In Africa for instance, women always carry their babies on there back

while they are cooking. Rising health costs and unproductive workers might be a consequence of Indoor Air Pollution.
For the Improved stove projects implemented by GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) and financed by DGIS (Dutch Directorate for International Co-operation), an improved stove must permit a reduction of about 50% of biomass consumption (wood or charcoal) and/or permit a significant reduction of smoke. Dr. Marlis Kees from GTZ underline that improved stoves "studies have showed that respiratory diseases by women and children can be reduced by 50%" [3]. This fact shows that the reduction of smoke is as important as the reduction of biomass consumption. A stove with the same Biomass consumption as a traditional one but with far less smoke can be considered to be an improved stove. The reduction of Indoor Air Pollution matched with the Millennium Development Goals (MDV) [4].

2 THE IMPROVED STOVES IN AFRICA

2.1 History of the introduction of improved stove in Africa in the 1980s

At the beginning of the 1980s, facing the ongoing desertification in western Africa some African governments took some measures to fight against this problem. At the same time, there was a 7 years lasting terrible draught in the sahelian countries. In Senegal for instance, the goal was to introduce massively liquid petroleum gas (LPG) to avoid deforestation. Thanks to public subventions this plan was and is still very successful. Senegal is today the undisputed leader in LPG consumption in western Africa (about 130 thousand tonnes in 2006 compared with 30 thousand for Mali for instance). However, this program alone was and is still not enough and, in collaboration with implementation agency of the German government, the GTZ, improved stoves for the local population were developed and put in the market. Nearly the same improved stove program was put into place in Mali and in Burkina Faso. In Burkina Faso, during the revolutionary times, one of the three national priorities was the fight against abusive tree cut. A special improved stove department was created and the possession of at least one improved stove per household was compulsory. However, none of theses strategies of improved stove dissemination due to several reasons was really sustainable. After the end of the public and internationally financed stove programs, the improved stove activities slowed down.

2.2 The reasons for the decrease of the improved stove business in western Africa at the end of the 1980s

In all countries, the production and distribution process of improved stoves nearly stopped when there was no longer a project financing by the state or by international donors. This phenomenon has different reasons. First of all, it can be assumed that during the 1980s and to some extent in the 1990s, there was no real need for improved stove as fuel prices (wood and charcoal) were not high enough to encourage people to pay for an "expensive" improved stove compared to a traditional cheaper one. In rural areas this is even more obvious than in the cities: why should a poor rural household buy an improved stove when the 3-Stone fire is free (one can find 3 stones everywhere in the world where human dwell)? Labour of women and children is free of charge.
In urban areas the failure of improved stoves is probably more difficult to explain but some probably rightful assumptions can be made. First of all, the relatively high price of improved stoves can be one explanation. Compared to traditional very simple and bad quality metal stoves for charcoal, an improved stove cost easily about 3 to 5 times more. This is a huge difference for people living on a day to day basis where no savings are made. The argument that people will save money with the improved stove as they will spend less for biomass in the long term (usually the pay-back period is some month) does not convince people, probably because they are not accustomed to it and because they don't have the money to buy the improved stove.
Another explanation concerning non sustainability of improved stove activities is probably the price subvention accorded by international projects. The objectives of price subvention are not illogical. The idea is to introduce massively a product on a market with the goal of boosting production and allowing a big part of the population to see the positive effects of an improved stove. Later, the subvention will slowly disappear but people will continue to buy the product even if the price is higher as they are accustomed and convinced of the new product. However, a big problem was created by price subventions: people get used to low improved stove prices and where not willing to pay a higher price than the price they paid before. In the mind of the population, an improved stove costs X but X is a subsidised price, not the market price. Moreover, the population in developing countries knows that there will often be international donors who will subsidies the stove price. It is in fact only a matter of time for the population. The subvention however creates problems for entrepreneurs willing to invest into the improved stove business: they know that the people will stop to buy stoves once the subvention is over. So, why should they invest in a sector with no future and risk to go bankrupt? Moreover, some uncompetitive player will stay on the market as long as there is a subvention. Nonetheless, some subvention for introduction might not be the worse thing to do. Indirect subvention can acceptable (marking, etc).
But there is still a contradiction because it was observed during several occasions that the population asked for new stoves and where ready to pay higher prices but there were not enough stoves on the market. This proves that it is not only a question of the price of a stove but that we deal with complex circumstances.

2.3 The ongoing of improved stoves activities in eastern and western Africa.

After all theses failures in western Africa the improved stoves activities nearly stopped in the 1990s. In Senegal, the NGO "Enterprise Works" continued some training programs for producers but after this project, the improved stove activity nearly stopped. In Eastern and southern Africa, the situation was different because improved stove projects started in this area with success in the 1990s. Western Africa lost its pole position in improved stoves activities and today, all the technological knowledge is in south and eastern Africa. New production and distribution strategies were also developed with a big success. GTZ-Projects such as the

ProBEC (Programme for Biomass Energy Conservation, www.proben.org) which is implemented in several countries in southern Africa and the SADC countries had and still have very significant results. The challenge of today for western Africa is to "bring back" all the knowledge that was lost in the improved stoves since the beginning of the 1990s and to launch sustainable projects. This process has started with different improved stove projects implemented by the GTZ and financed by DGIS (Dutch Directorate for International Co-operation) since mid 2005. The four so-called DGIS countries in western Africa are Senegal, Burkina Faso, Mali and Benin. All four projects have had at the beginning ambivalent results but today success is coming up. However, Mali will not continue the improved stoves activities after the end of June 2007 as a national Malian state agency AMADER (Agence Malienne pour le Développement de l'Energie Domestique et de l'Electrification) subsidize the stove prices which permits not fair competition and no sustainability.

3 THE RESEARCH AND DEVELOPMENT PROCESS OF AN IMPROVED STOVE

3.1 The different phases in a development of an improved stove

The development of an improved stove starts with an investigation about the potential buyer. This means that the inventor has to know if the potential buyer lives in urban or rural areas, what type of food he usually cooks, how many times he cooks per day, if the stove has to be portable or not, size of the family, what his purchase power is, what type of pot the uses (big, small, with or without legs, etc.), etc. Usually and considering the purchase power of the buyers, the stove should not be something very expensive to produce and to sell. Nearly all improved stove that exists today are either made of mud, clay (fired or unfired), metal or a mix of fired clay and metal. Some stoves are also made of cement such as the Ethiopian Mirt-Stove or the STOws-cooker. When all theses things are know, the proper research and development of an improved stove can start.

Depending on the target consumer different possibilities exists. For urban areas, the best is to construct an only metal stove or a metallic stove with a ceramic (fired clay) insert. Depending on the city, improved stoves using charcoal, wood or both should exist. For rural areas, it is possible to have the same stove as in urban areas but for consuming wood only. As metal is expensive for rural areas, a ceramic stove should also be available. An improved mud stove can also be developed but in this case, it will be a fixed stove. The producer has to come to the house of the costumer to build the stove there.

When the prototype are finished, first of all Water Boiling Tests (WBT) have to be done. A WBT is done in laboratory conditions. There is no international definition of what exactly a WTB is but in a general sense, a WBT consists in brining to boil 5 litres of Water and to simmer it for 45 minutes. After the simmering, the same procedure can be repeated with the same stove: in this case we talk about a cold (first test) and hot (2d test) start.

A conditioned biomass is weighted before the test in order to re-weight it after the test in order to know the exact amount of biomass consumed. The temperature of the Water at the beginning of the procedure is measured and every 2 to 5 minutes the Water Temperatures is taken in order to see the exact increase of the Water Temperature on a time scale. The Stove + the pot + the combustible (biomass) are put on a scale at the beginning of the test and the scale has to show "zero" (usually press on "reset"). As biomass is burning during the test phase when the water is not boiling (below 100°C), everything that is minus zero represents brunt biomass. Afterwards, once the Water is boiling, it is more difficult to know the exact consumption of biomass as Water is boiling out of the pot. During the 45 minutes simmering phase, the Water temperature has not to be more than 3 degrees below Water boiling temperature (if it does, the test is not valid). At the end of the test, the rest of biomass is weighted on the scale in order to know the exact amount of biomass consumed for the test. The consumption of traditional stoves (for example the 3-stone fire) has also to be measured (if not known) under laboratory conditions (WBT) and the improved stoves should at least consume 33% less than the traditional stoves. There should be at least three WBT executed.

Once the improved stove passed this step, controlled kitchen tests (CKT) have to be done. The CKT consists in engaging one or more local cook-woman who will cook typically local meals on the traditional stoves and on the improved stoves. Again, there should be at least three cooking tests done under the same weather condition. The fuel consumption is measured at the beginning and at the end of the test. The improved stove should be at least 33% more effective that the traditional stoves and if possible, easy to use for the cook-woman.

If the improved stove passed all theses tests successfully, field tests have to be done. A Field test consists in selecting a household sample (usually about 50) where during about 1 to 3 weeks the everyday consumption of the traditional stove (usually the 3-stone fire in rural areas) is measured. Afterwards the same families get an improved stove and use it everyday for about one month. The new everyday consumption is measured and at the end of the field test, the improved stove should be at least 40% more effective than the traditional stove in order to be considered as an improved cooking stove. Notifications concerning the usability of the users have to be analysed carefully. The tests for smoke reduction and Indoor Air Pollution are more difficult to be put into place and need very good laboratory conditions. The World Health Organisation is under way to fix an international standard of what an improved stove is. Today, a significant visual smoke reduction in laboratory and field tests is sufficient.

3.2 One example of a new developed improved stove by the GTZ program PERACOD (Senegal)

The STOws-cooker (fig.1) was developed in Senegal by FASEN (Improved Stove Senegal), a component of the GTZ PERCOD (Program for Rural Electrification and Sustainable Management of Household Fuels). The goal of this research and adaptation work was to bring a stove model to Senegal which had a big success in Ethiopia, the Mirt stove. The Mirt stove is especially designed for the "pancake" Injera and made of concrete. Therefore not be copied one to one in Senegal. However, the construction idea of the Mirt stove is very interesting for the Senegalese context. Indeed, cement is available everywhere in the country and not very expensive. As there was no cheep accepted improved stove for the rural population in Senegal, the idea was to make an improved stove with at least one concrete part to reduce production cost.

Figure 1: The STOws-cooker during laboratory test [5]

The Water Boiling Tests were very satisfying, with a fuel economy of about 40%. The controlled kitchen tests were also satisfying even if other improved stoves such as the Senegalese Diambar, Senegalease Sakanal or the Rocket stove outperformed the STOws-cooker. The big advantage of the STOws-cooker in eyes of the inventors is the possibility to produce it locally as the main body is made of concrete. The ceramic combustion chamber can be made on an industrial basis thanks to an extruder. Even the metallic skirt around the pot would probably not have been a very big problem to resolve for mass inexpensive production. However, after not very satisfying field test, the adaptation and research phase was stopped without trying to resolve the problems such as bad production on the field of the concrete bodies, bad ceramic inserts made by an in inappropriate kiln, wrong top plate design of the body (one piece instead of two), etc. For the field tests, the advices and recommendations of Mister Pemberton Pigott, an international recognized stove expert, were not completely followed. For Mister Pemberton Pigott, there is no doubt on the effective usage possibilities of the STOws-cooker as shown by the following text written after successful WBT: [6]:

"*Design Brief:*
The development of a stove for use in low income areas of rural Senegal.
Target market: semi-nomadic farmers/herders in near desert conditions + settled dryland farmers in rural Senegal.
Performance demand: 40% saving of firewood (or more).
Cost: as low as possible, under $6.00, preferrably under US$5.00.
Fuel: Wood only
Pot size: It was expressed as a 'kilo' size meaning the pot that would N-kilos of cooked rice. The size was stated to be '4 to 7 Kg' of cooked rice. Such pots will accomodate 5 litres of water so the performance test is done using the 'normal' pots the stove is intended for but without rice in it.
Developers: Crispin Pemberton-Pigott (ProBEC) together with Rolf-pieter Owsianowsk[i] (PERACOD) and Johannes Owsianowsk[i] (FASEN)
Description: It has a concrete body with a non-insulated ceramic combustion chamber. The top, bottom and outside cylinder are separate concrete parts. There is a metal centralizing ring that holds the top of the ceramic combustion chamber in the middle of the top deck. The overall dimensions are 413 mm (base diameter) and 370 mm high. The concrete body is 360 mm O.D. The top and bottom are separate pieces which can be modified to accomodate future design developments. The ceramic cylinder measures 320mm high, 120 inside diameter and 144mm outside diameter. It weighs about 3.7 Kg after the holes are carved in it.
It has preheated primary and secondary air. The heat is conducted through the ceramic element at a rate of approximately 400-500 watts continuous in a good fire.
Combustion type: In principle, the well-known Rocket Stove-type fuel feed (side feed with no grate for the charcoal) is used. In addition it uses a contra-flowing primary air supply like the Lion Stove in which the primary air enters the combustion chamber from the 'back' of the fire and below the fuel. It also features a counter-flowing (downdrafted) preheating system.
There is an air gap between the concrete body and the combustion chamber. Preheated secondary air can enter the combustion chamber through the fuel feed hole in the ceramic cylinder, a hole which is not necessarily attached to the similarly-sized hole in the outer body. This type of pre-heated air supply may be novel.
A metal sheet supports the fuel across the gap between the two fuel feed holes. Air entering the stove body either through a rear lower hole, or a smaller front hole above the large outer fuel hole, from where can flow to the fuel entry hole.
The outer fuel entry hole is normally muffled with paper or cloth to prevent excessive amounts of air entering the combustion chamber. The development of a suitable metal closure is under way. This choking has been shown to increase the gas temperature at the pot, reduce carbon monoxide emissions and increase the effectiveness of heat transfer.
A ceramic pot skirt is under development.
Materials: Concrete and ceramics, steel for the centralizing ring, steel for the sheet (or cylinder) supporting the fuel across the air gap.
Mass: about 40 Kg.
Air supply: controlled at the back by a simple plug. This is closed once the pot is boiling. Thereafter air enters the body through a round hole above the fuel feed hole.
Air Control: by placing objects or cloth/paper over the holes you wish to close.
Computer model: This stove has been modelled in a spreadsheet, accurately to the extent that the first tests gave exterior temperatures that agreed with the model. Beyond that, similarities may be fortuitious rather than by intent! The model predicts a temperature of 65 degrees C for the exterior surface of the concrete after the stove has cooked for several hours, in a room with an ambient temperature of 33 degrees.
In practise the concrete reached a temperature of 66 degrees C except at the rear of the combustion chamber (a small round spot on the body) which reached 85 degrees. The lower portion of the front only reached 52 degrees. The average was about 65 C, agreeing well with the calculated heat transfer through the ceramic tube,

across the internal air gap and through the concrete.
Performance:
Water Boiling Test: From a cold start the stove heated 5 litres of water to a boil in 40 minutes. From a hot start this reduced to 27 minutes. It is expected a third pot would heat even faster. The stove emits very little smoke. efficiency of combustion. The CO[i] ppm reading remained about the same as this happened. At an EA of 350% the CO[i]/CO2 ratio was typically 5%. When the EA increased to 800% the ratio increased to 12%, usually during a low-fire simmer. In general it showed that for a COr of under 3%, the excess air should be held below 250%. Less air meant a cleaner burn probably due to a higher combustion temperature. During simmering it was difficult to get the EA below 1000%. More air control may be necessary to achieve low CO[i] levels when simmering. The fire was extremely small when simmering. It was found that if the main fire is extinguished, the glowing charcoal and retained heat maintained the pot temperature well, dropping only 0.1 degrees per minute for many minutes at a time.
Specific Fuel Consumption: The figures for fuel consumption had to be adjusted for the large amount of water lost during the initial firing of this stove which was only 5 days old. It is recommended the stoves be aged with water for 1 month before use.
On test day, it is mostly cast concrete and quite damp, as was the ceramic cylinder which lost 300 gm of water early on. Allowing for the loss of water boiled off during the first test, (but not for the loss of flame efficiency doing so) the specific fuel consumption was 715 gm per 5 litres cooked from a cold start, and 610 gm for the hot start. The stove stores a considerable amount of heat and this assists the simmering phase greatly. The amount of fuel consumed during simmering is very small. Because the SFC number is affected by the boiling off of water during the test, the average SFC was 660 gm / 5 litres boiled and simmered for 45 minutes.
Tests without the skirt have been disappointing showing that the extra draft, or at least some of it, is needed for proper functioning.
Fuel savings: It is expected that the typical open fire has a fuel consumption of 1500 gm per 5 litres boiled and simmered. The savings are +50% based on an average SFC of 660 gm for the hot and cold stove tests.
Cost:
Ceramic combustion chamber: CFA 600 ($1.2 without transport)
Concrete stove body CFA 400 ($0.80)
Concrete top deck CFA 80 ($0.16)
Concrete base CFA 100 ($0.20)
Centraliser ring CFA 250 ($0.50)
Expected retail price: CFA 2500 ($5.00)
Production Plan: 10,000 units per month
Manufacture: It is intended that the ceramics be produced centrally and distributed through regular marketing channels.
Concrete components: The concrete parts will be produced very close to the point of sale to minimize cost. The price in cement in Senegal is very low ($3/50Kg). The parts will be produced in locally manufactured steel or aluminum moulds.
The concrete has a coefficient of thermal conduction of about 1.05. Using limestone aggregate may cause the stove to perform differently as it has a lower coefficient of heat conduction. The modelling shows safe operating temperatures for the concrete at 1.05 and higher. The stone used so far was purchased in Dakar.
Ceramic components: A central cylinder is made on a wheel at the moment but extruding tooling is under construction. The cylinders are strong enough not to break when a fire is lit inside them.
They have a coefficient of thermal conduction of about 0.72. It is important that this coefficient by LOWER than that of the concrete in order for the concrete not to overheat and disintegrate. Work is starting on lowering the coefficient of thermal expansion of the cylinder, presently at about 7.8 x 10^-6/Deg C. Lowering it will extend the life of the components by increasing heat shock resistance. It is expected the rate can be reduced to <2.0*10^-6.
There is to be an insulative ceramic 'puck' at the bottom of the combustion chamber. In the tests so far this part was not in place. The concrete reached a temperature of 150 C in the middle of the base. The base did not crack.
Distribution: Assisted by women's organisations.
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4 THE PRODUCION PROCESS OF IMPROVED STOVES

4.1 The supply of raw materials clay and metal

The raw materials used for improved stoves are mud, clay or/and metal. Mud is used with biomass such as straw to get fixed stove for rural areas (“Ban Ak Suuf” in Senegal). Clay can be used to produce improved stove which can be fired after drying in a kiln to increase longevity. Clay can also be used to produce ceramic inserts (after drying and firing) that can afterwards be used in a metallic body. Stoves made of metal only exist too. In Senegal one type is called Sakanal. In developing countries, the purchasing power of the customers is not very high and the people that use biomass for cooking live on a day to day basis most of the time. This is why production costs should be very low but still allowing a fair profit for everyone. Concerning the clay, it is better if the clay pit is not far away from production centre in order to keep transport costs low. Depending on countries, the transport systems are different. In Malawi for instance, the clay is transported on the head of the people and that is why the clay pit should not be more than 5km away from production centre. In Senegal however, small donkey cart exists that allow having a production centre a bit further away and still have acceptable transport cost. The same problematic exists for the water that is needed for the clay. Bigger clay-transforming-centres have usually their water supply on the place but smaller production centres have to organize the supply chain. Buckets of water must be brought from outside and this costs time, money and labour. Thus water supply issue must always be placed in the centre of every production unit.

The metallic part is an important cost factor of the production process as metal is very expensive, and gets more and more expensive because China buys scrap metal worldwide. For this reasons smaller producers prefer to buy old metal sheets such as old drums for example. In every African city a reseller system exists for old metal and the improved stove producers get their supply of old metal from this market. For the cooperation projects there is no need to organize this market. However, for scaling up reasons, statistics show that there is not enough old metal on the second hand market to produce large quantities. If demand for improved stoves rises, the price for old metal sheet will rise and it will become more and more interesting for producers to buy new metal sheets.

4.2 The production of clay stoves or clay inserts

The clay is used is two ways. One possibility consists in producing an improved stove completely out of clay. Theses stows are usually the less expensive one but the longevity is not so long. The other possibility consists in producing a ceramic insert which is afterwards used in a metallic stove: the ceramic insert is in this case the heart of the stove as the ceramic has isolating properties. The clay is collected in a tone pit. As the clay "holds" the combustible/biomass, it is better if it has refractory characteristics in order to hold the heat. Laboratory tests should be done to test theses capacities. Once the ceramic inlays for the improved stoves are produced, they have to dry for some weeks without cracking. Enough space in the shadow should be available for this purpose. After the drying process, the ceramic inserts are fired. In kilns: Theses kilns, depending of the type, can use different fuels. Bigger one use gas but small kilns for small production units use biomass: sawdust, groundnut shells, wood, etc. Supply of this fuel has also to be organized.

4.3 The production metallic part

When the ceramic stove or the ceramic inserts are finished they have either to be brought to the distributor in the case of a finished stove or to the metallic producer in case of a ceramic insert.

There are two sorts of metallic producers. On one hand, there are small handcraft structures which are the main producers today. The use nearly all the time only old metal sheets (metal drums, refrigerators, etc.). Their production capacity is low and they are not used to economies of scale. However, it can be foreseen that bigger production units will see the day in near future to increase production and allowing the market to expand in western Africa. Theses production centers will use new metal sheets and workers will work in a very organized way. The quality and the design of new metal sheets used for improved stoves are better and production is much faster. The production time for one stove can be reduced from 60 minutes in a small handicraft structure to about 15 minutes for one stove [7].

5 THE DISTRIBUTION OF IMPROVED COOKING STOVES

5.1 Distribution through women organisations

In developing countries, women organisations play often an important role. Indeed, their activities are principally done for their members, the women.

The activities of the women association are always to enable a better live to women and the society in general. Bigger associations have for example their own micro credit bank.

In the case of improved stoves, the idea is to "use" the women association as a well organised distributor. They women associations have their own regular activities with their members in urban and rural areas and can promote and sell the improved cooking stoves at the same time. They can even sell them on a credit base as the users will spend less money in buying the biomass or spend less time in collecting it and use this time productive activities (for example, allowing children to go to schools instead of working in the households, etc.).

5.2 Distribution through the private traders

However, a problem with the women organisation is that they are sometimes behaving too much as a social welfare organisation and not clearly as private sector organisation where the objective is to earn money. For this reason an improved stoves project should also set up a relation between the producer and the private distributor.

5.3 The issue of logistics

Concerning the distribution, the logistics are evidently a key issue and represents a big cost factor. The improved stove has to be brought from the producers to the distributor and then to the final client. In order to avoid storage coast, the best production organisation would probably be a production system on demand. The customer can see the improved stove (fig. 2) in some special places or by vendors going around showing them. Then the women can order an improved stove that fits with their pot at home. When the order is made, the production process can start. This way of producing and distributing might not fit with habits in developing countries but is probably a very effective way to reduce production and distribution cost.

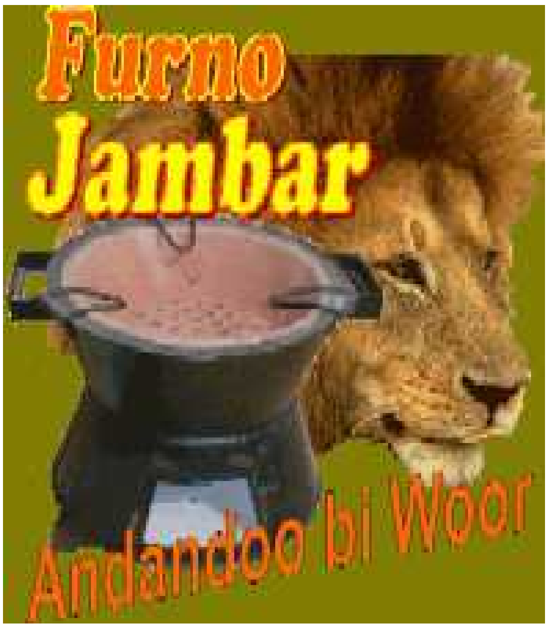

Figure 2: An improved charcoal stove called "Jambar" in Senegal [8].

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[8] Photo: NGO Enterprise Works. Web site: http://www.angelfire.com/yt2/EnterpriseWorks/ (consulted May 4th 2007)